

Exploring the Engagement of Patients with Diabetes via mHealth Applications:

A Mixed-Methods Study with Primary Care Providers

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A DISSERTATION SUBMITTED TO THE FACULTY OF GRADUATE
STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF

Doctor of Philosophy in
HEALTH POLICY & EQUITY

York University
Toronto, Ontario
Canada

ABSTRACT

Research Aims

The use of mHealth diabetes self-management applications has emerged as a potential enabler for improving patient care. However, the uptake of such applications in vulnerable and marginalized patient populations remains unclear. This knowledge gap is concerning from a health equity perspective, especially when rates of diabetes are high among these populations. This study aims to examine how the understanding of health equity by primary care providers varies by practice type, as well as the barriers faced when attempting to use these applications.

Methods

Ecological systems theory and Weber's conflict theory informed the review of the literature and interpretation of the results. I collected the data from August to October 2020. A convenience sampling approach was used for the survey and I conducted the interviews either by phone or on an online platform. Participants received the survey link through listservs and newsletters from the collaborating organizations, such as The Alliance for Healthier Communities, the Association of Family Health Teams of Ontario, and the Nurse Practitioner Association of Ontario. Forty-eight participants completed the survey, and fifteen participants completed the interview.

Results

Providers in Community Health Centres had a slightly higher understanding and application of health equity in their practice when compared to non-CHC settings. The hierarchical regression analysis did not explain the variance beyond the number of years in practice, education/training on the social aspects of health, professional status, and service to minorities/vulnerable patients. Even though the results did not support the hypothesis, the overall model explained 33% of the variance in the main outcome. Thus, this study shows that the factors collectively impacting the engagement of providers with diabetic patients included funding, training, and location of the practice. As a result, we can conclude that these factors influenced their application of a health equity lens to their daily work and recommendations for mHealth diabetes application utilization.

ACKNOWLEDGMENTS

I wish to acknowledge and sincerely thank Dr. Farah Ahmad, Dr. Peter Tsasis, and Dr. Lora Appel for their tremendous support throughout my Ph.D. journey, while also extending a heartfelt thanks to Dr. Claudia Chaufan for her emotional support, especially at the end, where it was needed the most. Your help was greatly appreciated!

I would also like to thank my research partners, including Dr. Jennifer Rayner from The Alliance for Healthier Communities, whose input and cooperation were greatly appreciated. I am also sincerely grateful to Kavita Mehta and Sandeep Gill from the Association of Family Health Teams of Ontario, Claudia Mariano from The Nurse Practitioners Association of Ontario, and Cliff Ledwos and Shaneik Hall from Access Alliance for their tremendous support.

I am eternally grateful to my supportive husband, Narine and wonderful daughter Nadia for the sacrifices they have made so that I could successfully complete this journey. Nadia, Mommy is forever grateful for the sacrifices you have made in the early years of your life. My sincere gratitude also goes out to my uncle, Dr. Ajax Persaud (University of Ottawa) for being my first role model, and my inspiration in deciding to pursue a Ph.D., your silent support was always felt. I also dedicate this degree to my late grandmother and grandfather, in acknowledgment of the sacrifices they made to ensure that I had a great start in life and a solid foundation to build upon. When you educate a girl, you educate a village! I consciously attempt to pay it forward every day, in order to ensure that this degree is not only beneficial to me, but to everyone who I cross paths with.

TABLE OF CONTENTS

Abstract	ii
Acknowledgements	iii
Table of Contents	iv
List of Tables.....	vii
List of Figures	viii
List of Acronyms	ix
 CHAPTER 1: INTRODUCTION	 1
 CHAPTER 2: LITERATURE REVIEW	 4
1. EMPIRICAL REVIEW	6
i. The Chronic Condition of Diabetes.....	6
ii. Primary Care as Canadians’ Healthcare Entry Point: Ontario Delivery Models	13
iii. Evolving Role of Registered Nurses.....	17
iv. Vulnerable Communities and Access to Care.....	22
v. eHealth Interventions as Potential Solutions – mHealth	24
2. THEORETICAL REVIEW	32
i. Weber’s Conflict Theory.....	32
ii. Ecological Systems Theory	33
3. OVERARCHING RESEARCH AIM	38
CHAPTER 3: METHODS	40
1. RESEARCH PARADIGMS	40
i. Overview	40
ii. Study’s Research Paradigm.....	41
2. MIXED METHOD APPROACH	41
3. CROSS-SECTIONAL SURVEY STUDY	43
i. Aims and Objectives	43
ii. Eligibility, Sampling and Sample size	44
iii. Measurement: Main Outcome and Explanatory Variables	46
iv. Data Collection Procedures	50
v. Data Analysis Approach.....	50
vi. Limitations	51

4. QUALITATIVE INTERVIEW STUDY	52
i. Purpose of Qualitative Interviews	53
ii. Sample and Recruitment	54
iii. Rapport and Interview Guide	55
iv. Data Collection Procedures	55
v. Thematic Analysis	57
vi. Quality and Rigor	59
vii. Limitations.....	60
 CHAPTER 4 –FINDINGS OF SURVEY STUDY	 60
i. Response Rate.....	61
ii. Sample Characteristics.....	62
iii. Understanding of Health Equity and mHealth Diabetes Self-Management Applications	64
a. Descriptive statistics	65
b. Hierarchical Regression.....	66
iv. Barriers, Facilitators and mHealth Diabetes Self-management Applications.....	70
a. Patient-Provider Barriers	74
b. Clinic Barriers.....	75
c. Systems Barriers	76
v. Virtual Care During the COVID-19 Pandemic.....	77
vi. Summary.....	78
 CHAPTER 5: FINDINGS OF QUALITATIVE INTERVIEW STUDY	 80
Theme 1: Burden of Challenges.....	82
Theme 2: Multi-Layered Challenges.....	86
Theme 3: Self-Management Diabetes Applications and Virtual Care.....	94
Theme 4: Provider Recommendations	96
 CHAPTER 6: DISCUSSION & CONCLUSIONS.....	 100
i. Patients’ Life Context & Provider’s Primary Care Work.....	100
ii. Digging Deep - Provider Primary Care Work and CHC Model	106

iii.	Provider Primary Care Work and Exo-System	108
iv.	Digital Health: Gaps and Opportunities.....	111
v.	Implications for Practice and Policy	114
vi.	Future Research Directions	119
vii.	Strengths and Limitations	121
viii.	Conclusions.....	123
REFERENCES.....		125
APPENDICES		161
	APPENDIX 1: York University Ethics Approval.....	161
	APPENDIX 2: TCPS Certificate	163
	APPENDIX 3: Research Invitation Letter.....	164
	APPENDIX 4: Survey Consent	166
	APPENDIX 5: Survey Instrument	169
	APPENDIX 6: Qualitative Interview Consent.....	178
	APPENDIX 7: Qualitative Interview Guide	181
	APPENDIX 8: Regression Assumption Check.....	183
	APPENDIX 9: Tertiary Analysis	187

List of Tables

Table 1: Research Gap

Table 2: Survey Response Rate by Practice Type

Table 3: Survey Response Rate by Provider Type

Table 4: Participant Demographics

Table 5: Participants' Patient Types

Table 6: Health Equity Understanding

Table 7: Hierarchical Regression for Health Equity Understanding

Table 8: Model Summary

Table 9: Contributions of Independent Variables

Table 10: Barriers and Facilitators for mHealth Applications: Component Loadings and Communalities

Table 11: Barriers and Facilitators for mHealth Applications: CHC vs. Non-CHC

Table 12: Practice Setting Urban vs. Rural Settings

Table 13: Participants in Qualitative Interviews

Table 14: PCP Survey- Modes of Providing Care During 1st Lockdown of the COVID-19 Pandemic

Table 15: PCP Survey- Encryption Status of Virtual Care Tools During the COVID-19 pandemic

Table 16: PCP Survey- Provider Concerns in the Use of Non-Encrypted Virtual Care Tools During the COVID-19 Pandemic

Table 17: PCP Survey – Patients' Expressed Concerns in Use of Non-encrypted Virtual Care Tools During the COVID-19 Pandemic

Table 18: Research Variables and Sources

List of Figures

Figure 1: Provider Engagement with Patients in Primary Care for Diabetes Management

Figure 2: Cattell's Scree Plot

Figure 3: Provider-Patient Barriers (CHCs)

Figure 4: Provider-Patient Barriers (Non-CHCs)

Figure 5: Clinic Barriers (CHCs)

Figure 6: Clinic Barriers (Non-CHCs)

Figure 7: Systems Barriers (CHCs)

Figure 8: Systems Barriers (Non-CHCs)

Figure 9: Primary Care Provider and Microsystems

Figure 10: Provider Primary Care Work and Social Determinants of Health

Figure 11: Political Ideologies

Figure 12: Political Ideologies & the Social Determinants of Health

List of Acronyms

Association of Family Health Teams of Ontario: AFHTO

Canadian Medical Association: CMA

Canadian Nursing Association: CNA

Canadian Institute for Health Information: CIHI

Cumulative Index to Nursing and Allied Health Literature: CINHALL

Community Health Centres: CHCs

Continuing Medical Education: CME

Diabetes in Canada Assessment: DICE

Electronic Health: eHealth

Ecological Systems Theory: EST

Family Health Organization: FHO

Family Health Network: FHN Family

Health Teams: FHT

Family Physician: FP

Human Development Index: HDI

Institute for Clinical and Evaluative Sciences: ICES

Journal of Medical Internet Research: JMIR

Local Health Integration Networks: LHINS

Medical Subject Headings: MeSH

Mobile Health: mHealth

Ministry of Health and Long-Term Care: MOHLTC

Missing Values Analysis: MVA

Non-Community Health Centres: Non-CHCs

Nurse Practitioners: NPs

Nurse Practitioner Association of Ontario: NPAO

Nurse Practitioner-Led Clinics: NPLC

Organization for Economic Co-operation and Development: OCED

Ontario Health Teams: OHT
Ontario Telemedicine Network: OTN
Primary Care Providers: PCPs
Principal Component Analysis: PCA
Public Health Agency of Canada: PHAC
Registered Nurses: RN
Registered Nurses Association of Ontario: RNAO
Social Determinants of Health: SDOH
Statistical Package for Social Sciences: SPSS
Socio-Technical Systems: STS
Total Design Method: TDM
United Kingdom: UK
The University of Toronto Practice-Based Research Network:
UTOPIAN
World Health Organization: WHO

CHAPTER 1: INTRODUCTION

Diabetes is among the leading causes of morbidity and mortality in Canada (Statistics Canada, 2022). There are now approximately 424,000 individuals living in the province of Ontario with diabetes or prediabetes (Houlden, 2018; Wodchis & Reid, 2020). In 2019, the cost of providing care to diabetes patients in Canada rose to \$30 billion (Diabetes Action Canada, 2019). As a result, there has been increased clinical focus on proactivity and prevention in diabetes patient care and chronic disease management (Wodchis & Reid, 2020). The use of interactive technologies for diabetes self-management, monitored remotely by a clinician, has emerged as a vital facilitator of timely and proactive diabetes patient care (Bhatia et al., 2020; Shaw, 2020; Yu et al., 2021). However, in the practical application and implementation of mHealth technologies, there have been significant disparities in when, how, and to whom it is recommended (Shaw, 2020). Advocates have expressed that diabetes patients from vulnerable and marginalized patient populations are at a disadvantage as a result of systemic barriers that prevent or hinder access to mHealth resources. At the physician level, advocates warn that provider misconceptions may result in an unfounded judgment that a patient is incapable of using mHealth technologies (Bhatia et al., 2020; Shaw, 2020). As demonstrated in Table 1, published studies available on the use of mHealth applications for chronic disease management (including diabetes management) primarily examine the number of patients adopting the tool and clinical outcomes (reduction or effective management of glucose/HbA1C levels) but do not report on the socio-cultural characteristics of the patients using the technology. Additionally, the studies shown in Table 1 do not identify the number of participants belonging to vulnerable and marginalized populations, nor whether these participants were successful in adopting mHealth technologies for diabetes self-management consistently and for a sustained period that was long enough to realize improved clinical outcomes.

According to Havrilla (2017), vulnerable is defined as “a state of dynamic openness and opportunity for individuals, groups, communities, or populations to respond to community and individual factors through the use of internal and external resources in a positive (resilient) or negative (risk) manner along the continuum of illness (oppression) to health (growth)”. This definition reinforces the importance of equity and vulnerability considerations whilst providing care. When providing care to patients belonging to groups that include LGBTQ+, Indigenous Peoples, ethnic minorities, homeless, and those suffering from mental health and addiction challenges, clinicians should consider that these patients may be vulnerable to various forms of inequities and discrimination.

This mixed methods study aims to examine the perspectives of primary care clinicians regarding

contextual factors (systemic and provider-based) that influence access to and use of technology in patient populations. A sharp increase in the use of virtual care tools during the COVID-19 pandemic has renewed and increased the urgency for highlighting, understanding, and eliminating these barriers to allow for improved, proactive management of diabetes in vulnerable patient populations.

Chapter 1 provides an overview of the dissertation focus along with the structure of the dissertation. A comprehensive literature review is presented in **Chapter 2**, highlighting the need for the dissertation study and the purpose of the interlinked quantitative and qualitative studies undertaken by mixed-method design. I introduce the significance of diabetes as an illness that impacts a large percentage of the Canadian population and the current challenges of managing it proactively. I discuss the promise of interactive technologies for diabetes self-management as a recent innovation that can help to prevent complications that may result from proactive diabetes management. I advance this discussion by evaluating existing health equity concerns around diabetes management: first, the high prevalence of diabetes among vulnerable and marginalized patient populations that lack access to proactive diabetes management, and second, failing to incorporate the needs of these communities into patient care models for facilitating the adoption and utilization of interactive technological tools for diabetes self-management. I evaluated the latter as an outcome of published studies that have focused on lifestyle characteristics related to diabetes care, and identify healthcare challenges that have surfaced during the COVID-19 pandemic. I then demonstrate how my mixed methods study can provide an understanding of the identified contextual and systemic barriers as they exist in Ontario, and provide insight into how to improve existing healthcare delivery models to better respond to the needs of vulnerable patient populations.

I discuss in detail the theoretical perspectives underpinning my research questions and this dissertation. Specifically, I discuss the theoretical frameworks that have informed the examination of the studied phenomena and assess the link between health services accessibility, health/digital equity, and health outcomes. I further examine the availability of universal healthcare as a social determinant of health that is important in reducing premature mortality and, conversely, how the design and delivery of health services can increase health inequities if attention is not given to the identified challenges to patient engagement among vulnerable and marginalized populations. This chapter closes with a presentation of my research questions and specific objectives.

In **Chapter 3**, I describe in detail my research paradigm and the methods I used to examine my research questions. Specifically, I discuss my research orientation as a pragmatic researcher and my decision to use a mixed-method approach, which includes a quantitative study via a survey with primary care providers and follow-up qualitative interviews for deeper understanding. I describe my methods in detail by providing a step-by-step description of the planning of the studies, collection of data, and the analytical process. Finally, I explain how I sought and obtained ethical approval to proceed with my study, and the impact of the COVID-19 pandemic on data collection. The results are presented in Chapters 4 and 5.

In **Chapter 4**, I present the results of the survey study with sections that describe the demographics of the study's clinician participants ($n=48$) and the results for the primary and secondary outcomes.

In **Chapter 5**, I present the thematic analyses of the semi-structured qualitative interviews, which were conducted with a subset of survey participants ($n=15$). Each of these chapters concludes with a summary of results and gained insights.

In **Chapter 6**, I discuss the major findings of both quantitative and qualitative studies as they relate to one another. Informed by my theoretical lens, I unpack the interpretations of the findings and their implications for practice and policy. I suggest how my findings fit with what is already known in the literature, and I describe how my analysis is uniquely positioned to offer an important contribution by tackling digital inequity in a real-world scenario. The chapter ends by discussing how my thesis contributes to both practical and theoretical knowledge on digital inequity and its implications for policy-based change, along with directions for future research to facilitate equitable utilization of health technologies in real-world practice.

CHAPTER 2: LITERATURE REVIEW

In this dissertation, “health” is understood as “physical, mental, and social well-being” and not the mere absence of disease or illness, as defined by the World Health Organization, first adopted at the International Health Conference, New York in 1946, and enforced in 1948 in the Preamble to the Constitution of the World Health Organization (World Health Organization, n.d.). Further, health inequality and inequity are recognized as themes of increasing prevalence among policymakers, practitioners, and researchers. The term ‘health inequality’ refers to any difference in health and its related dimensions, while ‘health inequity’ refers to “the unfair and avoidable differences in health and healthcare access, quality, or outcomes across the population” (Bartley, 2016; Canadian Institute for Health Information, 2016; Lawrence, 2005). Health equity is an ideal state that is achieved when every person can reach their full health potential, with equitable access to high-quality care that is competent and appropriate to their needs, no matter where they live, who they are, or what health conditions they have. Access to timely healthcare, including access to care for chronic health conditions like diabetes, is a key determinant of health equity.

Additionally, it is important to distinguish the difference between the concepts of primary care and primary health care. Primary care (PC) and primary health care (PHC) are related concepts, but they are not the same, as primary care is only one aspect of the broader realm of primary health care. Primary care includes managing illness when it occurs with a trained provider who makes a diagnosis or treats a patient (Muldoon et al., 2006). Primary care can occur anywhere, but they usually offer it in a clinic or at a hospital, and most recently, virtually. Primary health care extends far beyond the management of illnesses and includes disease prevention (e.g., immunization) and health promotion (e.g., social determinants of health, including education). Primary health care includes the utilization of an extended health care team to help patients manage the social determinants of health factors impacting their health outcomes. The concept of primary health care was elaborated in the 1978 Alma-Ata Declaration (World Health Organization, n.d.) which is based on the principles of equity, participation, intersectoral action, and appropriate technology and is the central role played by the health system.

Similarly, primary care is more than just a level of care or the gatekeeping of health through treatment; it is a key process in the broader system of healthcare. In most cases, it is a patient's first point-of-contact with the healthcare system, and therefore, should be accessible, equitable, comprehensive, and coordinated. It is the first point-of-contact for patients at a time of need, or a central point-of-contact for patients requiring ongoing care, that focuses on the long-term health of a patient rather than on the short duration of the disease. It is considered a comprehensive range of services that are appropriate to the common problems in a respective population. While diagnosis and treatment are the central functions of primary care, coordination of care is another key role that primary care providers deliver, including coordinating with other specialists that the patient may need. Though primary care is a subset of primary health care, high-quality primary care is the foundation of the healthcare system; it provides continuous, patient-centered, relationship-based care that responds to the needs and preferences of individuals, families, and communities (Muldoon et al., 2006). Without access to high-quality primary care, minor health problems can spiral into chronic diseases, making chronic disease management difficult and uncoordinated. Without primary care, visits to emergency departments increase, preventive care lags, and healthcare spending soars to unsustainable levels.

Unequal access to primary care remains a concern, and the COVID-19 pandemic has amplified pervasive economic, mental health, and social health disparities that ubiquitous, high-quality primary care might have reduced (Bhatia et al., 2020; Shaw, 2020). Primary care is one of the few areas of healthcare where an increased supply is associated with better population health and more equitable outcomes (Starfield et al., 2005). For this reason, primary care is considered a common good, which makes the strength and quality of the country's primary care services a public concern. Primary care is usually thought of as the shorter-term, narrower concept of "family doctor-type" services delivered to individuals. Primary health care is a broader term that is derived from the core principles articulated by the World Health Organization, and that describes an approach to health policy and service provision that includes both services delivered to individuals (primary care services) and population-level "public health-type" functions. In the context of this study, both concepts defined and described above are important. Evaluation of the factors (variables) influencing both primary care and primary health care is important because they play a key role in determining patient health outcomes. Factors influencing primary care delivery and outcomes, such as structure, compensation, and equity in access, are imperative to understand.

A comprehensive understanding of primary healthcare factors is of equal importance because such factors broaden the scope of the evaluation of the larger healthcare system. This includes factors (variables) such as social determinants of health and equity. With these concepts in mind, the researcher conducted a review of the empirical literature and relevant theories and frameworks.

1. EMPIRICAL REVIEW

A comprehensive literature review was conducted using electronic databases (Medline and CINAHL), as well as a search for reports and government documents through Google search. Multiple keywords and MeSH terms were used to capture the scope of diabetes as an epidemic and strain on the Canadian healthcare system, followed by an examination of existing primary care delivery models, access to care among vulnerable communities, and eHealth innovations for diabetes management.

i. The Chronic Condition of Diabetes

Diabetes is a chronic condition, often disabling and sometimes fatal, that occurs when there are complications with the body's insulin production and use, leading to high levels of blood sugar (Diabetes Canada, 2018). Kidney disease, diminishing vision, loss of feeling in limbs, chronic pain, and cardiovascular disease are long-term diabetes complications (Diabetes Canada, 2018). There are three types of diabetes: Type 1, often referred to as insulin-dependent and is thought to be an autoimmune reaction that affects the cells of the pancreas that contain insulin; Type 2, referred to as non-insulin-dependent and adult-onset; and a third type, gestational diabetes, which occurs and progresses during pregnancy and normally goes away postpartum. In recent years, there has been an upward trend in the occurrence of Type 2 diabetes in youth in Canada due to an increase in caloric intake, processed foods, and a lack of physical activity after school. Generally, Type 2 diabetes is managed and treated through a change in diet, physical exercise, and oral medications.

In Canada, diabetes is among the major causes of morbidity and premature mortality (Statistics Canada, 2022). The cost of treating the disease in Ontario in 2019 was \$1.5 billion (Canadian Diabetes Association, 2020). Nationally, the cost of treating diabetes has risen to just under \$30 billion this year (Canadian Diabetes Association, 2020). According to Dr. Hux, President of Diabetes Canada, "the high prevalence and overwhelming impact of diabetes on our healthcare system implies that urgent action needs to be taken" (2022). An investment of \$150 million over seven years is needed to change the course and impact of the disease, according to Diabetes Canada (2022). This will save the healthcare system more than \$9 billion and will prevent the emergence of nearly one million cases of

Type 2 diabetes. Type 1 and Type 2 diabetes rates have risen by 42% since 2009, and Ontario has more people living with diabetes per capita than anywhere else in the world (Canadian Diabetes Association, 2020). There are now 424,000 individuals in the province with diabetes or pre-diabetes (Houlden, 2018). Pre-diabetes is clinically defined as having a higher-than-normal blood sugar level; however, these levels are not high enough to be considered Type 2 diabetes. Without lifestyle changes, adults and children with pre-diabetes are more likely to develop Type 2 diabetes. Notably, someone in Canada is diagnosed with diabetes every three minutes, and there are approximately 11 million people with diabetes or pre-diabetes living in Canada (Canadian Diabetes Association, 2020).

Canada has the third highest mortality rate among its peer countries due to diabetes, earning it a "C" ranking (Houlden, 2018). Canada's 2004 report on mortality statistics for diabetes documented 18 deaths per 100,000 people (Canadian Institute for Health Information, 2016). Though it fell to an estimated 16 deaths per 100,000 people in 2006 (Canadian Institute for Health Information, 2016), the rate is high when compared to other developed countries (Public Health Agency of Canada, 2013). Canada earned A rating of 'C' in the 1960s and 1970s when compared with Denmark, Norway, Japan, and the U.K. (Public Health Agency of Canada, 2013). In the 1980s, the rank was improved to a 'B' momentarily, but as Finland, France, Ireland, and Sweden improved their numbers in an attempt to join the roster of 'A'-level countries, Canada dropped again to a "C" in the 1990s by comparison. By the 2010s, Canada fell into a 'D' ranking. In five decades, only three countries have ranked as an 'A': Japan, Norway, and the U.K. Japan has a rate of 5.5 deaths associated with diabetes per 100,000 people, and this rate is the target for many other countries, including Canada (Public Health Agency of Canada, 2013). This begs the question of why Canada has been performing so poorly.

Many studies have assessed Canada's poor performance when compared to other first-world countries. Preliminary findings suggest that Canada's changing demographic profile might be a reason for its low ranking. First, the age pyramid in Canada has been inverted in the last decade; the number of people aged 65 and over exceeds the number of people under the age of 18 (Canadian Diabetes Association, 2020). The risk of developing Type 2 diabetes increases with age, and older adults with diabetes are more likely to be frail and experience diminished functioning and increased mortality associated with progressive frailty. Second, the diversity of the Canadian population is on the rise. Approximately 30 percent of self-identified Canadians are of African, Arab, Asian, Hispanic, or South Asian descent (Canadian Institute for Health Information, 2016). Of minority populations in Canada, the Indigenous population, of which there are approximately 1.7 million

people, has a relatively higher rate of diabetes and related adverse health effects when compared to the Canadian population as a whole (Canadian Institute for Health Information, 2016). Some contributing factors to these high rates of diabetes are poor living conditions, low levels of education, and a lack of healthy food options because of the remoteness of many First Nations communities and resulting transportation challenges. The Human Development Index (HDI) published annually by the United Nations since 1990 shows that Canada is regularly among the top few countries for the overall HDI, but ranks several folds lower within Canadian Indigenous communities. In its 2019 report, Indigenous Services Canada reported an HDI of 0.71 and 0.73 for registered Indigenous persons in 2006 and 2016, respectively, compared to 0.82 to 0.84 for the rest of Canadians (Cooke, 2020). This highlights how risk factors for diabetes vary according to socio-economic and socio-cultural statuses in Canada at the population-level.

At the individual level, Canadian statistics show a high-risk profile for adults with diabetes. Evidence shows that a high number of Canadians are physically inactive (45.4%), overweight (36.3%), obese (26.8%), and/or consume inadequate amounts of fruits and vegetables (71.4%) (Houlden, 2018). However, these lifestyle factors that are individually measured are not influenced solely by individual choice. An individual, for example, might work two jobs to make ends meet, and not have enough financial means and/or time to exercise. They may not have access to fresh fruit because of a lack of affordability or no availability. Determinants of health like income, education, food security, the built environment, social support, and access to healthcare are the ultimate drivers of population health (Raphael, 2012). Diabetes is normally associated with poverty due to the resulting constraints on these determinants that it presents, but it should be noted that there has been a sharp increase in the rate of diabetes in patients with higher socioeconomic statuses linked to higher caloric intake, longer working hours, and a reduced amount of physical activity.

Many Canadians are deeply worried about the economic burden of living with diabetes despite the social healthcare system (Diabetes Action Canada, 2019). The government's current commitment to care is perceived as inadequate, as diabetes patients in Canada must pay directly for dietary changes and other resources needed to manage/mitigate the complications of uncontrolled diabetes. Among people in Ontario who have been affected by the disease (those who are living with it or caregivers to those with diabetes), almost nine in ten say they are taking medication or insulin and 70% say it is difficult to pay for their healthcare bills (Diabetes Action Canada, 2019). One-third of these people pay out of their pocket, which directly impacts those living with or caring for someone with diabetes financially. In Ontario, four out of every ten people affected by diabetes have missed work, and half of

these individuals have been out of work in an average year (Public Health Agency of Canada, 2013). Diabetes has been shown to shorten an individual's lifespan by an average of 10+ years, and people with the condition are more likely to experience vision loss. A diabetes diagnosis means a significant increase in healthcare visits, as diabetes management guidelines support checking A1C every 3-6 months, placing additional strain on patients, their families, and the healthcare system.

When diabetes is poorly managed, patients are at an increased risk of amputation, renal failure, heart attack, stroke, and heart failure (Raphael, 2012). In addition, patients experience increased levels of health-related anxiety and chronic disease burnout, resulting in a lack of motivation to remain compliant with their prescriptive treatments. A national strategy and an evidence-based action plan at the system level are required to address the growing population's needs around diabetes. "The longer we delay coordinated efforts with targeted outcomes, the higher the prevalence of diabetes and the more Canadians will experience its tragic complications," predicts Dr. Hux (Diabetes Canada, 2022). According to results from the 2018 Ipsos Public Relations poll, 89% of the 1,000 Canadians surveyed agreed that it should increase their funding to treat diabetes in Canada (Ipsos, 2018). In addition, it ranked diabetes as the second most significant disease of concern, second only to cancer-related diseases. Only six out of every ten people living with diabetes in Ontario are expected to receive support because of introducing a national diabetes plan (Ipsos, 2018). Some notable system-level developments are discussed below.

Given the significance of diet, Health Canada launched its Healthy Eating Plan in 2016, which aimed to strengthen the food climate and reduce the risk of chronic diseases like Type 2 diabetes by encouraging healthy eating through the revision of the Canada Food Guide (Health Canada, 2016). This initiative restricted the sale of unsafe food and drink to children, and reinforced the need for accurate food labels to make it easier for Canadians to recognize foods high in sugar, saturated fat, and salt (Health Canada, 2016). Health Canada committed to working with food suppliers and restaurants to reduce the amount of sodium and trans fats in foods while increasing access to, and the availability of, healthy foods through its Nutrition North initiative (Health Canada, 2016). Despite these steps taken by Health Canada to reduce the impact of diet-related factors, Type 2 diabetes is a complex disorder that requires ongoing self-management in collaboration with primary care clinicians.

‘Food insecurity’ is defined as a sustained inadequacy within the supply, quality, or quantity of food at any given time (Raphael, 2012). Food insecurity is a major challenge among individuals with diabetes; it is estimated that approximately 1.1 million Canadian households experience food insecurity regularly. According to Raphael (2012) and other prominent researchers (Hutchinson & Tarasuk, 2022; Men et al., 2021), food insecurity negatively impacts individuals with diabetes, because it is a barrier to adequate nutritional intake. People experiencing food insecurity consume fewer amounts of fruits and vegetables, dairy products, and other nutritious foods than those in food-secure households. Specifically, households experiencing food insecurity were 80% more likely to report having diabetes than households with sufficient food (Raphael, 2012). In most cases, a lack of financial resources causes food insecurity. This demonstrates the need for changes to public policy that help with reducing poverty and is subsequently another way of reducing food insecurity.

While Indigenous communities in Ontario regularly experience food insecurity as a result of financial insecurity, two additional challenges—the remoteness of many First Nations communities and the resulting transportation issues exacerbate this reality. Indigenous diabetes patients in urban areas are far more likely to have access to healthy, affordable food than those in remote areas. Most Indigenous communities in remote areas are serviced by one food supplier, the Northern Food store, which is owned by the North-West Corporation. All food items supplied to these remote communities need to be delivered by planes, which limits the variety of fresh fruits and vegetables that can endure the shipping time without spoiling. It is these challenges that go beyond the scope of individual behaviour that clinicians must consider when assessing the impact of diabetes outcomes and the improvement of these outcomes regionally. Clinicians working in the CHC model of care, for example, in response to the correlation between food insecurity and effective diabetes management, have established food pantries in CHC clinics and also formed industry partnerships to help vulnerable and marginalized patients experiencing food insecurity. Food pantries often contain non-perishable food items such as canned corn, tuna, beans, soups, etc., in addition to boxed foods such as pasta and cereals.

In Canada, the entry point of most patients into the healthcare system is through primary care clinicians. The social health insurance program of their province or territory's government primarily funded their services. Despite universal access to care, a 2003 "Diabetes in Canada Assessment" (DICE) report showed that one in two Canadians with Type 2 diabetes could not regulate their blood sugar, and was less likely to do so that their diabetes was left unmanaged. The cost of approximately 70% of diabetic medications, including insulin, is not publicly funded by the government for most Canadians, not including coverage for Indigenous persons, seniors, and patients (including children) on social welfare (Canadian Diabetes Association, 2020). For most diabetes patients, pharmaceutical costs (including diabetes medications) are primarily paid for out-of-pocket or by private insurance. Thus, the use of appropriate drugs for diabetic treatment in Canada is lessened because of the associated costs, and even more so in vulnerable and marginalized patient populations (Canadian Diabetes Association, 2020). As a result, primary care providers can now apply to pharmaceutical companies for monetary support for patients that cannot afford their medications (Diabetes Canada, 2022).

The approaches described above differ vastly from the approaches used in other developed countries such as Japan (considered an 'A' country by the World Health Organization) with lower rates of poorly managed diabetes. The DICE study cited "clinical inertia" as the explanation for why information is not converted into more meaningful care plans (Diabetes Canada, 2018). For instance, half of the family physicians in Canada state their practices are not well-equipped to treat patients with numerous chronic health conditions (Canada Health Infoway, 2021). In its study, "Why Health Care Renewal Matters: Lessons from Diabetes," the Health Council of Canada (2014) reports that less than half of Canadians with diabetes have both the laboratory tests and procedures recommended by experts to track blood sugar levels, blood pressure, cholesterol, kidney health, vision, and foot health. The significance of meaningful provider and patient engagement is supported by evidence showing that when people with diabetes receive meaningful advice from clinicians with a preventive orientation toward daily life routines, their health is better than when they do not receive such advice (The Alliance for Healthier Communities, 2020). This outcome is improving because of new features within electronic medical records (EMRs) that send automatic reminders to patients and providers for tests and follow-ups they require based on their diagnosis.

It is noteworthy that the Health Council of Canada (2014) also points out that having a family doctor does not necessarily mean a higher standard of treatment. It was found that only half of the general practitioners refer their patients for proactive help, such as diet and exercise. In contrast, interprofessional healthcare teams who can provide cross-disciplinary case management are shown to increase the quality of care for chronic diseases, such as diabetes and heart disease (Beagrie, 2012; Yu et al., 2021). Effective diabetes care should be delivered within the framework of the Chronic Care Model and centred on the individual who is supported in their self-management (Boehmer et al., 2018). To achieve this, the healthcare system needs to support and allow for sharing and collaboration between primary care providers and specialists as needed. A multifactorial approach using an interprofessional team addressing healthy behaviours, glycemic control, blood pressure control, lipid management, and cardiovascular protection measures has been indicated to lower the risk of development and progression of serious complications effectively and dramatically for individuals with diabetes (The Alliance for Healthier Communities, 2020). Additionally, information technology was shown to help healthcare administrators with capacity planning by providing them with tools such as chronic disease registries (Canada Health Infoway, 2021). Even though approximately 90% of family physicians in nine European countries and Australia use computers for at least some patient care, a recent survey of family physicians in Canada shows that only 70% of Canadian family physicians use computers (Canada Health Infoway, 2021). The most common use is the administration of prescriptions for patients accompanied by online laboratory results. It should be noted that computer use in Canada by family physicians has been closer to 85%–90% since the COVID-19 pandemic (Canada Health Infoway, 2021).

Engaging patients holistically is of high importance for the successful management of diabetes, calling for strong patient engagement strategies (Canadian Diabetes Association, 2020). Clinical Practice Recommendations for the Prevention and Treatment of Diabetes in Canada now call for more patient-engaged care plans that align with the parallel UK study. However, these recommendations don't seem to be fully integrated into patient care yet. For example, the DICE study reports that while family physicians are knowledgeable about these recommendations, they still focus on recommending behavioural improvements in patients rather than beginning early blood sugar regulation and oral medication, which can be started when a patient is pre-diabetic if risk factors are present, according to the Canadian Diabetes Guidelines. According to the Canadian Diabetes Association (2020), not only is more aggressive care needed for those with diabetes, but there must also be an emphasis on preventive measures through patient engagement and counselling. Indeed, engaging individuals means

empowering them to discuss their challenges with clinicians, understand their contextualized needs, ask critical questions, and participate in their own planning and care for successful results. The importance of filling this research gap was echoed by Crawford and Serhal (2020): “in the current response to the COVID-19 pandemic, digital health has been rightly heralded as an innovative health solution that can ensure ongoing access to clinical care and allow public health measures that stem rapid viral transmission and spread. However, unexamined inequities in access to and implementation of digital health and the quality of care afforded by digital health can recapitulate and deepen the inequities that have long existed within our healthcare system.” These authors have rightfully indicated that vulnerable and marginalized patient populations have not primarily been the target of evaluations on the uptake and utilization of technologies aimed at enhancing access to proactive and ongoing chronic care. They (Crawford & Serhal, 2020) and many other researchers (Bhatia et al., 2020; Chan Nguyen et al., 2022; Dover & Belon, 2019; Shaw, 2020; van Deursen, 2020) reiterates the need for an improved understanding of how to improve current patient engagement practices.

ii. Primary Care as Canadians’ Healthcare Entry Point: Ontario Delivery Models

Healthcare services in Canada are primarily publicly funded by the federal and provincial governments through the Canada Health Transfer, a cost-sharing agreement between the federal and provincial governments (Latham & Marshall, 2015). The percentage breakdown of funding is approximately 70% public and 30% privately funded through personal health insurance. There are ten provinces and three territories in Canada, and the percentage of publicly and privately funded healthcare varies in each province. For example, in Ontario, the percentage of publicly funded healthcare by the provincial government is approximately 38%, and the rest is privately funded. The percentage of publicly funded healthcare services is a key determinant of healthcare accessibility and highly applies to the type and quality of healthcare services accessible to diabetic patients, especially those that are vulnerable and marginalized.

In Ontario, there are five basic types of primary care models: Family Health Teams (FHTs), Community Health Centres (CHCs), Nurse Practitioner-Led Clinics (NPLCs), solo practices of family physicians, and Family Health Organizations/ Family Health Networks (FHOs/FHNs) (Peckham et al., 2018). The main characteristics and determinants of the model type are patient enrollment, group-based care, and physician remuneration. FHTs (Aggarwal, 2009) primarily comprise family physicians, as well as other multi-disciplinary and interdisciplinary team members. These teams include nurses, NPs, and allied health professionals, including social workers, registered dietitians, pharmacists, behavioural mental health

specialists, and community outreach professionals who work on a salaried basis in the Family Health Team model. The structure of diabetes management in FHTs dictates that both the family physicians and NPs are compensated through a salaried model; however, patients are rostered to the physicians and, as a result, they receive all government incentives for effectively managing diabetes patients. NPs do not receive these incentives through their collaborative care model agreement with the board (Peckham et al., 2018). It should be noted that although family physicians are compensated through a salaried model in FHTs, they have additional opportunities to earn more money for some patient care services that are not reimbursed by the Ministry of Health (these are also known as out-of-basket billings).

