CHANGES IN PRIMARY CARE OF OLDER ADULTS SINCE COVID-19

THE ASSOCIATION BETWEEN FRAILTY STATUS, MULTIMORBIDITY, AND PATIENT DEMOGRAPHICS, AND CHANGES IN PRIMARY CARE SINCE THE COVID-19 PANDEMIC: A RETROSPECTIVE COHORT STUDY

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TITLE: The Association between Frailty Status, Multimorbidity, and Patient Demographics, and Changes in Primary Care Since the COVID-19 Pandemic: A Retrospective Cohort Study

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Lay Abstract

Many adults ≥65 years of age live with chronic conditions or frailty, requiring ongoing monitoring. Primary care physicians are fundamental in providing this continuous care. With the COVID-19 pandemic, healthcare access was restricted, many doctors switched to temporarily providing virtual care, and there were concerns about patients' mental health. Questions arose regarding possible gaps in primary care and where efforts should be focused post-pandemic. The objectives of this thesis were 1) to understand how the pandemic impacted the management of this population and the changes in care patterns (modality, encounter numbers overall and for anxiety/depression, and chronic condition management); and 2) identify patient characteristics associated with changes. There was an overall virtual care driven increase in encounters peri-pandemic and for visits relating to anxiety/depression. Frequencies of chronic condition care activities dropped, however older patients and those with increasing levels of frailty and numbers of conditions tended to be better monitored.

Abstract

Purpose: With the start of the SARS-COV-2 pandemic in March 2020, Canadian primary care practices temporarily shifted from in-person to virtual care. The purpose of this thesis was to understand whether the pandemic impacted the primary care management of older adults with varying levels of frailty and multimorbidity in terms of care modality, volume of encounters, and visits for anxiety/depression. It also aimed to identify which patients comparatively experienced greater reductions in frequencies of routine preventive care and monitoring activities.

Methods: A research database from a sub-set of MUSIC family practice for patients ≥ 65 years of age (n=1813) was employed. Patient demographics, clinician-assessed frailty status, encounters, and chronic disease management information were retrieved. Changes from 14 months pre to 14 months since (peri) the pandemic were described and associations between patient characteristics and the extent of changes in outcomes from pre- to peri-pandemic were analyzed using regression models.

Results: The mean age was 74 years, with a mean of 2.5 chronic conditions (26% hypertension, 14% diabetes). 2.1% of patients experienced high frailty levels. The mean number of encounters increased peri-pandemic overall (peri: 10.4 (SD 11.1) vs. pre: 7.1 (SD 5.5)) and for anxiety/depression, with most visits becoming virtual. Increasing numbers of overall visits were significantly associated with female sex, increasing frailty level, and having 4+ conditions. While the frequency of routine preventive and monitoring activities related to chronic conditions decreased, the mean values (e.g., lab results) did not considerably change. In the adjusted models, generally older patients, with increasing levels of frailty, and numbers of conditions tended to receive more care, however most associations were not statistically significant.

Conclusion: Overall encounters and visits related to anxiety/depression increased peri-pandemic. Despite concerns about pandemic-related care disruptions, common elements of primary care among higher risk older patients were not notably impacted.

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List of All Abbreviations and Symbols

SES	Socioeconomic status
COPD	Chronic obstructive pulmonary disease
BMI	Body mass index
HbA1c	Hemoglobin A1c
eGFR	Estimated glomerular filtration rate
MUSIC	McMaster University Sentinel and Information Collaboration network
HiREB	Hamilton Integrated Research Ethics Board
EMR	Electronic medical record
CPCSSN	Canadian Primary Care Sentinel Surveillance Network
CPCSSN-MUSIC	Canadian Primary Care Sentinel Surveillance Regional MUSIC network
CFS	Clinical Frailty Scale
OHIP	Ontario Health Insurance Plan
ATC codes	Anatomical Therapeutic Chemical Classifications
UTOPIAN	University of Toronto practice-based research network
HT	Hypertension
DM	Diabetes
CKD	Chronic kidney disease
ICD-9	9th revision of the International Classification of Disease codes
CHF	Congestive heart failure
GERD	Gastroesophageal reflux disease
SBP	Systolic blood pressure

DBP	Diastolic blood pressure
SD	Standard deviation
BP	Blood pressure
MD	Mean difference
UK	United Kingdom

Declaration of Academic Achievement

I, Shireen Fikree, declare my thesis to be my own research work. I am the sole author of this paper and was actively involved in all stages of the project under the supervision of Dr. Michelle Howard. Dr. Lauren Griffith and Dr. Gina Agarwal contributed to the editing and review of my thesis and were members of my thesis committee. Dr. Liisa Jaakkimainen acted as the external reviewer. To the best of my knowledge, this thesis does not infringe upon any existing copyrights.

1. Introduction

1.1 Primary Care and The Ageing Population

Within Canada, primary care refers to the provision of longitudinal and comprehensive personalized healthcare services (i.e., health promotion and disease diagnosis, treatment, and prevention) which are accessible, equitable, integrated, efficient and person-centred.[1,2] Health care systems with strong primary care achieve better health outcomes and are more equitable.[3] Family physicians are typically the main providers and the first point of contact for patients, however interdisciplinary teams (including nurses and other healthcare professionals) can also play a key role in providing continuous efficient care.[1,2] These collaboration efforts are especially beneficial for individuals with ongoing needs due to chronic conditions such as older adults, as these models have the potential to reduce healthcare utilization (e.g., emergency room visits, hospitalizations) and improve patient-reported outcomes (i.e., quality of life, satisfaction with care).[4]

The global population is aging, and the pace with which it is occurring is much faster than in previous years. It is estimated that by 2050, the number of people aged 60 years and older will double to reach 2.1 billion, and the population of those aged 80 years and older will triple to reach 426 million.[5] This demographic change can be attributed to two factors: an increase in life expectancy (influenced by medical and technological advancements, improved social conditions, etc.) and decreased fertility rates.[6] Health care systems, including primary care, need to respond to these demographic changes and provide integrated continuous care.[7] Older individuals experience a greater number of chronic conditions (e.g., diabetes, chronic kidney disease, cardiovascular disease etc.) than younger people, and as such it is expected that the prevalence

rates of those living with multiple chronic diseases will subsequently increase with these demographic changes.[5,6] In a report from the Public Health Agency of Canada, it was noted that the prevalence of people living with heart failure, diabetes, hypertension, and osteoarthritis all increase with age, with the highest prevalence being reported in those 85 years and older, with the exception of diabetes (highest among those 75-84 years old).[8]

1.2 Multimorbidity

In Western countries such as England and Canada, primary care practices are increasingly providing care for patients with 2 or more existing chronic medical conditions, otherwise known as multimorbidity.[9,10] Globally, the prevalence of multimorbidity among older adults is high, ranging anywhere from 55-98%.[11] Furthermore, this statistic remains high when analyzing data of older individuals across countries of all income levels. A cross-sectional population-based study analyzed cross-national, multi-continent data to reveal that Russia had the highest prevalence of multimorbidity (71.9%), followed by Poland (69.4%), while Ghana (48.3%) and China (45.1%) had the lowest. Hypertension was the most common comorbidity specifically among those with diabetes, angina, and obesity. Moreover, across countries certain patterns of multimorbidity occurred with the most prevalent being cardio-respiratory (angina, asthma, chronic obstructive pulmonary disease) and metabolic (diabetes, obesity, hypertension) in nature.[12]

Patients living with multiple chronic conditions often experience many challenges both during their treatment and day-to-day life. There is an inverse relationship between quality of life and multimorbidity, specifically within physical, social, and psychological quality of life domains.[13] Disability, functional decline, medication-routine burden, and associated healthcare costs/utilization are among the challenges that patients and their caregivers face.[11,14,15] Moreover,

higher mortality rates are significantly related to the conditions which specifically affect cardiopulmonary and renal regulatory systems.[15]

Some patients may have a higher risk of experiencing multimorbidity. The sociodemographic determinants associated with higher odds include lower education, social deprivation, older age and being female.[12,11,16] Other strong determinants for multimorbidity include associated cardiovascular risk factors such as obesity, smoking, and hypertension. [16] Lastly, individuals with a family history of chronic disease may experience multimorbidity in the future.[17]

While patients face numerous challenges, physicians may also experience difficulty when managing patients with multimorbidity. Firstly, clinical guidelines which are typically based on evidence generated from randomized controlled trials of single disease treatments often exclude those with multiple chronic conditions.[18] Additionally, given the accumulation of chronic conditions, there may also be challenges relating to medication management and polypharmacy.[19] This can have serious consequences as polypharmacy has been associated with an increased risk of adverse outcomes.[20] Lastly, physicians face time constraints, and this can limit their ability to deliver comprehensive healthcare assessments to this patient population.[21,22]

1.3 Frailty

Aging can bring about an increased number of chronic conditions but also a new level of susceptibility due to frailty.[23] Frailty is considered a multidimensional syndrome of reserve loss (energy, physical and mental abilities), which gives rise to vulnerability and increases the patients risk to adverse medical events.[24,25,26] In the literature, there are many definitions that exist for frailty.[27] Two different yet complementary operational definitions often referenced are the Fried frailty phenotype and the Rockwood *et al.* Frailty Index.[24,28,29] Fried defined frailty as a "clinical syndrome in which 3 or more of the following criteria were present: unintentional

weight loss (10 lbs in past year), self-reported exhaustion, weakness (grip strength), slow walking speed, and low physical activity." Depending on the number of criteria a patient possesses, their level of frailty is categorized as robust (none of the criteria), pre-frail (1 or 2 criteria), or frail (3 or more criteria).[24] This phenotype is useful for stratifying initial risk, however it provides no information about which treatment measures should be put in place as the underlying causal condition is unknown.[29] On the other hand, Rockwood *et al*. developed the Frailty Index, a checklist of (originally) 70 clinical conditions (shorter checklists of 50 items are still considered robust).[28,30] An index score is calculated based on the proportion of present *deficits*, which are certain symptoms, signs, disabilities, diseases, and laboratory measures. The continuous nature of this scale may allow practitioners to determine the effectiveness of a treatment and can prevent misclassification based on subjective cut-offs.[28,29]

Millions of older adult's experience frailty, but defining the global prevalence proves challenging as there is limited data, especially from developing regions, and no consensus definition. In 2021, a systematic review and meta-analysis of 240 studies covering 62 countries and territories was undertaken, estimating the global prevalence of frailty to be between 12 and 24% for adults 50 years and older (depending on the definition used).[31] When specifically investigating data from studies using the Fried Frailty Phenotype for older adults, a systematic review published in 2020 deemed the global prevalence to be between 4.9-65.2%. Higher frailty rates ranging from 42.6-65.2%, were found in low middle income countries such as Chile and Thailand respectively, whereas lower rates ranging from 4.9-5.8% were seen in high income countries such as Switzerland and Taiwan respectively.[32] Within Canada, the overall prevalence of frailty was 7.6% for individuals 18-79 years old and 7.8% for those 65 years and older when referencing the Fried definition.[33]

Frail patients often experience negative and serious health outcomes. They may experience declines in cognitive function, endurance, muscle mass, balance, and mobility. Consequently, they are more prone to falls, disability, institutionalization, hospitalization, and mortality. Living with such conditions can severely impact their health related quality of life, including their physical and social functioning as well as their mental health.[24,34,35] It has been reported that older adults experiencing frailty are 4 times more likely to have clinically meaningful depressive and anxiety symptoms even when controlling for factors such as pharmacotherapy for a history of depression or anxiety.[36] It is important to note that frailty status is also of concern to informal caregivers which include children, spouses etc., as the proportion of those experiencing caregiver burden can increase according to the level of frailty impairment.[37] Besides the negative effects of frailty on patients and their families, people experiencing frailty also have increased healthcare expenditure and utilization.[38,39]

Some patients may be at a higher risk for frailty depending on their pre-existing conditions. Several studies have revealed the association between chronic conditions and frailty.[40] Moreover, conditions such as hypertension, diabetes mellitus, arthritis, and osteoporosis are significantly more prevalent for those experiencing frailty.[41] It has also been reported that there are higher prevalence rates among older adults, women, ethnic minorities, and those of low socioeconomic status (SES).[31,42,43,44]

1.4 Context of Frailty in Primary Care

Primary care contributes to high functioning health systems and population health through ensuring access to care, comprehensive care and longitudinal continuity with patients.[3] Family physicians and primary care providers play a key role in providing this longitudinal care, as they are able to proactively address issues that arise with functioning and quality of life in aging.[43] As such, they are naturally positioned to screen for frailty and create care plans for diagnosed patients with the main goals being to improve quality of life and functional abilities, and prevent unnecessary admission to hospitals or long-term care homes.[45] Due to the limited evidence for tools which can prevent, delay, and treat frailty, primary care physicians are encouraged to utilize a person-centered approach to care when planning physical activity, nutrition, and medication reviews. Moreover, since frailty is heterogeneous in nature, collaboration with an interdisciplinary team is often essential to provide optimal care.[19]

With the population continuing to age globally and high prevalence of multi-morbidity and frailty, it is necessary to direct primary prevention efforts towards identifying vulnerable patients and assessing their frailty status.[19] At the primary care level physicians who assess frailty status are able to implement proactive interventions to delay worsening health outcomes, recognize and improve the management of comorbidities that may be contributing to frailty, and determine end-of-life preferences.[46,47] A practical framework for addressing frail patients is The Frailty 5 Checklist.[48] This guideline covers five key domains of care: 1) feelings, 2) flow, 3) function and falls, 4) “farmacy”, and 5) future and family, with suggested screening questions and assessment tools for each. Following this guideline, clinicians can utilize a structured approach in identifying areas for intervention.[48] Incorporating frailty assessment tools may present initial increased resource costs, however the long-term benefits of this clinical investment can be justified both in

terms of economics and patient outcomes.[49,50] Early identification of pre-frail patients is key because once the syndrome progresses it can become very challenging to reverse.[49,51] As a result, patients may not have access to their choice of plausible targeted treatment options.[19]

1.5 Frailty and Primary Care in the Context of COVID-19

Beginning in March 2020, there was a shift in primary care practices in recognition of public health measures to limit transmission of the SARS-COV-2 virus. Physicians within Ontario rapidly transitioned from providing in-person care to delivering the majority of services through virtual telemedicine encounters.[52,53] Telemedicine is the delivery of remote clinical services through technology, and virtual healthcare is embedded within it (includes same platforms of phone, email, etc.).[54] Some of the impacts to Canadian primary care have been noted, as during the pandemic period of March 11-July 28 2020, there were substantial immediate declines in in-office physician services with visits dropping by 79.1%, and virtual visits increasing 56-fold.[52,55] Moreover, the overall number of patients accessing care (regardless of modality) between March 14 and Jun 30, 2020 declined by 34.5%, varying on characteristics of patient age and sex, but not SES.[56]

With this change in care delivery there were also significant reductions in incidence rates (reduction in diagnoses) of diseases commonly seen in primary care. In Spain during 2020 the annual number of new cases of hypertension, hypercholesterolemia, chronic kidney disease, and chronic obstructive pulmonary disease all significantly decreased, suggesting gaps in primary care.[57] Reasons for visits also changed as an Ontario-based study found that visits for anxiety rose from 6.5% in 2019 to 9.2% in 2020 (regardless of modality). Moreover, 90.6% of virtual visits were for mental health concerns (anxiety and depression). When it came to chronic disease care, the frequency of visits dropped by 23.7% for patients with diabetes and 26.2% for those

with hypertension. Similarly, the number of individual patients accessing care for diabetes and hypertension declined by 19.5% and 28.8% respectively.[58] The implications for these patients include reductions in necessary assessments (i.e., blood pressure and cholesterol measurements), fewer new medication visits, and less disease prevention/control. [58,59]

Physicians have expressed concerns over challenges of providing care virtually, including patients' limited access and knowledge about technology, and the lack of integration with current electronic medical records.[60] These views highlight patients who are affected by the *digital divide* (those with difficulties accessing and using new technologies), as this inequality disproportionately impacts vulnerable individuals including those who are of older age, living with disabilities, and have low SES and education levels.[61,62] In a survey conducted during the pandemic, only 20 out of 313 frail individuals accessed specialized technologies for rehabilitation/therapeutic support *without* problems or difficulties.[63] Another study quantified differences in the utilization of such technologies and found that frailty level was significantly and inversely related to at-home internet usage.[64]

Given the overlap in sociodemographic factors associated with frailty and the digital divide, questions arise as to how such complex clinical syndromes were managed during this period. Caring for frail patients requires an individualized approach, and the monitoring of underlying multi-morbidities often requires in-person consultations (i.e., lab tests etc.).[65] To date, there have been no studies evaluating the extent of changes to primary care management of older frail patients during the COVID-19 pandemic. As the prevalence of frailty and the aging population increases, it is important to understand the impact that the pandemic had on primary care for patients with varying levels of frailty.[19] With virtual care becoming further integrated within the healthcare system, this research will inform future primary virtual care processes and provide

evidence to prioritize addressing pandemic-related gaps in the care of patients experiencing frailty.

This study aims to answer the following questions:

1) Among adults aged 65 and older, to what extent has the modality (office versus virtual) and *overall* number of contacts with primary care changed, comparing 14 months pre-pandemic to 14 months peri-pandemic? Additionally, among adults aged 65 and older, to what extent has the number of contacts with primary care regarding *mental health care* for anxiety and depression changed comparing 14 months pre-pandemic to 14 months peri-pandemic? Are any of these changes associated with patient age, sex, socioeconomic status, multimorbidity, and level of frailty?

   Hypothesis There will be changes to the modality with which primary care visits are conducted, and there will be changes to the number of contacts with primary care overall and for mental health care specifically. These changes will vary according to patient characteristics such as level of frailty, multimorbidity, socioeconomic status, age, and sex.

2) Among adults aged 65 and older to what extent has the frequency of routine preventive care activities defined as weight, and body mass index (BMI) measurements changed, comparing 14 months pre-pandemic to 14 months peri-pandemic? Are these changes associated with patient age, sex, socioeconomic status, multimorbidity, and level of frailty?

   Hypothesis: There will be changes to the frequency of all routine preventive care activities for the whole cohort. These changes will vary according to patient

characteristics such as level of frailty, multimorbidity, socioeconomic status, age, and sex.

3) Among adults aged 65 and older with hypertension, diabetes and/or chronic kidney disease to what extent has the frequency of routine monitoring activities (blood pressure, number of prescriptions, hemoglobin A1c (HbA1c) tests, estimated glomerular filtration rate (eGFR) tests) changed comparing 14 months pre-pandemic to 14 months peri-pandemic. Are these changes associated with patient age, sex, socioeconomic status, multimorbidity, and level of frailty?

   Hypothesis: There will be changes to aspects of chronic disease care which can be indicative of the intensity of monitoring during the pandemic. These changes will vary according to patient characteristics such as level of frailty, multimorbidity, socioeconomic status, age, and sex.

2. Methods

2.1 Study Design and Settings

A retrospective closed cohort (quasi-experimental, pre-post design) was conducted using data from the McMaster University Sentinel and Information Collaboration (MUSIC) network. This study was reviewed and approved by the Hamilton Integrated Research Ethics Board (HiREB; approval number 14193).

MUSIC data is comprised of regularly updated de-identified patient-level clinical data from primary care electronic medical record (EMR) systems held by 55 primary care providers within Hamilton, Ontario, Canada. There are over 38,000 active patients represented in the MUSIC network, and they live within diverse neighbourhoods and represent a broad range of SES. The data is updated every 6 months and contributes to the Canadian Primary Care Sentinel Surveillance Network (CPCSSN) data set (CPCSSN-MUSIC). The acquired data are processed into a standard format irrespective of source EMR system or data entry practices and are made available for surveillance and research. The frequency and comprehensive quality of CPCSSN-MUSIC data is ideal for the study of changes in practice, through time, in response to significant environmental imperatives.

2.2 Participants

This study employed a sub-set of MUSIC family practices (McMaster Family Practice and Stonechurch Family Health Centre) that recently (2020) completed a physician assessment of frailty for patients aged 65 and older who had a visit to the clinic in 2020 as of the point of data collection, and for whom the family physician had adequate knowledge of the patient to apply the Clinical Frailty Scale (CFS).[66]

2.3 Data Source and Preparation

2.3.1 Goals of Analysis

The general objectives of analysis were to create equivalent observation periods pre and peri-pandemic and investigate 1) the changes in overall volume of primary care in terms of number of contacts with the practice as well as the modality (i.e., office, virtual, home), 2) changes in the volume of mental health-related contacts, 3) changes in the frequency of relevant indicators of chronic disease management and prevention for all patients and patients with specific chronic conditions (diabetes, hypertension, chronic kidney disease), and 4) investigate associations between level of frailty, multimorbidity, age, and socioeconomic status, and the extent of changes in outcomes from pre-pandemic to peri-pandemic.

2.3.2 Cohort Creation

The cohort for this study was developed from a previous MUSIC cross-sectional study of patients who were ≥65 years and had an encounter with their primary care physician in 2020. Family physicians of these eligible patients were asked to complete a CFS between January and June 2020. No other exclusion criteria were specified at the time. Patients were then deidentified as their scores were entered within the research database. As described previously in Mangin et al., 2022, appropriate data quality exclusions were applied and of the eligible patients, CFS scores were completed for 77% of them.[67] The final sample size for the current study was 2043. For this study, the observation period was defined as 14 months pre-pandemic (Feb 19, 2019 - March 14, 2020) to 14 months peri-pandemic (March 15, 2020 - May 9, 2021). Each “month” was considered as having a standard of 30 days. Defining the start of the pandemic as March 14, 2020, aligns with when the new changes to the Ontario schedule of benefits for physician services (billing codes) came into effect, capturing virtual care visits in response to the pandemic.[68]

From the sample of 2043, patients were further excluded from the analyses of outcomes of interest if they died or were otherwise designated as inactive (e.g., left the practice) during study period. As such, 75 "inactive" patients were removed from all analyses, along with 10 "deceased" patients, leaving 1958 patients. When analyzing outcomes of interest, *all* deceased patients were removed (n=139) to accurately investigate changes in care without having results biased by missing data. We also removed a very small number of patients (n=6) who were turning 65 during the month which these assessments began leaving the "active" cohort to have 1813 patients in total (Appendix, *Figure 2*).

2.4 Outcome Definitions

2.4.1 Overall Indicators of Care

To understand the overall volume and access to primary care we began by investigating encounter data. Patient encounters with family practices were classified using the billings table in MUSIC. In Ontario, family physicians bill their encounters with patients and are reimbursed through the Ontario Health Insurance Plan (OHIP). Thus, for each encounter an OHIP service code and diagnostic code are recorded. In accordance with the most up-to-date schedule of benefits, we identified the number of days that there were one or more service codes billed to understand the total number of visits patients had during each observation period, as well as the modality (office, virtual, or home visit).[69] We excluded codes for premiums, management fees, tracking codes, and interviews with relatives, as these do not correspond one-to-one with a patient encounter and may be billed in addition to other codes so they are redundant. Furthermore, any codes which did not state any element of a virtual visit (i.e., phone or video consultation) were considered to be office visits (See *Supplementary Table 1*, for billing code

exclusions and codes used to indicate virtual consultation). The virtual consultation code did not distinguish between telephone or video.

2.4.2 Mental Health Care Indicators

We chose to focus on the conditions of anxiety and depression, as these are among the top reasons that patients seek primary care.[70] Consequently, we elected not to include visits for neurocognitive disorders or tests as mental health encounters. To understand changes specific to depression or anxiety, we first identified patient encounters using relevant billing codes (See *Supplementary Table 1*). The same methods were used as described in the previous paragraph, however adding this specific category allowed us to better understand the pattern of visits during a time when many individuals may have been isolated and as such may require further mental health support.