The Community Health Centre (CHC) is another model of primary care in Ontario—a non-profit organization that offers a range of multi-disciplinary primary health care and socially related services to their communities. CHCs were first established in the 1960s and began receiving funding from the Ministry of Health in the early 1970s. Over the last few decades, the number of CHCs across Ontario has increased to 101, to better serve individuals with complex needs. Fundamentally, they were created as a model that aims to address gaps in primary care by designing and offering services to one or more distinct, underserved priority groups. Because of this fundamentally different approach, CHCs expanded rapidly to meet the needs of diverse populations in neighbourhoods with the most need. The CHC movement received a strong boost in 1972 when the Hastings Report endorsed CHCs as a good model for primary care and health promotion. By the mid-1970s, a pilot CHC Program was established at the Ministry to support the ten urban health centres in existence. In 1982, the CHC Program was established as an ongoing Ministry program. Today, the Community Health Centre Program is an established program of the Ministry of Health and Long-Term Care, which provides full funding for approved programs.

The CHC model of primary care also includes family physicians and other multi-disciplinary team members, but the remuneration model comprises primarily salary-compensated physicians with benefits for full-time physicians. A unique feature of the CHC model is the mandate to serve vulnerable communities, such as low-income and racialized subgroups. CHCs offer outreach programs to engage these community members, while some centres also conduct research activities (The Alliance for Healthier Communities, 2020). CHCs are sponsored and managed by community boards that involve members of the community and others who provide health and social services. Community governance enables health services to be more easily oriented toward what community members identify as their most important needs. CHCs operate under the principle that people's health is influenced by the social and physical environment, employment, education, and housing, as well as access to appropriate and effective healthcare services. CHCs consider the specific

characteristics and risk factors associated with each distinct priority group and plan care accordingly. The model supports the premise that people are healthier when they have a sense of belonging and purpose. Two other models of primary care are Nurse Practitioner-Led Clinics (NPLC) and Solo Physician practices. The Solo Physician model of care relies on a fee-for-service model of remuneration (Peckham et al., 2018), where fees are paid per patient visit that falls within specific time frames (15 minutes for follow-up visits and 30–45 minutes for new visits/ consultations). The fees paid for each visit or service type are outlined in the Ontario Schedule of Benefits (a document created by the Ministry of Health that stipulates how much providers will be compensated for various visits and procedures) and are periodically updated (Ministry of Health and Long-Term Care, 2022). The Solo Physician model of care is slowly being phased out and replaced by the other models of care that promote collaboration amongst clinicians.

Nurse Practitioner-Led Clinics are funded similarly to CHCs. Each staff position receives compensation for their roles as outlined in the Recruitment and Retention document. In addition, overhead costs for rent, utilities, equipment, cleaning, and EMRs, among other costs, are also covered (Association of Family Health Teams of Ontario, 2014). The clinic receives an overall budget, and NPs are compensated from that budget as well, as it is not a fee-for-service or fee-per-patient model of compensation. NPs are not allowed to directly bill the Ontario Health Insurance Plan (OHIP), and therefore cannot bill per patient. Despite the numerous benefits of an NPLC model of care, funding for clinics has not increased in many years, and overhead costs, including rent and utilities, are constantly increasing, making it difficult for some clinics to continue operating. For the last 10 years, there has been no new funding available for new NPLCs, FHTs, and CHCs. However, a few NPLCs recently received funding for satellite clinics, as they had increased patient wait lists. If the Ministry of Health continues to provide no funding in this area, some local cities, town councils, and community groups will be forced to raise funds to support the creation of new clinics or increase the functions of existing clinics. Nurse Practitioner-Led Clinics were initially used in rural areas to compensate for the low number of physician practices in those areas. However, they have expanded their practices into urban areas (Peckham et al., 2018). NPLCs also comprise of onsite multi-disciplinary and interdisciplinary teams, including social workers and dietitians. Finally, Family Health Organizations (FHOs) and Family Health Networks (FHNs) are models that require at least three physicians and follow a blended capitation model of remuneration, where a defined basket of services for enrolled patients determines the capitation amount. Additional services are based on a fee-for-service model (Peckham et al., 2018).

The model of primary care used is likely to influence the level of provider engagement with patients, as it influences their community orientation. Earlier work shows that primary care providers in Ontario rate themselves as high in ‘community orientation’ (Muldoon et al., 2010). A survey was conducted by Muldoon et al. in 2010 with primary care providers in Ontario (CHC = 182, fee-for-Service/ FGH = 58, FHN = 81, Health Service Organization = 42) in which they asked four questions on a four-point Likert scale to assess the participants’ community orientation by evaluating their frequency of home visits, their perception of knowledge adequacy about community needs, their perceived ability to get opinions/ ideas from professionals to improve care, and their perceived ability to change healthcare service in response to community needs. The mean score for the CHC providers was significantly higher (0.85) than in other models, which ranged from 0.75 to 0.81 (Muldoon et al., 2010). However, a major limitation of the study is that almost all respondents were family physicians and only one nurse-practitioner from a CHC participated. Given the expansion of primary care models in Ontario to include Nurse-Practitioner-Led Clinics, there is a need to advance knowledge on all providers’ community orientation.

Further, scholars discuss the variability in the providers’ community orientation based on the differences in the compensation model, the type of services offered, and the patient mix across various primary care models. Family physicians in CHCs are compensated for patient care primarily through salaried government funding, and this provides the opportunity for physicians to spend more time with each patient, which can enhance their relationship with patients and improve engagement (Peckham et al., 2018). In addition, family physicians in CHC settings have a greater opportunity to participate in emerging and innovative approaches to care delivery, such as social prescribing. This phenomenon (a non-medical approach to treatment and care) has been gaining momentum in CHC settings and has started to indicate signs of positive results (Bloch & Rozmovits, 2021). In contrast, providers in family practices have difficulty spending more time with patients, as their fee-for-service remuneration model drives the volume of patients up and reduces the average time spent per patient (McLeod et al., 2016). The patient mix in a practice also determines the average amount of time spent per patient. For example, seeing a chronically ill patient takes more time and may influence the extent of their discussion covering the social determinants of health topics, which have been shown to influence health outcomes (Institute for Clinical and Evaluative Sciences, 2010). Physician advocates such as Glazier (2012) have expressed concerns about equity in patient access to care because of physician remuneration models in primary care as a potential system-level contributor impacting the quality of care for marginalized patient populations. This is of particular concern, as only 36% of family

physicians are compensated through a salaried model (Canadian Institute for Health Information, 2016).

To address the concerns discussed above, the Ontario government implemented the Patient First Act in 2016 as a reminder to health providers that patient needs and values should be at the forefront of everything they do. The aim of utilizing this incentive model was to encourage physicians to be a facilitator of accessible care for those that need it the most. The Patient First Act is overseen by the Local Health Integration Networks (LHINS); however, this only covers primary care providers within FHTs and CHCs and does not include providers outside of these two primary care models (Peckham et al., 2018). A physician's or nurse's perspective on the importance of equity and the impact of the social determinants of health-on-health outcomes is equally vital (Glazier, 2012), as several factors could influence their perspectives and practice style. Evidence also shows that improvements in pay or bonuses do not always reduce access disparities. For example, a 2012-2013 study of Family Health Teams revealed that neither the quality of care nor access to care improved despite physicians receiving better incentives (Glazier et al., 2019). Likewise, access to care in rural areas for complex patients (including patients with diabetes) did not improve significantly, even after offering better incentives (Canadian Institute of Health Information, 2016). Although a substantial body of literature on primary care models has focused on family physicians, nurses participate in many of these models, and their perspectives and role warrant further attention.

iii. Evolving Role of Registered Nurses (RNs)

Nurses comprise the largest group of practicing professionals in the Canadian healthcare system. Registered Nurses (RNs) are key members of primary healthcare care teams across Ontario. Their scope of practice (the tasks that an RN is legally allowed to perform in Ontario) in diabetes management has been primarily supportive for a long period; however, there is an anticipation that their legal scope of practice will be extended to match that of NPs, allowing RNs to assess and diagnose patients, prescribe medications, and order medical tests, expecting this will provide much-needed relief for the family physicians shortage. However, it should be noted that RNs currently do not perform the same tasks as their NP colleagues. It should also be noted that there is a difference between the scope of practice and the roles/responsibilities of each role. While the scope of practice is legally and provincially regulated and is clearly outlined in relevant nursing regulations, roles/responsibilities encompass tasks that RNs perform in relation to other healthcare providers.

Additionally, this includes their position in healthcare institutions (College of Nurses of Ontario, 2021).

The Role of RNs in Diabetes Management

Registered Nurses play an important role in the day-to-day care of patients with diabetes in various models of care. However, given their current scope of practice, the oversight of a physician is required. As previously mentioned, registered nurses cannot prescribe medications, order tests, and directly bill OHIP, and therefore need the oversight of a physician. Despite the important role of RNs in the day-to-day care of diabetic patients, incentives have been introduced for chronic disease management (including diabetes) that primarily benefits physicians. These new incentives are referred to as Chronic Care Incentives. Several provinces in Canada have introduced incentive payments programs to target the treatment of patients with chronic illnesses, including diabetes. This approach is called pay-for-performance or condition-based payments.

Diabetes incentive payment programs were rolled out for primary care physicians. For example, the Ontario Diabetes Management Incentive provides a \$60 annual per-patient payment to providers who complete and document the required elements of care recommended by the Canadian Diabetes Association guidelines (Government of Ontario, 2021). In Family Health Teams, this incentive is not offered to RNs because RNs cannot directly roster patients even though RNs are directly involved in treating patients with the oversight of a physician.

Studies of Ontario's pay-for-performance showed modest improvements (10%) in the delivery of some preventive services and no change in the management of patients with diabetes (Institute for Clinical and Evaluative Sciences, 2010). The results of the Ontario pay-for-performance studies are difficult to interpret because of the modifications in physician payment mechanisms that occurred at approximately the same time. This may have influenced the care for patients with chronic diseases and the uptake of chronic care incentives. RNs are projected to take on a greater role in the remote monitoring of chronic conditions, including diabetes. During the COVID-19 pandemic, there was a significant increase in the utilization of virtual health, with RNs pivoting and primarily taking on the responsibility for remote care monitoring (Canada Health Infoway, 2021). This trend continued into 2021 as the pandemic stretched on. The trend of remote monitoring of chronic conditions is expected to increase, and RNs are projected to continue taking on key roles in this emerging model of care (Canada Health Infoway, 2021). In the long term, RNs are expected to take on an overall greater role

in the utilization of digital health tools (Canada Health Infoway, 2021).

Similar to Ontario's Chronic Illness Incentive program, other provinces also have their own programs. For example, family physicians in Nova Scotia are eligible for additional payments through a Chronic Disease Management program if they complete and document an assessment of diabetes risk factors and annual monitoring (Government of Nova Scotia, 2020). Similarly, in British Columbia, family physicians are offered chronic disease management payments for several chronic conditions per the Full-Service Family Practice Condition Payments, which were introduced in 2003. Physicians can receive a \$120 payment (per patient) for providing care according to the British Columbia clinical guideline recommendations for diabetes over the preceding 12 months (Government of British Columbia, 2021).

The Roles of Nurse Practitioners (NPs)

Nurse Practitioners are also key members of primary healthcare teams across Canada. The NPLC model of care was introduced in Ontario in 2007. They are now one of the fastest-growing groups of healthcare professionals in the system (NPAO, 2021). NPs working to their full scope of practice can increase patient access to care and reduce the number of unattached patients (as of July 1, 2010). Advanced practice nursing roles in Canada have a rich history that can be traced back to the 19th century, when outpost nurses began working in an expanded scope of practice to meet population health needs and address physician shortages. Since then, Nurse Practitioner-Led Clinics (NPLCs) have emerged in many jurisdictions across Canada, and have extended to 26 localities across Ontario since the first one opened in Sudbury in 2007.

Nurse Practitioners in Ontario work within all primary healthcare settings, including FHTs, CHCs, and NPLCs (Heale et al., 2018). The current scope of practice for NPs in Ontario is the broadest in the country, allowing providers to assess, communicate diagnosis, order diagnostic testing, complete specialist referrals, and prescribe medications, including narcotics and controlled substances (College of Nurses of Ontario, 2021). NPs' scope of practice in chronic disease management (including diabetes management) was primarily supportive for a long period but has been extended (College of Nurses of Ontario, 2021). Thus, NPs have been able to practice independently and autonomously when managing chronic diseases. In the NPLC model of care, NPs provide primary healthcare services directly to patients (DiCenso et al., 2010; Heale et al., 2018). Family physicians can be located either on- or off-site and have a consultative relationship with NPs, in which they can

collaborate on patient cases. This has fostered the removal of previous restrictions on their scope of practice, resulting in improved access to healthcare services. In 2017, NPs in Ontario were given the authority to prescribe controlled substances (College of Nurses of Ontario, 2021).

NPs can now remotely monitor patients as well, significantly improving the quality and effectiveness of chronic condition management. However, it should be noted that NPs are not incentivized like physicians to target this patient population. Nonetheless, the extension in the Nurse Practitioner's scope of practice has led to the establishment of several NP-Led Clinics, allowing for faster and improved access to healthcare services, and shifting some responsibilities off of the primary care system. Though the early proliferation of NPLCs in Ontario was primarily in rural areas, in recent years NPLCs have spread across urban areas in the rest of Ontario, and have been impactful in helping to address the shortage of primary care physicians (Donald et al., 2010; Marceau et al., 2020). For example, there are currently 4,511 NPs working in Ontario, serving approximately 13.6 million Ontarians, including in rural areas. NPs have helped with treating approximately 20,000 unattached patients (Ontarians who cannot find a primary healthcare provider) (Heale et al., 2018). In 2010, 2,486 NPs were practicing in Canada, up from 1,129 in 2006. In 2020, there were over 6,000 Nurse Practitioners across the country (Marceau et al., 2020). Additionally, NPs have also helped with treating patients in urban areas. However, the greatest impact is seen in rural areas, where there's an ongoing shortage of family physicians (Donald et al., 2010; Marceau et al., 2020).

Within primary healthcare, the role of a Nurse Practitioner should be autonomous, allowing them to provide the first level of contact within the healthcare system for individuals of all ages. According to Heale et al. (2018), the autonomy of NPs within primary care has resulted in comprehensive care and an optimized scope of practice. Particularly for patients living with chronic disease or multi-morbidity who face challenges accessing primary healthcare and present complexities for healthcare providers, the NP role can help with reducing health inequities (Heale et al., 2018). The benefits of NPs to the primary care model became more clear during the COVID-19 pandemic, as they could see patients, monitor them remotely, and prescribe medications (Marceau et al., 2020). The use of NPs in primary care was shown to improve access to high-quality care at a lower cost (Kaasalainen et al., 2010). The greatest benefits of the NPLC model of care are:

i. An increased capacity to treat patients and higher volumes

Given the shortage of family physicians (especially in rural areas), NPs with an advanced scope of practice can help patients, especially those with chronic illnesses, monitor and manage their conditions. This is especially helpful in preventing exacerbations and unnecessary hospital visits (DiCenso et al., 2010; Floriancic, 2021; Heale et al., 2018; Keith & Askin, 2008; Marceau et al., 2020).

ii. A reduced strain on physicians

In NPLC settings, NPs can provide a range of services that relieve the pressure currently on physicians. Chronic disease management is one area that has significantly benefitted from the utilization of NPs in primary care (DiCenso et al., 2010; Floriancic, 2021; Heale et al., 2018; Keith & Askin, 2008; Marceau et al., 2020).

iii. An improvement in chronic disease management

As noted above, one of the valuable roles NPs play in primary care in Ontario is in the management of chronic conditions. The NP role (in Ontario) allows providers to incorporate health promotion and disease prevention into care while providing comprehensive chronic disease management. This makes NPs a valuable addition to healthcare teams (DiCenso et al., 2010; Floriancic, 2021; Heale et al., 2018; Keith & Askin, 2008; Marceau et al., 2020).

The Canadian healthcare system continues to be challenged by limited access to primary care physicians, increased prevalence of chronic disease presentations, and limited resource availability (Lukewich et al., 2019). There continues to be a consistent supply of new primary care physicians graduating and practicing in the province, however, research has shown that they are not practicing in rural areas or accepting complex marginalized populations equal to the number of individuals requiring care. A strong primary healthcare system is recognized as the cornerstone of health systems and leads to better health outcomes, improved patient experiences, and lower costs (Haj-Ali et al., 2021). Situating Nurse Practitioners in autonomous practices such as NPLCs is imperative for the sustainability of primary care in Ontario. Removing some of the constraints and power imbalances of physician-led practices to allow Nurse Practitioners to become the Most Responsible Provider (MRP) for a group of patients within an interprofessional team model has the potential to be an effective and innovative model for managing complex chronic disease.

In summary, the Registered Nurses Association of Ontario (RNAO) and the Canadian Nurses Association (CNA) jointly support the expansion of RN and NP roles in primary care organizations. This was echoed through this statement: “the anticipated benefits (of RNs and NPs) in primary care organizations [include] a) treat an increased patient capacity and volume b) decreased strain on physicians c) improved chronic disease management d) enhanced ability to achieve targets set by the government and other funding agencies” (RNAO, 2021).

iv. Vulnerable Communities and Access to Care

The burden of diabetes is not equally distributed across various population groups. Research shows that marginalized populations, including low-income groups or members of racialized, immigrant, or Indigenous communities, are at a higher risk of developing Type 2 diabetes due to their lifestyle and related social determinants of health, including education level, income, and poverty (Bartley, 2016). It is important to acknowledge that marginalization is not an in-born characteristic of individuals, but a societal process that pushes people, or groups of people, to the edge of society by hindering their ability to have an active voice or identity. This is done through both direct processes, including racism and discrimination, and indirect processes, including a lack of equitable access to opportunities and resources in the areas of education and healthcare, among others (Brunner & Marmot, 2005; Lawrence, 2005). Marginalized groups may be relegated to an inferior position in society, or made to feel as if they are less important than those who hold more power or privilege (Kivimäki & Kawachi, 2015).

Evidence shows (Chiu et al., 2011; Institute for Clinical and Evaluative Sciences, 2010) that the burden of diabetes, as measured by costs and clinical outcomes, is higher for individuals in these marginalized groups than their privileged counterparts (Fox & Alldred, 2016). In 2010, the Institute of Clinical Evaluative Sciences reported that of 140 Toronto neighborhoods studied, poverty and immigration status were the key determinants for developing diabetes. For example, studies document that South Asian communities in Canada have higher rates of diabetes than Caucasians and Europeans living in Canada (Chiu et al., 2010, 2011). The prevalence of diabetes is noted as 3–5% among those of European descent, whereas it is 12–15% among South Asians living in Canada (National Collaborating Centre for Determinants of Health, 2019). Despite having a high risk of developing diabetes, members of marginalized communities experience barriers to accessing universally available healthcare in Canada (Glazier, 2012). For example, in the case of South Asian-Canadians, approximately 35% reported that they experienced unfair treatment based on their language, accent,

ethnicity, or religion when attempting to access healthcare services (Institute for Clinical and Evaluative Sciences, 2010).

Others report that approximately 74% of South Asians who experienced discrimination felt that it was based on their race, and 59% reported that they also experienced discrimination while seeking employment (Statistics Canada, 2022). South Asians are also noted to earn \$16,000 less annually (on average) than Caucasians and Europeans earn in Canada even though their prevalence of advanced education is higher (Bajaj & Banerji, 2004; Chiu et al., 2010). The impact of a constrained socio-economic position on the rates of diabetes among patients from marginalized communities is notable (Chiu et al., 2011). For example, one of the top concerns of new Canadian immigrants with diabetes is the affordability of medications (Canadian Diabetes Association, 2020). New immigrants to Canada are unaware of how they can receive subsidized or low-cost medications through compassionate care programs offered by pharmaceutical companies. Compassionate care programs were created by companies in the pharmaceutical industry to help patients in need get access to required medications (Lexchin, 2016). Additionally, the COVID-19 pandemic revealed significant disparities in who contracted the COVID-19 virus, illnesses, hospitalizations, morbidity, and mortality for immigrants, visible minorities, and vulnerable and marginalized patients (Mulligan et al., 2020). Therefore, healthcare providers must consider health equity and access to medications when providing diabetes care.

Clinicians and healthcare organizations must recognize and acknowledge the diverse needs of patients from marginalized and vulnerable communities to effectively engage them in the self-management of their conditions, whether they are experiencing pre-diabetes or diabetes. Due to the ongoing COVID-19 global pandemic, there is an urgent need to adopt virtual care strategies. However, emerging policies provide short-term solutions and do not guarantee that the health needs of underserved communities are addressed without further exacerbating the digital divide. Long-term plans are required for the creation and adoption of virtual care resources for all communities, particularly vulnerable and disadvantaged populations. These technologies are now more important than before the pandemic, because of advances in the virtual health dialogue, and in broader discussions surrounding long-term challenges in healthcare.

The digital divide goes beyond improving access to technology, as challenges to adoption exist even when technology is available. This includes patients who are distrustful of technology or those who are forced away from using technology due to improper implementation of digital applications (Bhatia et al., 2020; Shaw, 2020). An example of the lack of faith in technology that exists in Canada is one affecting Indigenous communities due to the history of aggressive marginalization from the practice of settler colonialism that created mistrust in formal structures such as healthcare (Truth and Reconciliation Commission of Canada, 2012). This means that Indigenous communities may be wary of using digital technology for health, particularly when implemented by the same institutions they do not trust. Another example of mistrust includes patients from other marginalized communities being ‘turned off’ from technology because of the limited design of the tool due to a lack of representation or an accessibility issue. For example, if a patient’s gender orientation is not represented, or if a font is too small to be read by those with vision impairment. These examples urge healthcare innovators to consider the end-user in its entirety. While there is no single group responsible for providing access to technology for all, many patients agree that the provincial government should lead the implementation of initiatives aimed at improving access to technology for all (Canada Health Infoway, 2021) with a focus on standardization. This underlines the need for equity-oriented digitalization when considering mHealth technologies.

A 2021 survey study conducted by Canada Health Infoway (2021) revealed that a high percentage (over 60%) of people are open to accessing healthcare services via technology. However, it should be noted that this should be done in a manner appropriate to the populations served. It is also clear that patients expect joint, but transparent, efforts across jurisdictions (e.g., clinicians, researchers, and private industry working together). Patients care about the methods used to facilitate the application of digital innovations in healthcare settings, and they expect this to be done inclusively and equitably. They also believe that this requires cross-sector collaboration (Canada Health Infoway, 2021).

v. eHealth Interventions as Potential Solutions – mHealth

The traditional brick-and-mortar approach where patients visit clinicians at healthcare institutions and receive recommendations for self-care at home has several shortcomings. First, there are significant structural and organizational challenges associated with offering in-person visits, which are not designed to proactively monitor patients with chronic conditions (Wodchis et al., 2015). This results in a lack of on-going management, and – as is the case with diabetes – the symptoms of the condition become exacerbated (Kiran et al., 2012). Second, current funding mechanisms are oriented toward treating acute illnesses and are ineffective in supporting the proactive care required for the

management of chronic conditions (including diabetes) in patients' homes and communities. Patients from marginalized communities have more difficulty navigating this model of care and the frequent, required in-person visits to the clinic (Sarkar et al., 2011) because a significant majority of diabetes clinics provide care during the day only and are located in major cities. In addition, patients with precarious employment or no medical benefits are unable to take time off from their jobs to visit a clinic during the daytime (Sarkar et al., 2011). Consequently, ineffective primary care of diabetic patients contributes to a high number of visits to emergency departments, which is shown to cost the healthcare system approximately ten times more (Glauser, 2020; Wodchis & Reid, 2020).

eHealth is an encompassing term and its definitions have evolved because of the advances in health communication technologies. The most cited definition is the one provided by Eysenbach in 2001:

“eHealth is an emerging field in the intersection of medical informatics, public health, and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development but also a state-of-mind, a way of thinking, an attitude, and a commitment to network, and global thinking, to improve healthcare locally, regionally, and worldwide by using information and communication technology.” (Eysenbach, 2001).

This definition was confirmed by Pagliari et al. in 2005 after conducting a literature review that found 36 other definitions. These researchers extended the definition to include eHealth's ability to offer new ways of providing traditional healthcare. In the initial wave of eHealth innovations, patients were engaged in managing their chronic conditions through patient portals (Grunman, 2014), which provided them with access to their health records and laboratory results. The goal was to motivate patients to use their health records to influence a behavior change (Chaufan & Weitz, 2009). With the advancement of technology, organizations have moved towards the utilization of interactive applications for the management of diabetes. These eHealth tools are also referred to as mHealth, which are Internet-based eHealth tools where the software applications (also known as “applications”) can be used through smartphones, tablets, and desktops.

Over the last decade, eHealth interventions have been touted as the solution to ineffective episodic care (Wodchis et al., 2015). However, given the limited number of studies (as outlined in Table 1 below) demonstrating the effectiveness and feasibility of these technologies for vulnerable and marginalized patient populations, further studies are necessary. As demonstrated in Table 1, there is limited or no focus on this patient population, and this was echoed by Crawford and Serhal (2020) as follows: “In the current response to the COVID-19 pandemic, digital health has been rightly heralded as an innovative health solution that can ensure ongoing access to clinical care and allow public health measures that stem rapid viral transmission and spread. However, unexamined inequities in access to and implementation of digital health as well as the quality of care afforded by digital health can recapitulate and deepen the inequities that have long existed within our healthcare system.”

Table 1

Research Gaps

Note: the studies listed in Table 1 below are a subset of the literature reviewed, and are not inclusive of all the research reviewed to uncover the research gap (population gap). Further, at the time of this study’s literature review, there were a limited number of studies on this topic available in Canada. However, during the COVID-19 pandemic, there has been an increase in interest and focus on digital equity/ inequity.

Authors (year)	mHealth Applications features	Study Setting and Patient Type	Sociodemographic Characteristics
Raheleh et al., 2021	Monitoring of various biomarkers, sending reminders and advice	Patients with Type 2 diabetes	This study focused on evaluating whether the clinical guidance provided by diabetes self-management applications was rooted in clinical best practices. The usability of the applications was also evaluated by patients. Missing populations: no explicit mention of vulnerable & marginalized groups, immigrants, ethnicity, socioeconomic status, etc. ***The “usability” of the applications was assessed, however, there was no explanation of the impact on patients with disability or language barriers.
Eberle et al., 2021	HbA1c monitoring and feedback	Patients with Type 1 & 2 diabetes mellitus and gestational diabetes in Germany	This study primarily focused on the clinical aspects of diabetes management via mHealth applications. Missing populations: no explicit mention of vulnerable and marginalized groups, immigrants, ethnicity, socioeconomic status, etc. ***Social factors were mentioned, but there was no analysis of how these factors influence health outcomes for diabetes.

Shaw, 2020	An updated systematic review of studies on diabetes self-management applications during the COVID-19 pandemic	Patients with Type 1 & 2 diabetes in Canadian clinical settings	<p>This systematic review evaluated diabetes self-management applications to determine whether equity considerations were made in their utilization during the COVID-19 pandemic.</p> <p>Missing populations: patients with disabilities.</p> <p>An outstanding job in highlighting the need for equity considerations.</p>
Crawford & Serhal, 2020	Evaluating care provided to vulnerable/ marginalized patient populations	Patients with Type 1 & 2 diabetes in Ontario, Canada	<p>This systematic review evaluated diabetes self-management applications to determine whether equity considerations were made in their utilization during the COVID-19 pandemic.</p> <p>Missing populations: patients with disabilities.</p> <p>An outstanding job in highlighting the need for equity considerations.</p>
Bhatia et al., 2020	Evaluating care provided to vulnerable/ marginalized patient populations	Patients with Type 1 & 2 diabetes with CHC's in Ontario, Canada	<p>This systematic review evaluated diabetes self-management applications to determine whether equity considerations were made in their utilization during the COVID-19 pandemic.</p> <p>Missing populations: immigrant populations</p> <p>An outstanding job in highlighting the need for equity considerations.</p>
Shaw, 2019	A systematic review of studies on diabetes self-management applications	Patients with Type 1 & 2 diabetes in Canadian clinical settings	<p>This systematic review evaluated diabetes self-management applications to determine whether equity considerations were made in their development and utilization.</p> <p>Missing populations: patients with disabilities.</p> <p>Otherwise, an outstanding job of highlighting the need for equity considerations.</p>
Torbjørnsen et al., 2019	HbA1c monitoring and patient feedback	Patients with Type 2 diabetes in Norway	<p>This study focused on evaluating the users (patients') usability and acceptance of a self-management diabetes application.</p> <p>Missing populations: no explicit mention of vulnerable & marginalized, groups, immigrants, ethnicity, socioeconomic status, etc.</p> <p>***Digital distress was noted as a factor impacting usability & acceptability; however, a definition/ explanation of this term was not provided.</p>
Huang et al., 2018	Glucose monitoring and abnormal values and alerts	Patients with Type 1 and 2 diabetes in clinical settings in 10 different countries (titled "a global review")	<p>This study focused on the clinical efficacy of diabetes applications in addition to factors such as language, culture, and socioeconomic barriers to adoption and utilization. This study highlighted the negative impacts of these barriers and recommended further research.</p> <p>Missing populations: no explicit mention of immigrants.</p>

Boels et al., 2018	HbA1c monitoring, abnormal values alerts, one-way texting, glucose variability alerts	Patients with Type 1 and 2 diabetes in clinics in the Netherlands	<p>This study primarily focused on the clinical and behavioral aspects of diabetes management via mHealth applications.</p> <p>Missing populations: no explicit mention of vulnerable and marginalized groups, immigrants, ethnicity, socioeconomic status, etc.</p> <p>***The cost of phone & internet services was considered, however, there was no in-depth evaluation of the impact of this on the aforementioned groups.</p>
Latulippe et al., 2017	A systematic review of studies on diabetes self-management and related theories/ frameworks	Diabetic patients	<p>This study was a systematic review with a focus on inequalities in eHealth provision. Theories and frameworks were also evaluated for appropriateness.</p> <p>Missing populations: None</p> <p>An outstanding job in highlighting the need for equity /equality considerations.</p>
Chavez et al., 2017	Type 2 diabetes monitoring, texting, various alerts, and patient engagement functionalities	Patients with Type 2 diabetes in Spanish clinical settings	<p>This study focused on evaluating the accuracy of the content in diabetes self-management applications compared to clinical practice guidelines.</p> <p>Missing populations: no explicit mention of vulnerable & marginalized groups, immigrants.</p> <p>***Ethnicity and socioeconomic status were briefly mentioned when the reference was made to the number of Americans with a mobile phone, however, there was no in-depth evaluation of the impact of these factors on the aforementioned groups.</p>
Brahmbhatt et al., 2017	Type 1 diabetes bloodsugar tracking, medication tracking, some messaging features	Secondary study of patients with Type 1 diabetes in various Canadian clinical settings	<p>This (secondary) study focused on evaluating the factors influencing the uptake of mHealth diabetes applications.</p> <p>Missing populations: no explicit mention of vulnerable & marginalized, groups, immigrants, ethnicity, socioeconomic status, etc.</p>
Goyal et al., 2016	Self-monitoring of blood glucose levels and automated feedback	Patients with Type 2 diabetes in various Canadian clinical settings	<p>This (secondary) study primarily focused on behavioral factors influencing patients' effective use of mHealth applications.</p> <p>Missing populations: no explicit mention of vulnerable & marginalized groups, immigrants, or ethnicity. Socioeconomic status, etc.</p>
Young Kim et al., 2016	Monitoring of blood glucose, etc., and sending medication reminders	Patients with diabetes and other health challenges in the USA.	<p>This study focused on the efficacy of manual vs. automated data entry in self-management applications.</p> <p>Missing populations: no explicit mention of vulnerable & marginalized groups, immigrants, ethnicity, socioeconomic status, etc.</p>
Zhao et al., 2016	An evidence review of studies on diabetes self-management applications	Patients with diabetes in low- and middle-income countries	<p>This evidence review primarily focused on patient populations in low- and middle-income countries.</p> <p>Missing populations: None</p> <p>A great job at highlighting the need for equity considerations in mHealth utilization.</p>

The goal of mHealth applications is to make it easy for patients to take care of their health conditions ubiquitously (Young Kim et al., 2016; Zhao et al., 2016). mHealth applications for diabetes self-management are used primarily for the proactive engagement of patients, and the clinician's ease of monitoring. Patients record data on their diet, exercise, medications/ injections, and/ or blood sugar levels via interactive features on their smartphone, tablet, or desktop version of the application(s). They receive alerts for dose or diet adjustments based on self-tests for blood glucose and share their profile with clinicians on an ongoing basis, leading to educational opportunities for patients through their care teams. The clinician's monitoring responsibilities can be done through a physician, nurse, or diabetes educator, who can review patient data and glucose levels and assess this data about the patient's diet and routine. This data can be reported to the care team via the submission of self-reported patient data (manually entered into a mobile application) or directly captured and reported by the mobile application (via Bluetooth devices on cellphones).

Overall, diabetes mHealth applications allow patients to track their diabetes status and manage their treatments in the comfort of their homes with remote clinical monitoring and a reduced need to visit clinics in-person. This not only allows for flexibility but helps clinicians to easily monitor and advise their patients according to large amounts of real-time data collected remotely. Current mHealth applications for diabetes self-management have been evaluated during the last few years, and a systematic review of 23 studies has shown efficacy in the studied samples (Zhao et al., 2016). Though several applications have emerged, mHealth technology for diabetes management falls into two main categories: privately funded and publicly funded (Brahmbhatt et al., 2017). It is estimated that there are approximately 3374 Android and 4477 iOS mHealth diabetes applications that have been privately developed/ funded (Huang et al., 2018), while the number of publicly developed/ funded applications is only around 200 (Brahmbhatt et al., 2017).

Patients are informed about the availability of mHealth diabetes applications through media campaigns or educational resources in healthcare settings, with the latter being a smaller proportion (Goyal et al., 2016). In the case of media campaigns, private industry is often the dominant player, while public organizations (Canada Health Infoway or Digital Health Canada, for example) may occasionally promote evidence-based applications (Goyal et al., 2016). In healthcare settings, patients learn directly about these tools from hospitals (like SickKids and the University Health Network in Ontario) or through their primary care providers. Patients learn about the application features through built-in videos and training modules in privately developed/ funded applications (Goyal et al., 2016).

Training opportunities are limited in publicly developed/ funded applications unless patients are a part of a pilot study or an early adopter of the tool (Brahmbhatt et al., 2017), and therefore, the expectation is that health providers will educate their patients about the features of these tools. As with broader mHealth resources, there are similar challenges in using mHealth tools for diabetes self-management, for example, the risk that a poorly designed application will deter patients from using it. Issues in ease of use are usually a result of an improperly designed user interface or hardware (Scheibe et al., 2015).

This barrier can result from a lack of understanding among mHealth application developers of the diverse needs of patients (their end-users), to better support patients who may have difficulties reading text on screens, hearing alerts, or understanding the language or medical terminology (Scheibe et al., 2015). At the same time, scholars (Young Kim et al., 2016; Zhao et al., 2016) have stated that mHealth interventions are a powerful mechanism for facilitating the engagement and empowerment of individuals living with diabetes to self-management. Yet, adherence to self-management programs is uneven and complicated due to patients' life contexts like poverty, discrimination, social inequities, social exclusion, and other structural inequities (Grunman, 2014). Researchers have identified occurrences where eHealth innovations have contributed to greater inequality between different social classes. Posing the risk of patient populations with existing barriers being excluded on a large-scale from the potential benefits of eHealth resources (Latulippe et al., 2017).

The landscape for mHealth is transforming in Ontario. The Digital First for Health Strategy of 2020 outlines investments that would make digital technology (like electronic devices with software applications) a more integral part of the healthcare system (Canada Health Infoway, 2021). Such technologies present an opportunity for greater ease, quality, and personalization of healthcare, as 66% of Canadians own a smartphone, and many more have consistent access to a personal computer (Canada Health Infoway, 2021). The widespread use of mobile devices and other digital technologies means that the potential for mHealth applications in healthcare is immense. However, some risks are especially evident from an equity point of view. Some individuals and groups (vulnerable and marginalized) are systematically excluded from the benefits of technology (Bhatia et al., 2020; Crawford & Serhal, 2020; Shaw, 2020). As discussed above, not all individuals and communities have equal access to connected digital devices (Bhatia et al., 2020; Crawford & Serhal, 2020; Shaw, 2020). Thus, as healthcare systems concentrate on deploying mHealth solutions, policymakers and practitioners need to consider that not all communities can access digital technology in an obvious way. The concepts of the digital divide, digital equity, and digital inequality become relevant in this

context.

The term “digital divide” refers to unequal access to digital tools, including those used for health enhancement. Latulippe et al. (2017) further elaborate that a digital divide can be primary (unequal access to the Internet or electronic devices), secondary (a knowledge gap in the use of electronic devices, tools, and applications), and tertiary (a disparity between the available resources and those needed, in the context of healthcare, when “health information [is not] comprehensible and useful for disadvantaged populations”). It is crucial for Ontario and other provinces to consider the digital divide’s implications for transformative digital health visions. Notably, “eHealth has the potential to widen the gap between those at risk of SHI [social health inequities] and the rest of the population” (Latulippe et al., 2017).