The second indicator for assessing mental health care was the number of times anti-depressant medications were prescribed. Medications were defined in accordance with the Anatomical Therapeutic Chemical Classifications (ATC codes). This allowed us to identify the total number of prescriptions documented during the pre- and peri-pandemic periods. Medications used to treat anxiety and depression were analyzed for the whole cohort regardless of the baseline chronic condition, as an indicator of mental health impacts of the pandemic. Since depression and anxiety often co-exist, the medications are typically prescribed interchangeably, and we have thus combined them into one category. The classes of medications are listed in accordance with those from the University of Toronto practice-based research network (UTOPIAN) technical appendix for EMR data. UTOPIAN is another Ontario primary care research network of 1400 family physician practices within the Greater Toronto Area, all of whom ultimately contribute to the CPCSSN data repository (*Supplementary; Table 2*).[71,72]

2.4.3 Prevention Indicators

To identify if patients were participating in preventive services that are typical of a periodic primary care visit, we assessed whether weight and/or BMI was measured. Generally, OHIP provides funding for one periodic primary care visit for each patient per 12 month period, and the rates of these visits typically increase by the number of comorbidities the patient has.[73] Mass measures (weight and BMI) were attained from the measurements section of the MUSIC tables.

2.4.4 Chronic Disease Indicators

Monitoring: Blood Pressure and Labs

To understand changes to chronic disease care, specifically the management of hypertension (HT), diabetes (DM), and chronic kidney disease (CKD), we evaluated whether patients with those chronic conditions had their blood pressure monitored by their primary care practitioner, and if they completed routine laboratory assessments. Blood pressures were attained from the measurements section of the MUSIC database; we counted the number of times this measure appeared in the module and assessed the population's systolic and diastolic blood pressure during each period. Laboratory measures were attained from the labs section of the MUSIC database. We specifically analyzed the number of times patients completed a test for HbA1c and eGFR, and the values for each.

Monitoring: Prescriptions

As described above, medications were defined by their ATC codes. For chronic disease specific outcomes, we primarily focused on medications used to manage DM and HT. The classes of medications for each disease group are listed in accordance with those of a technical appendix for EMR data (*Supplementary; Table 2*).[71]

2.4.5 Demographics and Health Status

Patient demographics including sex and age were retrieved from the MUSIC data. Sex was categorized as male or female. Neighbourhood level income quintile data, derived from Statistics Canada 2016 Census, had been previously linked to this patient sample using postal codes (Mangin et al., 2022).[67,74,75]

To identify the total number of baseline chronic conditions, we used the disease registry section of MUSIC (coded using 9th revision of the International Classification of Disease codes (ICD-9)). We included common conditions of interest that were previously identified in the original study sample: chronic obstructive pulmonary disease (COPD), CKD, dementia, depression, DM, dyslipidemia, HT, osteoarthritis, anxiety, atrial fibrillation, congestive heart failure (CHF), and gastroesophageal reflux disease (GERD). Condition codes of similar origin were regrouped for simplification during analysis. For example, "Hypertension" (ICD-9 401) and "Benign Hypertension" (ICD-9 401.1) were grouped under the overarching label of "Hypertension".

The Clinical Frailty Scale

To assess frailty status, physicians utilized the CFS (Appendix, *Figure 1*). The CFS was first developed by Rockwood *et al.* in 2005 as a judgement-based tool used by healthcare professionals to measure the degree of frailty and provide predictive information about mortality and the requirement for institutionalized care.[66] The tool was originally a visual chart with corresponding descriptions, grading frailty on a 7-point scale. The higher the score, the greater the frailty risk, i.e., 1 – "very fit" to 7 – "severely frail". Since then, the CFS been expanded to 9 points, distinguishing the "severely frail" category into 3 distinct groups for those who are living with "severe frailty", "very severe frailty", and those who are "terminally ill".[66,76] Typically, a cut point score of ≥5 has been used to indicate a frail state. The scale has been clinically

validated for individuals ≥65 years, and has also reliably predicted other outcomes including comorbidity, complications, falls, cognitive decline, mobility, and functional decline.[77,78] It is most widely used in hospital settings (i.e., geriatric medicine departments) within Canada and the United Kingdom, but also has been administered in other regions including Asia and South America. Besides hospital settings, the CFS has increasingly been applied to outpatient populations.[78] This is largely because of the ease of application as it focuses on criteria which are readily observed i.e., balance, use of walking aids, etc.[78,79] Given that the CFS requires practitioners to combine their clinical judgment with observable and objective measurements, it has become one of the most practical ways of screening for the presence of frailty and provides valuable data that helps to guide routine patient care.[78]

2.5 Statistical Analysis

2.5.1 Descriptive Analyses

We described patient demographics (age, sex, income quintile), frailty scores, baseline chronic disease status, and number of conditions for the "active" cohort of 1813 patients. For variables that were continuous such as age and number of conditions, mean, median, standard deviations, and interquartile ranges were calculated. For categorical variables, percentages were calculated. Descriptive statistics were compared for patients who were active versus those who were excluded in further analyses (i.e., deceased, or inactive).

The mean number of per patient monthly encounters (overall, virtual, office, and home) from 14 months pre-pandemic (Feb 19, 2019 - March 14, 2020) to 14 months peri-pandemic (March 15, 2020 - May 9, 2021) was presented using a line graph. Active and deceased patients, up and until the month of death, were included (n=1958).

Outcome variables

To explore the changes in outcomes from pre to peri-pandemic for the "active" cohort, demographic variables were further classified. Ages were categorized into 5 groups (65-69, 70-74, 75-79, 80-84, 85 years and older), and frailty scores were grouped as per Mangin et al., 2022 – low (scoring 1-3), medium (scoring 4-6), and high frailty (scoring 7-9).[67] Additionally, the number of conditions were categorized in accordance with prior literature on multimorbidity, defining it as the sum of chronic conditions, grouped as 0, 1, 2, 3, and 4+.[80]

The outcome variables of change were either treated as continuous or categorized if the outcome occurred infrequently in the time period. Outcomes treated as continuous included changes in number of overall encounters (further stratified by office, virtual, home), number of mental health-specific encounters, blood pressure (number of measures, mean systolic blood pressure (SBP) and diastolic blood pressure (DBP)), mass measures (mean BMI and weight), and number of prescriptions (all medications and anti-depressants). Outcomes for which categorical variables were created for were changes in number of BMI measures, weight measures, HbA1c lab tests, and eGFR lab tests. To model categorical changes in outcomes, we created dichotomous variables for whether there was a reduction in the frequency of blood pressure measures, number of prescriptions and lab tests in the peri-pandemic period versus pre-pandemic, compared to the same or a greater frequency of services in the peri-pandemic period versus pre-pandemic period.

Descriptive analysis of changes from pre to peri pandemic periods

For all patients, changes in outcomes from pre to peri-pandemic were calculated overall and stratified by the patient demographic characteristics (age, sex, income quintile, frailty score, baseline number of conditions). For continuous outcome variables, mean change and standard deviations were computed. For outcomes that were categorical, the percent of patients who

received fewer preventive and monitoring services during the peri-pandemic period was calculated.

For patients with specific chronic conditions, the same descriptive analysis of relevant outcomes was done in sub-groups of patients with chronic conditions. For patients with HT, DM, or CKD, changes in monitoring and prescriptions were described. The first group of indicators focused on blood pressure measures, specific to any patient with DM, HT, or CKD. The next group focused on the number of times medications were prescribed. We specifically explored medications used to treat HT among a group of patients who had HT in the absence of DM, and patients who had DM in the absence of HT. Also, we analyzed the number of times metformin was prescribed to patients with DM. Lastly, the frequency and values for specific lab tests were assessed. We focused on HbA1c measures for patients with DM, and eGFR measures for patients diagnosed with DM, HT, or CKD.

2.5.2 Factors associated with changes overall and within chronic disease subgroups

To examine associations between patient characteristics and changes in outcomes, we completed regression analyses for selected outcomes that demonstrated the greatest degree of change, and represented aspects of overall contact with primary care, mental health care and chronic disease care. We used multiple linear regression for the change in overall visits and visits for mental health care. We utilized binary logistic regression models for the dichotomous variables described above representing change in the frequency of blood pressure measures, change in number of medications prescriptions (metformin and HT treatment) and change in number of lab measures (HbA1c and eGFR), controlling for age, sex, socioeconomic status, frailty level, and multi-morbidity count category. All prespecified variables were included in the model. Furthermore, model significance was tested by either the F test of overall significance (linear

regression), or the Likelihood Ratio test (logistic regression). For multiple linear regressions, beta coefficients, 95% confidence intervals and p-values were reported, and for logistic regressions, odds ratios, 95% confidence intervals and p-values were reported.

Statistical significance for all analyses was set to $p \leq 0.050$ (two-tailed). All analyses were completed using IBM SPSS 28.0.1.0.

3. Results

3.1 Patient Characteristics

The mean age of the active patients was 74 years (standard deviation (SD) 7.2), and 60.8% were female. Also, 69.4% were in the lowest three neighbourhood income quintiles, and 60.0% had a frailty score of 1-3 (low) (Table 1). Patients had a mean of 2.5 (SD 2.9) diagnosed chronic conditions. The most diagnosed chronic disease was HT (25.7%), followed by osteoarthritis (15.8%), and DM (14.2%). Deceased and inactive patients were on average older, had higher assessed frailty level, and had been diagnosed with a greater number of chronic conditions compared to the active patients (*Supplementary; Table 3*). The median income quintile distribution was similar between active, inactive, and deceased patients.

Table 1: Demographic and clinical characteristics for a cohort of 1813 "active" patients that excludes any individual marked as "inactive" or "deceased"

		N (%)
Age groups (years)	65-69	549 (30.2)
	70-74	509 (28.0)
	75-79	341 (18.7)
	80-84	212 (11.7)
	85 & older	202 (11.1)
	Mean (SD)	74.4 (7.2)
Patient sex status	Male	713 (39.2)
	Female	1105 (60.8)
Frailty scores grouped	Low (1-3)	1092 (60.0)
	Moderate (4-6)	689 (37.9)
	High (7-9)	38 (2.1)
Median neighbourhood income quintile	1 (lowest)	94 (5.2)
	2	483 (26.6)
	3	684 (37.6)
	4	474 (26.1)
	5 (highest)	84 (4.6)
Baseline chronic disease status	Diabetes	259 (14.2)
	Hypertension	468 (25.7)
	Hyperlipidemia	185 (10.2)
	Osteoarthritis	287 (15.8)
	Anxiety	102 (5.6)
	Atrial Fibrillation	108 (5.9)
	CKD*	88 (4.8)
	Dementia	47 (2.6)
	GERD†	105 (5.8)
	CHF‡	56 (3.1)
	COPD§	80 (4.4)
	Depression	182 (10.0)
Number of conditions	None	642 (35.3)
	1	112 (6.2)
	2	345 (19.0)

* CKD: Chronic kidney disease
† GERD: Gastroesophageal reflux disease
‡ CHF: Congestive heart failure
§ COPD: Chronic obstructive pulmonary disease

	3	233 (12.8)
	4+	487 (26.8)
	Mean (SD)	2.5 (2.9)

3.2 Overall Changes From Pre- to Peri-pandemic Periods

Figure 1 shows the mean per patient monthly in-office, virtual and home visits during the 14 months prior to the start of the pandemic and the subsequent 14-month peri-period. The mean number of overall visits increased (peri mean 10.41 (SD 11.13) vs. pre mean 7.13 (SD 5.52), mainly accounted for by the rise in virtual visits. The number of office encounters dropped during the peri-period, and the number of home visits remained low. For visits regarding care for depression or anxiety, there was a slight increase during the peri-pandemic period (peri mean 0.69 (SD 2.27) vs. pre mean 0.26 (SD 1.08)) (Table 2a).