The existing digital divide was further exacerbated during the COVID-19 pandemic when patients with diabetes who were at increased risk for being infected were unable to access ongoing diabetes care as a result of their low socioeconomic status and lack of ability to acquire the technologies necessary to access ongoing care (Bhatia et al., 2020; Wang & Tang, 2020). According to a recent report (June 2020), 42% of Canadians with diabetes (1,000 patients surveyed) would prefer using telemedicine or virtual health over in-person visits since the COVID-19 pandemic (Diabetes Canada, 2022). Despite the Ministry of Health and Long-Term Care issuing a billing code for virtual care during the COVID-19 pandemic, vulnerable and marginalized patient populations were not the ones heavily benefitting from this due to a lack of access to the necessary technologies (Bhatia et al., 2020; McMahon et al., 2020). Additionally, despite the increase in the utilization of virtual health during the COVID-19 pandemic, vulnerable and marginalized patient populations with diabetes were unable to benefit due to the widening social health inequities (Mulligan et al., 2020). According to Hollander & Carr (2020), the COVID-19 pandemic has “crystalized the important linkages between the social determinants of health, technology utilization, and diabetes outcomes”.

Indeed, this highlights the importance of asking whether primary care providers consider a patient's life context (social determinants of health) when determining whether to recommend mHealth applications for the self-management of diabetes. Their attitude towards health equity is vital in examining whether the potential exists for these mHealth tools to be leveraged as universal diabetes management tools (Young Kim et al., 2016). Additionally, this information has become vital since the COVID-19 pandemic and the increasing dialogue about using mHealth or digital tools on a long-term basis (Bhatia et al., 2020; Mulligan et al., 2020).

In summary, the empirical review of the literature demonstrates that the management of diabetes through interactive mHealth tools for patients has the potential to improve access to care, but it remains unclear whether vulnerable and marginalized communities have access to these technologies through primary care providers like FPs and NPs and how it might have changed during the pandemic.

2. THEORETICAL REVIEW

Given that system-level adoption of mHealth innovations could be influenced by forces at the micro, meso, and macro levels, theories with a focus on these factors were reviewed. As a result, the Ecological Systems Theory and Weber's Conflict Theory were found relevant to facilitate data collection and/ or the interpretation of the findings. These two theories (Ecological Systems Theory and Weber's Conflict Theory) are summarized below:

i. Weber's Conflict Theory

Weber's Conflict Theory (Cockeram, 2015; Dobratz et al., 2019) is premised on the idea that not all people are treated equally in society and that people of different classes are treated differently. People of "higher status" are cited as people with "prestige" by Weber. He argues that "higher status" people receive differential and respectful treatment compared to people of "lower status" who receive very little respect. The "Weberian approach" to social inequality is inclusive of other factors such as age, gender, and ethnicity. This theoretical lens is crucial to this study, as it offers insight as to whether primary care providers (assumed to be a higher social class) consider the everyday life context and the social determinants of health when treating vulnerable and marginalized patient populations (assumed to be of a lower class). Following Weber's Conflict theory (Cockeram, 2015; Dobratz et al., 2019), salient biases among healthcare providers (assumed to be of higher social class/ status) hold the power (due to their position in society) to determine whether mHealth applications can help patients with

diabetes from vulnerable and marginalized patient populations.

Weber's Conflict Theory has not been heavily used in digital health research in the past by social scientists but has been common within race, gender, and related social sciences research. The reason for this is that eHealth research is traditionally conducted to demonstrate uptake, utilization, value, or cost savings, which is difficult to demonstrate using this theory, as it focuses on salient inequities in class, and social and economic status. Additionally, eHealth research is conducted to justify government investment in various technologies, using indicators outside the scope of this theory. In the context of this dissertation study conducted with primary care providers (PCPs), Weber's Conflict Theory allowed me to shift the focus from an individual level to explore systemic biases and provide insights for equitable policymaking and practice recommendations.

ii. Ecological Systems Theory

The Ecological Systems Theory (Bronfenbrenner, 1981; Stokols, 1996), which connects an individual with the broader environment, is another relevant framework. The theory proposes interacting layers of microsystem, mesosystem, exo-system, and macrosystem. The micro-layer refers to the systems closest to an individual, such as home, work, and school (i.e., microsystems) while the mesosystem refers to the interactions between various microsystems. The exo-system refers to the context that has an indirect influence on a person, such as funding models influencing practice style. The macro-layer refers to the shared beliefs and norms such as cultural or societal customs (e.g., gender and race) and laws.

The Ecological Systems Theory (EST) has previously been used in healthcare research in the following broad domains to study disparities, interprofessional education, and collaboration in varying contexts, such as:

- 1) To understand disparities in black maternal morbidity and mortality
- 2) To understand barriers to accessing care for Latino mental health services
- 3) To understand interprofessional education in healthcare settings
- 4) To understand interprofessional collaboration in healthcare settings
- 5) To study challenges in the use of technology (biomedical) in this space

Given the aforementioned, EST has previously been used to study disparities, interprofessional education, and collaboration in varying contexts. However, EST has been used in a limited capacity to study disparities in the adoption and utilization of mHealth technologies. Thus, given the past utilization of this theory to study disparities, interprofessional education, and collaboration, it is reasonable to utilize this theory to study the current topic. EST has not been frequently used in eHealth research, as it focuses on multiple levels of interactions, whereas traditional eHealth research (for funding purposes) focuses on the lower levels of interactions, such as impacts and patient outcomes. eHealth research responds to the prerequisite for government-funded (eHealth) innovations in Canada where successful pilot studies and implementation data are an expectation.

In summary, Ecological Systems Theory offers a comprehensive framework to examine the micro-, meso-, macro-, and exo-system level forces influencing PCPs about mHealth tools for patient use while its weaknesses (e.g., power dynamics) could be overcome by drawing from Weber's Conflict Theory to reveal the challenges around power dynamics. The review of these two theoretical lenses (EST and Weber's Conflict Theory) offered theoretical sensitivity to the researcher that informed the planning and interpretation of the results with suggestions for policy and practice developments.

3. Providers and Patient Engagement

Age: Age is a proxy indicator of one's experiences, such as breadth and depth of practice and training, and is likely to influence how PCPs behave and work. This includes how physicians or nurses treat patients and whether they discuss topics relating to equity before recommending the use of mHealth for diabetes management. For example, Roos et al. (2004) noted that even though older physicians (age 50 and older) were aware that hospitals could save 15% of total hospital expenditures by reducing socio-economic differences in health, they were not comfortable with discussing the topic with their patients. Scholars argue that this is a consequence of weak integration of the social determinants of health in medical school curriculums (O'Brien et al., 2014; Roos et al., 2004). Nonetheless, physicians may learn about population health and broader contextual determinants of health through public health training offered in the field, residency, or dual MD/ Masters programs. For nursing professionals, this is not problematic, as nursing professionals are socialized during their schooling about the importance of assessing and treating the "whole patient" (Canadian Association of Schools of Nursing, 2014; Nkunu & McLaughlin, 2018). The historical emphasis on the social context in nursing was well summarized by Olshansky in 2017 as follows:

“Nursing has always had a strong focus on SDOH. Florence Nightingale emphasized the importance of hygiene, nutrition, social network, and social class. Lillian Wald, the founder of public health nursing, established the Henry Street Settlement, out of which developed the Visiting Nurse Service of New York, which provides healthcare to the poor. The Code of Ethics for Nurses of the American Nurses Association includes principles of social justice and emphasizes the need to integrate social concerns into nursing and health policy.” (Olshansky, 2017).

Gender: It is well documented that a physician’s gender also influences their practice style, including communication with their patients (Glazier, 2007; Nkunu & McLaughlin, 2018; Roter & Hall, 2004; Russel et al., 2009; Sinha & Schryer-Roy, 2018). Male physicians are less likely to discuss equity or topics related to the social determinants of health with their patients. Comparably, female physicians are more likely, and more comfortable, raising these topics, identified Roter & Hall in their 2004 comprehensive study. The study found that “female primary care physicians and their patients engaged in more communication that can be considered patient-centered and had longer visits than did their male colleagues” (Roter & Hall, 2004). They also found that female physicians engaged more in psychosocial questioning than male physicians (Roter & Hall, 2004). This point of view is also supported by other scholars like Glazier (2007). Additionally, in a 2018 study conducted by Nkunu & McLaughlin, six out of ten physician participants involved in advocacy work were women. The author pointed out that this is important to note because, amongst their patient populations, women/ female patients appeared to be the most marginalized group. Thus, it is problematic if their male physician is not comfortable with discussing topics on equity or the social determinants that could be having a great impact on their health outcomes. Among nursing professionals, women were primarily the ones involved in equity advocacy work, as well; however, the data may be skewed higher for females, given that they comprise 80–85% of the nursing population (Canadian Association of Schools of Nursing, 2014; Nkunu & McLaughlin, 2018).

Advances in medical education and training are providing the opportunity for increased awareness and action amongst clinicians about the role of the social determinants of health in their work, with new discussions emerging on concepts like social prescribing/innovations. This focus is socializing clinicians to their (salient) role of treating the whole patient (Bloch & Rozmovits, 2021). These authors pointed out that awareness for clinicians first begins with acknowledging the connection between the social determinants of health and the health outcomes of their patients. Despite advances in medical

training, these issues persist and will take time to improve, as pointed out by Sinha & Schryer-Roy (2018) in their article titled “Digital health, gender and health equity: invisible imperatives”. Therefore, it is important to measure the association between a physician’s gender and conversations on equity issues with their patients.

Language and/ or ethnicity: The language and/ or ethnic concordance between a physician or nurse and patient is a strong indicator of their ability to frame equity issues in a non-judgmental and culturally sensitive manner when engaging patients (Canadian Association of Schools of Nursing, 2014; Chaufan & Weitz, 2009). Discussing equity issues is highly sensitive in nature. Patients may not be comfortable with or may refuse altogether to discuss their equity challenges with their family physicians or nurses from dis-concordant ethnic origins. Dobson et al. (2012) stated that physicians may be unsure of how to frame the topic and the appropriateness of raising equity-related issues with their patients, as communication sensitivity around equity issues and topics was not fundamental to medical training and was considered an optional responsibility in their scope of practice. Therefore, language and ethnic know-how in framing equity issues on a PCP’s part was relevant for this research and was assessed. This previously cited practice gap is being addressed both in medical training and practice through advancements, such as social prescribing (Bloch & Rozmovits, 2021). This approach to care encourages primary care providers to consider non-traditional/ non-biomedical ways of treating the whole patient (Bloch & Rozmovits, 2021). For example, if an elderly newcomer patient to Canada presents with symptoms of depression due to isolation, then culturally appropriate social and recreational activities could be considered as the first line of treatment instead of medications or other traditional medical approaches. The social prescribing approach previously discussed could be applicable here, as it is proving to be successful in the United Kingdom (UK) and has been gaining momentum in Canada in some primary care models such as CHCs (Mulligan et al, 2020).

As previously discussed, nursing professionals are more comfortable with discussing equity issues with their patients for two reasons: first, the majority of the nursing workforce are women and, as previous research shows, women are more comfortable with doing so; second, nursing professionals are comfortable with discussing equity issues as a result of their holistic training approaches (Canadian Association of Schools of Nursing, 2014).

Place of training: A PCP's place of training is another possible determinant of if and how equity issues were taught to them during their school years. In a 2018 study by Nkunu & McLaughlin, only one in ten study participants (physicians) reported learning about equity issues in his/ her undergraduate classes. However, all participants agreed that medical schools have a responsibility to provide training and enhance awareness of this (Nkunu & McLaughlin, 2018). For example, some medical schools place high importance on the biomedical aspects of care only (Lawrence, 2005). At that time, if physicians were trained at these schools, their training on the impact of equity on a patient's health outcomes was most likely limited. Physicians in the study by Nkunu & McLaughlin (2018) noted that "this (equity) was not a focus at medical school". Instead, they learned about equity challenges in healthcare before starting medical school (due to personal experiences) or during their clinical residencies (such as on Indigenous reserves). However, recent progress has been made in both medical education and training. For example, the inclusion of CanMeds in medical education focuses on the social determinants of health and equity issues in primary care provision. CanMeds was introduced in 1993 and is now a standard part of medical training in Canada (The College of Family Physicians of Canada, 2017). Additionally, clinicians are now exposed to concepts such as social prescribing, which incorporate awareness of treatments of a non-medical nature (Bloch & Rozmovits, 2021). As discussed earlier, this is not the case for nursing professionals, as their training includes a holistic view/ assessment of patients when providing care. For example, nursing schools include discussions on psychology, counseling, health behavior change, and population and community health from a non-biomedical perspective (Canadian Association of Schools of Nursing, 2014).

Remuneration: Existing studies (Peckham et al., 2018) appraised during the literature review highlighted strong correlations between practice settings, remuneration models, and opportunities for context-oriented discussions. Remuneration models dictate how much time a family physician (FP) spends with a patient, which allows time for conversations about everyday life challenges. A similar sentiment was echoed by Aggarwal (2009), stating that physicians compensated on a salaried model were less concerned about the volume of patients they saw and, therefore, were able to inquire about equity issues. Following the same argument, nursing professionals are then also more likely to ask about everyday life context, as they are salaried PCPs regardless of their appointment in a primary care model. Others suggest that PCPs in remuneration models with high patient volumes are likely to worry about the visit time (Wildevuur et al., 2017). Further, the time spent on remote monitoring or virtual visits is not routinely reimbursed in the current Canadian health system, even though this might be beneficial for diabetes care using mHealth applications (Kiran et al., 2012).

mHealth Tools: The adoption of mHealth tools by PCPs to engage patients could also be influenced by some of the factors discussed above, along with the design of technology, such as usability features, privacy/security of data, and patient eHealth literacy. In addition, privacy laws/legislations hinder PCPs from easily exchanging patient data with their peers out of fear of a privacy breach. When PCPs and their peers are not co-located in the same clinic, data exchanges require data-sharing agreements (Canada Health Infoway, 2021). The need to enhance the user-friendliness of mHealth tools for both patients (e.g., ease to enter data) and providers (e.g., time flexibility to review results) has also been recognized by primary care clinicians and researchers (Mastrototaro, 2016; Pludwinski et al., 2016; Wildevuur et al., 2017). Further, physicians constantly hear about privacy concerns from their patients (Canada Health Infoway, 2021) and this may add to their hesitations in introducing mHealth applications to patients. They are also found to struggle to provide explanations to patients for how their health information is kept private and secure, because privacy legislation is complex, and concepts such as consent for data sharing are not easy to articulate (Canada Health Infoway, 2021). Finally, diverse levels of patient health literacy are often not accounted for in developing mHealth tools (Schimmer et al., 2019) and could be a barrier for PCPs when adopting these tools. In summary, it is important to look beyond PCP behaviors and examine multi-layered factors that make it challenging for patients and PCPs to engage in partnerships for the management of diabetes (Latham & Marshall, 2015). Indeed, equity-informed care ought to utilize a holistic approach that ‘treats the whole person’ by acknowledging both their social and medical needs.

3. OVERARCHING RESEARCH AIM

The review of relevant literature informed the development of a mixed-method study as the dissertation project. The overarching aim of the study is to examine the engagement of primary care providers (PCPs) with patients about their everyday life context when offering advice about the potential use of mHealth tools for diabetes self-management. For this purpose, a cross-sectional survey study was conducted with PCPs practicing in Ontario, followed by qualitative interviews with a subsample. More details are provided in the next chapter, including a discussion on the difficulties encountered during data collection due to the COVID-19 pandemic restrictions. A focused search of the literature was undertaken to understand the macro-, meso-, micro, and exo-system factors (variables) that may influence PCP attitudes toward advising on the use of mHealth tools. It should be noted that not all of the factors (variables) that emerged from the literature were chosen for further investigation and analysis. Only the variables that were deemed important to the study and in

alignment with the EST were chosen for further evaluation. These variables are as follows: age, gender, ethnicity, language, place of training, remuneration, and mHealth Tools. The aforementioned variables were chosen to be included in the study as they emerged from the literature (Bhatia et al., 2020; Chan Nguyen et al., 2022; Dover & Belon, 2019; Shaw, 2020, van Deursen, 2020) as indicators/ factors capable of determining whether digital equity/ inequity was present or not. In addition, consideration of the length of the survey played a role in the number of variables selected to be included in the study. The survey had to be of a reasonable length to incentivize clinicians to complete it, given that the survey was distributed during the COVID-19 pandemic when clinicians were struggling with burnout. After evaluation of the aforementioned variables, they were categorized as follows: macro-, meso-, micro, and exo-system factors.

CHAPTER 3: METHODS

This chapter begins with an overview of the research paradigm and the theoretical stance taken by the researcher. Next, a mixed-method approach is discussed, followed by the survey study and qualitative interviews chosen by the researcher with details on their appropriateness, procedures for data collection, and analysis, along with limitations. Before the collection of any data, ethics approval was obtained from York University (Appendix 1 and 2).

1. RESEARCH PARADIGMS

A research paradigm refers to the worldview of a researcher with a set of assumptions underlying her/his research inquiry. This section presents the chosen research paradigm (pragmatic) for this research, followed by an explanation of the researcher's worldview along with justification.

i. Overview

A research paradigm can be defined in terms of ontological (i.e., the nature of reality), epistemological (i.e., nature of knowledge and the relationship between the inquirer and research objects/ subjects), and methodological (i.e., approach towards knowledge acquisition) assumptions or beliefs that mold all stages of a disciplined inquiry, from the formulation of a research question to the dissemination of results (Hatch, 2002; Lincoln & Guba, 2005). The research enterprise in social sciences usually adheres to one of these research paradigms: positivism, post-positivism, critical social theory, constructivism, participatory, and pragmatic paradigm. In contrast, researchers following pragmatism reject the necessity to adhere to any single set of worldviews.

The *pragmatists* reject the duality between an objective (as in post-positivism) and a subjective (as in constructivism) reality. Pragmatists believe that reality exists both in the mind and independent of the mind. Instead of focusing on ontological and epistemological concerns, the focus is on a better understanding of a research problem by relying on pluralistic methodological approaches (Creswell & Poth, 2017; Morgan, 2007). The epistemological belief is that the studied phenomena can be measured using multiple tools if appropriate, such as the use of "mixed methods." The ontological belief is that there are multiple truths, therefore the truth can be interpreted and negotiated. The current mixed methods study adheres to pragmatic philosophical assumptions and relies on both quantitative and qualitative approaches to grasp an expanded/ enriched understanding of the constructs studied and the hypotheses evaluated.

ii. Study's Research Paradigm

This dissertation inquiry is informed by a pragmatic research paradigm with its emerging focus on social justice and advocacy (Morgan, 2014). This aligns well with the researcher's interest in real-world change and a focus on equity in access to care. The pragmatic paradigm can be defined as an approach that focuses on actionable, community-based research involving participants. In many cases, the pragmatic approach involves the utilization of a mixed methods methodology that involves collecting, analyzing, and integrating quantitative (e.g., surveys) and qualitative (e.g., focus groups and individual interviews) methods. This aligns well with the mixed-method approach taken by the researcher (described below) to inform practice and policy for equitable access to care among patients with diabetes. The use of methodological triangulation in pragmatic research allows the researcher to pursue their questions and areas of interest, as well as capture the voice of participants.

2. MIXED METHOD APPROACH

A mixed-method approach to research combines techniques from both quantitative and qualitative approaches. There are several classification systems of mixed method designs in social and health sciences research (Creswell & Plano Clark, 2017). This study employs a sequential mixed methods design which is explained in greater detail in the subsequent paragraphs. Creswell (2017) identified six types of mixed method designs based on four important aspects of timing, weighting, mixing, and theorizing. **Timing** refers to whether the quantitative and qualitative data collection occurs concurrently (i.e., in a single-phase) or sequentially (i.e., in distinct chronological phases). As stated above, this study employed a sequential approach starting with the quantitative study (cross-sectional survey), followed by the qualitative study (one-on-one interviews). Further details on these studies, along with the rationale for these choices are explained in subsequent paragraphs.

Weighting refers to whether the quantitative or qualitative research was given priority in the mixed-method study. In this research, the weight of both studies was equal as the qualitative study (one-on-one interviews) complemented the insights gained from the initial quantitative study. Further details on these studies along with the rationale for this choice are explained in subsequent paragraphs.

Inherently, employing this approach implicitly shows that an emergent design was utilized. An emergent design by definition can be described as "the ability to adapt to new ideas, concepts, or findings that arise" (Pailthorpe, 2017). Additionally, an emergent design welcomes unanticipated information, often adding to the richness of the data. An emergent design is not limited only to the

data collection and analysis; an emergent approach is embedded within every stage from conceptualization to publication (Pailthorpe, 2017). The “researcher takes cues from the data, process or conclusions and the whole study is a reflection of varying levels of emergent characteristics within those research processes” (Pailthorpe, 2017). And finally, **the mixing** of the quantitative and qualitative data can occur at any stage, including the data collection stage, the data analysis stage, and/ or the interpretation stage. In this study, the mixing took place at all aforementioned stages, but primarily in the data analysis and interpretation stages for the reasons previously mentioned. The qualitative study results were evaluated in tandem with the quantitative study to strengthen the insights gained from both studies. Lastly, a mixed-method study may or may not utilize a theoretical perspective to guide the entire design. In this research, a theoretical perspective was utilized.

The current study utilizes a sequential mixed methods design by conducting two studies (Creswell & Plano Clark, 2017). Study 1 involved the use of a survey with primary care providers and Study 2 involved semi-structured qualitative in-depth interviews with a subset of willing survey participants. Several reasons informed the researcher’s selection of a mixed-method approach. Utilizing the quantitative surveys allowed for reaching a larger number of primary care providers including those serving patients from marginalized communities. Further, the qualitative in-depth interviews generated a deeper understanding of primary care providers’ challenges when employing an equity perspective in their everyday practice. This provided greater insights not only for the interpretation of the survey findings but also in the areas untapped by the survey though deemed relevant by the participants in their real world. Additionally, a mixed-method approach is epistemologically aligned with the pragmatic research paradigm.

Whether conceptual congruence is needed between the overarching research paradigm and the use of mixed-method design is a topic debated among mixed-method scholars. For example, Creswell (2017) and Patton (2014) follow a-paradigmatic stance emphasizing substantive theory over paradigm, while Greene & Hall (2010) and Tashakkori & Teddlie (2010) emphasize congruence with a single paradigm. According to Tashakkori & Teddlie (2010), paradigms having congruence with the mixed method design are pragmatism, critical realism, and transformative paradigms (e.g., Mertens, 2007).

3. CROSS-SECTIONAL SURVEY STUDY

There were several reasons for the selection of an online survey method (Dillman et al., 2014). A survey allows a researcher to reach a large number of eligible participants and increases the possibility of attaining a representative sample from the studied population. The online survey method is convenient for participants, especially if they are busy and need time and flexibility to complete it in one or more sitting. This was viewed as very relevant for the dissertation project that aimed to recruit primary care providers. Another advantage of using the survey method is that participants are more likely to respond to sensitive questions truthfully when anonymity is offered. An online survey is relatively low cost and was seen as feasible for the student researcher. With the COVID-19 pandemic leading to lockdowns and social distancing policies, the survey method enhanced the continuity of research despite some challenges.

The following section provides the survey study details, including the aims and objectives, sample size, measurement, and limitations. Before the collection of any data, ethics approval was obtained from York University, and the approved protocol was shared with the potential collaborating organizations with primary care providers as their members. The survey study invitation, consent form, and survey questionnaire are included in Appendix 3, 4, and 5.

i. Aims and Objectives

The overarching purpose of the survey study was to investigate the perceptions of primary care providers (PCPs) about the use of diabetes self-management mHealth tools (i.e., diabetes applications on mobile phones or web-accessible portals) among patients. The **primary aim** was to examine PCPs' understanding of health equity (main outcome) when considering mHealth diabetes self-management applications during a hypothetical patient encounter. It was hypothesized that the type of practice setting (i.e., CHC vs. Non-CHC) would contribute significantly to predicting the PCP's understanding of health equity (main outcome), over and above provider-related (set A) and patient-related (set B) possible explanatory variables. A hierarchical regression analysis was planned. The **secondary aim** of the study was to examine the barriers and facilitators that PCPs consider important in the adoption and use of mHealth diabetes self-management tools and how these might vary by the providers in CHC and Non-HC practices. Mean score calculation was planned. Given the collection of data during the COVID-19 pandemic, the study's collaborators expressed interest in gathering information about the virtual care experience of providers; this added a **tertiary aim** for the

study to examine virtual care during the pandemic. However, since this is not the main focus of the study, the results are presented in the appendix.

ii. Eligibility, Sampling and Sample size

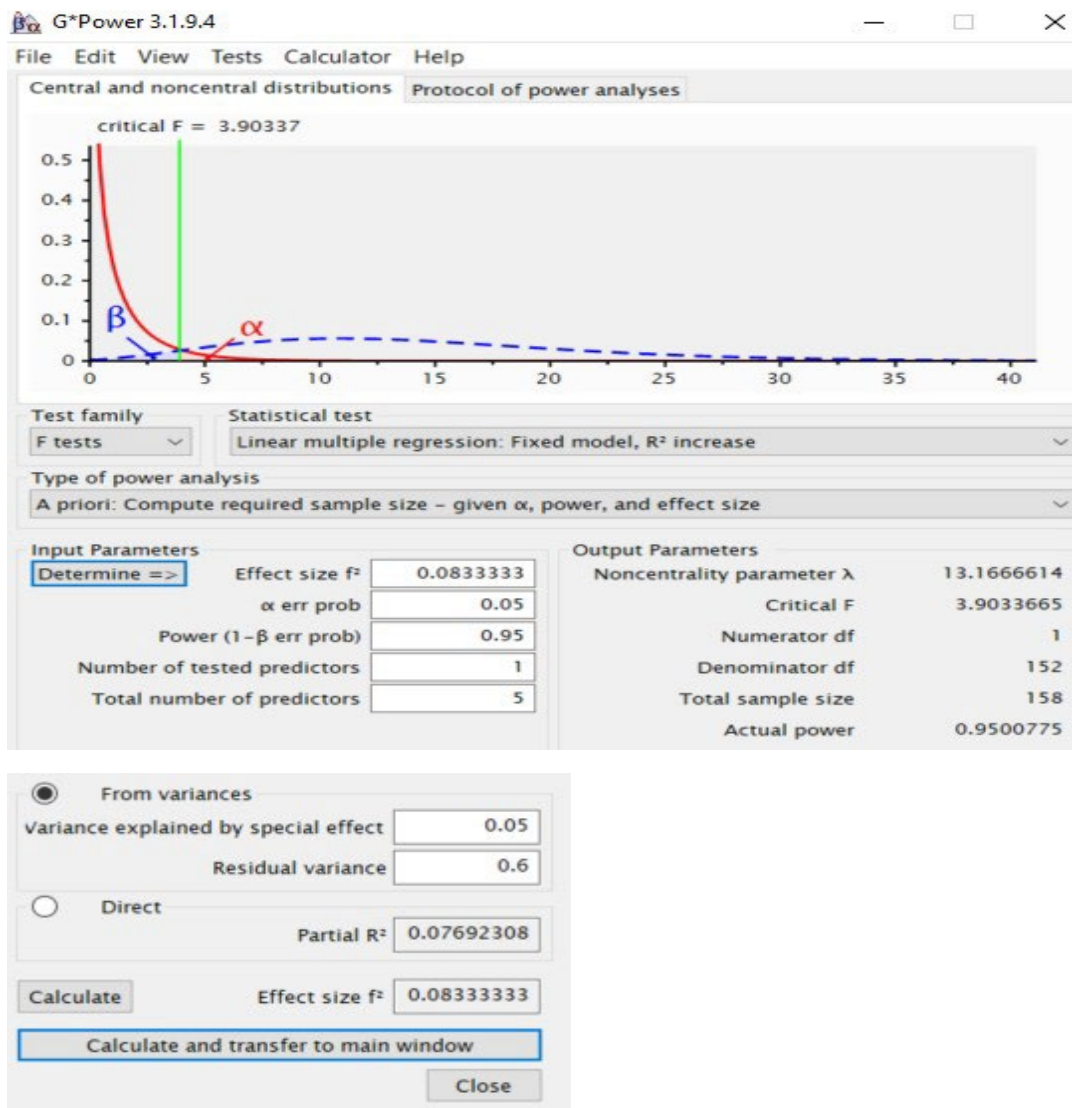
The primary care providers eligible to participate in the study were family physicians, nurses, and nurse practitioners practicing in any model of primary care in Ontario at the time of the study.

The criteria were kept broad given the low response rates known for research involving clinicians (Dillman et al., 2014) and the COVID-19 pandemic at the time of data collection.

To identify a sampling frame, the primary researcher and her advisors communicated with several organizations, including The Alliance for Healthier Communities, the Association of Family Health Teams of Ontario (AFHTO), the Nurses Practitioner's Association of Ontario (NPAO), and the University of Toronto Practice-Based Research Network (UTOPIAN). The first three organizations/associations initially agreed to an earlier data collection start date, but later requested a delay due to COVID-19 restrictions. The last organization (UTOPIAN) had to completely withdraw participation from the study due to organizational mandates and constraints, for example, the review of human participant research protocol was halted for all research unless it was directly related to COVID-19. The collaborating organizations distributed the online survey link in their newsletters to members via email. The number of PCPs who reviewed the study invite is unclear and hence, the exact denominator cannot be calculated. A limitation of the online survey was that the email list of eligible participants was not provided to the researcher. These circumstances made the study sample convenience based.

To test the primary hypothesis, the sample size calculation was conducted for hierarchical regression analysis using the G*Power calculator (Box 1). Multiple Linear Regression, Fixed Model (for an increase in R^2) analyses were used. It was assumed that set A predictors will explain a variance of 15%, set B variance of 20% and set C variance of 40%. With assumptions of sample homogeneity, type I error set at 0.05, power of test set at 0.8, three sets of predictors with a total of five variables, and anticipated effect size f^2 set at 0.08 (i.e., between small and medium), the estimated sample size was 152.

Box 1: Sample Size for Sequential Multiple Regression



iii. Measurement: Main Outcome and Explanatory Variables

The variables included in this research were selected through the processes outlined below (steps 1-4) and echoed by Chowdhury & Turin (2020) as academically/professionally appropriate for the identification and refinement of variables to be included in research studies. They (Chowdhury & Turin, 2020) also noted that these processes can be generally applied to many areas of research, and stated that “one way to refine the list of potential variables is to choose the candidate variables first, especially if the sample size is small”. Candidate variables for a specific topic are those that have demonstrated previous prognostic performance with the outcome.

Additionally, Chowdhury & Turin (2020) also stated that “systematic reviews and meta-analyses can be performed to identify candidate variables”. And that a systematic review can be used to help count the number of times a variable is important/ significant across different studies, in addition to its helpfulness in identifying candidate variables. Finally, Chowdhury & Turin (2020) acknowledged that a prior understanding of the topic (referred to as “subject matter knowledge”) can help with the identification and grouping of variables before the study begins. Chowdhury & Turin (2020) stated: “that grouping and combining similar and related variables based on subject knowledge can also help with refining the number of variables included in a study”. Arguably, if variables are strongly correlated, combining them into a single variable is considered pragmatic.

1) Previous literature highlighting the need for further studies in these areas:

- a) inclusion of consideration of the social determinants of health
- b) an identified research gap: vulnerable/ marginalized patient populations were missing from current studies utilizing mHealth applications
- c) the need to evaluate the impact or lack thereof of self-management applications on the health outcomes in vulnerable and marginalized patient populations

2) Previous studies establish the correlation between digital inequity, the social determinants of health, and health outcomes in vulnerable/ marginalized populations.

3) Prior understanding of the social determinants of health factors and their impact on health outcomes formed the basis of where to begin the exploration of digital inequity.

4) Length of the survey study. Through the literature review process, a large number of variables were proposed to be studied further, however consideration needed to be given to the length of the survey. This impacted the number of variables chosen and included in the survey.

The main outcome variable is the PCP consideration of health equity, which was operationalized by offering a scenario (Box 2) and a list of items to rate their likelihood/ unlikelyhood to “ask/ assess these in your practice when recommending mHealth applications to your patient for diabetes care?” Based on the literature review (see Table 18), the included 15 items were on the patient’s health (i.e., diabetes control, diabetes complications, other comorbidities), socioeconomic conditions (i.e., work status, income, education), family dynamics (i.e., cooking and living with others or alone), healthcare access (i.e., commute, English fluency, computer/ smartphone) and literacy (i.e., health and technology). Table 18 provides a summary of the literature reviewed for the identification of the variables included in the study, including the survey. The variables chosen to evaluate the patient’s health status were derived from the following studies: Chavez et al., 2017; Huang et al., 2018; Zhao et al., 2016. Similarly, the variables influencing the patient’s socioeconomic status were derived from the following studies: Bhatia et al., 2020; Crawford & Serhal, 2020; Shaw, 2020. Additionally, the variables influencing patients' healthcare access were derived from the following studies: Chavez et al., 2017; Latulippe et al., 2017; Shaw, 2020. Finally, the variables influencing patient uptake and utilization of digital health technologies, including mHealth applications, were derived from the following studies: Chavez et al., 2017; Crawford & Serhal, 2020; Zhao et al., 2016.

Each of the aforementioned items was rated on a seven-point Likert scale (1 being “very unlikely” to 7 being “very likely”). Seven-points were preferred over a five-point scale to reduce respondent sensitivity (e.g., the Hawthorne effect) and to capture adequate variances in the responses to minimize the possibility of the ceiling effect. The Hawthorne effect is a consequence of participants knowing that they are being studied (Streiner et al., 2014). The ceiling effect occurs when participants are offered a limited range of responses as options, and their responses then aggregate at one end of the provided range (Streiner et al., 2014). A draft version of the scenario and question was refined through two focus groups with a sample of PCPs (details provided below).

The survey also gathered data on variables that might be associated with the main outcome. These explanatory variables asked about PCP practice type, gender, self-reported ethnicity, and visible minority status, as well as languages spoken, age, place of school affiliation for clinical training, sources of learning about SDOH (undergraduate degree, medical school, residency program, continuing medical education or CME, practice site, research articles), and years of practice in primary care. On the patient side, the survey asked the PCP to indicate the proportion of their patient population that possibly belonged to marginalized communities (% visible minority, % immigrant, % low income, % Indigenous, % child or youth, % women, and % seniors). Given that PCPs may work in different clinical settings, the CHC setting was derived by counting participants who reported working in a CHC for over 40% of their practice hours.

Box 2: Patient Scenario in Survey

Consider you are seeing a patient who is struggling to comply with the traditional in-clinic management of diabetes care due to their difficulties in regularly attending in-person clinics or is struggling to follow the dietary recommendations. You are inclined to offer a mHealth diabetes management tool where they can record their activities (e.g., insulin test result, physical activity, diet and so forth) and the data is shared with you or another allied staff at the clinic.

For the secondary aim of the study, the survey also asked about practice and organizational level factors that could influence the PCP's uptake of mHealth for diabetes self-management. Participants rated ten items on a seven-point Likert scale for "the level of importance/unimportance in influencing [their] adoption of mHealth applications for diabetes care in clinical practice." These items were identified through a literature review and consolidated via focus groups. Given the COVID-19 pandemic, a section on the use of Virtual Healthcare during the pandemic was added. Virtual Healthcare is referred to as "the synchronous (i.e., live/ real-time) or asynchronous (i.e., not live/ not real-time) use of audio, video, and texting tools by PCPs with patients/ family caregivers." This section of the survey was added at the request of some community collaborators and further details are presented elsewhere.

A limitation of the survey method is its self-reported style, and the unavailability of the researcher to answer any questions that a participant may have (Dillman et al., 2014). To address this concern, particular attention was given to the wording and flow of questions and response options, so that participants could clearly understand the questions and respond without bias (Harkness et al., 2004). Another factor affecting the survey's development was the need to enhance measurement accuracy through the use of psychometrically valid scales whenever possible. As the researcher could not find a pre-existing validated scale on the main outcome, several strategies were used to develop a multi-item scale with face and content validity (Streiner et al., 2014). First, a comprehensive literature review was conducted to identify items that could present the equity-orientation of the PCPs when offering a mHealth tool for diabetes self-management. The findings were discussed with the thesis advisors and a draft survey was developed. Next, two focus groups were conducted with PCPs to enhance the content and face validity of the survey.

The PCPs for these focus groups were recruited from the collaborating CHC, Access Alliance for Multicultural Health and Community Services in Toronto. In total, five PCPs (three men, and two women) agreed to join the focus group discussion with three of the participants being nurses/ nurse practitioners and two of the participants being family physicians. To enhance the depth and breadth of the discussion, two groups were organized with the first group having three PCPs and the second group having two PCPs. All participants provided written informed consent and each group discussion lasted for approximately 45 minutes. The data was audio-recorded and detailed notes were taken. The researcher revised the survey based on this feedback. For example, the PCP focus group recommended clarifying the term mHealth applications and similar wording, as well as technical terms such as “synchronous” versus “asynchronous.” Additionally, the group suggested expanding the levels of education listed to be more inclusive and to accurately capture the various levels of nursing education. Finally, a few questions were added to the survey to capture PCP well-being (especially mental health) and perceptions of providing care/ virtual care during the COVID-19 pandemic. After the collection of data, the scales were also assessed for internal consistency (described in the 'Results' chapter).

iv. Data Collection Procedures

The self-administered, anonymous survey was formatted as an online survey using RedCap Survey, available to York University staff and students. The procedures for data collection were informed by the Total Design Method (TDM) conceptualized by Don Dillman in the 1970s and updated in 2014 for online surveys. The TDM method recommends the following steps for online surveys: 1) send an initial email with an introductory letter about the research with a link to the web survey; 2) follow up with non-responders after one week by email; and 3) follow-up with non-responders again by email at three weeks and seven weeks (Dillman et al., 2014). With the assistance of collaborating organizations, the researcher availed some of these steps for the online survey to reach the busy PCPs and followed up with them at the recommended intervals (one week, three weeks, and seven weeks). The reminders were not individually sent, as the list of PCPs was not provided to the researcher, and instead sent in the newsletter or other email communication to members of the collaborating organizations.

The survey was officially distributed on July 30th, 2020, with an initial survey end date of September 16th, 2020. However, due to the low response rate, the survey end date was extended to October 30th, 2020, while the Nurses Practitioner's Association of Ontario (NPAO) agreed on August 31st, 2020, for the distribution of the survey. The registration link of the online survey contained a study information letter along with consent information (Appendix 2) and the data fields with the necessary information to conduct the surveys. Participants received information on the study objectives and confidentiality, their rights as research participants, and ways to contact the researcher. At the end of the survey, participants were asked about their interest in participating in a semi-structured, one-to-one qualitative interview. Those who expressed an interest were asked to provide their email address and name to receive further details.

v. Data Analysis Approach

The RedCap survey data was exported into Statistical Package for Social Sciences (SPSS). First, the data accuracy was checked, followed by the completion of a Missing Value Analysis for the non-demographic survey objects. A Missing Values Analysis (MVA) is a statistical method that 1) detects missing value trends in a dataset; 2) decides whether these values are missing at random; and 3) calculates the mean values that can be entered for the missing values (Dancey et al., 2012; Tabachnick & Fidell, 2007).

In the SPSS software package, these mean values can be determined using pairwise missing data, listwise missing data, and regression.

Following the completion of the MVA, the imputation of the missing data was undertaken as follows: out of the completed responses ($n = 49$), five surveys had values missing at random. Thus, the k nearest neighbors' algorithm was used to replace the values missing. The k nearest neighbours' algorithm uses feature similarity to predict the missing values, especially when they are numeric. After the imputation of the missing data, a descriptive analysis was executed (i.e., range, minimum and maximum values) to identify any out-of-range data values; no such issue was identified. Next, descriptive statistics (e.g., frequencies and means) were executed, followed by a correlational analysis with the main outcome variable. Descriptive statistics (e.g., proportions, means, median and inter-quartile range) were used to describe the sample characteristics.

The primary hypothesis was tested by conducting hierarchical regression analysis to enter the explanatory variables in three sets: related (set A), patient-related (set B), and type of practice (set C). The variables for each set were identified through correlational analysis and theoretical understanding of the variance of the main outcome of PCP understanding of health equity when considering mHealth diabetes self-management applications during a hypothetical patient encounter. For the secondary objective of the study, PCP barriers and facilitators considered important in the adoption and use of mHealth diabetes self-management tools were assessed by calculating the overall sample mean and comparing the means scores of the CHC and Non-CHC participants using an Independent Sample Student t-test. Prior to calculating the mean scores, Principal Component Analysis was executed for data reduction and three subscales were derived: provider-patient barriers; clinic-barriers; and system barriers. Details are provided in the Results chapter.

vi. Limitations

The main biases in survey research include *respondent bias*, due to the self-reported nature of data, and *selection bias*. To reduce respondent bias, the survey questions and responses were developed carefully, followed by focus groups to enhance clarity and simplicity, while also establishing the face validity and content validity of the main outcome. To reduce selection bias, the researcher approached primary care groups in Ontario for establishing a sampling frame. Several professional groups expressed interest but could not distribute the survey to a specific mailing list due to

workplace chaos under COVID-19 restrictions. The proposed study inadvertently became a survey with a convenience sample. In absence of a sampling frame, selection bias is difficult to determine. Further, a major limitation of this survey study is the lack of significant participation from family physicians – a key stakeholder group in the primary care model. The participation from this group was hampered due to the COVID-19 pandemic. The majority of PCPs were overwhelmed by the rapid change happening in virtual care delivery. Further, the interpretation of the findings about the relationship between the examined explanatory variables and the main outcome should be reviewed with caution, as a cause-and-effect relationship cannot be deduced from a cross-sectional study. This also calls for caution in the interpretation of survey results.

4. QUALITATIVE INTERVIEW STUDY

The approach to qualitative research could be deductive or inductive in nature (Magnusson & Marecek, 2015). The deductive approach generally aligns with the positivist and post-positivist worldviews with the goal of theory testing while the inductive approach aligns with the interpretivist tradition where researchers aim for a deeper understanding and for theorizing around the studied phenomenon (Zirakzadeh, 2009). In the deductive approach, the research question has a narrow focus, and the analysis of qualitative data uses pre-existing coding schemes. In contrast, the inductive approach allows a researcher to ask broad questions, and the analysis of qualitative data does not use priori schemes, rather, it identifies the patterns within the collected data. Once the analysis is completed with an inductive approach, the researcher then interprets the findings in light of existing theories and generates new insights and theorization about the studied phenomenon (Magnusson & Marecek, 2015; Zirakzadeh, 2009). In this dissertation, an inductive approach was selected for the Qualitative Interview Study to generate newer insights in the area of PCP views about the potential of mHealth tools for diabetes-management (i.e., diabetes applications on mobile phones or web-accessible portals) among their diverse patient populations. The analysis was guided by the meaning-making interpretive approach (Magnusson & Marecek, 2015).

The qualitative design of one-on-one, semi-structured interviews was chosen to gather the perspectives of the PCPs (Creswell, 2017; Green & Thorogood, 2018; Hlady-Rispal & Jouison-Laffitte, 2014; Magnusson & Marecek, 2015; Patton, 2014; Starks & Brown Trinidad, 2007). The qualitative interview participants shared their views with rich details without being bound by fixed questions as in the survey method. Compared to the focus group method, one advantage of using

one-on-one interviews is gaining participation from the targeted group without the participants being affected by group thinking, or whether their responses will affect their social desirability (Kvale, 1996; Patton, 2014).

Additionally, participants do not get influenced by the perspectives of peers in a one-on-one interview as they do in a group discussion. Further, individual interviews are easier to schedule for busy healthcare professionals, as they rely on the schedule of only one PCP at a time. In a one-on-one qualitative interview, the use of a semi-structured interview guide with open-ended questions also offers flexibility to the participants while allowing the researcher to center on the key areas of interest. Prompts add further opportunities for the researcher to gain new and deeper insights (Kvale, 1996; Patton, 2014). The challenge with conducting qualitative interviews is that the interviewer should be well prepared to build rapport with the participants and effectively ask appropriate follow-up questions. Additionally, the interviewer needs the right skillset to keep the dialogue within scope and time limits while taking adequate notes and ensuring active listening. It is challenging to simultaneously perform these tasks, and requires the interviewer to both practice and prepare.

i. Purpose of Qualitative Interviews

The primary objective of the qualitative interview was to delve deeper into PCP perceptions and experiences regarding patient challenges in managing diabetes, and the potential of mHealth applications for diabetes management. Given the drastic changes to PCPs' experience in treating diabetes patients remotely during the COVID-19 pandemic, the topics of virtual health and stress were also added, to leverage the opportunity to gather insight from each PCP on the benefits and challenges of providing care through this medium. The consent form and interview guide used for the qualitative interviews are included in Appendix 6 and 7. Listed below are some of the questions on the main topics in the interview guide:

1. How would you describe your patient's challenges in managing diabetes? How do these vary by income, education, language, gender, culture, etc. What is your approach in these circumstances?
2. Have you used any mHealth tools asynchronously for diabetes management? If no, then why? If yes, then how is your experience? Please describe.

3. Do you have any recommendations for improving diabetes care/management in primary care? Should these vary by the type of primary care?

According to Magnusson & Marecek (2015), the stories and reflections of participants should not be ignored, even though they result in a substantial amount of data. They argue that this data is related in one way or another to the research questions, and thus must not only be taken into consideration, but included in the analysis and reporting of the data. Collectively, this data could provide insights into “shared meanings” (Magnusson & Marecek, 2015) or variations amongst the participants interviewed. Thus, the researcher aimed to gather participant stories and reflections through prompts like “would you please share an example to elaborate?”

ii. Sample and Recruitment

A purposeful and heterogenous sampling approach was used to recruit participants for this qualitative study (Green & Thorogood, 2018; Patton, 2014; Starks & Brown Trinidad, 2007). Purposeful sampling refers to the process of intentionally selecting interviewees who are most likely to provide information highly relevant to the study. Further, the heterogeneity criterion was employed to capture a breadth of the studied phenomenon and to enhance the transferability of the findings to other similar primary care settings beyond the research sample.

All participants who completed the survey were eligible for the follow-up qualitative interview study. Out of the 20 survey participants who expressed a willingness to join the qualitative interview study, 15 were selected, as they represented different geographic areas of Ontario and had work experiences in providing diabetes care. The number of participants needed in a qualitative research study cannot be predetermined. To determine whether an adequate number of participants have been interviewed, the criterion of data saturation was used, to determine the point in the data collection process when no new information emerges by adding new cases (Green & Thorogood, 2018). The thematic saturation for this study was achieved after interviewing 15 participants. In addition, it was revealed through a mid-way analysis that the same themes, topics, and sentiments were shared by participants. This was complemented by the researcher’s informal and ongoing reflections on the completed interviews.

iii. Rapport and Interview Guide

The building of rapport by the researcher is of high importance in qualitative interviews (Lynch & Smith, 2005). The participants' level of comfort around the researcher is a crucial determinant of the quality of data obtained from the interviews (Magnusson & Marecek, 2015). Further, Magnusson & Marecek (2015) point out that the researcher should try to uncover any hidden "cultural meanings" during the conversation with participants, as this would shed light on any feelings and beliefs that may not have been verbalized. This can be accomplished by the researcher building a good rapport with the participants to help them feel comfortable being honest and open, and to avoid the participant becoming reserved and withholding their genuine thoughts and feelings in fear of being judged. Therefore, in the qualitative interview study, multiple strategies were used to enhance rapport building. Attention was given to the researcher's friendly and approachable style and deliberate respect towards participant responses and exchange of opinions (e.g., by stating there are "no right or wrong answers" at the beginning of the interviews). Further, an open-ended interview guide was used to enhance the quality of data collected during the interviews. The open-ended nature of the questions (e.g., "how" and "why" questions instead of "what") allowed the participants flexibility in sharing their in-depth perspectives, while the presence of specific topics in the guide allowed the researcher to ask questions that were important for study. Finally, the researcher kept detailed field-notes before (e.g., logistical difficulties in organizing the interview, the mood of the researcher, etc.) and after the interview (e.g., rapport level, interruptions during interviews, participants' mood and dominant/ new points raised) to account for circumstances when analyzing the data.

iv. Data Collection Procedures

The qualitative interview study was originally planned as in-person one-on-one interviews, however, due to COVID-19 restrictions (social distancing and lockdowns), the interviews could not be conducted in person and, therefore, were conducted virtually. A subset of 20 survey participants showed a willingness to learn about the qualitative interview study, however, 15 were selected. They provided their email addresses in the survey and were subsequently given the interview study details along with a consent form for their review (Appendix 7). Those who agreed to join were sent the consent form via email before the interview. The interviews were conducted on a date and time that was convenient for the participants. All 15 interviews were completed either by phone or on an

online platform. The interviews were 20 to 45 minutes in length. Each interview was audio recorded using a digital recorder, and field notes were taken electronically on a laptop computer. At the end of the established interview questions, participants were asked if they had anything else they wanted to share; this information was documented as well. All interviews were transcribed verbatim onto a laptop computer and checked for accuracy prior to the analysis. Each transcribed interview was checked by the researcher by listening to randomly chosen segments of the audio files.

During the data collection process, the researcher attempted to understand “the person” in the interview in order to contextualize the conversation and gain an understanding of the “social and personal context” in which the participant was operating in. According to Magnusson & Marecek (2015), “the person” is a sum of all their dimensions, meaning their cultural backgrounds, their ethnic backgrounds, their professional backgrounds, etc. Additionally, the researcher tried to observe any patterns of sense-making that the participants verbalized or implied during interviews. For example, PCPs in CHCs referred to their patients as ‘clients’ versus ‘patients’, as opposed to other models of care (FHTs, etc.). The patient being referred to as a ‘client’ in the CHC model of care signifies and implies (in this setting) that the patient should be treated with the same level of respect as if they were a ‘paying customer’. This definition in the CHC model of care is important, given that the majority of the patients seen in this model are of a lower socio-economic status.

The researcher made notes of these observations and contextualized them based on the participant’s role (e.g., nurse, nurse practitioner), their type of practice (e.g., CHC, Family Health Teams), and their location of practice (e.g., rural, urban, patient population). These observations are important when interpreting and reporting the results of the study, as they help to provide a deeper understanding of interviews for analysis and interpretation. The researcher’s training and experience in considering the context in which the data was collected during the interviews are important in this context; she has acquired these skills through ongoing practice during the course work stages of her doctoral study. Additionally, her professional work experience has provided an understanding of the inherent working culture and perspectives found within these different roles and settings.

v. Thematic Analysis

The qualitative data management and preliminary analysis were facilitated by using Nvivo software, version 12. After transcription of the interviews, systemic procedures were undertaken to identify and synthesize the “shared meanings.” Nvivo software was chosen for qualitative data management and preliminary analysis for the following reasons:

- 1) Nvivo provides an organized and structured approach to analysis.** Regardless of the methodology adopted, a systematic approach is important to ensure that the qualitative data analysis is undertaken in a rigorous manner. Nvivo provides a good structure for this, as it facilitated keeping track of (and review of) the transcripts as they were imported into the project.
- 2) Everything is stored in one place.** Once the project is uploaded into Nvivo, everything (journal articles for the literature review, and the interview transcripts) is imported or created in one database.
- 3) Nvivo enables working effectively with different types of qualitative data.** When undertaking mixed methods research or qualitative study with a literature review component, Nvivo is extremely helpful in analyzing across different data formats utilizing the same thematic (node) structure. For example, I can import journal articles and other PDFs, and compare what my participants reported with the existing literature on the topic.
- 4) Nvivo makes sub-group analysis easier.** Nvivo allowed the researcher to view information across a large number of participants, while also exploring responses by different sub-groups within the sample (e.g., comparing what males and females said). Nvivo has features, such as matrix coding queries that can easily do this.
- 5) Nvivo helps with efficiency.** Nvivo saves time during the analysis and write-up phases, as the information extraction across selected criteria is easily accomplishable with only a few steps. The software was also useful when drafting the thesis, as it can easily insert text directly from the Nvivo project files.

Nvivo software was used for data management and preliminary analysis as outlined in the following sections. The study intended to develop explanations directly from the data, hence the grounded theory approach was adopted. The transcripts in Word format were transferred to Nvivo. After all of the necessary files were transferred, the next step was coding to group the extracts (across documents) that were related to each other into nodes. Since the analysis was driven by grounded theory principles, the transcript files were read in detail, and excerpts of interest were coded into the previously developed nodes. Coding strips were also turned on to help manage the coding process by providing some insights. For example, where the densest parts of coding are.

One of the important objectives of the study was to examine if primary care providers (PCPs) considered equity in their day-to-day work, especially when interacting with vulnerable and marginalized patient populations. To examine if this is the case, the node classifications containing the defined attributes for all respondents were created. When this was done, nodes associated with each source were created with the relevant details. Apart from coding to nodes, I was also able to connect ideas emerging from the sources using 'see also links.' Memos were also created for documenting my thoughts and the insights emerging as the data was reviewed. Annotations were created for the transcripts, as they functioned as reminders for certain excerpts. When the analysis process reached an advanced stage, mind maps were created to visualize thoughts and ideas, which were mapped out in Nvivo to show their connection to the central topic using connectors and shapes. Nvivo does not influence the design of the research, as a grounded theory was used for the study, but it appears that any approach could also fit. The presence of the nodes in Nvivo made it more compatible with grounded theory and thematic analysis approaches.

Following the preliminary analysis conducted using Nvivo software, the steps outlined below were conducted. The steps included (1) formulating a set of sub-questions or topics to amplify the overarching research question and make it more specific; (2) selecting portions of the interviews (i.e., excerpts) that aligned with each of the sub-questions; (3) annotating excerpts; (4) reading and re-reading all annotated excerpts to identify repeated ideas; and (5) bringing excerpts with similar ideas together and writing an integrative summary for the idea(s), unifying the excerpts and giving the section a label (i.e., theme or sub-theme). This is similar to a grounded theory approach with the constant-comparison method of starting with open-coding followed by axial coding (Glaser & Strauss, 1967; Starks & Brown Trinidad, 2007).

This process allowed for conducting a systematic line-by-line analysis of the interview material. As identified in Step 1 above, formulating sub-questions is often needed as the research question created at the beginning of the project is purposefully broad to generate rich discussions. The sub-questions are needed to unpack the broad question. Additionally, the sub-questions help with planning the analysis. The subsequent steps allow the researcher to engage with the material closely for inductive thematic analysis. Given the “interpretative research approach” adopted to understand “the meanings” in the research, the researcher dug deeper to understand “the person”, inclusive of their professional/ socio-cultural background, experiences, and life context to fully contextualize their “talk” and its relevance to the research (Magnusson & Marecek, 2015). This final step moved the analysis from description to interpretation.

vi. Quality and Rigor

The quality and rigor of qualitative research lie in the systematic ways applied to and reported for the study design, data collection, analysis, and interpretation (Creswell, 2017; Magnusson & Marecek, 2015). According to Yanow & Schwartz-Shea (2014), the emphasis should be on designing research that is based on choosing the “best” settings and the “best” interview participants. Hlady-Rispal & Jouison-Laffitte (2014) point out that in interpretative research, participants’ “local knowledge” is of key interest to researchers as it helps to generate findings with contextualized meanings. The term ‘rigor’ is often replaced with ‘trustworthiness’ to judge the quality of interpretative research. Several strategies were used to enhance the quality of the data collection and analysis processes. The design elements used purposive sampling and heterogeneity criteria. Some examples of the strategies used during the fieldwork included training of the interviewer, the use of a semi-structured interview guide with probes, an audio recording of the interviews, an accuracy check of the transcripts, recording of the field notes, and the use of a reflexive journal. The credibility of the results was accomplished in two dominant ways; first, the data was critically interpreted in the context in which it was collected, also known as discounting of data. This involves paying attention to details such as solicited versus unsolicited information, direct versus indirect statements, single versus multiple sources of information, disconfirming cases, and filtration of data through the researcher’s lens.

As discussed above, an accuracy check of the transcripts was conducted. This was accomplished through a member-checking process whereby the researcher reviewed the notes taken during the interview with the individual interviewees to validate the accuracy of the information captured. When necessary, corrections were made to the transcripts. In addition, a peer audit was conducted with the thesis committee members. The coded (by themes) transcripts were extracted from Nvivo in a Microsoft Excel format and sent by email to thesis committee members for their review (audit) and critical interpretation to ensure accuracy. If questions arose, the thesis committee exchanged emails to obtain clarification and met when necessary. A peer audit approach was used for the qualitative interviews due to a lack of a research team given that this is doctoral research.

vii. Limitations

A limitation of the qualitative interview study is that the interviews were conducted remotely via phone calls or video conferencing on an online platform. This mode of interviewing did not allow for the researcher to read the body language of the participants but did have some benefits, including increased comfort for the participants and sometimes, a degree of anonymity – which has been shown to increase honest sharing. This limitation may have prevented the researcher from uncovering any clues about the participant's discomfort with specific questions or probes. A second concern, as echoed by Groves & Kahn (1979) and Braun & Clarke (2006), is the lack of visual aids often used in face-to-face interviews (e.g. head nod, smile, frown, etc.) from participants during telephone interviews, which may have impacted the depth of conversation.

CHAPTER 4: FINDINGS OF SURVEY STUDY

This chapter presents the results of the survey study. For methodological details, please see the previous chapter. The primary aim of the survey study was to examine how PCPs' health equity understanding (main outcome) might vary by their practice location in CHC and Non-CHC settings, when considering mHealth diabetes self-management applications, over and above other possible explanatory variables at the provider and patient levels. For this purpose, the total score for the understanding of health equity was calculated first. Next, a bivariate analysis was executed to determine the associations between the main outcome and other possible explanatory variables. Finally, hierarchical multiple regression analysis was executed, where Model 1 had predictor variables related to PCPs, Model 2 also included predictor variables related to patient populations served, and Model 3 included CHC and Non-CHC settings as the predictor variables. The secondary aim of the survey study was to examine the barriers and facilitators that PCPs consider important in the adoption and use of mHealth diabetes self-management tools and how these might vary by the providers in CHC and Non-CHC practice locations. For this purpose, the items measuring barriers and facilitators were first reduced through Principal Component Analysis (PCA), and then providers in the CHC and Non-CHC settings were compared. Finally, the third aim of the study was established to meet the study collaborators' expressed interest in gathering information about the virtual care experience of providers during the COVID-19 pandemic, the period when the study data was collected. A descriptive analysis of virtual care during the pandemic is presented in this paper, and a detailed analysis is presented in Appendix 9.

i. Response Rate

Tables 2 and 3 below provide an overview of the response rate for the survey study. As discussed in the Methods section, the survey was distributed to several collaborating sites such as Community Health Centres, Family Health Teams, Nurse Practitioner-Led Clinics, etc. In total 85 surveys were opened; however, ten participants did not sign the Consent Form, and another eight did not respond to any questions and were therefore excluded from the study. Out of the remaining 67 who attempted the survey, 19 answered less than ten questions and were therefore excluded from the analysis. Therefore, the survey data of 48 participants were available for analysis. The number of participants from Community Health Centres was 31, and the number of participants from 'other practice types' (Family Health Teams, Walk-in clinics, Solo or Private practice) was 17.

It should be noted that the survey response rate was likely significantly (negatively) impacted by the COVID-19 pandemic, as the research participants were frontline care providers that were overwhelmed with the volume and complex nature of care needed during this difficult time.

Table 2

Survey Response Rate by Practice Type (n = 48)

Type of Practice	Numbers	Percentage
Community Health Centres	31/48	64.6
Other Practice Types (Family Health Teams, Walk-in clinics, Solo practice or Private practice)	17/48	35.4

Table 3

Survey Response Rate by Provider Type (n =48)

Provider Type	Numbers	Percentage
Nurses/ Diabetes Educators	16/48	33.3
Nurse Practitioners	28/48	58.3
Family Physician	4/48	8.3

ii. Sample Characteristics

The survey sample consisted of 48 primary care providers (nurses, nurse practitioners, and other PCPs) and their models of practice, which included Community Health Centres, Family Health Teams, Walk-In Clinics, and Solo and Private Practices. Most of the survey respondents were females (95.8%) and not visible minorities (83.3%). It should be noted that approximately 70% of nurses and nurse practitioners in the healthcare industry in Canada are females. They range in age from 25 to 70 years with a mean of 45.45 years (SD 10.88). While thirty-one (64.6%) of PCPs spoke only English, the minority were bilingual or multilingual. The majority of primary care providers were affiliated/ trained in Canada (91.7%). Participants had practiced between one and 39 years, with an average length of experience being 10.91 (SD 8.29) years.

Table 4
Participant Demographic (n = 48)

Variable	Numbers	Percentage or Mean (SD)
Age, mean	48	45.45 (SD 10.88)
Gender, %		
Male	2/48	4.2
Female	46/48	95.8
Visible minority status, %		
Yes	8/48	16.7
No	40/48	83.3
Language(s) spoken,		
%English only	31/48	64.6
English + French	8/48	16.7
English + other non-official language	7/48	14.6
English + French + Other language	2/48	4.2
Professional School affiliation, %		
Canada only	44/48	91.7
Outside Canada	4/48	8.3
Number of Practice Years, mean		
Family Physician	4/48	15.75 (SD 15.08)
Nurse Practitioner Nurses/	28/48	10.91(SD 6.12)
Diabetes Educators	16/48	11.84 (SD 9.31)
Training on social aspects health, mean (scale 1-4) †		
Formal training	16/48	9.38 (SD 3.04)
Informal training	8/4848	5.90 (SD 1.62)
<i>Overall composite mean</i>		14.07 (4.41)

† 1= no/can not recall, 2 = a little, 3 = somewhat, 4 = a lot. Six items in formal training (undergraduate, graduate, medical school, residency & continuing education); 2 items in informal training (research articles & on-site).

The survey also gathered information from the PCPs about their practice's geographic location and the patient populations seen in the practice, specifically, vulnerable and marginalized populations. These results are presented in Table 5.

Table 5:*Participants Patient Types (n = 48)*

Variable	Numbers	Percentage or Mean (SD)
Vulnerable Patients in Practice, mean (scale 1-6) ‡	48	
Visible minority		3.06 (SD 1.59)
Immigrants		2.58 (SD 1.59)
Indigenous		1.60 (SD 0.99)
Low income		3.85 (SD 1.55)
Children or youth		2.13 (SD 0.96)
Women		3.98 (SD 0.69)
Seniors		3.62 (SD 1.22)
Non-Insured		2.33 (SD 1.29)
<i>Overall composite mean</i>		23.08 (SD 4.86)
Practice Location %		
Urban	35/48	72.9
Rural	13/48	27.1

‡1 = Less than 10%; 2 = 11%-20%; 3 = 21%-40%; 4 = 41-60%; 5 = 61%-80%; 6 = 81%-100%

Table 5 above provides an overview of the patient types (vulnerable patients seen in practice) that participants in the survey study engaged with in their clinics. Several of the participants identified patients belonging to visible minority (mean 3.06 i.e., approximately 21-40%), low income (mean 3.85 i.e., approximately 41-60%), and predominantly women (mean 3.98 i.e., approximately 41-60%) groups. It should also be noted that the mean for seniors was 3.62, which is approximately 40-50%. This table confirms that PCPs in CHCs treat a large volume of patients with complexities (low income, etc.) far beyond their medical challenges, which justifies the need for a multi-faceted approach that considers both the medical and non-medical determinants of health.

iii. Understanding of Health Equity and mHealth Diabetes Self-Management Applications

In the survey study, the construct of health equity understanding – the dependent variable – was assessed across 15 items which were developed through a comprehensive literature review and focus groups as described in the methodology chapter. Each item was rated on a seven-point Likert scale (1 being “very unlikely” to 7 being “very likely”) for the participating providers as factors to consider when using a mHealth diabetes self-management application in a scenario provided to them. One respondent did not complete this scale; the sample size is 47 for related analysis.

a. Descriptive and T-test

The mean score for each item in the Health Equity Understanding is presented in Table 6. A total sum of scores for health equity understanding was used for further analysis. This composite variable has a high internal consistency with a Cronbach alpha of 0.906. The participant's scores for health equity understanding ranged from 37 to 99 with an average of 75.08 (SD = 14.99).

Given the dissertation's focus on the CHC and Non-CHC settings, health equity understanding scores for participants from both settings were compared. Next, the scores were also compared between NP and Non-NP participants as the NPs comprised almost half of the sample. An independent sample *t*-test was selected as the most appropriate analysis procedure for these comparisons (Warner, 2013).

Table 6

Health Equity Understanding (n = 47)

How likely/ unlikely are you to ask/ review the following when recommending mHealth applications to patients for diabetes care ‡	Numbers	Mean (SD)
Level of diabetes control	47	6.00 (1.13)
Complications of diabetes	47	5.17 (1.53)
Other co-existing health conditions	47	5.17 (1.67)
Disability/ mobility challenges	47	5.15 (1.47)
Commute (time/ distance)	47	4.62 (1.62)
Cultural context (e.g., who is cooking or buying food)	47	4.48 (1.49)
Working status (e.g., part-time, full-time, double job, or studying and working)	47	5.02 (1.49)
Income	47	4.58 (1.58)
Education level	47	4.54 (1.39)
Comfort with English	47	5.15 (1.50)
Access to computers/smartphones	47	6.04 (1.07)
Computer literacy skills	47	5.79 (1.25)
Health literacy skills	47	5.27 (1.41)
Cooking skills	47	3.87 (1.48)
Whether the patient is living alone or with others	47	5.00 (1.47)

‡ Scale of 1–7: 1 = very unlikely; 4 = neutral; 7 = very likely

When analyzing the total score for the composite variable, the results show that providers in CHC practices had slightly higher mean scores for Health Equity Understanding than Non-CHC participants, but these groups did not significantly differ based on the student *t*-test results. The effect size based on Cohen's (1988) conventions is small as well. When comparing NP and Non-NP providers, the latter group had higher mean scores for Health Equity Understanding than NPs, but the results of the independent samples *t*-test demonstrated that the two groups did not significantly differ ($t(47) = -.659$, $p = .513$; Cohen's $d = 0.208$); the effect size based on Cohen's (1988) conventions is also small.

b. Hierarchical Regression

The hierarchical regression analysis was conducted to examine if PCPs' Health Equity Understanding when proposing the use of mHealth applications for self-management of diabetes, could be predicted from their practice setting (i.e., CHC and Non-CHC) above and beyond provider-related factors and the extent of service to vulnerable patient populations (i.e., patient-related factors). The variables used in Models 1 and 2 were determined through a combination of theoretical knowledge and bivariate analyses. Three predictor variables were selected as provider related and entered in Model 1: number of years in practice, preparation on social aspects of health, and professional status of being an NP or Non-NP. The variable of age was not selected, as it was significantly correlated with the number of practice years ($r = 0.52$), and the latter is a better measure of providers' clinical experience. Although both formal and informal training of providers for the social aspects of health was measured, the two were significantly correlated ($r = 0.31$), hence, a composite average score was derived and entered in Model 1.

Given the insufficient variation in the self-reported gender, the variable of gender could not be entered in Model 1. The patient service-related predictor was entered in Model 2, and this variable captures the provider service to visible minorities and other vulnerable patients. Model 3 included practice setting in addition to the variables entered in the previous models. To determine if the null hypothesis is rejected (and a specific model is significant), the ANOVA table was examined for Model 1, Model 2, and Model 3. The *p* values below 0.05, call for rejection of the null hypothesis. The *p* values above 0.05, leads to failure to reject the null hypothesis, meaning the variables in a specific model do not significantly predict the criterion/dependent variable.

The first regression model (**Model 1**) contains the provider variable:

$$\text{Provider variables} = \text{Health equity understanding}$$

The second regression model (**Model 2**) includes the addition of the patient variables:

$$\text{Provider variables} + \text{Patient variables} = \text{Health equity understanding}$$

The third regression model (**Model 3**) includes the addition of the setting variables:

$$\text{Provider variables} + \text{Patient variables} + \text{Setting variables} = \text{Health equity understanding}$$

Table 7
Hierarchical Regression for Health Equity Understanding

ANOVA ^a						
Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	9341.46	3	3113.82	8.62	.000 ^b
	Residual	15889.18	44	361.11		
	Total	25230.64	47			
2	Regression	10074.56	4	2518.64	7.14	.000 ^c
	Residual	15156.07	43	352.46		
	Total	25230.64	47			
3	Regression	10200.45	5	2040.09	5.70	.000 ^d
	Residual	15030.19	42	357.86		
	Total	25230.64	47			

a. Dependent Variable: Q8_Health_Equity

b. Predictors: (Constant), NP/Non-NP, Years of Practice, Training

c. Predictors: (Constant), NP/Non-NP, Years of Practice, Training, Patient variable

d. Predictors: (Constant), NP/Non-NP, Years of Practice, Training, Patient variable, Setting

Table 8
Model Summary

Model Summary ^d										
Model	R	R square	Adjusted R square	Std. error of the estimate	R square change	F change	df1	df2	Sig. F change	Durbin-Watson
	.608 ^a	.370	.327	19.00310	.370	8.623	3	44	.000	
	.632 ^b	.399	.343	18.77410	.029	2.080	1	43	.156	
	.636 ^c	.404	.333	18.91723	.005	.352	1	42	.556	1.048

a. Predictors: (Constant), NP/Non-NP, Years of Practice, Training

b. Predictors: (Constant), NP/Non-NP, Years of Practice, Training, Patient variable

c. Predictors: (Constant), NP/Non-NP, Years of Practice, Training, Patient variable, Setting

d. Dependent Variable: Q8_Health_Equity

Model 1 contained the provider-related variables which are shown to significantly predict the Health Equity Understanding statistically, $R^2 = .370$ (adjusted $R^2 = .327$), $F(3,44) = 8.623$, $p < .001$. There is evidence to reject the null hypothesis. The provider's type (NP vs. non-NP) and other provider-related factors did significantly contribute to an explanation of the variance in their health equity score.

Model 2, which contained the provider variables and the patient service variable, did statistically significantly predict Health Equity Understanding, $R^2 = .399$ (adjusted $R^2 = .343$), $F(4,43) = 7.146$, $p < .001$. There was evidence to reject the null hypothesis. However, the addition of the patient service variable did not significantly contribute to explaining the variance in their health equity score, R^2 change = .029, $F(1,43) = 2.08$, $p = .156$.

Model 3 contained the provider, patient service, and setting-related variables. The model statistically significant predicted health equity understanding, $R^2 = .404$ (adjusted $R^2 = .333$), $F(5,42) = 5.701$, $p < .001$. There was evidence to reject the null hypothesis. However, the addition of the setting variable did not significantly contribute to the model, R^2 change = .005 $F(1, 42) = .352$, $p = .556$.

A discussion on variance change from Model to Model is warranted. The hierarchical multiple regression table, "R Square" column represents the amount of variation (also called R^2) in the dependent variable explained by the predictor variables in a model. Whether the change in the R^2 value from one model to another is or isn't statistically significant is presented in the "Sig. F Change" column which contains the p -value. When comparing the results of Models 1 to 2, we find that R^2 values explain a greater amount of variation in the dependent variable (i.e., R^2 value of .370 changes to 0.399), though the increase is very small and is equivalent to an increase of just 2.9%.

When comparing the results of Models 2 to 3, we find that R^2 values explain a greater amount of variation in the dependent variable (i.e., R^2 value changes from 0.399 to 0.404), though the increase is very small at only 0.5%. The hierarchical multiple regression was conducted to determine whether the variables added to each model are statistically significant. As shown in Table 8, the patient variables added in Model 2 did improve the explanatory power (i.e., R^2) of the model, but not at a significant level. The same is noted for Model 3. In other words, the patient service variable (added in Model 2) and the setting variable (added in Model 3) do not significantly add to explaining the variance in predicting Health Equity Understanding.

One might argue that the little improvement in the variance that we see from Model 1 to 2 and then to Model 3 is a statistical artifact, as Models 2 and 3 have more variables than Model 1. The overall size of the sample limits our ability to make clear conclusions about the impact of variables in Models 2 and 3 on the dependent variable, Health Equity Understanding. The contributions made by individual variables were further examined and are reported in Table 9 below. Notably, the level of training of PCPs on social aspects was independently a significant predictor of their Health Equity Understanding.

Table 9
Contributions of Independent Variables (N= 47)

Variable	β	<i>SE B</i>	<i>B</i>	<i>t</i>	<i>p</i>	Zero-Order <i>r</i>	Partial <i>r</i>
(Constant)	6.579	15.241		.432	.668		
Years of Practice	.318	.376	.104	.846	.402	.254	.130
Training	2.639	.771	.503	3.425	.001	.596	.467
NP/ Non-NP	1.631	6.441	.035	.253	.801	.267	.039
Patient variable	.856	.612	.180	1.398	.169	.344	.211
Setting	-3.454	5.823	-.071	-.593	.556	-.098	-.091

R^2 change of .030, $F(1,40) = 2.092$, $p = .155$.

In conclusion, the model, which contained the provider, patient, and setting variables, significantly predicted Health Equity Understanding statistically, $R^2 = .404$ (adjusted $R^2 = .333$), $F(5,42) = 5.701$, $p < .001$. However, the addition of the patient and provider's setting variables to the prediction of the model for the Health Equity Understanding did not lead to a statistically significant change in explaining the variance of the dependent variable. The variance explained in the variable of Health Equity Understanding increased by 2.9 % with the additional consideration of the patient variable and 0.5% with the addition of the setting variable. Again, these increases were not found to be statistically significant. In the final model, one variable (training) made an individual significant contribution (see Table 8 above). The Beta value was positive for the training variable: therefore, as training hours increased, so did scores for the Health Equity Understanding.

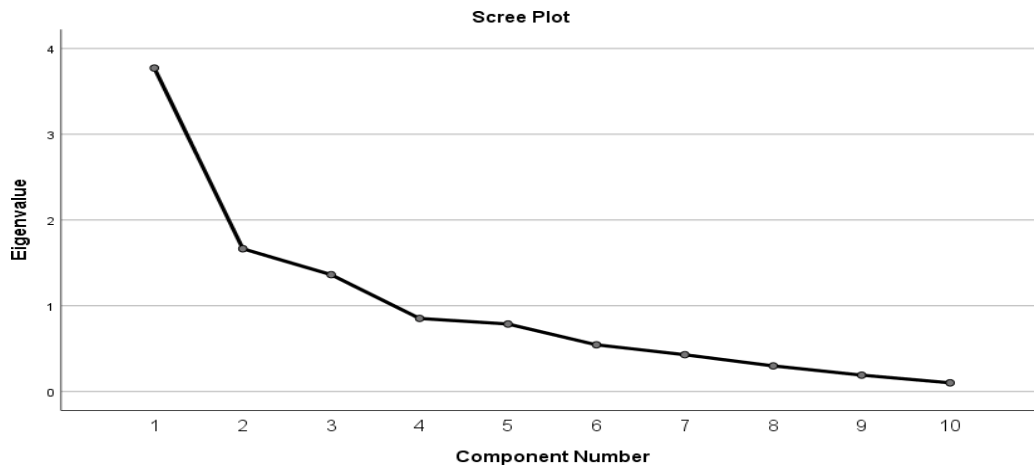
iv. Barriers, Facilitators and mHealth Diabetes Self-management Applications

The barriers and facilitators of PCPs towards the use of mHealth diabetes self-management applications were assessed through ten items developed through a literature review and focus group discussion, as discussed in the methodology chapter. Each item was rated on a seven-point Likert scale for “the level of importance/ unimportance in influencing your adoption of mHealth applications for diabetes care in clinical practice.” Three subscales were derived across 10 items, through Principal Component Analysis, to examine any difference between CHC and Non-CHC providers. The following section first provides the results of the Principal Component Analysis (Kaiser, 1974) and then a comparative analysis by provider clinical setting. The ten items were reduced to principal components through Principal Component Analyses (PCA) with varimax rotation. Coefficient alpha (Cronbach & Shavelson, 2004) was used to investigate internal consistency. The PCA is a variable reduction technique. It aims to reduce a larger set of variables into a smaller set of principal components that account for the variance in the original variables.