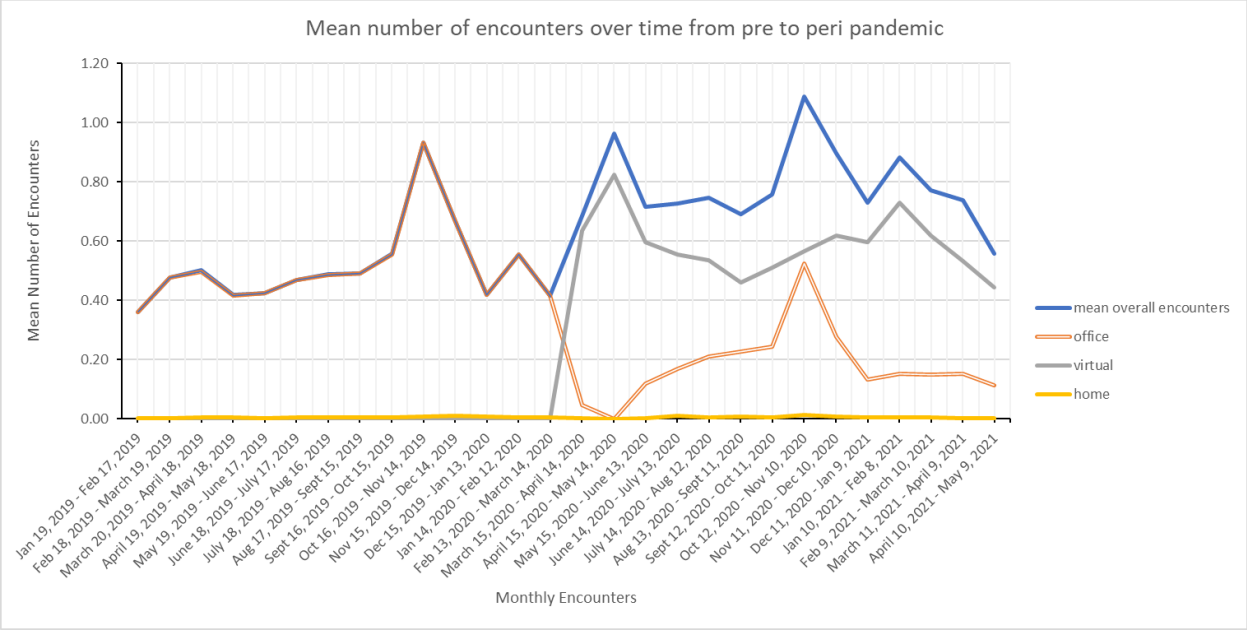

Figure 1: The mean per patient monthly encounters overall and by modality from 14 months pre-pandemic (Feb 19, 2019-March 14, 2020) to 14 months peri-pandemic (March 15, 2020 – May 9, 2021) for 1958 patients. Deceased patients were included up and until month of death.

In terms of the frequency of routine preventive care services, there was a slight decrease in the number of mass measures, however the mean weight and BMI values did not greatly deviate from measures during the pre-pandemic period (Table 2a**)**.

Lastly, for the frequency of routine monitoring services for patients with specified chronic conditions, the number of blood pressure measures dropped during the peri-pandemic period, however the mean SBP and DBP did not vary considerably (Table 2b**)**. The number of prescriptions for HT medication (for patients with HT or DM) decreased during the peri-pandemic period. This same trend was true for the number of times metformin was prescribed for patients with DM. For the number of specific lab tests, there was a drop in the number of HbA1c measures among patients with DM. The number of eGFR measures also decreased among patients with DM, CKD, or HT. The mean values did not appreciably change for either of these lab measures.

Table 2a: Comparing outcomes pre- (Feb 19, 2019-March 14, 2020) vs. peri-pandemic (March 15, 2020 – May 9, 2021) for a cohort of 1813 "active" patients that excludes any individual marked as "inactive" or "deceased"

	Pre-pandemic (Feb 19, 2019 - March 14, 2020)	Peri-pandemic (March 15, 2020 - May 9, 2021)
Outcomes relevant for all patients		
No. encounters [mean (SD); median; Interquartile range]		
Total	7.13 (5.52); 6.00; 5.00	10.41 (11.13); 8.00; 11.00
Office	7.07 (5.53); 6.00; 5.00	2.54 (3.75); 2.00; 3.00
Virtual	0.00 (0.00); 0.00; 0.00	7.80 (9.29); 5.00; 9.00
Home	0.05 (0.42); 0.00; 0.00	0.07 (0.52) 0.00; 0.00
No. encounters for depression or anxiety	0.26 (1.08); 0.00; 0.00	0.69 (2.27); 0.00; 0.00
# Blood pressure (BP) measures	1.17 (1.67); 0.00; 2.00	0.38 (0.83); 0.00; 0.00
Mean Systolic BP (SBP)	134.40 (14.58); 133.50; 18.33	134.14 (14.35); 133.00; 17.00
Mean Diastolic BP (DBP)	74.95 (8.42); 74.86; 10.67	74.11 (9.35); 74.00; 12.00
% With any HbA1c measure [n (%)]	1049 (57.9%)	584 (32.2%)
% With any eGFR measure [n (%)]	1344 (74.2%)	1010 (55.8%)
% With any body mass index (BMI) measure [n (%)]	34 (1.9%)	27 (1.5%)
Mean BMI (kg/m^2)	28.80 (5.13); 28.61; 5.99	27.80 (5.52); 28.10; 7.13
% With any weight measure [n (%)]	317 (17.5%)	179 (9.9%)
Mean Weight (kg)	80.45 (19.13); 78.80; 25.37	78.04 (19.38); 76.03; 27.82
No. Prescriptions given (all medications)	11.28 (10.97); 8.00; 11.00	10.73 (11.98); 7.00; 11.00
No. Prescriptions given for antidepressants	0.90 (2.43); 0.00; 0.00	0.87 (2.38); 0.00; 0.00

Table 2b: Comparing disease specific outcomes pre- (Feb 19, 2019-March 14, 2020) vs. peri-pandemic (March 15, 2020 – May 9, 2021) for a cohort of 1813 "active" patients that excludes any individual marked as "inactive" or "deceased"

		Pre-pandemic (Feb 19, 2019 - March 14, 2020)	Peri-pandemic (March 15, 2020 - May 9, 2021)
Outcomes among patients with specific chronic conditions: *diabetes (DM), hypertension (HT), chronic kidney disease (CKD)*			
# Times hypertension medication prescribed [mean (SD); median; Interquartile range]			
HT Only		2.59 (2.69); 2.00; 3.00	2.12 (2.30); 2.00; 3.00
DM Only		2.14 (2.42); 1.50; 3.00	1.73 (1.82); 1.00; 3.00
# Blood pressure (BP) measures			
HT or DM or CKD		1.70 (1.85); 1.00; 3.00	0.56 (0.98); 0.00; 1.00
Mean of BP measures: systolic (SBP) & diastolic (DBP) (mmHg)			
HT or DM or CKD	SBP	135.49 (14.46); 135.00; 18.00	134.21 (14.34); 133.33; 17.00
	DBP	75.16 (8.42); 75.00; 11.00	73.50 (8.99); 73.00; 13.00
# Times metformin prescribed			
DM		1.16 (1.63); 0.00; 2.00	1.03 (1.46); 0.00; 2.00
% With any HbA1c measure [n (%)]			
DM		228 (88.0%)	169 (65.3%)
Mean HbA1c measures (%)			
DM		7.15 (1.11); 7.04; 1.21	7.10 (1.16); 6.80; 1.29
% With any eGFR measure [n (%)]			
DM or HT or CKD		565 (85.9%)	452 (68.7%)
Mean eGFR measures (mL/min/1.73 m^2)			
DM or HT or CKD		65.70 (18.79); 66.63 (29.00)	62.80 (19.54); 63.00; 32.00

3.2.1 Association between patient characteristics and changes in outcomes

Supplementary Table 4a shows the changes in outcomes stratified by patient characteristics for overall primary care visits, visits for depression or anxiety, modality, and chronic disease prevention and monitoring indicators among all patients.

The mean increase in overall visits was greater among patients 80-84 years old compared to those 65-69 years (mean difference (MD) 5.67 (SD 12.98) vs. 3.12 (SD 9.04)), and for females compared to males (MD 3.85 (SD 10.57) vs. 2.35 (SD 8.45)). Those experiencing moderate to high frailty, and those diagnosed with either 1 or 4 or more chronic conditions also had a greater mean increase in visits compared to those with lower frailty or 2 or 3 conditions. These same patient groups also experienced the greatest increases in virtual care. The mean changes in home visits did not vary substantially by any characteristics. The mean change in visits specifically for mental health care increased slightly during the peri-pandemic period across all groups.

There were slight mean decreases across most sub-groups for number of prescriptions. There were increases only for patients aged 80 years and older, patients in the lowest two income quintiles, and patients with a single chronic condition. Mean differences in number of prescriptions for anti-depressants were negligible due to the small number overall.

When measuring changes in chronic disease prevention indicators, there were decreases in the number of mass measures (BMI and weight) for all demographic groups. The mean changes in weight and BMI values did not vary considerably.

For changes in chronic disease monitoring indicators, there were decreases in the mean number of blood pressure measures for all demographic groups, however the mean SBP and DBP did not appreciably change. Patients also had 51.4% fewer HbA1c and 54.8% fewer eGFR lab tests, most notably for younger populations (i.e., 65-69 years old proportion with fewer HbA1c measures: 14.7% vs. 85 & older: 5.2%), and patients experiencing low to moderate levels of frailty. With regards to median neighbourhood income quintile, there appeared to be no consistent trends for any of the outcomes.

Supplementary Table 4b shows the changes in outcomes for patients with specific chronic conditions, stratified by patient characteristics.

Among patients with DM, HT, or CKD, the mean number of blood pressure measures decreased across all groups. These changes were slightly less pronounced for female patients compared to males (MD -1.11 (SD 1.89) vs. MD -1.22 (SD 1.84)), those living with high levels of frailty compared to those with low levels (MD -0.60 (SD 1.31) vs. -1.19 (SD 1.88)), and patients diagnosed with 4 or more chronic conditions compared to those with 1 condition ((MD -1.02 (SD 1.63) vs. -1.07 (SD 1.86)). There were slight variations regarding the mean SBP and DBP during the peri-period, with most scores decreasing across all groups.

When analyzing the changes in number of specific medications prescribed, the number of prescriptions decreased slightly for almost all patient groups. There were no consistent trends within specific categories, however the overall drop in the number of metformin prescriptions was slightly less prominent than the drop in the number of HT medication prescriptions. The range of the mean change for metformin was between 0.00 (SD 1.46) and -1.14 (SD 3.02), whereas the overall range for HT medications was between 0.05 (SD 1.43) and -3.60 (SD 5.03).

Lastly, when measuring the frequency of HbA1c and eGFR measures, the number of lab tests decreased for almost all patient groups. When comparing between the different levels of frailty, patients living with higher frailty levels tended to have less reduction in tests compared to patients living with low levels, both for the number of HbA1c measures (% fewer: 25.0% vs. 64.5%) and the number of eGFR measures (% fewer: 36.8% vs. 56.1%). The scores for the tests also tended to drop slightly for most patient groups and there appeared to be no consistent trends within the categories.

3.2.2 Factors associated with changes for all patients

The multiple linear regression for the change in the number of overall visits was statistically significant (F (11, 1798) = 14.51, p<0.001, R^2= 0.082). When controlling for all other variables, individuals aged 75-79 years had the greatest reduction in overall visits compared to those aged 65-69 years (β= -2.24, 95% CI [-3.53, -0.95]). Female sex was associated with an increase in overall visits compared to male (β=1.02, 95% CI [0.12, 1.92]), as was increasing frailty level (β=1.09, 95% CI [0.73, 1.44]). Having one (β=6.14, 95% CI [4.23, 8.05]), three (β=1.69, 95% CI [0.25, 3.12]), and four or more conditions (β=3.48, 95% CI [2.31, 4.65]) was significantly associated with increases in the number of overall visits compared to those with no chronic conditions. Neighbourhood income quintile was not significantly associated with a change in visits (Table 3).

For change in visits for anxiety or depression (overall model F (11, 1798) = 5.19, p<0.001, R^2= 0.031) when controlling for all other variables, individuals aged 80-84 years had a significantly greater increase compared to those aged 65-69 years (β=0.38, 95% CI [0.04, 0.72]). Also, those with one and four or more conditions had a significantly greater increase compared to those with no chronic conditions ((β=0.52, 95% CI [0.10, 0.95]); (β=0.59, 95% CI [0.33, 0.85]), respectively). Patient sex, frailty score, and income level were not significantly associated with a change in number of anxiety or depression visits (Table 3).

Table 3: Association between patient characteristics and the change in number of visits comparing peri- (March 15, 2020 – May 9, 2021) to pre-pandemic (Feb 19, 2019-March 14, 2020) for a cohort of 1813 "active" patients that excludes any individual marked as "inactive" or "deceased"

LINEAR REGRESSION *Mean Change (peri – pre pandemic period)* – All patients		Overall Visits N=1810	Mental Health Visits N= 1810
Variables		β (95 % CI)	
Age groups (years)	65-69	Ref.	
	70-74	-0.45 (-1.59, 0.70)	0.00 (-0.25, 0.25)
	75-79	-2.24 (-3.53, -0.95)**	-0.19 (-0.48, 0.09)
	80-84	1.00 (-0.55, 2.55)	0.38 (0.04, 0.72)*
	85 & older	-1.07 (-2.70, 0.56)	0.17 (-0.19, 0.53)
Patient sex status	Male	Ref.	
	Female	1.02 (0.12, 1.92)*	0.03 (-0.17, 0.23)
Frailty scores	*1 point change in CFS*	1.09 (0.73, 1.44)**	0.07 (-0.01, 0.15)
Median neighbourhood income quintile	1-3	-0.08 (-1.03, 0.88)	0.11 (-0.10, 0.32)
	4-5	Ref.	
Number of conditions	None	Ref.	
	1	6.14 (4.23, 8.05)**	0.52 (0.10, 0.95)*
	2	0.67 (-0.57, 1.92)	-0.01 (-0.29, 0.27)
	3	1.69 (0.25, 3.12)*	0.22 (-0.10, 0.53)
	4+	3.48 (2.31, 4.65)**	0.59 (0.33, 0.85)**

* $p \leq 0.050$, ** $p < 0.001$

The binary logistic regression for the likelihood of a reduction in number of blood pressure measures was statistically significant ($\chi 2$ (11) = 60.236, $p < 0.001$), explained 4.5% of the variance (Nagelkerke R^2), and correctly classified 66.7% of cases. When controlling for all other variables, individuals aged 75-79 years were more likely to have a reduction in the frequency of measures compared to those aged 65-69 years (OR=1.39, 95% CI [1.04, 1.86]). Individuals with lower income levels (quintiles 1-3), were also more likely to have significantly fewer measures compared to those with higher income (quintiles 4-5) (OR = 1.30, 95% CI [1.05, 1.63]). Patient sex and frailty score were not associated with decreased numbers of blood pressure measures,

however individuals with any number of chronic conditions were significantly more likely to have received fewer measures when compared to those with no conditions (Table 4).

Table 4: Association between having fewer blood pressure measures (BP) in the peri-pandemic (March 15, 2020 – May 9, 2021) vs. pre-pandemic period (Feb 19, 2019-March 14, 2020) and patient characteristics, for a cohort of 1813 "active" patients that excludes any individual marked as "inactive" or "deceased"

LOGISITIC REGRESSION - All patients		BP Measures N= 1810
Variables		OR (95% CI)
Age groups (years)	65-69	Ref.
	70-74	1.06 (0.82, 1.39)
	75-79	1.39 (1.04, 1.86)*
	80-84	1.13 (0.79, 1.60)
	85 & older	0.95 (0.66, 1.39)
Patient sex status	Male	Ref.
	Female	0.87 (0.71, 1.07)
Frailty scores	*1 point change in CFS*	1.05 (0.97, 1.14)
Median neighbourhood income quintile	1-3	1.30 (1.05, 1.63)*
	4-5	Ref.
Number of conditions	None	Ref.
	1	1.77 (1.15, 2.72)*
	2	2.09 (1.57, 2.78)**
	3	2.00 (1.44, 2.76)**
	4+	1.91 (1.45, 2.50)**

* $p \leq 0.050$, ** $p < 0.001$

3.2.3 Factors associated with changes within chronic disease specific subgroups

The binary logistic regression for the change in the number of blood pressure measures among patients with HT, DM, or CKD, was not statistically significant ($\chi 2$ (10) = 12.468, p= 0.26). Furthermore, the model explained 2.5% (Nagelkerke R^2) of the variance regarding change in number of measures, and correctly classified 57.7% of cases. When specifying to these chronic disease groups, patients with lower income levels were more likely to have reduced numbers of measures during the peri-pandemic period in comparison to those with higher income levels (OR=1.49, 95% CI [1.05, 2.11]). Although age, sex, frailty scores and number of conditions were not significantly associated with the change in odds of having reduced frequency of measures, older patients (85 years + vs. 65-69 years) experienced a reduction of 3% in the odds of having reduced care, and those with greater numbers of chronic conditions (4 or more vs. 1) experienced a reduction of 29% (Table 5).

Table 5: Association between having fewer blood pressure measures (BP) in the peri-pandemic (March 15, 2020 – May 9, 2021) vs. pre-pandemic period (Feb 19, 2019-March 14, 2020) and patient characteristics, for a disease specific cohort [diabetes (DM), hypertension (HT), chronic kidney disease (CKD)]

LOGISITIC REGRESSION		BP measures
Chronic Disease Subgroup		Any patient with DM, HT, or CKD N= 657
Variables		OR (95% CI)
Age groups (years)	65-69	Ref.
	70-74	1.24 (0.82, 1.88)
	75-79	1.36 (0.86, 2.16)
	80-84	1.24 (0.73, 2.11)
	85 & older	0.97 (0.55, 1.73)
Patient sex status	Male	Ref.
	Female	1.00 (0.72, 1.38)
Frailty scores	*1 point change in CFS*	1.03 (0.91, 1.18)
Median neighbourhood income quintile	1-3	1.49 (1.05, 2.11)*
	4-5	Ref.
Number of Conditions	1	Ref.
	2	1.06 (0.54, 2.08)
	3	0.84 (0.42, 1.68)
	4+	0.71 (0.37, 1.34)

* $p \leq 0.050$

Regarding 1) changes in numbers of metformin prescriptions for patients with DM, 2) changes in numbers of HT medication prescriptions for patients with HT (and did not have DM), and 3) the changes in number of HT medication prescriptions for patients with DM (and did not have HT), none of the models were statistically significant and they each explained less than 10% of the variance. Controlling for all other variables, individuals aged 70-74 were slightly less likely to have had a reduction in the number of metformin prescriptions during the peri-pandemic period compared to those aged 65-69 years (OR = 0.35, 95% CI [0.16, 0.77]). There were no demographic variables that were statistically significantly associated with a reduction in number of HT medications for patients with HT, however for patients with DM those aged 75-79 years

were twice as likely to have received fewer numbers of prescriptions compared to those aged 65-69 years (OR = 2.66, 95% CI [1.02, 6.98]) (Table 6).

Table 6: Association between having fewer metformin and hypertension medication prescriptions in the peri-pandemic (March 15, 2020 – May 9, 2021) vs. pre-pandemic period (Feb 19, 2019-March 14, 2020) and patient characteristics, for a disease specific cohort [diabetes (DM), hypertension (HT), chronic kidney disease (CKD)]

LOGISITIC REGRESSION		Metformin	Hypertension Medications	
Chronic Disease Subgroup		Any patient with DM N= 258	HT only, no DM N = 372	DM only, no HT N = 166
Variables		OR (95% CI)		
Age groups (years)	65-69	Ref.		
	70-74	0.35 (0.16, 0.77)*	0.82 (0.47, 1.43)	1.32 (0.52, 3.34)
	75-79	0.45 (0.20, 1.02)	0.87 (0.46, 1.66)	2.66 (1.02, 6.98)*
	80-84	0.41 (0.14, 1.19)	0.80 (0.40, 1.62)	1.93 (0.61, 6.10)
	85 & older	0.29 (0.08, 1.12)	0.84 (0.39, 1.82)	1.17 (0.28, 4.88)
Patient sex status	Male	Ref.		
	Female	0.55 (0.30, 1.00)	1.07 (0.69, 1.67)	1.05 (0.52, 2.12)
Frailty scores	*1 point change in CFS*	1.18 (0.91, 1.53)	0.94 (0.78, 1.12)	1.29 (0.96, 1.74)
Median neighbourhood income quintile	1-3	1.15 (0.55, 2.38)	0.89 (0.57, 1.40)	0.67 (0.30, 1.52)
	4-5	Ref.		
Number of Conditions	1	Ref.		
	2	0.99 (0.32, 3.11)	1.12 (0.42, 2.94)	0.57 (0.19, 1.67)
	3	0.95 (0.28, 3.20)	1.20 (0.45, 3.20)	0.62 (0.18, 2.08)
	4+	0.88 (0.29, 2.67)	1.01 (0.40, 2.53)	0.61 (0.19, 1.90)

* $p \leq 0.050$

Lastly, for changes in the frequency of HbA1c measures among patients with DM, the model was not statistically significant, and it explained 6.3% of the variance in the outcome of a reduced number of measures (Nagelkerke R^2). None of the variables were significantly associated with a change in the frequency of measures. For changes in the frequency of eGFR measures among those with DM, HT, or CKD, the model was statistically significant ($\chi 2$ (10) = 19.393, p= 0.04), explained 4.2% (Nagelkerke R^2) of the variance, and correctly classified 59.9%

of cases. When controlling for all other variables, female patients were less likely to have had a reduction in eGFR tests compared to male patients (OR = 0.70, 95% CI [0.50, 0.98]). Patients with 2 chronic conditions and those with 4 or more conditions were twice as likely to have reduced numbers of measures compared to those with only 1 condition ((OR = 2.40, 95% CI [1.19, 4.87]); (OR = 2.19, 95% CI [1.12, 4.25]), respectively) (Table 7).

Table 7: Association between having fewer HbA1c and eGFR lab test measures in the peri-pandemic (March 15, 2020 – May 9, 2021) vs. pre-pandemic period (Feb 19, 2019-March 14, 2020) and patient characteristics, for a disease specific cohort [diabetes (DM), hypertension (HT), chronic kidney disease (CKD)]

LOGISITIC REGRESSION		HbA1c measures	eGFR measures
Chronic Disease Subgroup		Any patient with DM N =250	Any patient with DM, HT, or CKD N= 609
Variables		OR (95% CI)	
Age groups (years)	65-69	Ref.	
	70-74	0.53 (0.27, 1.04)	0.76 (0.49, 1.17)
	75-79	0.76 (0.36, 1.62)	1.21 (0.74, 1.97)
	80-84	0.42 (0.17, 1.04)	1.07 (0.62, 1.85)
	85 & older	1.14 (0.38, 3.44)	0.97 (0.53, 1.78)
Patient sex status	Male	Ref.	
	Female	1.10 (0.64, 1.88)	0.70 (0.50, 0.98)*
Frailty scores	*1 point change in CFS*	0.92 (0.74, 1.16)	0.93 (0.81, 1.07)
Median neighbourhood income quintile	1-3	0.98 (0.53, 1.84)	0.78 (0.54, 1.13)
	4-5	Ref.	
Number of Conditions	1	Ref.	
	2	1.21 (0.43, 3.40)	2.40 (1.19, 4.87)*
	3	0.57 (0.20, 1.64)	1.61 (0.79, 3.29)
	4+	1.00 (0.37, 2.69)	2.19 (1.12, 4.25)*

* $p \leq 0.050$

4. Discussion

The purpose of this thesis was to understand how the pandemic has impacted the primary care management of older adults in terms of care modality, volumes of care overall, and for mental health (anxiety and depression). We also aimed to understand associations between patient characteristics (demographics and frailty status) and changes in the frequencies of routine preventive care activities (weight and BMI measures). Among a subgroup of patients with HT, DM, or CKD, we aimed to understand associations regarding changes in routine monitoring activities (blood pressure measures, prescriptions, lab tests) when comparing pre to peri-pandemic periods.

4.1 Summary of Results

When analyzing the overall cohort of 1813 primary care clinic patients aged 65 years and older, the number of contacts with primary care increased during the peri-pandemic period, mainly accounted for by the rise in virtual visits. Increasing level of frailty, being female, and increasing number of chronic conditions were generally associated with greater increases in overall visits, however the trend with increasing chronic conditions was not consistent as patients with a single chronic condition had the greatest increase in the peri-pandemic period.

We also observed slight (close to one visit on average) increases in the number of visits for anxiety and depression across all strata of patient characteristics. Although a small increase on average, across the entire patient population this may be substantial in terms of workload for primary care if the need for mental health care triggered by the pandemic is sustained going forward. Individuals who were older and with higher numbers of conditions had significantly greater increases for this visit type compared to those who were younger and with fewer

conditions.

For routine preventive and monitoring activities relating to chronic conditions, there were decreases in the number of process measures during the peri-pandemic period, however the mean values of the outcome measures did not vary substantially. Generally, older patients, with increasing levels of frailty, and numbers of chronic conditions tended to receive more care, however these differences were not statistically significant.