First, pairwise correlations were executed. None of the three coefficients between items exceeded 0.564, indicating that none of the items included in the analysis violated the assumption of multicollinearity (Kaiser, 1960). The Kaiser-Meyer-Olkin value for sampling adequacy was 0.635, which encouraged the researcher to continue the analysis. The significant Bartlett's Test of Sphericity ($p > .001$; 179.134) provided support for the componentability of the data (Fields, 2009). Thus, the dataset was deemed suitable for a component analysis. However, it is noted that any principal component analysis requires a large sample size to produce a reliable result. Different rules-of-thumb have been proposed, such as 150 cases or 10 cases per variable as minimum sample sizes (Fields, 2009). Therefore, these results should be interpreted with caution given the small sample size of this study.

Five criteria were used to determine how many components to extract. Inspection of Cattell's Scree plot revealed a three-component solution (see Figure 2 below).

Figure 2
Cattell's Scree Plot



The Kaiser-Gutman rule also indicated a three-component solution, as three components possessed eigenvalues of 1.0 or higher. The parallel analysis also suggested a three-component solution as three eigenvalues (generated in the Principal Components Analysis) were larger than the corresponding random eigenvalues (Horn, 1965); details are shown in Appendix 1. One, two, three, and four-component solutions were run with the most interpretable of the solutions being a three-component solution, though the last component had only one item. With three criteria suggesting a three-component solution and the exploratory goal of analysis, the three-component solution was used.

Three components were rotated using a varimax method. A varimax orthogonal rotation was employed to aid interpretability (Fields, 2009; Thurstone, 1947). The PCA revealed the three components that had eigenvalues over 1 explained 37.72%, 16.50%, and 13.62% of the total variance, respectively. The three-component solution explained 67.99% of the total variance. The interpretation of the data was designed to measure strong loadings on Component 1, Component 2, and Component 3. Many items loaded strongly on Component 1 (i.e., above 0.5), (Tabachnick & Fidell, 2007). Where cross-loading of items occurred, the items were examined to determine if it was theoretically justifiable to retain them in the primary component and to determine if any loading on the non-primary components was more than 0.32 (Tabachnick & Fidell, 2007). Only one item had non-primary cross-loadings above 0.32. However, it was retained on the primary component

for theoretical reasons. The communalities (h^2) were above or greater except for one item (Kline, 1994; Tabachnick & Fidell, 2007). The component loadings and communalities of the rotated solution are presented in Table 10.

Through the content review (i.e., conceptual meanings) of the items, Component 1 was labeled as Provider-Patient Barriers, Component 2 as Clinic Barriers, and Component 3 as System Barriers.

- **Component 1-** Patient-Provider Barriers are conceptually defined as “barriers” with items intersecting both patients and their providers. For example, some of the items (barriers) within the Patient-Provider component are grouped as follows: “My patients have digital/health literacy challenges,” “The mHealth diabetes care tools are not available in languages spoken by my patients” and “There are too many mHealth tools for diabetes care available in the market to choose from”.
- **Component 2-** Clinic Barriers are conceptually defined as “barriers” with items related to challenges experienced by patients and their providers in clinic settings. For example, some of the items (barriers) within the Clinical Barrier component were grouped as follows: “The high volume of patients in the waiting room” and “the clinic doesn’t have enough allied health staff”.
- **Component 3-** System Barriers are conceptually defined as “barriers” arising from the challenges experienced by providers as a result of the structure of the (healthcare) system. The System Barrier component had only one item; “the way I’m (the provider) reimbursed”.

In terms of internal consistency, the subscale of Provider-Patient Barriers has good internal consistency (Cronbach alpha 0.83), and the Clinic Barriers subscale has moderate internal consistency (Cronbach 0.57). However, the System Barrier only has one item, therefore the internal consistency evaluation is not applicable here. Some challenges presented by utilizing a one-item scale are that the use of a single-item measure reduces the chance of a common method variance where spurious correlations are observed due to the use of the same response format rather than the content of items. Face validity, the extent to which a measurement method appears “on its face” to measure the construct of interest can potentially be challenged here, however, the face validity of the single-item measure should not be discounted. Even though face validity can be assessed quantitatively by having a large sample of people rate a measure to determine whether it appears to measure what it is supposed to, in reality, it is usually assessed through informal means.

Table 10
Barriers and Facilitators for mHealth Applications: Component Loadings and Communalities

Items	C1	C2	C3
1. There are too many mHealth tools for diabetes care available in the market to choose from	.833	.146	.116
2. I find that mHealth diabetes care tools have technical or usability issues	.790	.326	.308
3. The mHealth diabetes care tools are not available in languages spoken by my patients	.779	-.113	.029
4. I have concerns about the privacy/security of patient data	.766	.309	.095
5. My patients have digital/health literacy challenges	.686	-.134	-.302
6. My patients can't afford mHealth tools for diabetes care	.570	.400	-.548
7. The clinic doesn't have allied clinical staff	.003	.775	.086
8. The high volume of patients in the waiting room	.125	.773	-.190
9. I am not aware of reliable mHealth tools for diabetes care	.083	.588	.292
10. The way I am reimbursed	.186	.145	.903

† Principal Component Analysis with varimax rotation

Three independent sample *t*-tests were conducted to examine the second research objective of the Survey Study. For all three analyses, providers in CHC and non-CHC practices were examined. The providers across these two types of practices were compared on their scores for Provider-Patient, Clinic, and Systematic Barriers in which an average score for each construct was calculated. Each item was rated on a seven-point Likert scale (1 being “very unlikely” to 7 being “very likely”). Scores ranged from 1 to 7 with higher scores indicating higher levels of equity understanding. Table 10 below provides the descriptive statistics (mean, standard deviation, and standard error) disaggregated by CHC and Non-CHC.

Table 11
Barriers and Facilitators for mHealth Applications: CHC vs. Non-CHC

Sub-scale	CHC vs. Non-CHC	N	Mean	SD	SE
Provider-Patient Barriers	CHC	32	4.81	0.91	0.16
	Non-CHC	16	4.84	1.19	0.29
Clinic Barriers	CHC	32	4.25	1.21	0.21
	Non-CHC	16	4.20	1.35	0.34
Systems Barrier	CHC	32	2.35	1.28	0.23
	Non-CHC	16	2.55	1.74	0.44

a. Patient-Provider Barriers

Although Non-CHC providers had slightly higher mean scores (Figure 3), the results of the independent samples *t*-test demonstrated that the two groups did not significantly differ in their views on health equity, $t(47) = -.098, p = .922$, Cohen’s $d = 0.028$. The effect size, based on Cohen’s (1988) conventions, is very small.

Figure 3
Provider-Patient Barriers (CHCs)

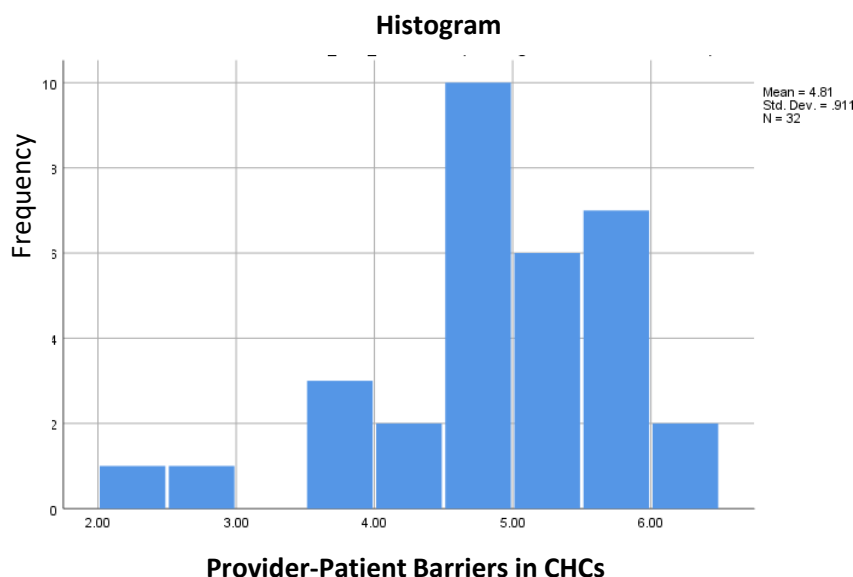
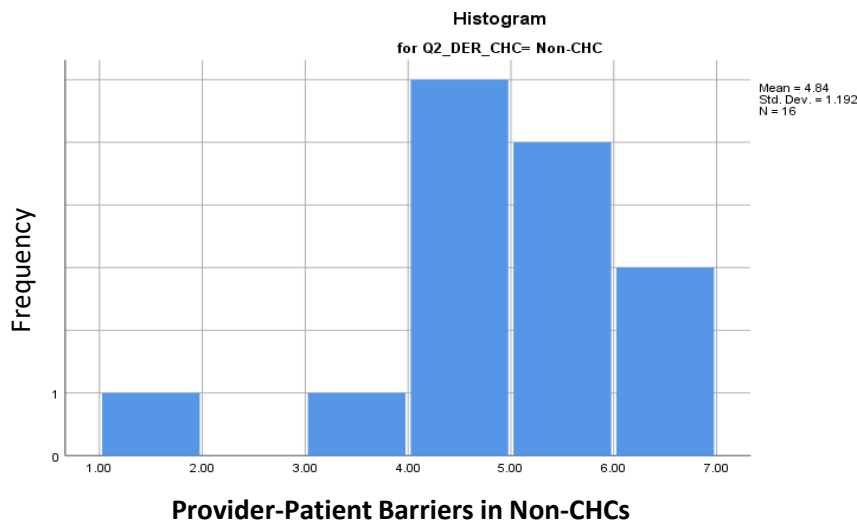


Figure 4
Provider-Patient Barriers (Non-CHCs)



Homogeneity of variance is the final assumption of the independent sample's *t*-test. It was examined using Levene's Test and found tenable, $F(47) = 1.147, p = .290$.

b. Clinic Barriers

Although CHC providers had slightly higher mean scores (Figure 5), the results of the independent sample's *t*-test demonstrated that the Non-CHC and CHC providers did not significantly differ in their views on health equity, $t(47) = -.127, p = .900$, Cohen's $d = 0.038$. The effect size, based on Cohen's (1988) conventions, is very small.

Figure 5
Clinic Barriers (CHCs)

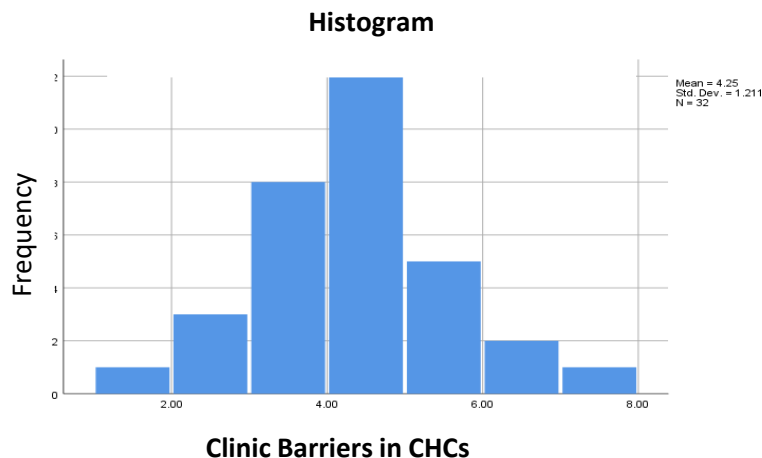
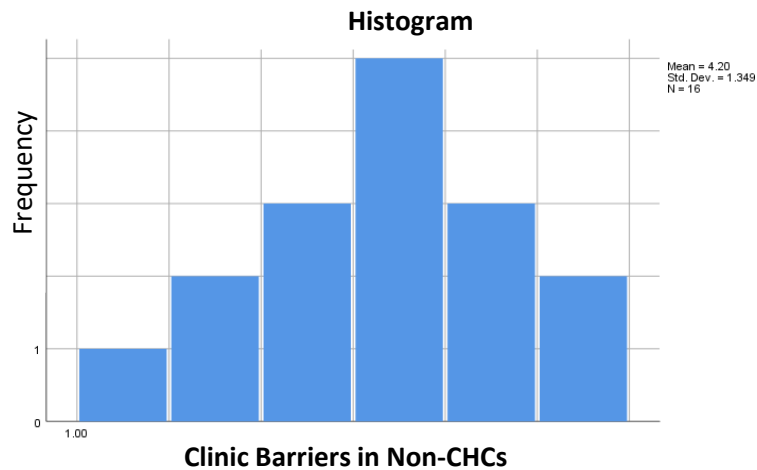


Figure 6
Clinic Barriers (Non-CHCs)



Homogeneity of variance, the final assumption of the independent sample's *t*-test examined using Levene's Test, was found tenable, $F(47) = .496, p = .485$.

c. Systems Barriers

Although Non-CHC providers had slightly higher mean scores (Figure 7), the results of the independent samples *t*-test demonstrated that the Non-CHC and CHC providers did not significantly differ in their views on health equity, $t(47) = -.453, p = .653$, Cohen's $d = 0.13$. The effect size, based on Cohen's (1988) conventions, is small.

Figure 7
Systems Barriers (CHCs)

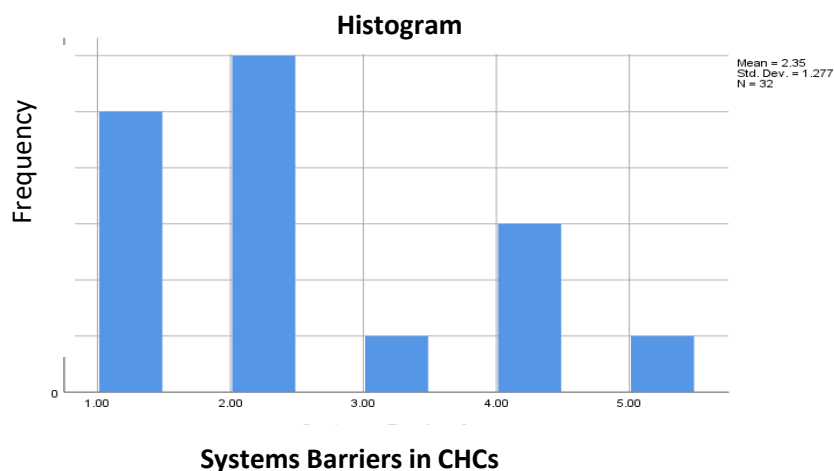
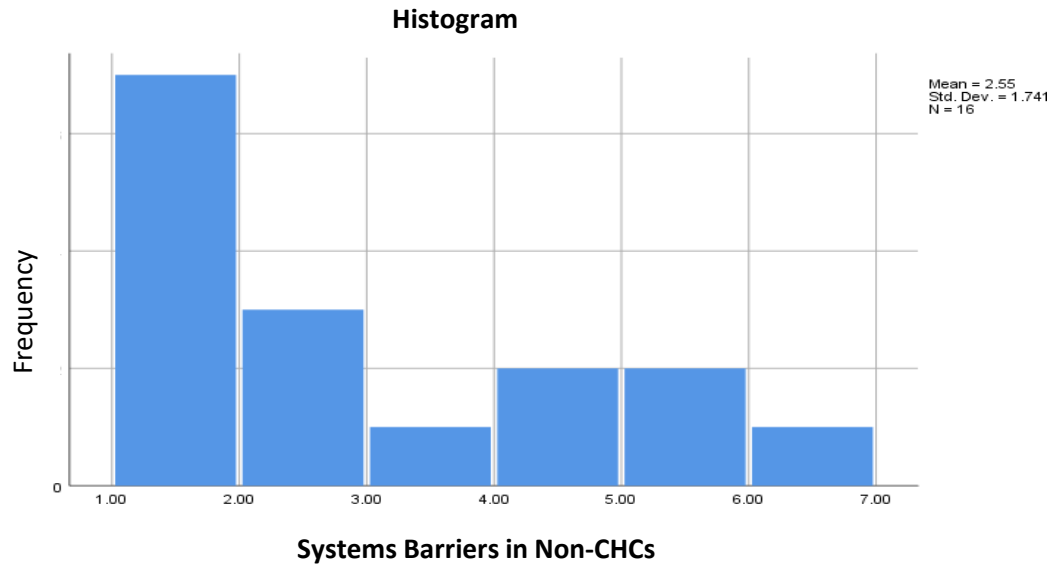


Figure 8
Systems Barriers (Non-CHCs)



Homogeneity of variance, the final assumption of the independent sample's *t*-test that was examined using Levene's Test, was found tenable, $F(47) = 3.187, p = .081$.

v. **Virtual Care During the COVID-19 Pandemic**

The availability of Virtual Care during the pandemic significantly varied by the location of healthcare providers and their practice settings. As shown in Table 12, there was a notable difference in provider accessibility (Urban settings 72.9% vs Rural 27.1%), which has had implications for virtual care during the pandemic. Both provider and virtual care accessibility, if low, can negatively impact health outcomes, for diabetic patients included. More detailed results are presented in Appendix 9.

Table 12
Practice Setting Urban vs Rural Settings

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Urban setting	35	72.9	72.9	72.9
	Small town/ rural setting	13	27.1	27.1	100.0
	Total	48	100.0	100.0	

The results show that the work of PCPs was highly disrupted during the COVID-19 pandemic. For example, the majority of PCPs replaced in-person care with phone consultation (89.4%) followed by video-based consultations (30.4%) during the 1st lockdown.

Many PCPs (45.7%-47.7%) were not aware of the encryption status of phone lines and video-based platforms allowed (e.g., Skype, Facetime, Zoom) during the COVID-19 pandemic. The percentage of those knowing the encryption status of applications was higher (79.5%). When PCPs were asked about the possible reasons for hesitations in using non-encrypted virtual tools during the COVID-19 pandemic, patient privacy had the highest mean (scale of 1-4: 3.43, SD 0.78) followed by their concerns about data security and patient technical skills. PCPs also reported that patients expressed concerns about the use of non-encrypted virtual tools. The highest mean scores were concerns about the patient's technical skills (scale of 1-4: 2.42, SD 1.12).

vi. Summary

The primary aim of the survey study was to examine how PCP understanding of health equity (main outcome) when considering mHealth diabetes self-management applications varies by their practice location in CHC and Non-CHC settings, over and above other possible explanatory variables. Despite the lack of statistically significant findings about the impact of a CHC vs. Non-CHC setting on the main outcome, there were some notable findings. For instance, the provider-related variables explained 32.7% of the variance in PCP understanding of health equity based on the adjusted R^2 scores. Further, in examining the contribution of all variables entered in the regression analysis, the training of PCPs on social aspects was a statistically significant contributor and a finding that has practice and policy implications.

Another notable finding is that providers in CHC practices had slightly higher mean health equity scores; 75.87 (CHC) versus 73.72 (Non-CHC), a finding that suggests the benefits of a CHC model for use of mHealth applications for self-management of diabetes. Additionally, an independent sample *t*-test was conducted to examine whether there were differences in health equity scores based on provider types (NP and Non-NP). The test results revealed that Non-NP providers had higher mean health equity scores: 77.50 (Non-NP) vs. 74.37 (NP). The sample of Non-NPs included only 16 participants and several of them were nurses and diabetes educators. This infers that the findings of the survey study suggest some trends, and should be examined further by recruiting a larger sample size that might reveal findings of greater statistical significance. The secondary aim of the

survey study was to examine the barriers and facilitators that PCPs consider important in the adoption and use of mHealth diabetes self-management tools. The descriptive analysis revealed that the following factors were of importance to PCPs: there were too many mHealth diabetes tools on the market to choose from; that existing mHealth diabetes tools have technical or usability issues, and how providers were reimbursed for using these tools was problematic. The ten items reduced by PCA identified three underlying concepts of Provider-Patient Barriers, Clinic Barriers, and System Barriers. The composite scores for each of them, when assessed according to CHC and Non-CHC settings, revealed that the two groups did not significantly differ in their scores for Provider-Patient Barriers, Clinic Barriers, and System Barriers. At the same time, the scores were descriptively higher for CHC providers for the Clinic Barriers, while the scores were higher for Non-CHC providers for the Patient-Provider and System Barriers. These suggestive insights could inform further inquiry into these dimensions. However, it should be noted that there are some challenges presented by using a one-item scale. One challenge is that the use of a single-item measure reduces the chance of a common method variance where spurious correlations are observed due to the use of the same response format rather than the content of the items. However, this does not mean that the face validity of the single-item measure should be discounted.

Chapter 5: Findings of Qualitative Interview Study

The inductive thematic analysis of the qualitative interviews with the 15 primary care providers (PCPs) in the Community Health Centres (CHC) and Non-CHC settings reveals four themes: Burden of Challenges; Multi-Layered Challenges; Self-Management Diabetes Applications & Virtual Care Awareness and Use; and Resolutions. The analytic approach to interpretation drew from the meaning-making framework. According to Magnusson & Marecek (2015), a “meaning-making” analysis within the thematic approach “designates the process by which people interpret situations, events, objects, or discourses in-light of their previous knowledge and experiences” (Magnusson & Marecek, 2015) and from conceptual tools of the Ecological Systems Theory, EST, (Bronfenbrenner, 1981) like micro-system (i.e., systems closest to an individual such as home, work, and school), meso-system (i.e., interactions between various microsystems), exo-system (i.e., the context that has an indirect influence on a person) and macro-system (i.e., shared beliefs and norms such as cultural or societal customs).

The Burden of Challenges theme entails sub-themes of PCP emotional engagement and stress, the dilemma of tied hands, and gaps in knowledge and skillset, capturing their experiences and perspectives mostly at the micro-system level. The theme of Multi-Layered Challenges delves into micro-system and exo-system along with meso-system challenges of providing care to the patients served by the PCPs; three sub-themes of Communicating with Patients, Working in Teams, and Funding Models are identified. Next, the theme of Self-Management Diabetes Applications & Virtual Care Awareness and PCP perceptions and experiences with mHealth within a primary care context. Finally, the Resolution theme presents PCP insights about how mHealth can facilitate overcoming digital inequities. Across the themes and sub-themes, specific discussion foci or categories were also identified and are presented (in bold italic font) in the following sections. Table 13 below presents a summary of participant demographics.

Table 13*Participants in Qualitative Interviews*

Participant	Gender	Professional Role	Years in Practice	Setting location	Geographic area
BH	F	Nurse	17+	CHC	Rural
CF	M	Nurse Practitioner	5+	Non-CHC	Urban
CS	M	Nurse Practitioner	2	CHC	Urban
EB	F	Nurse Practitioner	6	CHC	Urban
EW	F	Nurse Practitioner	5	CHC	Urban
HB	F	Nurse	10	Non-CHC	Rural
HW	F	Nurse Practitioner	8	Non-CHC	Urban/Rural
JO	F	Certified Diabetes Nurse educator	9	CHC	Urban
JR	F	Nurse Practitioner	2	CHC	Rural
KK	F	Nurse Practitioner	7	CHC	Urban
MB	F	Nurse	20	Non-CHC	Urban
NB	F	Nurse	15	Non-CHC	Urban
NK	F	Nurse	15	CHC	Rural
SL	F	Nurse Practitioner	10+	Non-CHC	Urban
TD	F	Diabetes Educator	20+	Non-CHC	Rural

The findings are broadly linked and demonstrate how PCP perceptions of and experiences with vulnerable and marginalized patient populations influence their recommendation, or lack thereof, of mHealth tools, as well as the adoption of these tools by patient populations. The qualitative study findings reaffirm prior research on the impact of the social determinants of health on the well-being of vulnerable and marginalized patient populations. The structural barriers and inequities continue to manifest within digital inequity. Notably, individual-level characteristics of patients (education, income, housing, and immigration status, among others) were less frequently considered in Non-CHC settings when compared with CHC settings.

The generated knowledge on digital inequity at the system level, such as models of primary care, demonstrates the need for further research, knowledge dissemination, and operationalization of strategies to address them. The gained insights also contribute theoretically to advancing existing theories on digital inequities in vulnerable and marginalized patient populations. The thematic findings are presented in the following section along with direct statements from the PCPs who were interviewed, the used acronyms for participants are based on assigned pseudo names. Given the

cross-cutting nature of some themes, the statements of participation may appear in more than one section.

i. Theme: Burden of Challenges

Under the theme of Burden of Challenges, the qualitative interview findings present the various levels of challenges that influence PCPs in general and, by extension, the utilization and adoption of mHealth diabetes applications by PCPs and the micro-system of PCP work and its interaction (i.e., meso-system) with the patient micro-system of life context are notable. The identified sub-themes are Emotional Engagement and Stress, the Dilemma of Tied Hands, and Skillset/Knowledge Challenges.

a) *Emotional Engagement and Stress*

PCPs' emotional engagement with vulnerable and marginalized patient populations varied from empathy to concern depending on the setting in which the care was provided. PCPs in CHCs expressed more passion for their work, and they perceived it as their mission to help others rather than just do their jobs. In the words of a participant, “CHC staff are more empathetic in terms of working a little bit above and beyond to help clients get the supplies they need” (CHC Participant, KK). Overall, they expressed more empathy for their patients' social situations and voiced a deeper level of concern about the implications of their actions or inactions. PCPs in Non-CHC settings expressed fewer concerns about their patients' social contexts. As shown in the survey results, it is not that they cared less about their patients, but that they acknowledged the constraints of the various structures (micro-, meso-, and macro-) and that they worked within their limited capacity to change it. For example, as shown in the second quote below, PCPs in Non-CHCs treat a smaller volume of vulnerable and marginalized patients (this aligns with the survey results) and are in some cases less prepared to deal with their non-medical challenges.

The other big challenge at the CHC is the population that we serve, it is-it's so-you're so inundated sometimes dealing with social complexities that it's not easy to just be like—let's focus on you, you know, the patient's medical needs – like you need to have a colonoscopy. It's very hard and stressful for us in these situations (CHC Participant, JO).

So, we don't see a huge population of vulnerable patients. Our catchment is quite affluent, however, when we see vulnerable patients it's more challenging to help them because they sometimes have no status (refugees with no OHIP coverage) and no insurance. So, how are we to help them? (Non-CHC Participant, SL).

The participant discussions revealed that the challenges may vary between CHC and Non-CHC settings and patient populations, thus contributing to higher levels of stress for PCPs, a meso-system case when the provider and patient micro-systems interact through different underlying mechanisms. Patients treated by the CHC providers were perceived to have more social issues relating to income, employment, housing, immigration status, and other factors when compared to patients in the Non-CHCs (FHT/Solo-based practice, etc.).

As shown in the survey results, given the large volume of vulnerable and marginalized patient populations treated in CHCs, PCPs from these settings expressed feelings of frustration and helplessness regarding the provision of care to them. They associated such feelings with the multiplicity of contextual issues in their patients despite being in a multi-disciplinary clinic environment. In comparison, PCPs from the Non-CHC settings shared their perceived inability to adequately address patients' social issues, though they noted that they encountered such patients less frequently. They perceived the challenges to be of a high magnitude that could not be adequately addressed in some clinics due to their rural or remote geographic locations. PCPs from the Non-CHC clinics also discussed the constraints of the short duration of clinic visits and thus, having to treat/ address only one condition at the expense of ignoring comorbidities at times, another example of provider and patient microsystems interacting with each other. Some participants also shared their views about their lack of access to multi-disciplinary teams in the same location and feelings of being inadequately equipped to deal with the complex nature of vulnerable and marginalized patients. They also expressed concerns about the lack of awareness of available social services. Thus, the stressors induced by patient social context seem to be more of a practical nature among PCPs in Non-CHC settings.

A lot of vulnerable populations where either it is seniors that are frail or more low-economic status clients that have a lot of mental health and addictions as well. So that would be the majority of our population. Of course, because we are in a sort of like an up-and-coming area, we have people who are like low economic status all the way up to people that have a higher status as well (CHC Participant, CS).

I have mostly affluent patients, but I also have patients that are more vulnerable and more impoverished and some of them have – you know – they'll see anyone without OHIP. But it is – it's – you know, we don't have that kind of protected funds from the government to be able to serve that population like the CHCs do. And we should (Non-CHC Participant, SL).

Overall, PCPs seem to experience feelings of stress, such as being overwhelmed by the number and/or volume of social challenges faced by vulnerable and marginalized patient populations in their clinics and/ or the availability of care options at hand to offer. This is compounded by meso- and macro-level challenges that are presented later in this chapter.

b) The Dilemma of Tied Hands

There were some notable differences in the topics on which PCPs felt their “hands were tied.” For example, PCPs in the CHCs discussed struggling with not being able to help patients with a high number of social needs/challenges (housing, immigration status, etc.), whereas PCPs in Non-CHCs expressed more concerns about their patient’s immediate medical needs, such as medication accessibility, the lack of availability of multi-disciplinary teams as mental health specialists, and the lack of accessibility to emergency care when needed. These findings suggest that interactions between the provider and patient micro-systems may have varying outcomes depending on whether the provider is in a CHC or Non-CHC setting. A participant who worked in both models of care articulated it well as presented in her words below.

But for instance, at the CHCs that I've worked in, I have a pharmacy in the back room where I can give samples and I can, you know, kind of be able to bridge someone until EAP is filled out. But we don't accept samples at our FHT. And you know, I don't sell low-priced birth control. Like that's never an option. Most people at the FHTs have at least two insurance, more than they need. But the others (vulnerable) don't have it, but they need it. And so, you know, I—I feel like I should just go back to the CHC because clearly, this is what I believe in (Non-CHC Participant, EF).

The differential availability of staff/ services in the rural versus urban areas posed another dilemma for the PCPs – a case of micro- and exo-system interaction where the former is the PCP’s work, and the latter is related to the funding of services. They discussed the implications of these differences on patient outcomes. Additionally, as shown in the survey results and in alignment with the qualitative study’s findings, there were notable differences in awareness, understanding, and acceptance of social challenges in certain patient populations among PCPs in the rural CHCs. For example, PCPs in the rural CHCs were more aware and accepting of social challenges such as alcoholism, and distrust in the medical system/medical professionals among Indigenous patient populations. As per the Ecological Systems Theory, this finding is suggestive of interacting layers between the PCP’s work (micro-system), limited availability of social services (exo-system), and historically built distrust of institutions within Indigenous communities (macro-system).

These PCPs conveyed the importance of trust being established first before care or treatment plans can be developed and adhered to.

Like a lot of the nurses that I talked to um, you know they have clients with tons and tons of complicated pharma issues, abuse, alcoholism and, you know, just basic poverty, right? And we simply don't have the staff or services here up north, we barely have doctors and residents rotating from Ottawa to see patients every couple of months (CHC Participant, BH).

I have worked in CHCs before in the north and that was more, you know – like I saw waymore vulnerable patients and marginalized people-newcomers and refugees and kind of that. So, we do have patients in our FHT that are low income-that you know struggle more with the social determinants of health (Non-CHC Participant, TD).

c) Skillset/ Knowledge Challenges

A PCP's knowledge or skillset for treating marginalized/ vulnerable/ new immigrants/ refugee patient populations seems to vary by their practice setting. Those in the CHCs felt more knowledgeable about treating these populations when compared to their peers in the Non-CHC settings. Clinicians in CHCs also strongly believed that they are less judgemental when treating vulnerable and marginalized patients and believe that their mission/ purpose is to enable others or contribute to a greater good, rather than being focused on financial gains. Many providers in CHCs inferred a sacrifice (lower pay) in pursuing this line of work (not for profit). Although participants from the Non-CHC settings considered themselves as knowledgeable in treating these patient populations (based on the location). They also acknowledged that there is a difference in the mindset among CHC providers as compared to them (in Non-CHC settings).

CHCs are better at treating vulnerable and marginalized populations because we advocate for the clients and go above and beyond to try to do whatever. For example, we provide interpretation, and we try to connect and make everybody feel as comfortable as we can (CHC Participant, NK).

So, if that service (translation) could be available, that I think makes a huge difference because sometimes the doctors refer people to us and say, "Oh you know there might be some cognitive issues and blah, blah, blah." And you talk to the client after you have an interpreter and there's nothing wrong with anyone. It's just there was a language barrier. So that's been an issue (CHC Participant, EM).

The other thing I'm going to comment on, I did comment on this in the online questionnaire is the language barrier. That was a factor when we did virtual care because we also didn't have accessibility to interpreters (Non-CHC Participant NB).

As shown in the quotes above, most PCPs in CHCs appear to take a holistic approach to patient care where health concerns are inclusive of a patient's social context. The most notable difference was among nurses in the Non-CHC settings compared with nurses in CHC settings.

The difference inferred carries a reference to the amount of effort placed and time spent on finding holistic and creative solutions for vulnerable and marginalized patients – a case of provider and patient micro-systems interacting with one another. It was noted that this opportunity is made possible due to the flexibility in terms of the amount of time that a CHC provider (primarily salaried compensation type) can spend with patients compared to a Non-CHC provider (largely fee-for-service compensation type), which demonstrates how funding as an exo-system impacts the workplace micro-system.

ii. Theme: Multi-Layered Challenges

Another theme identified across the interviews is the multi-layered challenges experienced by PCPs. Their discussion centered on communicating with patients, working in teams at the micro-system, and funding models at the exo-system.

a) Communicating With Patients

Primary care providers in both CHC and Non-CHC settings expressed frustration and concerns about encountering barriers when attempting to initiate meaningful communication with patients. Their challenges ranged from clinic hours to a lack of mHealth and/or virtual care device availability (both for themselves and their patients), and a lack of training on the use of digital health tools for both them and their patients. They also discussed communication challenges related to English proficiency, which is presented under Working in Teams.

At a micro-system level, PCPs in CHCs were concerned about clinic hours, which are difficult for their patients (vulnerable and marginalized) to make and attend appointments within, due to precarious employment and a lack of pay for sick days or days away from work. They expressed that current clinic operating hours are not set up to accommodate their patient population needs, and they argued that this makes it difficult for patients to follow care plans or comply with office visits at intervals that support the proactive management of diabetes. Comparatively, PCPs in Non-CHC settings expressed fewer concerns about the ability of their patients to keep their clinic appointments. However, they noted that a small population of their patients (mostly vulnerable and

marginalized) struggled to keep up with regular office visits or referrals to other specialists, and they perceived it as a consequence of co-occurring health/social conditions.

Unfortunately, with the pandemic, we've had to reduce our hours so we're not doing evening or weekend appointments. And that's been a barrier for sure, for a lot of these people that are so precariously employed, and they can't take time off so they can't come between nine and five Monday to Friday which is when we're currently open, so that's been an issue (CHC Participant, EM).

And that went on—like there were six, seven missed appointments. But again, we're [in Toronto] dealing with mental health issues, addiction issues, and poverty—you know (NonCHC Participant, MB).

The quote above shows a CHC provider highlighting the negative impacts of the COVID-19 pandemic on patients, as a result of the clinic only being open during business hours (when marginalized patients are working) and not on weekends – an example of macro-system (i.e., pandemic) influencing the PCPs' work (micro-system) and health access of patients (micro-system). One notable point of interest is that despite the lower rates of patients keeping up with their clinic visits in urban areas, this was not the same for rural clinic visits.

As shown in the survey results, a lack of mHealth and/ or virtual care device availability/ accessibility was also expressed as a major concern by PCPs in both CHC and non-CHC settings; however, it was discussed with more intensity by providers from CHC settings as being more problematic for their work. Given that the interviews were conducted during the pandemic, the devices to provide virtual care were perceived as low in availability by the clinicians – an exo-system issue influencing PCP's workplace micro-system. Providers in CHC settings explained that they were expected to utilize their own devices (mobile phones, iPads, etc.) to provide virtual care during the COVID-19 pandemic. On the contrary, providers in Non-CHC settings, such as Family Health Teams (FHT), expressed fewer concerns about device availability. For example, the administrative management of FHT clinics was more organized in their approach to virtual care despite initially being delayed in offering patients virtual care. PCPs noted that they preferred this delay, as it helped them to make the transition to virtual care slowly and more smoothly, as their teams were better equipped to acquire devices and evaluate them.

At the beginning of the COVID-19 pandemic, we were not allowed to work at all from home. We had to come in to see our patients. No one (management) told us that this was due to not having devices for us. Then we were allowed to rotate and work some days in person and others from home. But I was worried about using my home computer for work (CHC Participant, NK).

.... During COVID, like in the early phases, it was telephone assessments. And then later we got iPads, and it became virtual. I think it was called OTN. Some of us had devices/Internet and others didn't. During the first wave, everybody tried to do it from home. Because nothing was opened to go to anyways (Non-CHC Participant, NB).

In alignment with the survey results, another relevant concern raised by PCPs during the interviews was about the use of devices for communicating with patients centered around their legal obligations of privacy of information – macro-system interacting with micro-systems. PCPs in CHC settings expressed concerns about using unencrypted devices to communicate patients' status and personal information with their peers as they were not fully informed about all the risks involved in providing care through this medium. In contrast, PCPs in Non-CHC settings shared relative comfort in using the provided tools as they asked relevant questions about their privacy as well as their patient's privacy prior to adopting them. Overall, providers in both the CHC and Non-CHC groups overwhelmingly expressed that privacy and security are of extreme importance to them and that they wanted to be reassured that their respective management teams considered this when choosing devices or various software programs to facilitate virtual visits.