4.2 Comparisons to Prior Research and Interpretation

Consistent with our prior hypotheses, there were changes to the number of primary care visits and to the modality of care during the peri-pandemic period. The overall increase in the number of visits, and drop in office visits, leads us to believe that virtual visits more than compensated for the reduction to office visits during this time. A prior study looking at the changes to primary care visits during the COVID-19 pandemic in Toronto, Ontario found that the overall number of visits dropped by 4.9% during the pandemic, however they had a shorter observation period and did not specify to patients over the age of 65.[58] The same study found that virtual care became the dominant form of primary care visits during the pandemic (making up 77.5% of all visits; 75.9% of visits for HT and 70.8% of visits for DM) which is consistent with our results.[58] Another study also found the decline of in-person visits during the pandemic was associated with the increase of virtual care. They discovered that this increase was consistent across all chronic disease patient populations.[81] Additional previous studies with similar results did not specify how many conditions patients had at baseline.[56,82] This increase may imply that this model offers an effective and patient-centred approach which can focus on prior gaps in chronic disease care such as ease of access and patient engagement; care may be comparable if not better than in-office visits.[83,84,85,86]

When examining demographic characteristics such as sex, previous studies have found results similar to ours. One Ontario-based study found that male patients experienced larger decreases in overall visit rates (-25.5%) since the pandemic compared to female patients (-19.5%).[56] Although this study was not limited to our patient population and had shorter peri-pandemic periods, the general trend is still consistent with our findings that females had fewer reductions in the frequency of visits.

There were general concerns highlighted in prior studies regarding how older and low-income patients accessed care virtually, given the barriers of comfort with technology, access to smartphones, etc.[87,88] Our results imply that the digital divide may not be an issue for this older cohort given the association between increased frailty level, number of comorbidities, and increased numbers of overall visits in the peri-pandemic period. Additionally, the association between change in number of visits and neighbourhood income quintile in the current study was small and not statistically significant. This suggests that the patients who have a high risk of contracting COVID-19, such as those who are older and live in lower income neighbourhoods, are the ones who can take advantage of virtual visits and avoid in-person contact.[82,89] One Ontario-based study found that the proportion of patients 65 years and older who had a virtual visit in 2020 increased significantly compared to patients who used this modality prior to the pandemic. They were also the highest users of this care delivery system.[82] The same study and one additional study on residents of Ontario concluded that patients of low-income neighbourhoods may have not been significantly impacted by the switch to virtual care as they stated that declines in visit rate and volume did not vary based on socioeconomic status.[56,82] Although these studies were not limited to our patient population and evaluated shorter peri-pandemic periods, they did similarly use median neighbourhood income quintiles. A possible

explanation for this result may be that contrary to general beliefs, older adults are not reluctant to use new technologies, and are highly satisfied with telemedicine.[87,90] It may also be that this modality of care reduces the "cost of physical contact" which the pandemic has amplified. This includes the cost of commuting, time off work, and access to personal protective equipment.[91]

There was a drop in services that typically require in-person visits either to the office or labs (i.e., BMI/weight measures, blood pressure measures, lab tests). Generally, patients who were older, living in lower income neighbourhoods, with increasing levels of frailty, and greater numbers of conditions did not access these services as frequently during the peri-pandemic period. This finding is supported by a prior study which found that periodic health exams decreased by 89% when comparing the number of visits during the period of March 14-December 31st 2019 to the same period in 2020.[58] In terms of monitoring blood pressure, a nationally representative audit of outpatient care in the United States also found results consistent with ours as they determined that there were decreases in the occurrence of blood pressure assessments (by 50.2%) during the second quarter of 2020 compared to the second quarters of 2018 and 2019.[59] Since the mean values of these measures that are used in part to monitor interventions with respect to primary or secondary prevention did not appear to be adversely impacted in the short term, it may suggest that patients were still being monitored sufficiently despite the pandemic. While guidelines recommend that blood pressure be checked at least once per year by a clinician (or more often for those with hypertension), there may be no immediate adverse effects of reducing the frequency.[92] This may have implications for burden of care to patients in traveling to clinic visits. However, periodic preventive visits have been shown to be of benefit for individuals 65 years and older, in terms of reduction in mortality and adherence to preventive care and chronic

disease recommendations, so we may need to observe further into the future to see if there are substantial changes to the health outcomes of these individuals.[93,94,95]

Regarding the changes in the frequency of lab test measures, a prior UK-based study also noted a drop during the start of the pandemic, however they did not specify to HbA1c or eGFR tests.[96] Additionally, an Ontario population-based study using health administrative data found a significant decrease in the number of lab tests at the start of the pandemic when specifying to patients with CHF, mental health concerns, COPD, and DM. They also discovered that these volumes began to increase gradually during June 2020.[81] These results may be explained in part by the lack of testing capacity in Ontario during the start of the pandemic as changes were made to laboratory infrastructure in order to focus on COVID-19 testing.[97]

On the other hand, for services that could be delivered virtually (visits for anxiety and/or depression, medications prescribed), there was a general trend where the same patient groups (older, living in lower income neighbourhoods, with increasing levels of frailty, and greater numbers of conditions) were not negatively impacted by this switch in modality, and in some cases received the same or greater levels of care. Others have reported that the pandemic increased the demand for anxiety and depression visits, with the number increasing by approximately 3% in one study, and another reporting that virtual care was adopted at the highest rate for mental health visits after March 14, 2020.[58,81] It was proposed that these increases could be due to the ease and efficiency of providing virtual appointments for patients presenting with symptoms, and these appointments could be conducted on a more regular basis.[58] It is not clear as of yet if there has been greater diagnoses for anxiety and/or depression during the pandemic, with one city in the UK noting that there has not been an increase.[96] If virtual care does increase access to mental health care, this may be an opportunity to address unmet need going forward.

When assessing the change in the frequency of prescriptions, we did observe a slight mean decrease across most sub-groups. Prior studies also reported that visits in which medications were continued or new medications were initiated also dropped since the pandemic by 8.9% and 26.0% respectively.[59] Another United Kingdom (UK) population-based study of primary care EMRs observed that the number of first prescriptions for medications used to treat DM, mental health problems, cardiovascular disease, and cancer were lower than expected during the period of March 1st - May 31st, 2020 (i.e., 35.7% reduction in metformin prescriptions). However, this study only used data from a single deprived urban city, and they may have not been able to consult with their family practitioner through telemedicine as easily compared to the rest of the UK population.[96] It is important to note that we specified our findings to specific medication classes and for specific patient chronic disease subgroups who are more likely to have received treatment for their pre-existing conditions. We are unable to determine which of these prescriptions were for new or continued medications. Given the importance of stable use of hypertension and diabetes medications, it was not surprising that the number of these prescriptions decreased only slightly, and this may have been due to extended durations given to avoid trips to the pharmacy for older patients.

In this study it was important to consider frailty as an independent risk factor, given its association with chronic conditions, greater prevalence among older adults and potentially modifiable impacts on health.[40,42] Primary care physicians are naturally positioned to screen for frailty and create proactive care plans to address the comorbidities that may be contributing to frailty.[45,46,47] The family practices in this study utilized frailty status during the pandemic as a means of prioritizing which patients to check on. Our results suggest that patients with higher frailty level were not negatively impacted by the switch to virtual care during the pandemic,

given they had significantly greater numbers of encounter overall and they accessed monitoring services that could be provided virtually. In the regression models, frailty level had little association with changes in care whereas there were associations between changes to care patterns and age and number of conditions. This may be because these characteristics are also highly related to frailty status. This study did not have large enough numbers of patients with higher frailty levels to analyze whether frailty modified associations between age or number of conditions and changes in care. Prior studies have noted that frailty is also prevalent in young and middle-aged adult populations (Fried Model; 18-34 years: 5.3%; 35-49 years 5.7%), and there is benefit to screen young adults with chronic conditions earlier to mitigate frailty progression.[33,98] This practice is not widely implemented as of yet and this older study population may have been monitored more closely regardless of level of frailty.

4.3 Strengths and Limitations

Our study was strengthened by its large sample size and the fact that the CFS's scores were completed for a very large proportion of patients who were 65 or older (77%). Moreover, the setting of a practice-based research network which draws on multi-physician practices as well as comprehensive and improved disease coding in the EMR helped to improve the overall representativeness of our study.[99] Unlike previous studies on changes to primary care during the pandemic, we examined a longer period of time peri-pandemic (14 months) and we also stratified patients by number of conditions using validated case definitions and codes. A benefit of using time periods slightly more than one year was that care that is indicated annually or bi-annually but was slightly delayed due to the pandemic had a greater chance of being captured than if we had used a shorter time period. Lastly, to our knowledge, this is the first study to

investigate the association between patient frailty status and changes in the frequencies of routine preventive care and monitoring activities.

This study also has a few limitations. Firstly, given the retrospective nature of this study, all the data was not collected directly, and we were limited in the quality and availability of information. For instance, when analyzing the change in the frequency of prescriptions, we were unable to decipher if these were first-time medications, how many refills were given, and if patients complied with taking medications. Additionally, we used neighbourhood income quintile and not the individual patient SES, so this may not be the most accurate representation of SES. Overall, there may be additional variables which could be contributing to the changes we observed given that not all the regression models were statistically significant, and they did not explain a large percent of the variance observed. This reflects the caveat of retrospective study designs as we cannot control for unknown confounders such as the exact reasons for the reduction in care, whether patients chose to avoid the clinic themselves or if they were discouraged from visiting. We are also unaware of the strength of the patient-physician relationship, and it may be that those with strong relationships pre-pandemic were able to continue maintaining such connections peri-pandemic. Moreover, it may not be that patient characteristics play as large of a role in managing chronic conditions such as DM or HT, but rather the routine guidelines that physicians follow which are further individualized and tailored to each patients' circumstances. We did not evaluate changes at specific points in time, such as when the province allowed for resuming in-person care because the occurrence or non-occurrence of interventions such as lab tests that are ordered relatively infrequently would have been difficult to interpret.

Our reliance on billing codes also has some drawbacks as we specifically utilized the new temporary OHIP virtual care fee codes that were introduced in March 2020, so we do not have an accurate representation of exactly how often virtual care was used prior to that time, and we cannot distinguish between phone and video visits. Moreover, the choice of billing code is often up to the discretion of the practitioner, and we cannot verify its accuracy or appropriateness. Along the same lines, because we looked at overall patterns and changes by characteristics, we cannot verify if care was appropriate for the management of every patient (ex. appropriateness of prescribing). Also, this study was conducted within physician practices specific to the MUSIC network and a universal public health care system, so these findings may not necessarily be representative of patient experiences without universal coverage, and we are unaware if patients accessed care from external providers.

4.4 Future Directions

This study compared several outcomes during two time periods (14 months pre- to 14 months peri-pandemic), and further investigation is required to understand the long-term trends in care provision as well as any associated changes in health outcomes that may take longer to appear. Furthermore, majority of patients included in our analysis were rostered (patients were registered with a family practice and had a formal patient-physician relationship), and it may be of interest to understand how access to care varied for older patients without a family doctor.[100] Lastly, further research may be done to understand the quality of visits that were conducted virtually, as well as the patient perspectives regarding changes in care, i.e., whether patients were discouraged from coming into the office or if they preferred virtual care.

5. Conclusion

The COVID-19 pandemic has brought about changes to the ways older adults with varying levels of frailty and multimorbidity access key primary care services. Compared to 14 months pre-pandemic, the total numbers of encounters overall and for anxiety and depression increased, with majority of visits becoming virtual. There were decreases in routine preventive and monitoring activities relating to chronic conditions, however there was not a substantial change to the disease monitoring parameters. Generally, older age, increasing levels of frailty, and increasing numbers of chronic conditions were associated with receiving more care. It also appeared that those living in lower income neighbourhoods were not negatively impacted by pandemic changes. This suggests that the patients who have a high risk of contracting COVID-19 are the ones who can take advantage of virtual visits and avoid in-person contact. As telemedicine becomes further integrated within primary care practices, this modality may be a reasonable alternative to addressing prior gaps in chronic disease management and in the care of patients experiencing frailty. Nevertheless, it is important to continue monitoring this population to observe any substantial changes to their health outcomes as a result of pandemic-related primary care disruptions.

Supplementary

Table 1: Billing codes used to identify patient encounters by modality (in person, virtual, home visit), and visits for anxiety and/or depression

Encounters	In person	A001A, A003A, A005A, A006A, A007A, A008A, A071A, A075A, A076A, A310A, A311A, A315A, A318A, A425A, A680A, A770A, A775A, A888A , A900A, A903A, A905A, A911A, A917A, A937A, A945A, E075A, E079A, G004A, G010A, G011A, G014A, G031A, G123A, G202A, G212A, G219A, G227A, G228A, G231A, G235A, G264A, G265A, G310A, G313A, G328A, G370A, G371A, G372A, G373A, G365A, G384A, G385A, G391A, G394A, G395A, G403A, G409A, G420A, G420C, G462A, G489A, G521A, G523A, G538A, G590A, G593A, G840A, G841A, G842A, G844A, G845A, G846A, G847A, G848A, K004A, K005A, K007A, K013A, K022A, K023A, K028A, K029A, K030A, K032A, K033A, K037A, K039A, K131A, K132A, K680A, P003A, Q015A, Q042A, R031A, R094A, R160A, R161A, R163A, Z101A, Z113A, Z116A, Z117A, Z119A, Z122A, Z125A, Z128A, Z159A, Z162A, Z176A, Z203A, Z543A, Z770A, Z915A
	Virtual	G511A, K080A, K081A, K082A, K094A
	Home Visit	A900A, A901A, B990A
	Mental Health Encounter (anxiety and/or depression)	K082A [also virtual], K005A (in-person), K007A (in person)
Excluded Codes		_AH2, _AH1, _AH5, _ADDITIONA, _DISABILIT, _COPY, _+COPY, _OTHER,

	_FORM DRIV, _LAW, _NOTE , _FLRC80, _SKIN1, _S TRANSFE, _INSUR, _FOOT, _WSIB, _LEGAL, _LEGALMVA, _FORM8M, _SICK NOTE, _OCF-3/59, _FAFE, _MEDCERT, _TRAVEL, _INS MEDIC, _MISC, _SKIN LESI, _AH3, _CERT, _INSUR, _ATTPHY, _TB1, _TR-I, _M639, _COPIES, _SKIN2, _F TRANSFE, _M649, _M651, _M758, _3105, _OCF23, _M650 ADD, _FREEZ SKI, _FAF, _TAGS, _MOD DUTY, _T237A, _SKIN3, _EAR, _M650, _OCF-18/59, _CRA , _NOTE2, _AH3, _TR-F
	A002A, A771A, A902A, A963A, A990A, A998A, B103A, B203A, B960A, B961A, B962A, B963A, B966A, B990A, B991A, B992A, B993A, B994A, B996A, B997A, B998A, C010A, C960A, C990A, E071A, E077A, E078A, E080A, E080B, E080C, E430A, E431A, E542A, G271A, G512A, G592A, G593A, G700A, K002A, K003A, K015A, K017A, K035A, K038A, K040A, K054A, K055A, K070A, K070B, K071A, K072A, K083A, K130A, K623A, K730A, K731A, K731C, K734A, K738A, Q012A, Q020A, Q021A, Q040A, Q050A, Q060A, Q053A, Q130A, Q131A, Q140A, Q141A, Q142A, Q150A, Q200A, Q202A, Q401A, Q402A, Q403A, Q590A, T160A, W003A, W010A, Z101A, Z114A

Table 2: Summary of medications identified for the management of chronic diseases

Chronic Disease Group	Medication Class	Generic Name
Diabetes	Biguanide	metformin
Hypertension	Angiotensin-converting Enzyme (ACE) inhibitors	benazepril captopril cilazapril enalapril fosinopril lisinopril perindopril quinapril hcl ramipril trandolapril
	Angiotensin II Receptor Blockers (ARBs)	candesartan eprosartan irbesartan losartan olmesartan telmisartan valsartan
	Thiazide and Thiazide-like Diuretics	hydrochlorothiazide chlorthalidone/chlortalidone
	Beta-adrenergic Blockers	acebutolol atenolol bisoprolol labetalol metoprolol nadolol oxprenolol pindolol propranolol
Anxiety & Depression	Selective serotonin reuptake inhibitors (SSRIs)	citalopram fluoxetine sertraline escitalopram paroxetine fluvoxamine
	Serotonin–norepinephrine reuptake inhibitors (SNRIs)	duloxetine venlafaxine desvenlafaxine levomilnacipran
	Benzodiazepines	alprazolam bromazepam clonazepam chlordiazepoxide

		diazepam flurazepam lorazepam nitrazepam oxazepam temazepam triazolam
	Other	bupropion mirtazapine vortioxetine vilazodone agomelatine moclobemide

Table 3: Comparison of patient demographics and characteristics by patient status "active", "deceased", "inactive", for the entire cohort of 2043 patients (65 years+) with an encounter in the previous year

		Patient status		
		Active	Deceased	Inactive
		N (%)	N (%)	N (%)
Age groups (years)	<65	6 (0.3)	0 (0.0)	0 (0.0)
	65-69	549 (30.2)	17 (11.4)	17 (22.7)
	70-74	509 (28.0)	19 (12.8)	12 (16.0)
	75-79	341 (18.7)	27 (18.1)	6 (8.0)
	80-84	212 (11.7)	26 (17.4)	9 (12.0)
	85 & older	202 (11.1)	60 (40.3)	31 (41.3)
	Mean (SD)	74.4 (7.2)	81.7 (8.8)	80.2 (10.2)
Patient sex status	Male	713 (39.2)	73 (49.0)	20 (26.7)
	Female	1105 (60.8)	76 (51.0)	55 (73.3)
Frailty scores grouped	Low (1-3)	1092 (60.0)	25 (16.8)	24 (32.0)
	Moderate (4-6)	689 (37.9)	98 (65.8)	37 (49.3)
	High (7-9)	38 (2.1)	26 (17.4)	14 (18.7)
Patient median neighbourhood income quintile	1	94 (5.2)	7 (4.7)	3 (4.0)
	2	483 (26.6)	40 (26.8)	22 (29.3)
	3	684 (37.6)	74 (49.7)	25 (33.3)
	4	474 (26.1)	24 (16.1)	22 (29.3)
	5	84 (4.6)	4 (2.7)	3 (4.0)
Baseline chronic disease status	Diabetes	259 (14.2)	29 (19.5)	6 (8.0)
	Hypertension	468 (25.7)	33 (22.1)	17 (22.7)
	Hyperlipidemia	185 (10.2)	19 (12.8)	6 (8.0)
	Osteoarthritis	287 (15.8)	25 (16.8)	12 (16.0)
	Anxiety	102 (5.6)	14 (9.4)	5 (6.7)
	Atrial Fibrillation	108 (5.9)	34 (22.8)	9 (12.0)
	CKD[**]	88 (4.8)	13 (8.7)	5 (6.7)
	Dementia	47 (2.6)	9 (6.0)	12 (16.0)
	GERD[††]	105 (5.8)	15 (10.1)	2 (2.7)
	CHF[‡‡]	56 (3.1)	19 (12.8)	5 (6.7)
	COPD[§§]	80 (4.4)	19 (12.8)	7 (9.3)
	Depression	182 (10.0)	18 (12.1)	10 (13.3)
Number of conditions	None	642 (35.3)	32 (21.5)	22 (29.3)
	1	112 (6.2)	6 (4.0)	3 (4.0)
	2	345 (19.0)	23 (15.4)	19 (25.3)

[**] CKD: Chronic kidney disease
[††] GERD: Gastroesophageal reflux disease
[‡‡] CHF: Congestive heart failure
[§§] COPD: Chronic obstructive pulmonary disease

	3	233 (12.8)	23 (15.4)	6 (8.0)
	4+	487 (26.8)	65 (43.6)	25 (33.3)
	Mean (SD)	2.5 (2.9)	3.7 (3.4)	2.8 (2.9)

Table 4a: Changes in primary care visits, mental health visits and chronic disease prevention and monitoring indicators from 14 months before the onset of the COVID-19 pandemic (March 2020) versus 14 months after, among 1813 older adult primary care patients

		Mean Change (SD) from Peri to Pre period				
Encounter Type		Overall	Office	Virtual	Home	Mental Health
Overall mean change (SD)		3.28 (9.82)	-4.53 (4.72)	7.81 (9.29)	0.02 (0.53)	0.43 (2.11)
Age groups (years)	65-69	3.12 (9.04)	-4.32 (4.66)	7.39 (8.57)	.00 (0.15)	.33 (1.95)
	70-74	3.09 (9.83)	-4.41 (5.44)	7.45 (9.07)	.02 (0.35)	.37 (2.33)
	75-79	1.62 (6.97)	-5.14 (4.25)	6.80 (6.77)	.00 (0.12)	.21 (1.25)
	80-84	5.67 (12.98)	-4.57 (4.25)	10.29 (12.45)	.02 (0.76)	.87 (2.32)
	85 & older	4.41 (11.46)	-4.38 (4.05)	8.91 (10.91)	.08 (1.25)	.71 (2.74)
Patient sex status	Male	2.35 (8.45)	-4.27 (4.63)	6.62 (7.67)	.00 (0.39)	.37 (1.85)
	Female	3.85 (10.57)	-4.72 (4.76)	8.57 (10.11)	.03 (0.61)	.47 (2.27)
Frailty scores grouped	Low (1-3)	2.05 (8.52)	-4.34 (4.93)	6.37 (7.68)	.00 (0.10)	.26 (1.77)
	Moderate (4-6)	4.89 (11.09)	-4.86 (4.33)	9.75 (10.79)	.04 (0.70)	.67 (2.56)
	High (7-9)	8.79 (13.46)	-4.50 (4.73)	13.61 (12.62)	.11 (2.13)	.82 (1.69)
Median neighbourhood income quintile	1	4.57 (12.66)	-5.33 (6.21)	9.84 (13.55)	.17 (0.60)	.43 (2.68)
	2	3.21 (9.87)	-4.67 (4.61)	7.88 (9.27)	.04 (0.74)	.44 (2.03)
	3	3.45 (9.09)	-4.64 (4.60)	8.09 (8.84)	.00 (0.37)	.52 (2.29)
	4	3.07 (10.65)	-4.25 (4.89)	7.32 (9.32)	.00 (0.51)	.32 (1.90)
	5	1.65 (5.73)	-3.71 (2.83)	5.39 (5.54)	-.01 (0.11)	.20 (1.32)
Number of conditions	None	1.14 (7.98)	-3.77 (4.29)	4.92 (6.72)	.01 (0.28)	.17 (1.03)
	1	7.38 (10.97)	-2.92 (6.44)	10.26 (8.34)	.00 (0.33)	.73 (2.09)
	2	2.18 (7.94)	-4.82 (4.19)	7.01 (7.39)	.02 (0.64)	.19 (1.45)
	3	3.52 (8.93)	-5.03 (4.81)	8.56 (8.82)	.00 (0.63)	.45 (2.87)
	4+	5.76 (12.21)	-5.49 (4.84)	11.23 (12.08)	.04 (0.67)	.86 (2.92)
Blood Pressure (BP)		Number of measures		Systolic BP (mmHg)		Diastolic BP (mmHg)
Overall mean change (SD)		-0.79 (1.56)		-0.29 (13.96)		-0.60 (8.82)
Age groups (years)	65-69	-.69 (1.42)		.08 (13.65)		-.85 (8.53)
	70-74	-.76 (1.51)		-.12 (12.11)		.22 (8.28)