[Privacy] That's a major concern – Zoom applications and things like that outside of government control. Because of the confidentiality of patients' information. Yeah. We don't do that" (CHC Participant, NK).

Yes. Um, like all of the other clinicians, they are also concerned about privacy and security too. They (the docs) are worried about privacy even when using OTN (Non-CHC Participant, MB).

As echoed by the survey results, providers' lack of training to use virtual care devices was another issue discussed equivocally by both PCPs in CHCs and non-CHCs. Providers expressed concerns that they were not adequately trained on the devices and systems before having to provide virtual care; their challenges were multi-faceted. Providers noted that they were not trained on conducting secure virtual care sessions with their patients; that is, they were not informed on how to secure their sessions to prevent privacy and security breaches. Additionally, they were not consulted about whether they had "private spaces/ settings" within their homes to conduct virtual care sessions. Assumptions were made by their clinic's administrative leaders that they did and that was not

necessarily the case for some providers.

So, when the pandemic started our clinic decided to allow us – NPs and Diabetes Educators – to see patients virtually from home. But no one asked whether we had a quiet or confidential space for these virtual visits. It was upsetting that no one from the management team told us how to set up our devices or equipment. I worried about the privacy and security of my patient consults. I also had a lot of trouble with the Telus PSS EMR-lots and lots of stress (CHC Participant, KK).

Initially, we were only using the telephone for seeing patients. But then we got OTN, and we were told that we can rotate amongst the team which days each of us would come for in-person visits for patients who needed them and when we can work from home. I was initially not ok with it; I had concerns about my privacy like what if the patient sees something personal in my home? I was not sure, but a lot of us complained and then they (the clinic management) decided to give some training on virtual care. What to do, expect, etc. I was happy about that (Non-CHC Participant, HB).

On a similar note, providers were not trained on how to easily connect their data collection with their electronic medical records or electronic health records. Providers noted that they were double documenting – they initially documented on paper or a Microsoft Word document and then had to document again in their clinic’s health information systems. They voiced disdain for this process, as it was perceived to be a waste of their time and resources. Providers were also not consulted about using a consistent and streamlined process that was appropriate for their patients. Overall, providers felt inadequately prepared to provide virtual care services.

b) Working in Teams

In both the survey results and qualitative interviews, PCPs stressed the importance of having multi-disciplinary and inter-disciplinary team members in their clinics, however only PCPs in CHCs confirmed having this model of care currently in their day-to-day clinical settings. For example, they (PCPs in CHCs) explained that multi-disciplinary team members are vital in the effective management of patients with diabetes demonstrating how PCP’s workplace micro-system interacts with the patient’s micro-system of healthcare. They noted the importance of having these services all in one location, as it is easier for vulnerable and marginalized patients to attend multiple appointments with various specialists on the same day. In contrast, PCPs in Non-CHCs noted the shortcomings of not having as many multi-disciplinary and inter-disciplinary team members as in CHC settings.

I do feel like that's such an advantage for us that we have physiotherapists. And so, for patients that don't have status and can't afford to go see a physio, we have one that they can see for free. Like this is the stuff that I think is setting up to give these people a chance when they wouldn't have necessarily had a chance to get physio or to get these things (CHC Participant, HS).

..... appointments are shorter at the Family Health Team. They just don't have the time to use translation or to consider all the factors. And my friend that's a family doc at a family health clinic, it's just that they're dealing more with the medical issues. They just don't have time to deal with the psychosocial issues (Non-CHC Participant, TD).

As highlighted above, vulnerable and marginalized patients can benefit from this as they can be treated holistically instead of only medically. Some multi-disciplinary diabetes practitioners working at CHCs are diabetes educators, nurse practitioners, foot care specialists, etc. Diabetes educators, for example, are trained on advising marginalized patients on eating healthy on a budget and other lifestyle changes specific to this patient population. Additionally, diabetes educators are trained in understanding the impact of the social determinants of health on diabetes management. PCPs in Non-CHC settings felt disadvantaged when caring for diabetes patients, as they lacked the expertise that comes from a multi-disciplinary team.

A notable difference was in the team-based approach in rural primary care settings – in both CHCs and Non-CHC settings PCPs heavily utilized and relied on this model of care. However, it was noted that a team-based approach to care in this context does not necessarily include interdisciplinary/multi-disciplinary teams. The meaning of a “team-based approach” in these settings referred mostly to a collaborative and informed approach to care, in which all team members were aware of the patient’s status and care plans. It was also noted that team members in rural settings wore multiple hats, meaning that they took on multiple roles because they were the only permanent staff in those locations and other team members rotated on an in-frequent basis. Despite varying levels of operationalization of team-based care, PCPs in all settings agreed that it played a critical role in improving patient outcomes, the patient’s ability to visit multiple specialists, and the overall patient experience. The majority noted that this was an effective and efficient way to treat patients with chronic illnesses including those with diabetes.

When asked how the CHC approach to providing care is different, a provider stated that they treat patients from a multi-disciplinary-holistic perspective. This provider believes that it is important for rapport building and is anecdotally linked to increases in patient compliance. It was also highlighted that a holistic approach to patient care and understanding of the non-medical barriers helps providers provide judgment-free care.

So, it's still three of us (doctor, nurse practitioner, and dietitian). It's very patient-centered care in terms of we get to know the patient and that's why we have subsequent visits right? Multiple subsequent visits in the year depending on patient need and trying to understand OK – what are the barriers for this particular patient and then we'll try to assist them as best as we can (CHC Participant, NK).

Despite the survey results showing that a high number of participants in the study were of mixed ethnicities and spoke another language, PCPs in CHCs expressed their concerns during the interviews that their Non-CHC peers were unprepared to treat patients who were vulnerable, marginalized and did not speak English as their first language. They felt that this topic was important to address the language barriers when working in teams and caring for new immigrants and refugee patients with diabetes. Communication is a key factor between patients and their providers, especially in the case of diabetes where information is complex and can be misinterpreted. Thus, PCPs in Non-CHCs believed that they are at a disadvantage when communicating with new immigrants and refugee patients given the lack of translation services in Non-CHC primary care settings (FHTs, Solo Practices, and Nurse Practitioner-Led Clinics). Comparatively, CHCs benefit tremendously when communicating with these patient populations to which they credit the availability of translation services.

Yes, a lot don't speak English. And I think probably some of it is lost because it's not like they can show me where the pain is or show me what the pill bottle is that they just got. So, it's harder. Like follow-up appointments are working OK and if you're speaking English then that's generally not bad. But it's definitely a challenge for my non-English-speaking patients". (Non-CHC Participant, EF).

And so yeah, I definitely feel like CHCs are better equipped. We have all the services including translators that we can offer to people. Plus, we have time (CHC Participant, CF).

Many examples were provided by PCPs in CHCs of situations in which their colleagues in Non-CHC settings mislabelled patients as being “cognitively impaired” or having challenges comprehending the information shared with them, instead of acknowledging the language barriers that patients from these populations face. However, in being realistic they also acknowledged that PCPs in Non-CHC settings face challenges related to time constraints along with other structural barriers inherent in Non-CHC settings. Further challenges of providing virtual care during the pandemic will be discussed later in this chapter.

c) Funds and Primary Care

The type of funding models for primary care was a salient discussion point in interviews with providers in Non-CHC settings. Specifically, providers highlighted how a fee-for-service model directly impacts the quality of care that patients receive and noted that this model does not work well for patients with diabetes. Providers observed that patients with diabetes often require (more) complex care/ time and when compounded with low socio-economic status or language and other social barriers then it is more complex to provide care within the allocated visit time of 15 minutes. Providers argued that this influences them to rush through office visits in order to keep up with the high volume of patients daily and thus, may result in unintentionally “rushed care,” in the words of a participant, due to time constraints. PCPs in CHCs noted that not having the pressure to complete a patient visit for diabetes care in 15 minutes allowed the provider enough time to discuss the social determinants of health and their impacts on diabetes care outcomes.

CHC docs are more – I find are more, uh, empathetic in terms of working a little bit above and beyond to help their client get the supplies. But sometimes some doctors especially if they're in private practices and they're not working in CHCs, there's a lot of them that don't-they don't have the compassion because they don't have the time. That's just not apriority. (CHC Participant, CF).

Yeah. So, we have actually – as part of our center we have a Parkdale Food Market, and it's basically a farmer's market that's for our clients. And in order to have access to it, they need to be referred, right? So, a provider needs to refer them to the Parkdale Food Market where they can access fresh fruits and fresh vegetables, and more healthier options. So, if that is always the issue then I'll always refer them there, and that's when they go pick it up. And then, as well, we get community relations from different independent restaurants or places that I guess create food like lasagna or more healthier options, which I actually love because I actually go to one place as well for myself (CHC Participant, CA).

Some PCPs discussed the need for an upstream approach by having funding for diabetes medications and supplies. Participants from the CHCs shared stories about some patients having to choose between meeting their basic needs and their diabetes medications. When asked about challenges in providing diabetes care in Non-CHC settings, providers noted having to treat non-OHIP insured patients who are primarily from new immigrant and refugee patient populations. The difference between CHCs and Non-CHC settings highlights that CHC settings can treat such patient populations. A few participants shared their observations about the effectiveness of “subsidized or fully funded diabetes medications and supply programs in aiding patients with adherence to treatment plans”. This was well articulated by a nurse practitioner in Nunavut as presented in her statement below. Some providers noted that governments can benefit largely from the funding of diabetes medications as the upstream costs are significantly less than the costs related to downstream implications such as amputations, blindness, and other diabetes-related complications. Providers noted that immigrants and refugee patients can benefit even more from such programs as it will eventually impact their contributions to the Canadian economy.

If they can have access to, um, you know um medications and the, um, all of the supplies that they need to manage their diabetes, that would be excellent. Because again, if that's out of the way, people will be able to uh, you know, manage their, um, their diet and be able to buy food. Because now, sometimes people are deciding between buying food and buying supplies to manage their diabetes right (CHC Participant, CA).

As you may be aware already, the Government of Nunavut provides diabetes medications for Indigenous peoples (Inuit, First Nations, Metis) in the province. Um, this is amazing as it really helps both the patients and us. We can prescribe the right medications and know that the patients will get it. Um, [nervous laugh] and contrary to the belief in the center of Canada, you know where I mean, [nervous laugh] Toronto, patients here actually take their meds despite all of the other challenges that they have-you know alcoholism, abuse, etc. This should be the same everywhere, um all of Canada” (CHC Participant, NK).

As presented earlier, a **team-based approach to primary care** for chronic/ complex conditions was a topic of high importance to PCPs in both CHCs and Non-CHC settings. This was also discussed by participants as an exo-system level element because they associated the team-based funded model of primary care with the quality of care.

CHCs are better equipped. I think we do. We have to because for patients that's such a huge factor for everything. So, we're really lucky that we have social workers to help with you know transitions or whatever. We have community health workers that can help with food baskets or rent relief if they've got status. We've got health navigators that can help with applications for different programs. We've got the diabetes team that can help. So, I do feel like that's such an advantage for us (CHC Participant, HS).

Mm-hmm. I think it'd be helpful if our clinic (FHT) had a diabetes clinic because right now we're sending people to a community health center. For example, I have a client that I'm seeing today actually who is on triple p.o. medication, non-compliant. I want them to start insulin and they don't want it. They don't want insulin, but I need to start them on insulin and I'm going to be referring him to a community center just for the initiation and management of diabetes, so it's more focused right? So, if that was on site (Non-CHC Participant, MB).

But sometimes some doctors, especially if they're in private practices and they're not working in CHCs, there's a lot of them that don't have the compassion [for social context] and they don't have the time. That's just not a priority" (CHC Participant, KK).

iii. Theme: Self-Management Diabetes Applications and Virtual Care

Participant discussions on the use of diabetes self-management applications in primary care led to common threads across the interviews for a) provider awareness/ use and b) patient digital divide based on PCPs practice type. As the interviews were conducted during the pandemic, their use of virtual care was also discussed.

a) Provider Awareness/Use

When PCPs were queried about the use of diabetes self-management applications before the COVID-19 pandemic, the majority of them acknowledged that this medium for providing care and monitoring patients was not common and some were not familiar with the details of applications. PCPs in the CHCs expressed such sentiments more when compared with their counterparts in Non-CHC settings. Providers from the Non-CHC settings noted that their patients with diabetes consulted with them frequently about using self-management applications to document and track their diet, exercise, medication, etc. As this study revealed, during the pandemic there was a major increase in the utilization of virtual care in both CHCs and Non-CHCs, though mHealth diabetes applications did not receive more attention in these (types of) organizations. The Non-CHC participants expressed more utilization of virtual tools than those in the CHC settings. In terms of locations, PCPs and patients in urban settings seemed to fair better than those in rural settings, which lacked the basic infrastructure to support virtual care.

Again, um most of our clients aren't tech-savvy. They don't have computers. They won't even answer their phones because they don't want to waste their minutes (CHC Participant, JR).

My patients sometimes ask about using the, um Libre Life app-I think that's what it's called. This app helps them with managing their glucose on their own daily. And when they see me, we discuss like, the results for the previous week and make any adjustments. They like this app I think (Non-CHC Participant, NB).

When interviewed about modes of care provision and clinical encounters with patients during the COVID-19 pandemic, PCPs in both CHCs and Non-CHCs noted several challenges related to virtual care utilization including a lack of infrastructure, technical challenges, privacy concerns, security concerns, cybersecurity concerns, and a lack of technical expertise in their clinical settings. PCPs also expressed overall concerns about using this mode of care worrying that they might miss some important physical indicators of potential problems.

b) Patients' Digital Divide

As discussed above, patients' access to digital health technologies have historically been challenging in CHC settings compared to patients visiting Non-CHC settings. Through discussions with PCPs in CHC settings, it was clear that the lack of patient access to digital health technologies is underpinned by the social determinants of health such as (un)employment, (low) income, poverty, low education levels, and technology/ health literacy rates. PCPs in CHCs noted this was not deeply problematic before the COVID-19 pandemic as their clients always had the opportunity to visit the clinics in person and the majority of diabetes care was provided this way. However, according to PCPs in CHCs, with the onset of the pandemic patients experienced delays in accessing virtual care due to not having the required technology such as a phone, having difficulty using the technology, or not having access to fast/reliable Internet. In comparison, PCPs in Non-CHC settings seemed less concerned about patients' digital divide as critical to access care.

Patients lack access to a camera I think, right. So, either they don't have a phone, or their phone doesn't have the camera option, or they don't have an iPad. So, it's usually more, yeah, so usually-like a lot of clients sometimes they don't have a phone, so they have to go in person. But typically, otherwise, it is usually they just don't have access to that type of service (CHC Participant, CA).

They (the patient) can't afford um, you know the technology—not even a phone or like minutes on the phone. It's a big problem you know. Uh, it's her (the nurse's) personal cellphone but um she uses it [for the patients] because um she feels so sorry for them (Non-CHC Participant, HB).

The patient challenges to access virtual care in CHC settings are especially concerning to those with diabetes given their high risk of contracting severe COVID-19 illness (or any additional viral or bacterial illness). Yet, they were likely the ones having to go in person to diabetes clinics due, at least in part, to the digital divide. The interviewed PCPs from the CHC and Non-CHC settings did not perceive themselves as having expertise in utilizing digital health tools. Many providers expressed anxiety about using the tools, as well as worrying about any missed items of clinical significance. PCPs in both settings expressed frustrations about how they were expected to pivot

seamlessly to utilizing digital tools when the pandemic began without training or support. They acknowledged not being fully aware of having a comprehensive understanding of the technical jargon and understanding of the privacy and security risks involved with the use of some of the digital health tools. Providers admitted that both they and their patients were reluctant to use some of the technologies due to the fear of their privacy being invaded. One PCP in a CHC setting expressed anger at the assumptions made by her superior that she is comfortable working (caring for patients virtually) from her home. She was not consulted about her comfort level with providing care from her home or whether her home was the appropriate setting. Additionally, she shared that her patient was never consulted about her readiness for virtual care.

So, when the pandemic started our clinic decided to allow us – NPs and Diabetes Educators – to see patients virtually from home. But no one asked whether we had a quiet or confidential space for these virtual visits. It was upsetting that no one from the management team told us how to set up our devices or equipment (CHC Participant, KK).

Initially, we were only using the telephone for seeing patients. But then we got OTN, and we were told that we can rotate amongst the team which days each of us would come for in-person visits for patients who needed them and when we can work from home. I was initially not ok with it; I had concerns about my privacy like what if the patient sees something personal in my home? I was not sure, but a lot of us complained and then they (the clinic management) decided to give some training on virtual care. What to do, expect, etc. I was happy about that (Non-CHC Participant, HB).

iv. Theme: Provider Recommendations

The interviewed PCPs discussed several strategies for addressing the gaps in effective diabetes management in primary care. Their discussion centered on a) understanding diversity and b) revisiting the structure and delivery of healthcare services as potential paths forward. Given the cross-cutting nature of these sub-themes, some statements presented here are from earlier sections.

a) Understanding Diversity

The need for equity-informed care was expressed by a high number of participants in both the surveys and qualitative interviews, however, more participants from CHCs stated that this aligned with their organization's mission and values. One of the core values of the CHC model is "equity for all," this aligns very well with the "equity-oriented healthcare (EOHC)" framework (Ford-Gilboe et al., 2018). This framework provides guidelines for improving health equity at the point of care by creating "safe and respectful environments while tailoring healthcare services to fit the needs, priorities, history, and contexts of individual patients and populations served." It informs equity-based care at the patient-provider interaction level, the EOHC framework is responsive to social and

structural inequalities which underpin health differences.

So, if that service (translation) could be available, that I think makes a huge difference because sometimes the doctors refer people to us and say, “Oh, you know there might be some cognitive issues and blah, blah, blah.” And you talk to the client after you have an interpreter and there’s nothing wrong with anyone. It’s just there was a language barrier. So that’s been an issue (CHC Participant, EM).

Despite providers from both CHC and Non-CHC models of care pointing out in the survey that providing equity-informed care is of importance to them, the CHC providers felt that their peers in Non-CHC settings lacked awareness and understanding of equity-informed care and therefore placed the responsibility of managing health risks such as unhealthy eating and a lack of daily exercise solely on patients. These providers inferred that this demonstrated a lack of awareness of the social determinants of health and the structural origin of health risks. It should be noted that a small percentage (less than 5%) of Non-CHC providers inferred during the qualitative interviews that these patient behaviors were a personal choice that was shaped by cultural influences, race, gender, and education levels. For these providers, the locus of healthy behavior resides within the individual and was a choice that patients could control or influence, thereby neglecting the underlying societal structures that shape health risks or the biological basis of diabetes.

On the other hand, some CHC providers described their approach to care provision as being centered around multiple social determinants of health such as living conditions and the social needs of patients with a focus on empowering them. For these providers, safe housing and a livable income were considered prerequisites for healthy eating, daily exercise, and diabetes medication adherence. This description of care demonstrated “equity-informed care” by acknowledging the impact of structural inequities on an individual’s health and well-being. Based on Ecological Systems Theory, it also demonstrates CHCs’ PCP having a clearer understanding of the interaction between exo-system and microsystems. Additionally, many providers considered shared clinical management, particularly via interdisciplinary and multi-disciplinary care of great importance in providing equity-informed and holistic care to vulnerable and marginalized patients with diabetes. They noted that along with other frontline care providers, some pressure could be alleviated when attempting to deliver holistic, proactive, and preventative care within a short clinic appointment. In particular, providers explained that social workers, mental health specialists, medical translators, and other care providers are extremely beneficial in providing comprehensive care to diabetes patients.

CHCs are better equipped. We have to because for patients that's such a huge factor for everything. So, we're really lucky that we have social workers to help with you know transitions or whatever. We have community health workers that can help with food baskets or rent relief if they've got status. We've got health navigators that can help with applications for different programs. We've got the diabetes team that can help. So, I do feel like that's such an advantage for us (CHC Participant, HS).

CHCs are better at treating vulnerable and marginalized populations because we advocate for the clients and go above and beyond to try to do whatever. For example, we provide interpretation, and we try to connect and make everybody feel as comfortable as we can (CHC Participant, NK).

b) Revisiting primary care services

In alignment with the survey results, when questioned about recommendations for a path forward, primary care providers from both Non-CHC and CHC practices recommended restructuring the way care is funded and delivered for chronic illnesses such as diabetes – an exo-system focus. Non-CHC providers maintained that the current model which allots only fifteen minutes for “follow-ups” is unacceptable, as it does not allow enough time to fully address chronically ill patients' multi-faceted challenges. Additionally, it was noted that a “one main concern/ complaint” per visit model does not work well for this patient population and needs to be addressed moving forward, as it is an ineffective approach to chronic disease management.

..... appointments are shorter at the Family Health Team. They just don't have the time to use translation or to consider all the factors. And my friend that's a family doc at a family health clinic says it's just that they're dealing with more medical issues. They just don't have time to deal with the psychosocial issues (Non-CHC Participant, TD).

Primary care providers in CHCs raised concerns relevant to their settings – a micro-system focus; concerns such as medication accessibility, healthy food affordability, and stable (non-precarious employment) with benefits including medications were of a higher priority for this group of providers. Of the multiple concerns discussed, medication accessibility and affordability were of the highest concern – an interaction between micro- and exo-system. Providers in both groups felt that care provision was less satisfying and meaningful when patients are unable to access required medications. They also felt helpless when alternatives such as compassionate care programs and samples were unavailable.

Providers in CHCs voiced the need for a common understanding and awareness of health equity across the system and for their peers to acknowledge (regularly) the impacts of the social determinants (notably stable housing and employment) on the health outcomes of diabetes patients. They believed that primary care providers in Non-CHC settings do not think of this enough given their limited access to this patient population. Other concerns about language and cultural insensitivity and their impacts on patient's mental health and well-being were noted. The notable differences in the approaches to care in urban versus rural areas, the most prevalent being the acceptability of limited access to care in rural areas was highlighted as concerning. The PCPs perceived that patients were more acutely aware of the importance of attending scheduled diabetes clinic visits, as they were aware of the limited access to healthcare services.

CHAPTER 6: DISCUSSION & CONCLUSIONS

Utilizing the Ecological Systems Theoretical (EST) framework by Bronfenbrenner (1981), the main results of the quantitative survey study and qualitative interview study are discussed within a nested view of the patient microsystem (life context such as housing, education, income, etc.), provider microsystem (care work such as prescribing medications, referring patients to other providers, etc.), exo-system of healthcare (operational structure, funding models, universal healthcare, and digital health) and macro-system (policy and history), along with interactions across various systems that are also called meso-system by Bronfenbrenner (1981). Second, the implications for practice and policy are presented. Finally, the strengths and limitations of the dissertation research are discussed along with directions for future research advancement.

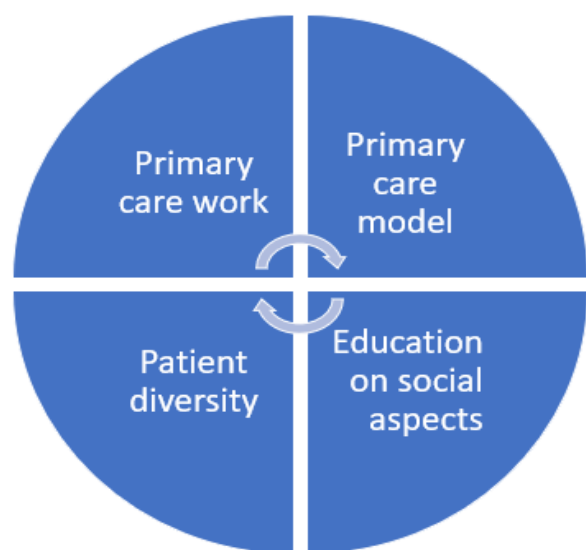
i. Patients' Life Context & Provider's Primary Care Work

In the survey study ($n = 48$), the understanding health equity' scale was utilized to assess how primary care providers (PCPs) assessed patients' "social context" when advising them on mHealth self-management diabetes applications. The findings of the survey study revealed that PCPs in the CHC practices had a slightly higher mean score (i.e., better insights) for the understanding of health equity when compared to the Non-CHC participants. The "higher mean score" (75.87 vs 73.72) can be interpreted as PCPs from CHCs had a better understanding of health equity than Non-CHC providers. This finding is aligned with the mission of CHCs "to provide equitable care to all" (The Alliance for Healthier Communities, 2020). Additionally, these findings are in coherence with earlier work in this area that shows that primary care providers in CHC settings rated themselves as high in "community orientation" though it was measured by four items only (Muldoon et al., 2010). However, it should be explicitly noted that the individual primary care provider factors are not the only ones influencing the outcomes, but the socio-contextual issues surrounding their work (volume of marginalized patients engaged, funding, policy constraints, etc.) are all influencing how PCPs interact with and react to marginalized and vulnerable patient populations. The understanding health equity scale used in this dissertation is distinct as it includes 12 items about the life context of patients which a PCP could incorporate in a clinical consult. The items were developed through a comprehensive literature review and focus groups and show high internal consistency (Cronbach alpha 0.91).

The hierarchical regression analysis of the Survey data did not find support for the primary hypothesis – the type of primary care setting (i.e., CHC vs. Non-CHC) would be a significant contributor in explaining the PCPs’ understanding of health equity over and above other variables entered in the model. A reason may be the small sample size and limited variation in the type of providers who responded to the survey; namely, only four family physicians participated, and most participants were either nurses or nurse practitioners. At the same time, important insights were gained including that 40% of the variance (33% adjusted R^2) in the understanding of health equity was explained by five variables (i.e., years of practice, training on social aspects, NP and non-NP status, service to minority/ vulnerable patients, CHC and Non-CHC setting) entered in the regression analysis. These findings collectively speak to the level of exposure and the formal training on social aspects as key determinants of PCP understanding of health equity in the final model. More importantly, the training of PCPs on social aspects remained an independently significant explanatory variable. Through the Ecological System Theory (EST) lens, these findings demonstrate the interactions among multiple microsystems that a primary care provider experiences. For instance, providers’ primary care work (a microsystem) is influenced by the models of primary care (a microsystem) offering them less or more exposure to the patients varying life context (a microsystem) and the education programs on social aspects (another microsystem); see Figure 9.

Figure 9

Primary Care Provider and Microsystems



These gained insights align with and contribute to the growing literature on finding effective ways to improve providers' application of the social determinants of health in everyday practice. Other scholars (Glazier et al., 2012; Starfield, 2009, 2012) have proposed that clinicians ought to incorporate the consideration of a patient's social context into their primary care practice for a better quality of care and health equity. Clinicians can use evidence and professional influence to positively impact health inequalities. Additionally, clinicians can use their position and expertise to advocate for changes to areas outside of traditional medical areas to promote equity. However, Bloch & Rozmovits (2021) stated that "most family physicians now report that they engage in some degree of social intervention in the management of patients. However, outside of community health centers, social interventions are still not a routine part of primary care practice and are not yet considered standard of care." Bloch & Rozmovits (2021) proposed the utilization of social prescribing as a way for physicians/ clinicians to get involved in equity advocacy work. Social prescribing has proven to be effective in the United Kingdom amongst vulnerable and marginalized patient populations. For example, improvements were seen in resiliency levels, mental health capacity, lifestyle factors, well-being, and overall health (Polley, 2022). Finally, the stronger links between primary care and community-based collaborators have helped with patients' unmet social needs (Polley, 2022).

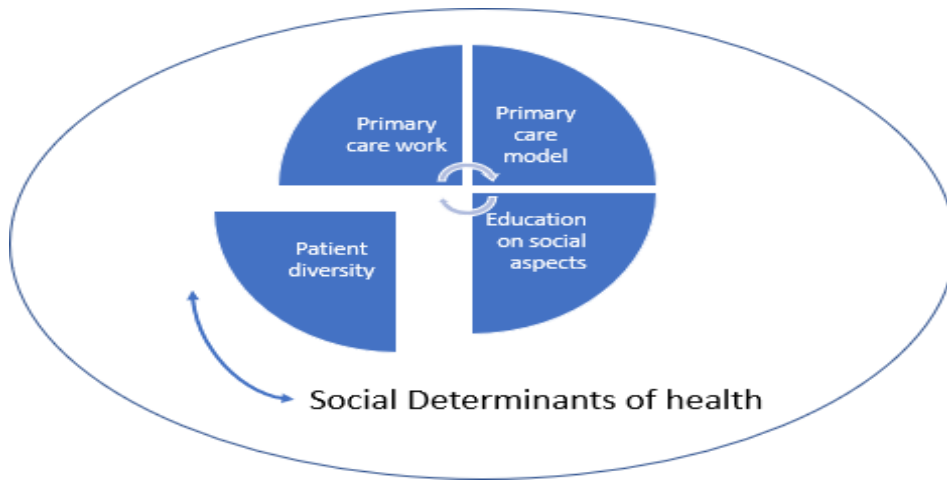
In terms of the interviews, one-on-one discussions with 15 PCPs offered rich contextual details. One of the key themes that emerged is the importance of the social determinants of health amongst patients for health-service accessibility and ultimately health outcomes. Many of the study participants, primarily from CHCs, shared the various ways in which social determinants of health such as employment, income, housing, food, and/ or legal status in Canada impacted their "clients" (patients) ability to access healthcare services. For example, one study participant (an NP) shared that her clients were not able to attend clinic visits to proactively manage their diabetes. She shared that the client worked during the same hours as when the clinic was open and thus, would have to take unpaid time off for clinic visits. She described that given this constraint the client was unable to attend several clinic visits and thus, had poorly managed diabetes for which she had no solutions or way to help them better manage their disease. At the same time, providers discussed this influencing their work. The client scenario described above is only one among the many shared by participants during interviews. It clearly links the social determinants of health to patient health outcomes. In the case described above of poorly managed diabetes, there could be significant exacerbations for a patient's uncontrolled diabetes resulting in a poor quality of life and significant downstream costs to the healthcare system.

The gained insights illuminate how structural barriers negatively impact the accessibility of health services and how they may eventually have detrimental health outcomes by limiting providers' engagement with them. The play of structural power on marginalized or vulnerable patients is palpable because their needs are likely left inadequately attended to by the existing health system. These findings align with those from other studies that theorize that individuals with lower socioeconomic positions are less likely to participate in preventative health checks (White et al., 2009). Based on the findings of the interviews, it appears that the two microsystems (i.e., patient's social context and providers' work) collide instead of working in a symbiotic manner due to the powers at play in the exo-system, such as trust and funding models (further details are provided below).

Scholars like Baum et al. (2016) have linked the lack of comprehensiveness in primary care to a consequence of growing neoliberalism (Baum et al., 2016). Similarly in Canada, neoliberalist approaches to healthcare reform have resulted in inadequate funding of the healthcare system and healthcare services thus putting the responsibility on individuals regardless of their resources and ability to proactively manage their own health (McGregor, 2001). Hajizadeh et al. in 2016 analyzed Canadian longitudinal data from the National Population Health Survey collected between 1998 and 2011 to examine trends in socioeconomic gradients in the Health Utility Index (HUI) and the Frailty Index (FI) (Hajizadeh et al., 2016). The authors found that in Canada during the nearly 15-year period, the education-related inequalities increased in both the FI and the HUI, and the income-related inequalities increased in the HUI, especially for women. Indeed, there is an urgent need to increase attention to the social determinants of health. The interpretation of these findings through theoretical lenses is presented in Figure 10 below.

Figure 10

Provider Primary Care Work and Social Determinants of Health



This neoliberalist approach to caring for patients with diabetes is problematic since the highest incidence is found in populations disadvantaged by a variety of social determinants of health challenges such as low income and education (Raphael, 2012). Therefore, this presents two specific challenges: (i) the high prevalence of the disease is among those with a great degree of risk, and (ii) the low uptake of preventative care is in the same target population. This calls for better equity-informed practices and policies – some suggestions are presented later in this chapter.

Another related finding from the interviews is the suggestive evidence of differential attention to the social determinants of health among PCPs. A large percentage of interviewed participants from the CHCs noted that their colleagues from Family Health Teams, Walk-in clinics, or Solo Practices, seem to have a limited understanding of the impact of the social determinants of health on diabetes management. For example, their clients (patients) have voiced concerns about interactions with providers from these other primary care models. They shared that sometimes providers from these settings inadvertently discriminate against patients due to a poor understanding of factors such as language and culture. Through an EST lens, a possible explanation is the varying level of exposure to minority and vulnerable patient populations across different models of primary care. Indeed, it is somewhat supported by the regression analysis as the variable on the amount of service to minority/vulnerable patients had a partial correlation of 0.211 second highest after the training on social aspects of health. Utilizing the EST lens, the correlation between the training on the social aspects of health can be explained by linking it to the exo-system of healthcare. That is, exo-system factors

such as operational structure and availability of funding for the professional development of staff can positively or negatively impact training and awareness of the importance of the social aspects of health on outcomes. Given this relationship between the provider micro-system and the exo-system, importance needs to be placed on ensuring that providers are trained and fully aware of their role in addressing the social aspects of health and ultimately patient health outcomes. Indeed, this is an area for further research.

Overall, the findings from the interviews highlight both the systemic and primary care provider barriers to proactive and preventative care for diabetes among patients in vulnerable and marginalized populations that are at the highest risk for exacerbations and poor quality of life. These findings reiterate the continued existence of primary care barriers to preventative diabetes care. Finally, the use of mixed method design and inclusion of theoretical lenses helped to gain richer insights into the interaction between patients' life context and providers' work in primary care. In the interviews, there is evidence that the structure of primary healthcare delivery, provider compensation methods, and clinic operations (further discussed in the section on Primary Care Provider Work and Exo-system) all influence the comprehensiveness of providers' engagement with patients, including their social aspects of life-impacting diabetes management. Similar insights are gained through five variables collectively explaining 40% of the variance in provider Understanding of Health Equity when offering diabetes mHealth self-management applications.

It was also evident from the interviews that primary care providers are indeed aware of the social determinants of health and their impacts on health outcomes. However, given the constraints listed above, they are limited in their capacities to fully provide the necessary support required by this patient population to overcome digital inequities. It was strongly evident that the CHC primary care providers are structurally supported to deliver this type of care given their compensation models (see the section on Digging Deep). Also, given that CHCs serve a larger population of marginalized and vulnerable patients, they have heightened awareness of the impacts of these inequities on patients when compared to their peers in FHTs and other primary care models.

ii. Digging Deep – Provider Primary Care Work and CHC Model

Many of the interview participants, primarily from the Community Health Centres, had a solid understanding of the “whole person” approach and aimed to operationalize this approach in their day-to-day practices. They discussed their practices around clients’ food adequacy, cultural inclusivity, and access to compassionate care programs in the community. On the contrary, the notion of holistic care was rarely raised by primary care providers from Family Health Teams and Walk-in clinics which demonstrates that even if awareness of the social determinants and their impact on health outcomes exists that this was not on the forefront of these providers’ minds. This could be attributed to several factors, such as less exposure to vulnerable populations (as discussed earlier) and working in models of primary care with limited financial incentives which will be discussed in the next section.

Interviewed CHC participants discussed the availability of (healthy) food pantries in the centers and/ or the vouchers for farmer's markets as being important for their clients’ holistic care. They shared that having the food pantries helped some of their clients to make not only better food choices but sometimes simply have food on the table under tough financial circumstances. This was considered a holistic and empathetic approach to patient care as it acknowledges the social factors influencing diabetes outcomes. Additionally, the importance of community partnerships with farmer's markets was raised as being important since it acknowledges the societal/ community approach to solving these challenges. Again, it was observed that there was a stark difference in that only primary care providers from CHCs raised these topics and not primary care providers in the other models of care.

Similarly, interviewed participants from the CHCs raised the importance of having culturally sensitive care, such as the ability to access interpreters and multilingual education materials. They strongly believed that this helps in providing effective diabetes care by enhancing communications between them and their clients. One noted that it helps with a better understanding of the client instead of assuming that they have comprehension difficulties. They highlighted that interpretation and culturally sensitive workshops, as well as educational materials, help with establishing trust with their clients and promote adherence to diabetes care plans. Working with compassionate care programs was also highlighted by participants from the CHCs as being important in helping clients to deal with the high costs

related to diabetes care, which includes both medications and other associated supplies. Primary care providers in CHCs discussed the challenges of providing diabetes care to patients with no medical insurance coverage due to precarious employment or non-legal status in Canada. They shared that compassionate care programs through pharmaceutical companies were the only sources of medications for some of these clients and that unfortunately these programs were being phased out of existence. These participants from CHCs also voiced the need for government-funded programs for patients that fall into this category (unable to afford diabetes-related costs). They argued that the upfront costs are significantly less than those resulting from exacerbations resulting from poorly managed/treated diabetes.

In the interviews, many providers from the CHCs noted that the healthcare system can respond to the inequitable uptake of mHealth interventions by engaging patients in the identification of the strategies to enhance their effectiveness. This approach is consistent with the equity-informed approach proposed by others (Starfield, 2012; Tugwell et al., 2006). Scholars also propose that this way patients can guide the development of a multi-prong approach such as education, resources, and the tools needed to maximize the availability and accessibility of care to the target population (White et al., 2009). This approach called “targeting” within universalism implies that a universally available intervention must be accompanied by specific uptake strategies that positively impact those at the highest risk (Frohlich & Potvin, 2010).

Equity-informed holistic care is fundamental to delivering contextually tailored and culturally safe care (Tugwell et al., 2006). This has been shown to improve the care experiences for vulnerable and marginalized patient groups as well as promote health equity. For example, the analysis of administrative datasets of 2008–2009 and 2009–2010 by scientists at the Institute of Clinical and Evaluative Sciences found that patients from the CHC model in both urban and rural areas of Ontario had lower visits to emergency departments, compared all other primary care models (Glazier et al., 2012). This is a significant finding given that the same report found that CHC patients were sicker than patients visiting other primary care models. Around the same time, Barbara Starfield, an international expert in primary healthcare reviewed the evidence on primary care-oriented health systems and concluded that “patient-focus” and “problem recognition” are key to successful primary healthcare” (Starfield, 2009).

However, the progress on the adoption of such holistic models of care in Canada, including Ontario, remains somewhat slow. This raises the question about the influence of exo-system and macro-system challenges.

iii. Provider Primary Care Work and Exo-System

A critical analysis of the findings on the primary care work of providers reveals its entanglement with the forces at exo-system (i.e., operational structure, funding models, and universal healthcare plan) and macro-system (policies and history) levels.

Several participants perceived the healthcare services' structure in Non-CHC settings (Family Health Teams, Walk-in-clinics, etc.) as a barrier to effective diabetes management, as the 15 minutes long clinic appointments do not allow enough time for primary care providers to adequately address patients' contextual concerns and challenges, especially in marginalized and vulnerable patient populations. People with diabetes often have multiple comorbidities which require additional clinic time to be addressed. Given the aforementioned issue, this presents further challenges to care, particularly in the context of the mismatched time allocated to provide care and the complex care needs of socially disadvantaged patients. Further, the interviewed primary care providers frequently emphasized the need for a more integrated approach to care that included a larger interprofessional team of nurses, nurse practitioners, social workers, mental health providers, and patient navigators as one way to improve preventative diabetes care.

Another exo-system factor identified in the interviews is the varying types of compensation models in primary care settings. Some primary care providers (Walk-in clinics and some Family Health Groups) are compensated on a fee-for-service basis, thus having to care for a large volume of patients to ensure adequate compensation. This results in short appointment visits to accommodate the large volume of patients. Subsequently, this is problematic for diabetic patients presenting with multiple comorbidities in addition to social challenges. Primary care providers are left with the option of addressing only the most pressing challenge at the time of the visit and this results in other factors including the social determinants often ignored. On the contrary, primary care providers in CHCs have some degree of flexibility in lengthening their appointments to fully address patients' needs. Additionally, the adequacy of a universal healthcare system also emerged as a discussion point.

On one side, participants from the CHCs expressed a desire for broader coverage of medication and supplies for the underprivileged group of patients they serve. On the other side, all participants agreed that government subsidies are needed for extending medical support, such as clinic operations and compensation for complex-care patients, while government partnerships with pharmaceutical companies were perceived as another possibility to reduce barriers for low-income patients. The health system and policy-level barriers to care need to be addressed, especially for chronic illnesses and, more importantly, in vulnerable and marginalized patient populations.

The interview study also offers new insights into the historical power dynamics continually impacting some marginalized communities such as Indigenous people. Some participants in rural locations with a high Indigenous patient population pointed out that developing trust with Indigenous patients is the first step before explaining care plans. Due to historical trauma, developing trust often takes several sessions. This is a clear example of how Canada's colonization history (macro-system) impacts the delivery of primary care such as causing distrust among patients when interacting with front-line clinicians. Notably, less than 5% of the PCPs interviewed questioned the underlying structural inequities impacting diabetes care. They did not largely question issues such as jurisdictional policies or the upstream factors that influence the unequal distribution of income and its implications for effective diabetes care. Overall, they only pointed out that improving health outcomes will require a multi-prong approach that includes a mix of interventions that improve access to care, as well as emphasizing the importance of improved compensation models and interdisciplinary/ multi-disciplinary care teams. There was less emphasis on the upstream factors and policies (such as the relationship between one's income and the affordability of diabetes medications) that can enhance the quality of life for vulnerable and marginalized patients.

The insights gained about the interaction of providers' care work with exo- and macro-system are depicted in Figure 10. These findings are in alignment with existing literature on policy-making and/ or socio-historical contexts having a direct or indirect influence on the delivery of care in primary care settings (Tugwell et al., 2006). For example, neoliberalism (macro-system) has an impact on policy-making (exo-system) in primary care as shown in Figure 11 below. Neoliberalism approaches to healthcare reform result in less comprehensive primary

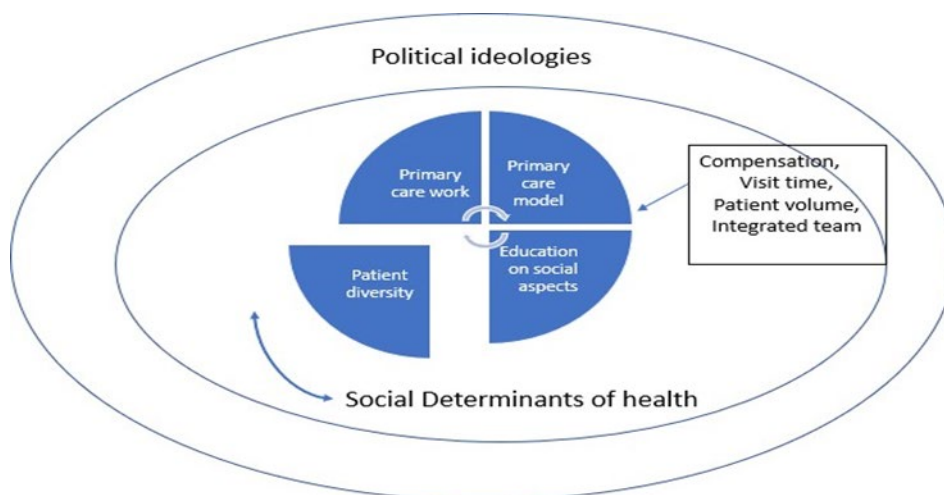
care health service coverage and more focus on clinical services provided by hospitals, even though prior research (Wodchis & Reid, 2020) shows that proactive primary care services such as diabetes management are best delivered in the community instead of in acute care institutions.

Community care delivery models such as CHCs are based on primary health care principles and policies such as equity, participation, intersectoral action, appropriate technology, and a central role played by the health system. These principles include a focus on equity which is a strength when compared to other models of care in the Canadian healthcare system. The establishment of CHCs in the 1970s, based on these primary health care principles are attempts at reforming the system. Comparably, other models of care such as those included in Non-CHC models are lacking overall, but most notably in following these established principles.

The current direction of healthcare funding is likely to result in less focus on community development activities such as advocacy, multi-sector collaboration, and addressing the social determinants of health. Neoliberal health approaches place more emphasis on outputs rather than on health outcomes. The conclusion can be drawn that neoliberalist approaches to healthcare delivery focus more on cure rather than on prevention, meaning more on the downstream factors (medications, surgeries, etc.) rather than on the upstream ones (setting-based health promotion and comprehensive social policies) that truly result in changes in health outcomes. Comprehensive primary care service is better suited to addressing the upstream factors (Baum et al., 2016).

Figure 11

Provider Primary Care Work, Social Determinants of Health, Operational Structures & Political Ideologies



iv. Digital Health: Gaps and Opportunities

The survey study and the interview study revealed different dimensions of the system gaps and opportunities to improve primary care via digital innovations. The survey study advances knowledge about the barriers faced by PCPs in adopting mHealth innovations (microsystem), which is also complemented by the findings in the interviews around the use of virtual care during the pandemic (exo-system and macro-system).

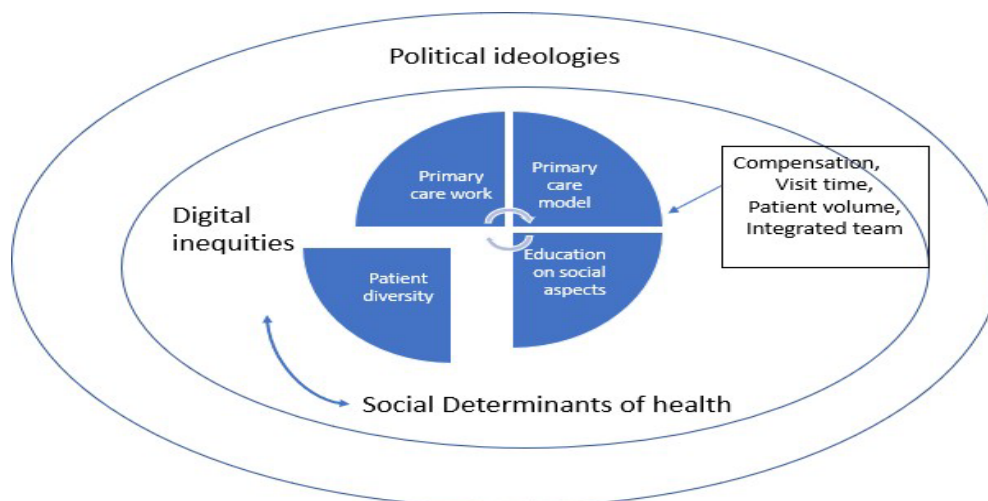
In the survey study, provider barriers to adopting mHealth diabetes self-management applications were assessed. Their scores for Provider-Patient, Clinic Barriers, and Systems Barriers did not vary by CHC versus Non-CHC setting; the small sample size and lack of variability in the provider type are probable underlying reasons. Overall, the Provider-Patient barriers are at the top rank followed by Clinic Barriers and then Systems Barriers. This finding should inform the development of further mHealth tools as the first step in addressing the digital divide is to make it user-friendly for both clinicians and patients. Further, the survey questions about virtual care during the pandemic revealed an increase in video-based consultations (30.4% identified it as a second common mode of delivering care) while a significant number (31%) were not aware of its encryption status. Not surprisingly, the top concerns of providers about virtual care delivery via non-encrypted means (like Facebook and Skype), which was allowed during the pandemic as an emergency measure, were patients' privacy and data security followed by patients' technical skills.

The interviews augmented the survey findings, for example, clinicians were asked elaborate on reasons why diabetic patients were not accessing ongoing/ preventative care during the pandemic. Many of them shared that patients were fearful overall about contracting COVID-19 infection, but more so as a result of their compromised health status. In addition, some of their patients lacked access to devices and Internet services which further reduced their accessibility. Thus, marginalized patients faced double challenges in accessing care; the first being that they are at a heightened risk of contracting the COVID-19 virus due to their diabetes status, and the second being not able to access care offered through virtual care.

Additionally, during the interviews clinicians were asked about their emotions/ perspectives around sometimes not being able to deliver services that some vulnerable and marginalized patients needed. There were clear differences in the responses to this question between CHC and non-CHC clinicians. However, it should be noted that the PCPs in CHCs' responses about having less familiarity and utilization of mHealth applications may have been influenced by less exposure in their clinical settings and low or no interest from their patients when compared to PCPs in Non-CHCs stating that they had more familiarity and utilization of mHealth applications in their settings and by their patients even before the pandemic. Electronic Medical Records (EMR) system reminders can be utilized by providers to be notified when diabetic patients are due to be seen. It should also be noted that Non-CHC settings have less volume of vulnerable and marginalized patient populations and more affluent ones. Thus, the implications of these findings can be interpreted as Non-CHC patients (and to some extent their providers) perceive themselves as individually responsible for their health outcomes and that the SDOH are not at the forefront of their minds. The CHC clinicians were aware of more free, compassionate, or subsidized services compared to their non-CHC counterparts. The insights gained are presented in Figure 12.

Figure 12

Provider Primary Care Work, Social Determinants of Health, Operational Structures, DigitalHealth & Political Ideologies



The insights gained about the digital divide in Canada are consistent with existing literature on this topic. From an equity perspective, the Canadian Medical Association Taskforce for Virtual Care in Canada evaluated this trend in 2022 and found that virtual care services were not heavily used by a large percentage of older people or people with more complex needs such as diabetes and other chronic conditions. The main reason for this is that people did not have access to a smartphone or were not comfortable using one. Given this inaccessibility, they were less likely to use these virtual health services (Canadian Medical Association, 2022). In addition, some of these services were only offered by private vendors such as Babylon by Telus and the Cleveland Clinic's use of Tyto Home. In these cases, the users need to pay directly for the services, and it is evident that this is an equity issue.

Similarly, the provision of virtual care for Indigenous populations requires special considerations, as Indigenous communities in remote areas of Canada are finally starting to embrace virtual care solutions. However, many communities still lack the availability of high-speed Internet services to access virtual care from their providers. The key to improving virtual care access for Indigenous communities is patient-provider partnerships as a starting point to restoring trust in the medical system and its providers. This can include the involvement of Indigenous community members in the development of potential solutions. Virtual care must be framed as complementary to in-person care rather than replacing it

(Canadian Medical Association, 2022). For example, Canada has the most expensive broadband Internet services in the world and thus low-income patients are unable to afford such expensive Internet services to access virtual care during the pandemic (Bhatia et al., 2020; Shaw, 2020).

The COVID-19 pandemic is hastening health systems to address the challenges of the modern day. On one side, taking on issues like justice, health, and social change has surfaced as foundational. On the other, the use of technology for delivering care and making social connections is setting the circumstances for significant improvements in the overarching goals of wellness and social justice. However, the challenges to accessing digital technologies would persist among disadvantaged and marginalized patients unless focused efforts are undertaken. The extent to which the health system would be responsive is also connected to economic growth and the country's neoliberalist ideologies which must be resolved to create equitable resilience to future crises. Instead of lamenting the past, healthcare systems and organizations must become more localized, less complicated, and antifragile becoming stronger in the face of crises.

A considerable collection of research on equity-focused frameworks for using digital technologies is emerging. However, converting them into practical guidance for the digital health setting in Ontario necessitates further analysis of the impact on the many stakeholders. Small groups of stakeholders across the province and country are interested in reaching this goal but achieving it will require coordinated efforts and shared accountability. Stakeholders in Ontario's digital health ecosystem must collaborate to develop realistic and effective programs for all members of society, especially vulnerable and marginalized patient groups. This work should be overseen by the Ministry of Health and Long-Term Care to ensure the development of a comprehensive strategy that contributes to an inclusive healthcare system, while also improving efficiency and quality of care through the use of digital health tools.

v. Implications for Practice and Policy

Several practice and policy implications can be drawn from this dissertation. The first is that vulnerable and marginalized patient populations cannot be treated by a one size fits all approach to healthcare delivery. As the study's findings suggest interprofessional teams of healthcare providers such as those in CHCs/FHTs who work on a salaried/ service-

based basis rather than on a fee-for-service basis (Walk-in Clinics) may be the ideal setting and well-positioned to provide comprehensive diabetes care that considers both medical care and social support services. Additionally, Community Outreach can be utilized to help patients that are unable to leave their homes or have transportation challenges; both CHCs/FHTs provide those outreach services. As such, an integrated approach to care has been shown to improve diabetes management by empowering patients to enhance their overall opportunities to attain good health. Further, equity-informed care is vital to improving health equity at the point of care. By understanding that health behavior and the subsequent outcomes are shaped more by the social determinants of health rather than by personal choices under one's control, PCPs can help in breaking the cycle of poor health outcomes due to social factors. To this end, training healthcare providers and extending experiential learning opportunities through an equity lens should be supported systematically at the policy and practice levels.

Similarly, consideration must be given to operational structures such as financial, administrative, and clinical activities that impact the provision of care. Many healthcare organizations strive for operational efficiency in the face of growing fiscal constraints, this may result in a reduction in the quality and comprehensiveness of care patients receive. Thus, healthcare organizations and primary care providers must seek to leverage community partnerships to provide the best care possible to patients. It is well known that striking the perfect balance between achieving operational efficiency and providing outstanding patient care is extremely challenging, thus it is of utmost importance that organizations create care pathways in collaboration with community partners to fully optimize the benefits of available resources. Also, the perspectives of diverse patient groups ought to be included by having them on the boards of healthcare organizations for long-term system improvements and program development.

Additionally, organizations as a whole need to acknowledge implicit biases and actively work on addressing them. Thus, organizations need to provide training and resources to empower staff to deliver culturally proficient care. This includes planning amongst teams on how to address patients' lack of resources in a culturally sensitive manner. Organizations should actively work on creating care pathways that leverage existing communities' resources. Simultaneously, organizations should work in partnership with patients to ensure that they

know what to do and how to follow up with their care teams for after-hours or emergency care. Organizations must recognize that this is not a one-time effort, instead, there should be a continuous engagement of the care teams and building momentum toward equity-informed care. Some initiatives required to accompany the uptake of a care-pathway strategy intended to positively impact those at the highest risk include the government and healthcare organizations incorporating a focus on digital equity into their charters, missions, and visions. This signals a commitment to addressing issues related to digital inequity.

One organization in Canada at the forefront of such work is The Alliance for Healthier Communities, they have intentionally revised their organizational charter to include a focus on acknowledging and addressing digital inequity challenges. Another intervention required is advocacy and awareness campaigns at the federal, provincial, and local levels. Again, The Alliance for Healthier Communities-along with researchers at Women's College Hospital, Toronto have started actively participating at various planning tables in the Ontario Government, Ontario Health, and the Office of the Information and Privacy Commissioner. Additionally, funds need to be committed to these efforts to make this vision a reality, as such the United Way of the Greater Toronto area has awarded funds to The Alliance for Healthier Communities to support their work in this area. However, isolated efforts are limited in their capacity to fully address this issue on a wider scale and as such requires the Ontario government's financial commitment, leadership, and governance. Finally, governments and healthcare organizations can look to the successful implementation of various strategies in other countries such as the United Kingdom (UK) and Australia (Shaw, 2020; The Alliance for Healthier Communities, 2020).

Some policy implications of this work demonstrate the need for funding reforms to support appropriate compensation and delivery methods for equitable care inclusive of the social determinants of health considerations. For example, in non-CHC settings, primary care providers are compensated for a 15-minute follow appointment window per patient including for those with diabetes that require more time with care providers to thoroughly discuss and address the impacts of the social factors on the patient's health outcomes. Similarly, education reforms and further development of curriculums focused on equity-informed care are required to ensure that PHC principles are embedded within all models of care. For example, programs such as the Canadian Medical Education Directives for Specialists

(CanMEDS) established in 1993 were created to identify and ensure that physicians possess the core competencies required to meet the needs of society (The College of Family Physicians of Canada, 2017). CanMEDs include a focus on health equity and the social determinants of health and have been in existence for many years now, however, programs such as this could be expanded to facilitate broader awareness.

In addition, educational institutions must be funded and supported to deliver such training to future care providers to foster the embodiment of these approaches. Additionally, funding reforms are necessary to support organizations with the financial means and technical resources necessary to facilitate the ongoing professional development of staff that may lack this training, expertise, and capacity to deliver equity-informed care. Finally, government and industry collaborations are necessary to incentivize broadband Internet providers to give vulnerable and marginalized patients subsidized internet access to reduce digital inequities in accessing virtual care. As such, The Alliance for Healthier Communities (2020) has proposed the approach shown below to highlight the importance of a multi-stakeholder approach to reducing digital inequities.

CSF: Collective Impact Approach



Rethinking the significance of “care” is highly connected with socioecological systems. We are increasingly confronted with a trade-off between capital-intensive medical investments (that rely on public-health expansion and the need for reorganization of institutions) and localized solutions with social embeddedness. While the use of digital health technologies has resulted in improvements, they have also caused new challenges. In the future, addressing the social determinants of health may yield greater gains in improving population health outcomes rather than focusing narrowly on individual health, increased medical care spending, and technology utilization.

vi. Future Research Directions

Given the research findings, some future research directions are proposed below:

- a) It is proposed that further research be conducted via Ontario Health Teams (OHT) utilizing an equity-informed approach. This would enable each geographically dispersed OHT to identify vulnerable and marginalized patients in their geographic areas that can benefit from ongoing chronic disease management (including diabetic patients). Using this approach would allow for a comprehensive analysis of whether equity was considered during the continuum of care and also to ensure that compensation planning is operationalized at the system level. Additionally, given the limited literature in exploring marginalized (priority), patient populations' experiences with mHealth applications, the logical next step would then be to conduct an exploratory qualitative study. Some of this work has already begun in OHTs with strategic oversight from Ontario Health; however, the aforementioned research needs to be conducted with a broad system's level view.
- b) Another recommendation for future research would be to conduct an intervention study where key groups (Indigenous, etc.) of marginalized patients with diabetes are engaged as partners to help with developing, and determining the feasibility/ accessibility of a mHealth application that they may use (tailored to meet their needs such as language, etc.), and subsequently, they are provided with training, and then guided in using the mHealth application for self-care management. Additionally, after supporting them in its use and following them for approximately 6 months, the study can then be conducted to examine the benefits/ challenges and efficacy of them maintaining their diabetes over time.
- c) It is also recommended that further research be conducted to investigate the most appropriate models of care and compensation types given the ongoing primary care reform in the province and the COVID-19 pandemic's impact on both care delivery and compensation. The structure of primary care in Ontario began undergoing reform in 2019 when the LHINs were officially dissolved, and the Ontario Health/Health Teams model of care was introduced (Embuldeniya et al.,

2021). Since then, primary care models have been undergoing changes such as being reorganized into one of the 6 regions and subsequently into Ontario Health Teams. There are many forthcoming changes to the primary care model in Ontario such as the Ontario Health Teams becoming a legal entity to facilitate data sharing across various organizations. Additionally, there are discussions between Ontario Health, Ontario Health Teams, the Ministry of Health, the College of Family Physicians of Canada, and physicians about the potential formation of physician associations and networks that will see physicians become a greater part of the public system instead of being individual entrepreneurs. Moreover, the NPAO is also advocating for Nurse Practitioners to be able to roster patients to themselves as opposed to a physician within a Family Health Team for them to have more ownership and responsibility for patient care. These changes are expected to have far-reaching impacts on both providers and patients. Providers such as nurses/ nurse practitioners can expect to play a greater role in the management of chronic conditions, as well as in the remote monitoring of patients. Patients can expect more care to be offered digitally, as well as a more organized primary care system.

- d) Further research is needed to investigate the efficacy of relationships between primary care providers/organizations and community partners. For example, the use of vouchers for farmers' markets and medication subsidies by pharmaceutical partners and its impact on health outcomes can be evaluated. A qualitative study can be conducted with primary care providers/ organizations and their community-based partners to examine whether their relationships are helpful for recipients of these services. Continued research efforts are required to investigate the efficacy of public-private partnerships to facilitate broadband internet access for vulnerable/marginalized patients that require it for proactive disease monitoring. Canada's broadband internet services are among the most expensive in the world, thus the digital divide is disproportionately higher in these patient populations. For example, in March 2021 Economic Development Canada created the "Universal Broadband Fund" through which they committed \$2.75 billion to reduce the "connectivity gap" also known as the digital divide. They committed up to \$50 million to support mobile internet projects that primarily benefit Indigenous peoples.

Currently, only 41% of rural households and 31% of First Nations households on reserves have access to 50/10 Mbps service when compared to 98% access in urban households (Economic Development Canada, 2021). Broadband internet access is important for access to virtual medical care, school, and other important services. A study can be conducted on the levels (%) of broadband Internet access in vulnerable and marginalized groups before and after this initiative, where funding is distributed to various private broadband Internet providers. In addition, the quality and reliability of such services can also be measured.

- e) Given the COVID-19 pandemic and the related increase in technology utilization for healthcare delivery, it is an appropriate time to (re)evaluate the levels of health and digital literacy gaps for vulnerable/marginalized patients. Evaluation of these factors (through research) in other jurisdictions has proven to be beneficial in positively influencing technology uptake and, ultimately, utilization. For example, the Good Things Foundation and the City of Seattle have implemented a service called Digital Pathfinder that trains and supports patients in acquiring digital and health literacy skills (The Alliance for Healthier Communities, 2020).

vii. Strengths and Limitations

The use of an inductive approach to the thematic analysis of the interviews allowed for themes in the research to naturally emerge, instead of imposing a theoretical framework for finding the themes. Thus, this approach to analysis provided the opportunity for context-specific findings. There are several strengths to this approach, as was demonstrated in the study, including the ability to analyze PCP perspectives within their specific social contexts. These findings are not only relevant to improving access to technology for diabetes management, but also a better understanding of the need to focus simultaneously on both the upstream (e.g., equity in access to healthy food and medications) and midstream factors (e.g., equity-informed operational, administrative and financial structures of primary care) to understand and respond to the social determinants of health impacting effective diabetes management.

The interpretation of the survey study needs caution. Given the small sample size of PCPs that participated in the survey due to challenges associated with COVID-19 restrictions, convenience-based sampling, and the stress on PCPs, the results may not be entirely generalizable to all areas of primary care at this time and may need further studies with a representative and larger sample. Further, the interpretation of the findings about the relationship between the examined explanatory variables (i.e., CHC and Non-CHC setting, years of practice, training on social aspects, NP and non-NP status, service to minority/vulnerable patients) and the main outcome (understanding of health equity) needs caution, as a causal relationship cannot be deduced from a cross-sectional study. Additionally, transferability within qualitative research refers to the researcher's ability to provide a thick description of the research process for future application by researchers based on the appropriate fit for the study setting (Nowell et al., 2017). This study's research process is described in detail with various stakeholders in mind, including researchers, policymakers, and care providers, to help determine its future transferability to similar healthcare settings and other chronic conditions. The study's preliminary insights could be useful for further research in primary care settings with various delivery structures/compensation models and other chronic conditions such as Chronic Obstructive Pulmonary Disease (COPD).

Although the initial research objectives did not include a focus on the delivery of virtual care amidst the pandemic, it was included before the start of data collection upon request from research partners. This resulted in some timely and relevant findings about virtual care, remote patient monitoring, funding, and care delivery challenges during a global pandemic. Given the increased rates of adoption of virtual models of care during the COVID-19 pandemic, and the expectation that this trend will continue permanently, the findings of these studies have become widely relevant to a broader scope of diseases and conditions beyond diabetes. The findings derived from this study can be applied to other chronic illnesses that can benefit from ongoing monitoring in the community. Some limitations should be noted:

- 1) **Larger sample size.** As a next step, it would be highly beneficial to undertake a similar study (with multi-disciplinary providers) with a larger sample size to confirm some of the study's preliminary findings.

- 2) Diverse participants.** It will be important to understand if PCP demographics and racial/ ethnic identities influence their perspectives, specifically when comparing the practices of family physicians with other groups of primary care providers, such as nurses and nurse practitioners. Additionally, another limitation is that only RNs and NPs were interviewed in the qualitative study. This has the potential to skew the findings when compared to the other groups that participated in the study.

viii. Conclusions

The research findings highlight the need for integration between healthcare organizational structures, funding of primary care, and provider compensation mechanisms to promote equity-oriented engagement of patients with diabetes mHealth applications. The use of the Ecological Systems Theory and a search for power dynamics has allowed for an in-depth analysis of these domains. Traditionally, these frameworks are not utilized in these domains, however, their application was useful in answering the identified research questions set out in this study.

The digital health ecosystem is made up of a dynamic network of stakeholder groups, each with its own expectations of how technology should be used in healthcare. Given this complex structure, advocating for the advancement of health equity through digital means is not a simple task. Despite this, if adequate resources are available, and strong collaborations take place among essential parties, digital equity can be achieved. It is important to stress that the cooperation of all stakeholders is critical to achieving digital equity. To improve equitable access to digital health technology, investments must be made to ensure the accessible design, implementation, and assessment of tools, including the opportunity for input/ feedback from underrepresented communities.

A comprehensive system that addresses the social determinants of health while also promoting the overall health and well-being of Ontarians is required. This approach can serve as the foundation for an equity-focused way of providing patient care that includes vulnerable and marginalized patients. All healthcare practitioners (including primary care providers) must recognize that their personal approach to patient care and the broader system through which they deliver care can be mechanisms for reducing barriers to access, and for improving the social determinants of health that predispose patients to illness and influence their health

outcomes. Understanding their role in this outcome is the first step toward solving digital inequity. This awareness must be followed by a structured approach to employing equity-oriented care during clinical encounters/ interactions with patients, specifically when considering the use of mHealth technologies. Finally, digitization of the Canadian healthcare system is expected to be exponential in post-pandemic years. Virtual care and mHealth applications are anticipated to be utilized widely for patient populations, including diabetic patients from vulnerable and marginalized communities. Thus, this study is a timely contribution toward Ontario's vision of equitable digital health for primary care.

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APPENDIX 1

York University Ethics Approval



Certificate #:	STU 2020-036
Initial Approval:	04/06/20-04/06/21
Amendments:	Amendment approved: 06/18/20 2nd Amendment approved: 07/21/20
Renewals:	
Current Approval Period:	04/06/20-04/06/21

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ETHICS AMENDMENT APPROVAL

To: Reshma Prashad - Graduate StudentHealth Policy and Equity Faculty of Health
reshma.prashad@gmail.com

From: Alison M. Collins-Mrakas, Sr. Manager and Policy Advisor, Research Ethics
(on behalf of Jennifer Kuk, Chair, Human Participants Review Committee)

Date: Tuesday, July 21, 2020

Title: Health equity in Primary Care Practice: Exploring Engagement of Patients with Diabetes via mHealth applications

Risk Level: ☒ Minimal Risk ☐ More than Minimal Risk

Level of Review: ☒ Delegated Review ☐ Full Committee Review

With respect to your research project entitled, “**Health equity in Primary Care Practice: Exploring Engagement of Patients with Diabetes via mHealth applications**”, the committee notes that, as there are no substantive changes to either the methodology employed or the risks to participants in and/or any other aspect of the research project, a renewal of approval re the proposed amendment(s) to the above project is granted.

Any further changes to the approved protocol must be reviewed and approved through the amendment process by submission of an amendment application to the HPRC prior to its implementation.

Ongoing research – research that extends beyond one year – must be renewed prior to the expiry date.

Any adverse or unanticipated events in the research should be reported to the Office of Research Ethics (ore@yorku.ca) as soon as possible.

For further information on researcher responsibilities as it pertains to this approved research ethics protocol, please refer to the attached document, **“RESEARCH ETHICS: PROCEDURES to ENSURE ONGOING COMPLIANCE.”**

Please note that prior to commencing any research activities, researchers are advised to review the latest updates on research involving human participants at:
<https://research.info.yorku.ca/frequently-asked-questions-faq/>

Should you have any questions, please feel free to contact me at 416-736-5914 or via email at: acollins@yorku.ca.

Yours sincerely,

Alison M. Collins- Mrakas M.Sc., LLM Sr.
Manager and Policy Advisor, Office of Research Ethics

APPENDIX 2
TCPS Certificate



APPENDIX 3

Research Invitation Letter



Ph.D. Research Invitation

Exploring Diabetic patient engagement via mHealth applications

Objective

The objective of this study is to explore Diabetic patient engagement via mHealth applications in primary care settings. Participants will be asked whether they engage diabetic patients via mHealth tools and their reasons for/against doing so.

Participation activities

Participants will be invited to complete an online survey with approximately 20 questions. After this, selected participants will be invited to participate in one-on-one interviews to facilitate an in-depth analysis of emerging themes.

Eligibility to participate

- You must be over 18 years old (at the start of the research)
- You must be a licensed/certified Primary Care Provider (Doctors, Nurses, and Nurse Practitioners) practicing in Ontario
- Your practice must be in either a Community Health Center, Family Health Team, or Solo Practice
- You must be a practicing physician for at least 5 years in Ontario (or Canada)

Confidentiality

All research participants' identities will be kept confidential. You will have the opportunity to withdraw from this study at any point in time. Ethics approval has been obtained from York University's Human Research Participants Committee.

If you have any questions related to this study, please contact Reshma Prashad (Principal Investigator) at rprashad@yorku.ca or my Ph.D. Supervisor-Dr. Farah Ahmad at farahmad@yorku.ca.

Thank you in advance for your cooperation.

Regards,

Reshma Prashad

Ph.D. Candidate, Health Policy and Equity

Faculty of Health York University

APPENDIX 4

Survey consent



Study Information and Consent Document

Date: May 28, 2020

Study Name: Survey for Exploring Engagement of Patients with Diabetes via mHealth Applications

Researcher name: Reshma Prashad- Ph.D. Candidate

York University-Faculty of

Health rprashad@yorku.ca

Purpose of the Research:

This doctoral research aims to explore how primary care providers (i.e., family physicians, nurses, and nurse practitioners) engage patients with diabetes via mHealth Applications in primary care settings and potential facilitators and barriers to their adoption. The use of other virtual tools to provide care during the COVID-19 pandemic will also be assessed.

What you will be asked to do in the research:

As a family physician, nurse, or nurse practitioner, you are invited to complete an online survey that would take probably 10 minutes of your time. The survey can be securely completed at your office or at home at any time during the study period. The survey will begin with general demographic questions followed by specific questions about your use of mHealth Applications for diabetes care and other virtual tools used during COVID-19.

Risks and Discomforts:

There are no anticipated or known physical risks to participants in this research. However, there is a possibility that you may feel uncomfortable when responding to some of the survey questions (e.g., age, training, and so forth). If you choose, you can withdraw from this study at any point in time.

Benefits of the research and benefits to You:

There are no direct tangible benefits to you through participation in this study. The outcomes of this research will help advance scholarly understanding of the engagement of patients with diabetes through mHealth Applications in primary care. You will be making a positive contribution by helping us better understand the facilitators and barriers to such adoption in primary care settings. The responses to your experience with virtual tools during the pandemic would also add much-needed urgent knowledge.

Voluntary Participation

Your participation in the study is completely voluntary and you may choose to stop participating at any time. Your decision to not volunteer, to stop participating, or to refuse to answer particular questions will not influence the nature of the ongoing relationship you may have with the researcher (Reshma Prashad) or the nature of your relationship with York University either now, or in the future.

Withdrawal:

In the event you choose to withdraw from the study, all associated data collected will be immediately destroyed wherever possible. Should you wish to withdraw after the study, you will have the option to also withdraw your data up until the analysis is complete.

Confidentiality:

Your confidentiality is very important. Thus, all information provided by you will be kept confidential to the fullest extent possible by law. The data for this study will be collected through an online survey tool to capture your responses to the survey. The researcher(s) acknowledge that the host of the online survey may automatically collect participant data without their knowledge (i.e., IP addresses). Although this information may be provided or made accessible to the researchers, it will not be used or saved without the participant's consent on the researchers' system. Further, because this project employs e-based collection techniques, data may be subject to access by third parties as a result of various security legislation now in place in many countries. Although confidentiality and privacy during web-based transmission cannot be guaranteed, the survey does not gather any names or identifiable information (unless you provide an email address to allow future contact for a follow-up qualitative interview). All information you supply during the research will be held in confidence, any identifiable information (e.g., clinic location) will not appear in any report or publication of the research.

Data Protection:

The collected data will be anonymized by assigning ID numbers to the participants. The data captured will be safely stored on an encrypted/password-protected USB key and/or computers so only the researcher (and her supervisor) will have access to this information. The data will be permanently destroyed in December 2025 by deleting it from the encrypted/password-protected USB keys and/or computers.

Questions about the Research?

If you have questions about the research in general or about your role in the study, please contact me at rprashad@yorku.ca or my supervisor Dr. Farah Ahmad at farahmad@yorku.ca and/or 416-736-2100 Ext. 33898. You may also contact the Graduate Program in Health at gradhlth@yorku.ca and/or 416-736-2100 ext. 22052. Please save or make a print of this Form for your information.

This research has received ethics review and approval by the Human Participants Review Committee at York University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process or about your rights as a participant in the study, please contact the Sr. Manager & Policy Advisor for the Office of Research Ethics, 5th Floor, Kaneff Tower, York University (telephone 416-736-5914 or e-mail ore@yorku.ca).

Before starting the online survey, there is an “Agree” button and by selecting it your consent will be recorded for the following:

Legal Rights and Signatures:

I consent to participating in the “**Exploring engagement of patients with diabetes via Virtual Health Applications**” study conducted by Reshma Prashad for her doctoral thesis project. I have read the Information and Consent Document, understand the nature of this project and wish to participate. I am not waiving any of my legal rights by signing this form. My signature below indicates my consent.

At the end of the online survey, the following option will appear for you:

We would also like to conduct a few one-to-one qualitative interviews via teleconferencing or phone with some of the survey respondents. Those who provide permission and their email address will receive more information and a new consent form. **Do you allow us to contact you again? If you select ‘yes’, then please provide your email address.**

APPENDIX 5

Survey Instrument

Confidential

Engagement Of Patients With Diabetes via Virtual Health Apps

Page 1 of 21

Clinical Practice

The current study is conducted with Primary Care Providers (PCPs). Are you a ...

- ☐ Family Physician
☐ Nurse Practitioner
☐ Other PCP

If you selected Other PCP, please use the space provided to specify.

Confidential

Page 2 of 21

Primary care providers may work in different types of clinical settings. During the last 12 months, what proportion of your clinical work was spent in the listed clinical settings?

	0%	Up to 20%	21%-40%	41%-60%	61%-80%	81%-100%
Solo practice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Walk-in-clinics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Family Health Team	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Family Health Group	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Community Health Center	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If you selected Other, please use the space provided to specify.

Confidential

Page 3 of 21

Is your practice located in a:

- ☐ Urban setting
☐ Rural setting
☐ Other

If you selected Other, then please use the space provided to specify.

Primary care providers may be compensated by different types of funding models. During the last 12 months, what proportion of your compensation was derived from the listed models?

	0%	Up to 20%	21%-40%	41%-60%	61%-80%	81%-100%
Fee for Service	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Capitation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Blended (defined basket for enrolled patients & additional service for fee or bonuses)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Salary	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hybrid (based on enrolled patients, plus benefits & bonuses)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If you selected Other, then please use the space provided to specify.

Approximately, how long have you practiced as a Primary care provider? _____ (years)

Approximately, what percentage of your patient population are:

	Less than 10%	11%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Visible minority	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Immigrants	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Indigenous	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Low income	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Children or youth	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Women	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Seniors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Non-Insured	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

mHealth Tools for Diabetes

Do you utilize mobile health (mHealth) applications (diabetes apps on mobile phones, web accessible portals etc.) in your practice for diabetes care?

- ☐ Yes, always
☐ Yes, sometimes
☐ No

Scenario: Consider you are seeing a patient who is struggling to comply with the traditional in-clinic management of diabetes care due to their difficulties in regularly attending in-person clinics or is struggling to follow the dietary recommendations. You are inclined to offer a mHealth diabetes management tool where they can record their activities (e.g. insulin test result, physical activity, diet and so forth) and the data is shared with you or another allied staff at the clinic.

Please review the items listed below and estimate the likelihood of you asking about them when recommending mobile health (mHealth) apps to your patient for diabetes care.

	Very unlikely	Unlikely	Somewhat unlikely	Neutral	Somewhat likely	Likely	Very likely
Level of diabetes control	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Complications of diabetes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other co-existing health conditions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Disability/Mobility challenges	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Commute (time/distance)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cultural context (e.g. who is cooking or buying food)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Working status (e.g. part-time, full-time, double job or studying and working)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Income	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Education	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Comfort with English	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Access to computer/ smart phones	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Computer literacy skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Health literacy skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cooking skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Whether patient is living alone or with others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Is there anything else that you would like to add?

Please rate the level of importance/unimportance for the following factors influencing your adoption of mobile health (mHealth) applications for diabetes care in clinical practice.

	Very unimportant	Unimportant	Somewhat unimportant	Neutral	Somewhat important	Important	Very important
The high volume of patients in waiting room	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The way I am reimbursed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The clinic doesn't have allied clinical staff	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am not aware of reliable mHealth tools for diabetes care	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There are too many mHealth tools for diabetes care available in market to choose from	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I find mHealth diabetes care tools have technical or usability issues	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have concerns about the privacy/security of patient data	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My patients have digital/health literacy challenges	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My patients can't afford mHealth tools for diabetes care	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The mHealth diabetes care tools are not available in languages spoken by my patients	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Are there any other factors influencing your adoption of mHealth applications for diabetes care in clinical practice? Please specify

Delivery of Healthcare During COVID 19 pandemic

Approximately, how many of your patients with diabetes accessed ongoing care as expected under COVID-19?

- ☐ None of them
- ☐ Up to 25%
- ☐ Up to 50%
- ☐ Up to 75%
- ☐ All of them

The following questions apply to all patient populations that you cared for during COVID 19.

The modes of providing care have changed during COVID-19 pandemic. Please select a rank for each of the following mode of care delivery across all patients during Lockdown Phase 1.

	Rank 1-Most Frequent	Rank 2	Rank 3	Rank 4	Rank 5-Least Frequent	Not Applicable
In person visit to clinic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Phone call	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Video consultation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Apps (mobile-based or web based)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Text messaging/emails	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other, please specify.

The Virtual Health Care here refers to the synchronous (i.e. live/real time) or asynchronous (i.e. not live/not real time) use of audio, video and texting tools by PCP with patients/family caregivers. What is/was their encryption status during COVID-19?

	A little	Somewhat	Completely	Don't know
Phone call	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Video consultation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Text messaging/emails	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Apps (mobile-based or web-based)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Considering your patient population, what are/were some of your hesitations about using the non-encrypted virtual tools (e.g. FaceTime, Skype, mobile phone)? The term non-encrypted refers to the exchange of information that may not be secure to maintain privacy.

	Not a concern	A little concern	Somewhat of concern	A lot of concern
Data security (where the patient data is stored)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Privacy of patient information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Technical skills of patient	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
English language skills of patient	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Costs to patients	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Did your patients' express concerns about use of the non-encrypted virtual tools (e.g. FaceTime, Skype, mobile phone)? The term non-encrypted refers to the exchange of information that may not be secure to maintain privacy.

	No	A little	Somewhat	A lot
Data security (where the patient data is stored)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Privacy of patient information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Technical skills of patient	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
English language skills of patient	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Costs to patients	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Approximately how many patients wanted access to care during COVID-19, but couldn't due to different reasons (e.g. fear of contracting COVID-19, lack of technology, disability, transportation, childcare etc.)

- ☐ None of them
☐ Up to 25%
☐ Up to 50%
☐ Up to 75%
☐ All of them

Demographics

What is your age? ____ (years)

What gender do you identify with?

- ☐ Man
☐ Woman
☐ Other

If you selected other above, please specify in the space provided.

Which of the following best describes your race or ethnic background? Select as many as relevant.

- ☐ Indigenous (e.g. Inuit, First Nations, Metis)
☐ Asian-East (e.g. Chinese, Korean, Singapore, Thailand)
☐ Asian-West (e.g. Iraqi, Israeli, Lebanese)
☐ Asian-South (e.g. Bengali, Indian, Pakistani, Sri Lankan)
☐ Africa-East (e.g. Kenyan, Ethiopian, Somali)
☐ Africa-West (e.g. Ghanaian, Gambian, Nigerian)
☐ Africa-North (e.g. Sudanese, Moroccan, Tunisian)
☐ Africa-South (e.g. South African, Zambian, Angolan)
☐ Africa-Central (e.g. Cameroon, Congolese)
☐ Caribbean (e.g. Guyanese, Trinidadian, Cuban)
☐ Mexico/Central America (e.g. Mexican, Costa Rican, Nicaraguan)
☐ North America (US American, Canadian)
☐ South America (e.g. Argentinean, Brazilian, Chilean)
☐ Europe-Eastern (e.g. Polish, Romanian, Russian, Ukrainian)
☐ Europe-Western (e.g. Belgium, French, German, Swiss)
☐ Europe-Northern (e.g. Estonian, Swedish, Finnish, Norwegian)
☐ Europe-Southern (e.g. (e.g. Croatian, Bosnian, Greek, Italian, Portuguese)
☐ Other

If you selected Other above, please specify in the space provided.

Do you consider yourself a visible minority? Based on the Canadian Employment Equity Act, members of visible minorities are defined as "persons, other than Aboriginal people, who are non-Caucasian in race or non-white in colour".

- ☐ Yes
☐ No
☐ Not Sure

What languages do you speak? You may select more than one.

- ☐ Arabic
- ☐ Bengali
- ☐ Cantonese
- ☐ Chinese
- ☐ English
- ☐ French
- ☐ Hindi
- ☐ Italian
- ☐ Mandarin
- ☐ Portuguese
- ☐ Russian
- ☐ Somali
- ☐ Spanish
- ☐ Urdu
- ☐ Vietnamese
- ☐ Other

If you selected Other above, please use the space provided to specify.

Where was your medical or nursing school located?

- ☐ Canada
- ☐ Outside Canada

If you selected Canada as the location of your medical or nursing school, then please specify the name of your university in the space provided.

If you selected Outside Canada as the location of your medical or nursing school, then please specify the name of your country in the space provided.

You might have learned about the Social Determinants of Health (SDH). Have any of the following sources offered you some learning about the SDH?"

	No	A little	Somewhat	A lot	Cannot recall
Undergraduate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Graduate Studies (Masters, PhD etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical School	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Residency	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Continuing Medical Education	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Research Articles	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Onsite (experiential experience)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Were there any other sources of learning for the social determinants of health?

☐ Yes
☐ No

If you selected Yes, then please use the space provided to specify.

We would also like to conduct a few one-to-one qualitative interviews via teleconferencing or phone with some of the survey respondents.

Do you allow us to contact you again?

☐ Yes
☐ No

If you agree, please provide your email address below. We will send you a new consent form and more information.

Appendix 6
Qualitative Interview Consent



Study Information and Consent Document

Date: May 28, 2020

Study Name: Qualitative Interviews for Exploring the Engagement of Patients with Diabetes via mHealth Applications.

Researcher name: Reshma Prashad- Ph.D. Candidate

York University-Faculty of

Health Email address:

rprashad@yorku.ca

Purpose of the Research:

The primary aim of this doctoral research is to explore how primary care providers (i.e., family physicians, nurses, and nurse practitioners) engage patients with diabetes via mHealth Applications in primary care settings and potential facilitators and barriers to their adoption. The use of other virtual tools to provide care during the COVID-19 pandemic will also be assessed.

What you will be asked to do in the research:

You are invited to participate in a 30-45 minutes semi-structured qualitative interview. The interviewer will seek to gather your perspectives on how/why patients with diabetes are engaged via mHealth Applications in primary care settings. The interview will be conducted by teleconference/telephone at your convenience. If you consent, the researcher will digitally record the interviews for transcription and data analysis purposes.

Risks and Discomforts:

There are no anticipated or known physical risks to participants in this research. However, there is a possibility that you may feel uncomfortable when talking about this topic. If you choose, you can withdraw from this study at any point in time.

Benefits of the research and benefits to you:

There is no direct tangible benefit to you through participation in this study. The outcomes of this research will advance a scholarly understanding of how patients with diabetes are engaged via mHealth Applications in primary care settings. You will be making a positive contribution by helping us better understand any facilitators and barriers to such adoption in primary care settings.

Voluntary Participation:

Your participation in the study is completely voluntary and you may choose to stop participating at any time. Your decision to not volunteer, to stop participating, or to refuse to answer particular questions will not influence the nature of the ongoing relationship you may have with the researcher (Reshma Prashad) or the nature of your relationship with York University either now, or in the future.

Withdrawal:

In the event, you choose to withdraw from the study, all associated data collected will be immediately destroyed wherever possible. Should you wish to withdraw after the study, you will have the option to also withdraw your data up until the analysis is complete.

Confidentiality:

Your confidentiality is very important. Thus, all information provided by you will be kept confidential to the fullest extent possible by law. The data for this study will be collected through a telephone interview. With your consent, the interview will be digitally recorded to capture your responses. All information you provide during the research will be held in confidence, your name will not appear in any report or publication of the research.

Data Protection:

The audio data will be transcribed verbatim; no names will be recorded. Once the transcribed data is checked for accuracy, all audio files will be destroyed immediately. The data will be anonymized by assigning ID numbers to the participants. The data captured will be safely stored on an encrypted/password-protected USB key and/or computers so only the researcher (and her supervisor) will have access to this information. The data will be permanently destroyed in December 2025 by deleting it from the encrypted/password-protected USB keys and computers.

Questions about the Research?

If you have questions about the research in general or about your role in the study, please feel free to contact me at rprashad@yorku.ca or my supervisor Dr. Farah Ahmad at farahmad@yorku.ca and/or 416-736-2100 Ext. 33898. You may also contact the Graduate Program in Health at gradhlth@yorku.ca and/or 416-736-2100 ext. 22052. Please save or make a print of this Form for your information.

This research has received ethics review and approval by the Human Participants Review Committee at York University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process or about your rights as a participant in the study, please contact the Sr. Manager & Policy Advisor for the Office of Research Ethics, 5th Floor, Kaneff Tower, York University (telephone 416-736-5914 or e-mail ore@yorku.ca).

Before starting the interview, your consent will be verbally recorded, and it will be used to express your agreement with the following statement:

Legal Rights and Signatures:

I _____ [real or pseudo name of participant] consent to participating in the **“Exploring the engagement of patients with diabetes via mHealth Applications”** study conducted by Reshma Prashad for her doctoral thesis project. I understand the nature of this project and wish to participate. I am not waiving any of my legal rights by signing this form. My signature below indicates my consent.

APPENDIX 7

Qualitative Interview Guide



Study: Qualitative Interviews for Exploring Engagement of Patients with Diabetes via mHealth Applications

Interview Guide

Icebreaker

Thank you for taking the time to join this qualitative research study. I understand from the survey that your clinic is located in XXXX and it's an XXXX type of practice. In terms of your patients, most of them are XXXXX. Did I get this right?

Thank you for clarifying.

Transition Question

1. As you know this study is about adult **patients living with diabetes**. How often do you see such patients in your practice?
2. What are their common challenges in managing diabetes? Why is it so? Would you please elaborate? how do you address them?

Probe: do the challenges vary by income, education level, language, gender, culture, etc. If so, what is your approach? Why is it so? Would you please elaborate?

Key Questions

Let's now focus on the mHealth applications. As you know some of these are real-time or synchronous in nature like video or phone consultations that connect the clinician and patient in live sessions. Others are asynchronous. For example, the glucose levels of patients can be checked and recorded by the patients at home and that data is then transmitted to the clinician remotely after a few readings.

3. Have you used **video or telephone consultations** with your patients before or during the pandemic?

If yes

- a. please elaborate on your experience and how it varied during the pandemic.
(probe: challenges/advantages) Please elaborate on why this is so.
- b. How about patients' experience and did it vary before and during the pandemic? Please elaborate on why this is so. (probe: does it vary by income, education level, language, gender, or culture, etc.)

If no,

- a. Please elaborate on why this is the case (probe: challenges about reimbursement, privacy, etc.)
- b. Did the patients want to use video or phone consults? Please elaborate on why was it this way (probe: does it vary by income, education level, language, gender, culture, etc.)
- c. What should be done to address these challenges? (Probe: practice level; system level; industry)

- ☐ *Summarize the responses to the above questions.*
- ☐ *Ask: is there something that you would like to add or change?*

4. Have you used any **asynchronous diabetes management** applications before or during the COVID-19 pandemic?

If yes

- a. Please elaborate on your experience and how it varied before and during the pandemic. (probe: challenges/advantages) Please elaborate on why this is so.
- b. How about patients' experience and did it vary before and during the pandemic? Please elaborate on why. (probe: does it vary by income, education level, language, gender, or culture, etc.)

If no,

- a. Please elaborate on why this is the case (probe: challenges about reimbursement, privacy).
- b. What should be done to address these challenges? (Probe: practice level; system level; industry)

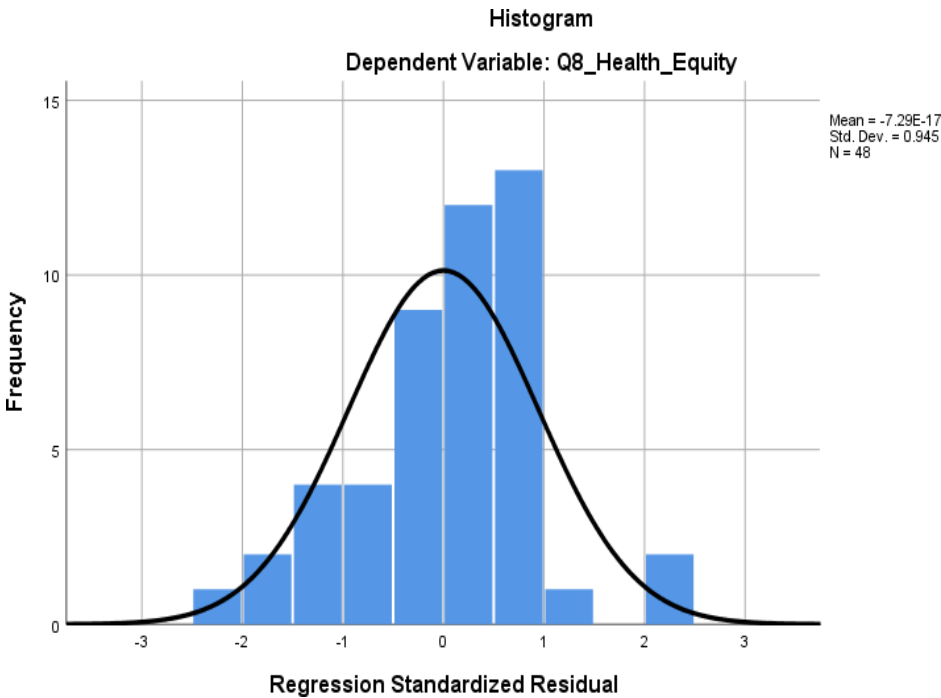
- ☐ *Summarize the responses to the above questions.*
- ☐ *Ask: is there something that you would like to add or change?*

5. Do you have **any other recommendations** for diabetes care/management in primary care? Should these vary by the type of primary care models? Why is it so, please elaborate.

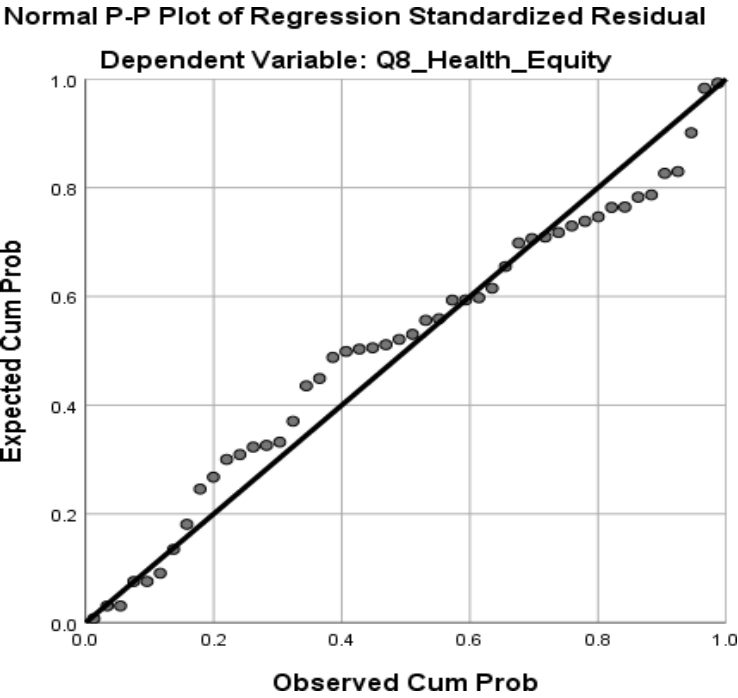
Closing Question

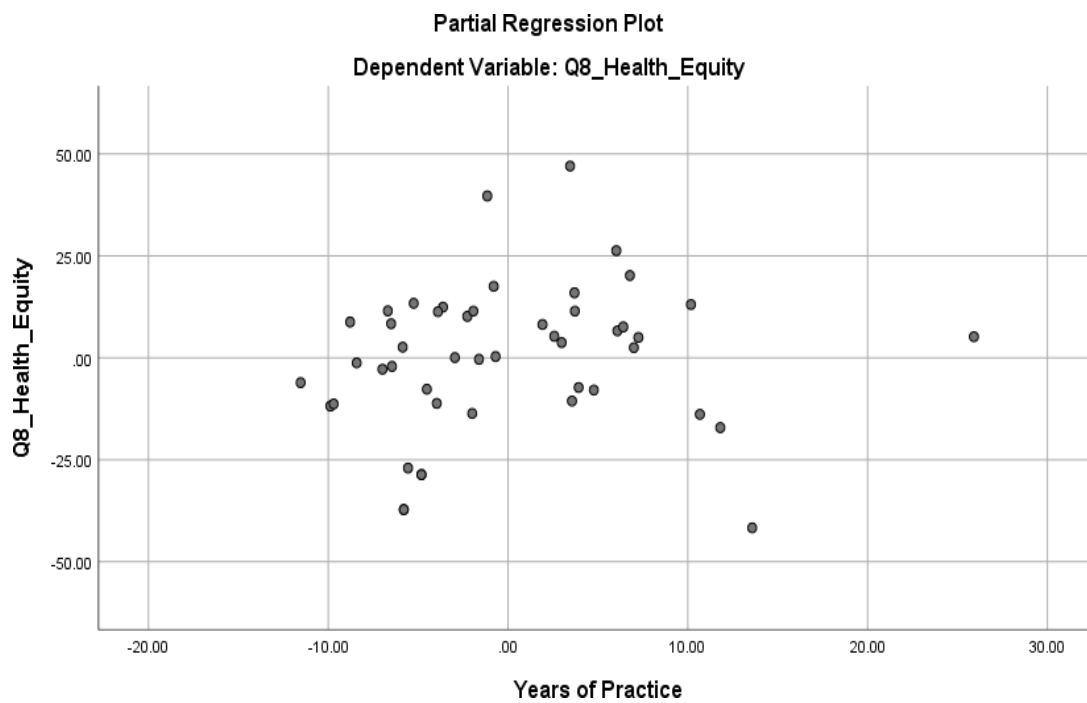
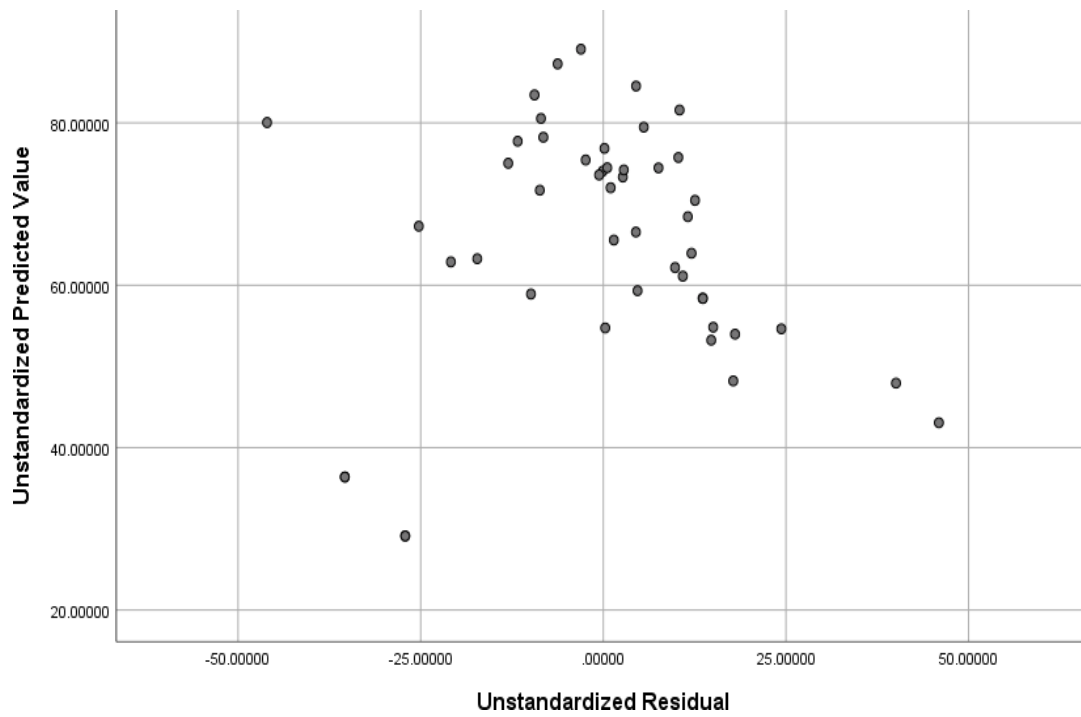
6. Is there anything else that you would like to add?

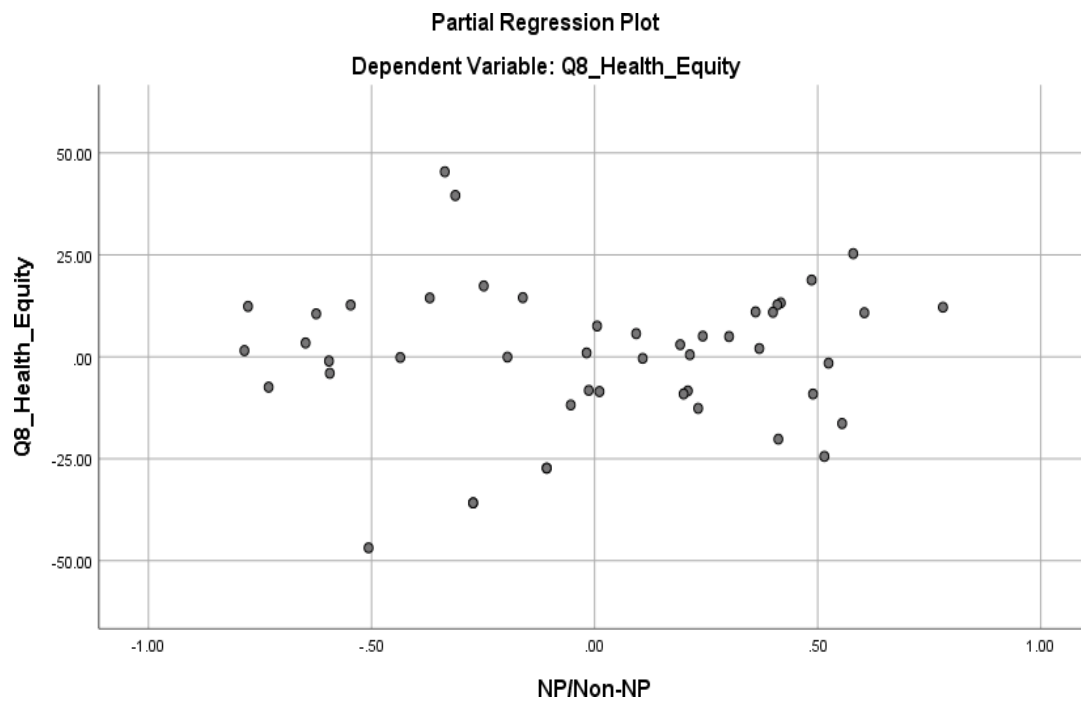
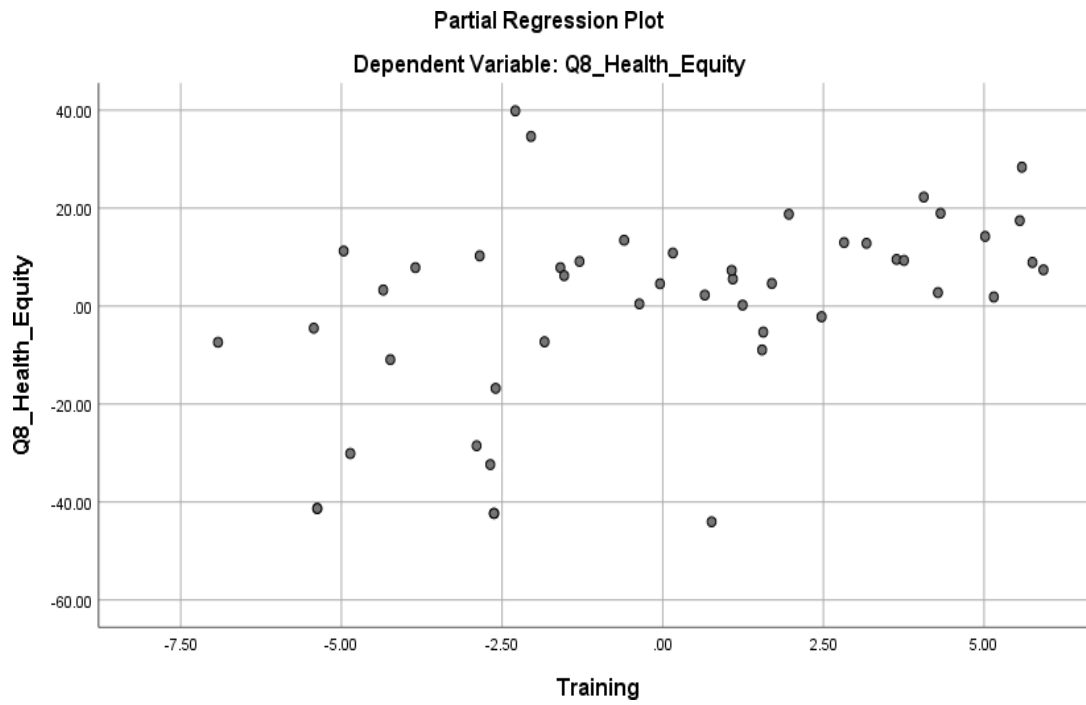
APPENDIX 8
Regression Assumption Check

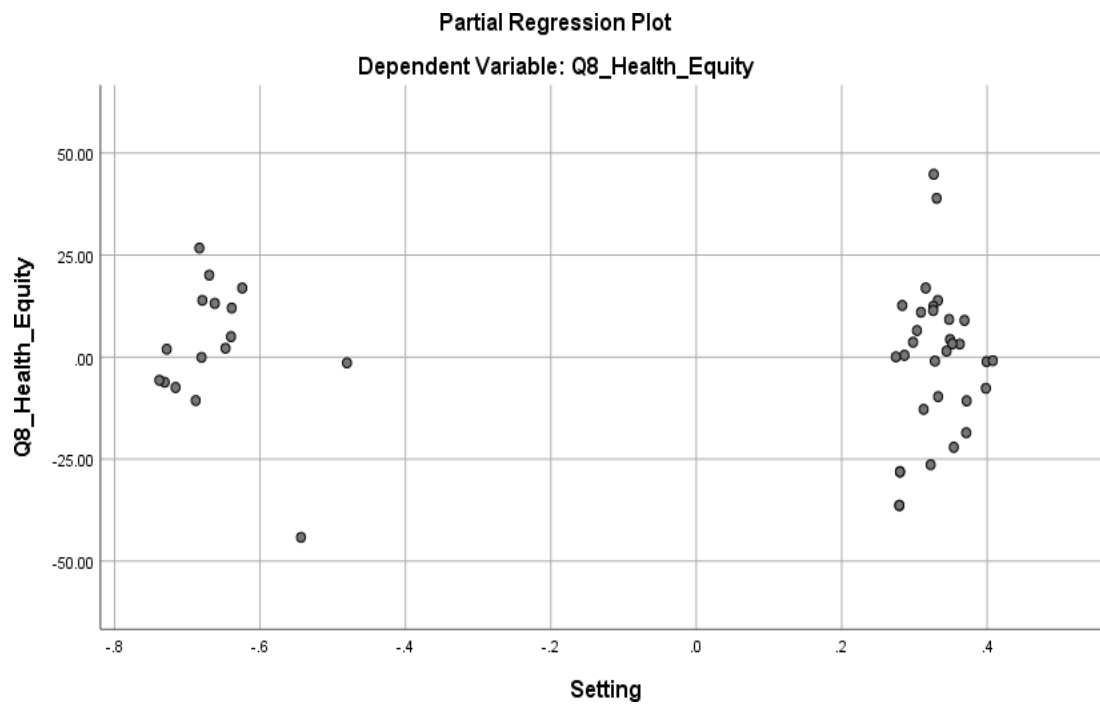
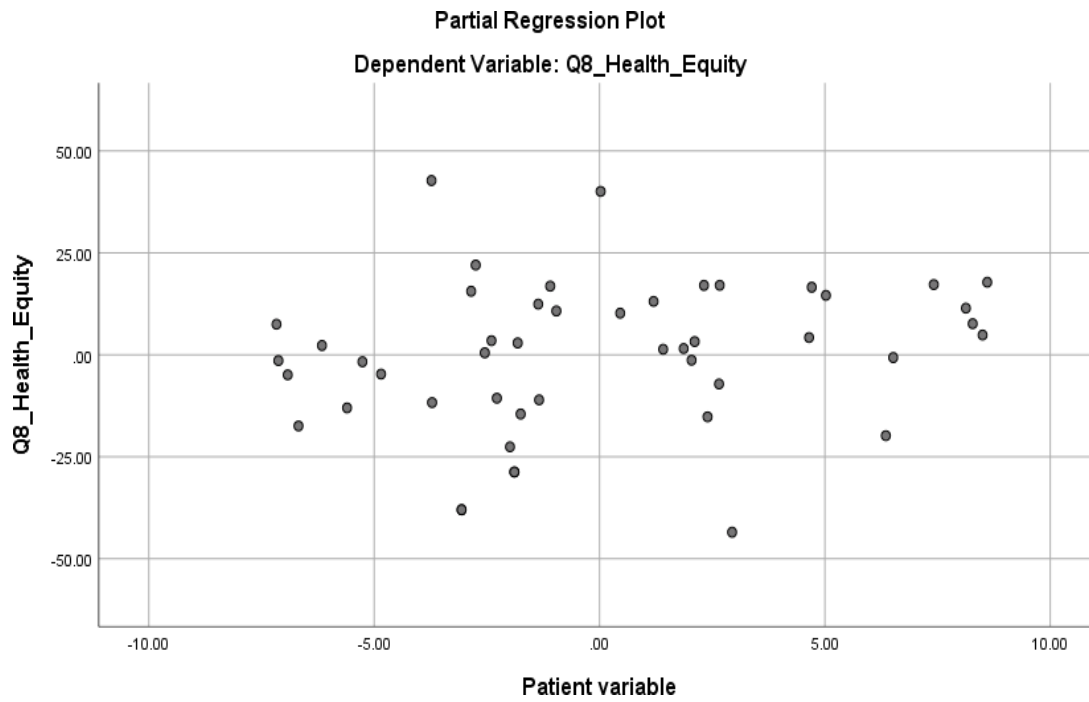


Regression Assumption Check









APPENDIX 9

Tertiary Analysis: Virtual Care delivery during the COVID-19 pandemic

Table 14

PCP Survey - Modes of Providing Care during 1st Lockdown during COVID-19

Variable	N	Percentage					Not Applicable
		Most Frequent-----Least Frequent					
In-Person Visit	46	2.2	21.7	17.4	4.3	45.7	8.7
Phone	47	89.4	2.1	4.3	0	4.3	0
Video-based	46	4.3	30.4	17.4	26.1	15.2	6.5
Applications (mobile or web-based)	46	0	6.5	10.9	13.0	17.4	52.2
Text messages/ emails	46	4.3	13.0	28.3	6.5	23.9	23.9

Analysis Summary for Table 14

The results show that PCPs' work was highly disrupted during the COVID-19 pandemic. For example, the majority of them replaced in-person care with phone consultation (89.4%) followed by video-based consultations (30.4%) during the 1st lockdown. Additional details are provided in Table 14 above.

Table 15

PCP Survey - Encryption Status of Virtual Care Tools During COVID-19

Variable	N	Percentage			
		A little	Somewhat	Completely	Don't Know
Phone calls	45	4.3	8.7	41.3	45.7
Video-based	46	8.9	15.6	44.4	31.1
Text messages/ emails	44	18.2	20.5	13.6	47.7
Applications (mobile or web-based)	44	9.1	4.5	6.8	79.5

Analysis Summary for Table 15

Many PCPs (45.7% -47.7%) were not aware of the encryption status of phone lines and video-based platforms during the COVID-19 pandemic. The percentage of those knowing the encryption status of applications was higher (79.5%). Additional details are provided in Table 15 above.

Table 16*PCP Survey – Provider Concerns in Use of Non-encrypted Virtual Care Tools During COVID-19*

Variable	N	Percentage				Mean (SD) scale 1-4
		No	A Little	Somewhat	A Lot	
Data security (storage of patient information)	46	8.7	13.0	26.1	52.2	3.22 (0.99)
Privacy of patient information	46	2.2	10.9	28.3	58.7	3.43 (0.78)
Technical skills of patients	46	4.3	17.4	30.4	47.8	3.22 (0.89)
English language skills of patients	46	17.4	21.7	30.4	30.4	2.74 (1.08)
Cost to patients	45	13.3	17.8	24.4	44.4	3.00 (1.08)

† Ontario Government approved use of non-encrypted tools (e.g., Facebook, Skype) as an emergency measure during the pandemic

Analysis Summary for Table 16

When PCPs were asked about the possible reasons for hesitations in using non-encrypted virtual tools during the COVID-19 pandemic, patient privacy had the highest mean (3.43, SD 0.78) followed by their concerns about data security and patients' technical skills. Additional details are provided in Table 16 above.

Table 17*PCP Survey – Patients' Expressed Concerns in Use of Non-encrypted Virtual Care Tools During COVID-19*

Variable	N	Percentage				Mean (SD) scale 1-4
		No	A Little	Somewhat	A Lot	
Data security (storage of patient information)	43	53.5	18.6	18.6	9.3	1.84 (1.15)
Privacy of patient information	42	52.4	23.8	14.3	9.5	1.81 (1.02)
Technical skills of patients	43	32.6	9.3	41.9	16.3	2.42 (1.12)
English language skills of patients	41	51.2	14.6	26.8	7.3	1.90 (1.04)
Cost to patients	42	54.8	9.5	19.0	16.7	1.98 (1.19)

† Ontario Government approved use of non-encrypted tools (e.g., Facebook, Skype) as an emergency measure during the pandemic.

Analysis Summary for Table 17

PCPs also reported that patients expressed concerns about the use of non-encrypted virtual tools. The highest mean scores found were about concerns about patients' technical skills (2.42, SD 1.12). Additional details are provided in Table 17 above.

Table 18

Research Variables and Sources

Study	Authors	Variables
Digital Health Technologies for More Equitable Health Systems: A Discussion Paper.	Shaw, 2020	Poverty Health literacy Digital literacy Lack of internet access (related to poverty) Homelessness Language (patient) Age (patient) Under-resourcing of health systems Providers of lack training. Provider compensation
Digital Health Equity and COVID-19: The Innovation Curve Cannot Reinforce the Social Gradient of Health.	Crawford & Serhal, 2020	Providers' lack of cultural humility Poverty Health literacy Digital literacy Lack of internet access (related to poverty) Homelessness
Virtual Health Care Is Having Its Moment – Rules Will Be Needed.	Bhatia et al., 2020	Poverty Health literacy Digital literacy Lack of internet access (related to poverty) Homelessness Language (patient) Age (patient) Providers of lack training. Provider compensation

Clinical relevance of smartphone applications for diabetes management: a global overview.	Huang et al., 2018	Poverty Health literacy Digital literacy Lack of internet access (related to poverty) Homelessness
Looking backward to move forward: A synthesis of Primary Healthcare Reform Evaluations in Canadian Provinces.	Latulippe et al., 2017	Poverty Health literacy Digital literacy Lack of internet access (related to poverty) Homelessness Under-resourcing of health systems Providers of lack training.
Mobile applications for the management of diabetes.	Chavez et al., 2017	Ethnicity Language (patient) Gender (patient) Disability (patient) Socioeconomic status
Can mobile applications influence people's health behavior change?	Zhao et al., 2016	Poverty Health literacy Digital literacy Lack of internet access (related to poverty) Homelessness Language (patient) Age (patient)