	75-79	-.99 (1.67)	-.54 (14.47)	-.82 (9.00)
	80-84	-.83 (1.77)	-.70 (13.95)	-1.28 (9.02)
	85 & older	-.77 (1.58)	-.71 (18.55)	-.96 (10.56)
Patient sex status	Male	-.83 (1.56)	.39 (13.38)	-.37 (8.14)
	Female	-.77 (1.58)	-.77 (14.35)	-.79 (9.30)
Frailty scores grouped	Low (1-3)	-.73 (1.49)	-.20 (13.68)	-.93 (8.02)
	Moderate (4-6)	-.89 (1.69)	-.67 (14.21)	-.29 (9.59)
	High (7-9)	-.71 (1.54)	6.46 (15.27)	.75 (11.74)
Median neighbourhood income quintile	1	-.67 (1.37)	1.25 (17.65)	1.46 (12.63)
	2	-.82 (1.67)	-1.24 (12.09)	-.53 (8.19)
	3	-.92 (1.70)	-.08 (14.20)	-.62 (8.39)
	4	-.65 (1.33)	.20 (14.48)	-1.60 (8.96)
	5	-.57 (1.34)	-1.24 (16.03)	1.89 (9.61)
Number of conditions	None	-.51 (1.13)	.99 (14.71)	1.01 (9.35)
	1	-.70 (1.64)	1.16 (12.20)	.74 (8.28)
	2	-1.08 (1.95)	-.39 (14.31)	-1.50 (9.12)
	3	-.90 (1.75)	-1.01 (12.82)	-1.24 (7.28)
	4+	-.93 (1.61)	-1.03 (14.32)	-1.10 (9.10)

Mass Measures		Percent with fewer BMI measures (%)	Mean BMI (kg/m^2)	Percent with fewer Weight measures (%)	Mean Weight (kg)
Overall mean change (SD) or % fewer measures		1.1%	-0.94 (2.15)	12.2%	-1.15 (8.37)
Age groups (years)	65-69	1.5%	-1.23 (3.15)	12.2%	-1.8 (5.93)
	70-74	1.0%	-0.63 (1.01)	11.4%	-1.2 (5.11)
	75-79	0.9%	-2.13 (1.02)	13.5%	0.05 (14.9)
	80-84	0.5%	-1.05 (2.05)	12.3%	-1.8 (3.56)
	85 & older	1.5%	0.57 (1.00)	11.9%	-1.07 (2.47)
Patient sex status	Male	1.7%	-1.24 (2.26)	13.8%	-2.06 (4.48)
	Female	0.7%	-0.53 (2.05)	11.2%	-0.28 (10.75)
Frailty scores grouped	Low (1-3)	0.8%	-0.54 (1.62)	11.2%	-0.66 (10)
	Moderate (4-6)	1.5%	-2.49 (3.50)	13.8%	-2.02 (4.75)
	High (7-9)	2.6%	-0.40 (0.00)	10.5%	-0.2 (2.84)
Median neighbourhood income quintile	1	1.1%	-6.50 (0.00)	9.6%	-5.15 (8.46)
	2	2.1%	-0.59 (1.79)	12.7%	-1.52 (4.82)
	3	0.6%	-0.73 (1.96)	14.5%	0.04 (11.76)
	4	0.8%	-1.05 (2.05)	9.5%	-1.75 (3.86)
	5	1.2%	0.33 (0.00)	8.3%	-1.56 (2.65)

Number of conditions	None	0.8%	-1.06 (2.38)	7.7%	-1.99 (5.47)
	1	0.9%	-0.03 (0.52)	14.4%	0.04 (2.84)
	2	1.5%	-0.85 (3.46)	17.2%	0.77 (15.84)
	3	0.9%	-1.82 (0.33)	16.8%	-0.87 (3.41)
	4+	1.4%	-0.80 (2.63)	12.0%	-2.17 (5.67)
Prescriptions		All medications		Anti-depressant prescriptions	
Overall mean change (SD)		-0.55 (7.84)		-0.04 (1.83)	
Age groups (years)	65-69	-1.04 (6.55)		-0.16 (1.68)	
	70-74	-0.76 (8.61)		-0.07 (2.26)	
	75-79	-0.7 (6.62)		0.01 (1.36)	
	80-84	0.13 (9.13)		0.00 (1.63)	
	85 & older	0.83 (9.22)		0.27 (1.89)	
Patient sex status	Male	-0.74 (7.28)		-0.03 (1.64)	
	Female	-0.43 (8.17)		-0.04 (1.94)	
Frailty scores grouped	Low (1-3)	-0.81 (6.63)		-0.07 (1.54)	
	Moderate (4-6)	-0.07 (9.22)		0.01 (2.02)	
	High (7-9)	-1.89 (11.37)		0.18 (4.35)	
Median neighbourhood income quintile	1	0.59 (8.02)		0.00 (2.79)	
	2	0.08 (8.37)		-0.04 (2.20)	
	3	-0.87 (7.90)		-0.03 (1.50)	
	4	-0.76 (7.47)		-0.04 (1.73)	
	5	-1.71 (5.15)		-0.06 (0.88)	
Number of conditions	None	-0.91 (5.47)		-0.03 (0.88)	
	1	1.49 (8.90)		0.08 (2.30)	
	2	-1.15 (6.97)		-0.05 (2.16)	
	3	-0.52 (7.27)		0.03 (1.87)	
	4+	-0.14 (10.52)		-0.09 (2.30)	
Labs		Percent with fewer HbA1c measures (%)		Percent with fewer eGFR measures (%)	
Overall % fewer measures		51.4%		54.8%	
Age groups (years)	65-69	50.2%		53.5%	
	70-74	49.5%		51.6%	
	75-79	58.2%		55.1%	
	80-84	50.8%		57.1%	
	85 & older	48.8%		64.0%	
Patient sex status	Male	53.8%		56.5%	
	Female	49.8%		53.7%	
	Low (1-3)	51.5%		52.1%	

Frailty scores grouped	Moderate (4-6)	51.8%	59.1%
	High (7-9)	42.4%	51.5%
Median neighbourhood income quintile	1	54.1%	54.1%
	2	51.0%	57.3%
	3	51.1%	52.5%
	4	51.2%	54.0%
	5	54.7%	67.2%
Number of conditions	None	47.1%	53.3%
	1	52.5%	41.4%
	2	54.9%	57.7%
	3	47.6%	54.8%
	4+	55.4%	57.6%

Table 4b: Changes in chronic disease monitoring indicators from 14 months before the onset of the COVID-19 pandemic (March 2020) versus 14 months after, among 1813 older adult primary care patients with specified chronic diseases [diabetes (DM), hypertension (HT), chronic kidney disease (CKD)]

		Mean Change (SD) from Peri to Pre Period		
Blood Pressure (BP)		Number of measures	Systolic BP (mmHg)	Diastolic BP (mmHg)
Conditions Specified		Any patient with DM, HTN, or CKD	Any patient with DM, HTN, or CKD	Any patient with DM, HTN, or CKD
Overall mean change (SD)		-1.14 (1.84)	-1.42 (13.50)	-1.37 (8.85)
Age groups (years)	65-69	-1.05 (1.71)	-1.49 (12.02)	-1.78 (8.39)
	70-74	-1.21 (1.82)	-2.67 (12.73)	-1.60 (8.86)
	75-79	-1.23 (1.81)	-1.16 (13.71)	0.03 (7.42)
	80-84	-1.09 (2.21)	0.79 (14.98)	-2.74 (10.11)
	85 & older	-1.12 (1.80)	-1.05 (17.81)	-0.24 (11.03)
Patient sex status	Male	-1.22 (1.84)	0.59 (14.23)	0.26 (8.52)
	Female	-1.11 (1.89)	-2.79 (12.85)	-2.47 (8.92)
Frailty scores grouped	Low (1-3)	-1.19 (1.88)	-1.80 (13.20)	-1.49 (8.65)
	Moderate (4-6)	-1.14 (1.89)	-1.63 (13.63)	-1.40 (8.89)
	High (7-9)	-0.60 (1.31)	6.46 (15.27)	0.75 (11.74)
Median neighbourhood income quintile	1	-0.72 (1.40)	1.50 (13.90)	0.97 (11.34)
	2	-1.30 (1.98)	-0.60 (12.11)	-0.27 (8.74)
	3	-1.27 (2.00)	-2.60 (13.26)	-2.39 (8.37)
	4	-0.94 (1.64)	-0.93 (15.44)	-1.80 (8.61)
	5	-0.89 (1.70)	-4.12 (25.28)	5.50 (20.51)
Number of conditions	None	.(.)	.(.)	.(.)
	1	-1.07 (1.86)	-2.17 (14.07)	-2.12 (8.85)
	2	-1.48 (2.21)	-1.92 (13.98)	-2.18 (9.14)
	3	-1.15 (2.01)	-2.34 (11.06)	-1.67 (7.43)
	4+	-1.02 (1.63)	-0.64 (14.40)	-0.76 (9.41)
Prescriptions		Hypertension Medications		Metformin
Conditions Specified		HTN only, no DM	DM only, no HTN	Any patient with DM
Overall mean change (SD)		-0.48 (2.70)	-0.41 (2.30)	-0.13 (1.37)
Age groups (years)	65-69	-0.51 (2.37)	-0.04 (1.92)	-0.54 (1.18)
	70-74	-0.70 (2.95)	-0.58 (2.33)	0.20 (1.54)
	75-79	-0.20 (2.84)	-0.70 (2.77)	-0.02 (1.42)
	80-84	-0.48 (2.85)	-0.45 (2.67)	0.00 (1.46)

	85 & older	-0.30 (2.40)	-0.67 (1.83)	-0.05 (0.89)
Patient sex status	Male	-0.55 (2.46)	-0.36 (2.01)	-0.18 (1.46)
	Female	-0.42 (2.82)	-0.45 (2.52)	-0.08 (1.31)
Frailty scores grouped	Low (1-3)	-0.65 (2.68)	-0.27 (2.10)	-0.15 (1.35)
	Moderate (4-6)	-0.11 (2.73)	-0.56 (2.49)	-0.12 (1.35)
	High (7-9)	-1.73 (1.74)	-0.50 (2.89)	0.00 (2.14)
Median neighbourhood income quintile	1	-0.13 (2.20)	-0.70 (3.40)	-0.47 (1.18)
	2	-0.89 (2.94)	0.05 (1.43)	-0.15 (1.30)
	3	-0.29 (2.63)	-0.44 (2.30)	-0.01 (1.34)
	4	-0.37 (2.68)	-0.35 (2.02)	-0.09 (1.27)
	5	-0.27 (2.05)	-3.60 (5.03)	-1.14 (3.02)
Number of conditions	None	.(.)	.(.)	.(.)
	1	0.00 (2.89)	-0.55 (3.16)	-0.55 (1.87)
	2	-0.57 (2.84)	-0.36 (2.04)	-0.04 (1.49)
	3	-0.92 (2.55)	-0.23 (1.74)	0.08 (1.15)
	4+	-0.32 (2.66)	-0.51 (2.50)	-0.18 (1.28)

Labs		Percent with fewer HbA1c measures (%)	Mean HbA1c score (%)	Percent with fewer eGFR measures (%)	Mean eGFR score (mL/min/1.73 m^2)
Conditions Specified		Any patient with DM	Any patient with DM	Any patient with DM, HTN, or CKD	Any patient with DM, HTN, or CKD
Overall mean change (SD) or % fewer measures		61.0%	-0.12 (0.90)	56.6%	-2.42 (7.53)
Age groups (years)	65-69	69.1%	-0.17 (1.09)	57.6%	-3.33 (8.11)
	70-74	55.1%	-0.06 (0.91)	51.1%	-1.74 (9.09)
	75-79	62.0%	-0.17 (0.62)	62.9%	-3.00 (5.67)
	80-84	45.2%	-0.06 (0.73)	58.3%	-2.99 (6.01)
	85 & older	70.0%	0.03 (0.94)	54.5%	-0.16 (5.50)
Patient sex status	Male	60.4%	-0.18 (0.95)	61.6%	-2.56 (7.58)
	Female	61.2%	-0.06 (0.85)	53.1%	-2.30 (7.52)
Frailty scores grouped	Low (1-3)	64.5%	0.03 (0.79)	56.1%	-2.11 (7.44)
	Moderate (4-6)	59.8%	-0.29 (0.96)	58.6%	-2.72 (7.18)
	High (7-9)	25.0%	0.40 (1.04)	36.8%	-2.52 (12.4)
Median neighbourhood income quintile	1	64.7%	-0.25 (0.60)	47.6%	-0.86 (8.49)
	2	60.0%	-0.25 (1.19)	56.2%	-2.59 (8.38)
	3	61.8%	-0.03 (0.83)	54.9%	-2.62 (7.15)
	4	58.2%	-0.13 (0.46)	58.7%	-2.18 (6.98)
	5	71.4%	0.86 (1.94)	87.5%	-2.88 (5.26)

Number of conditions	None	.(.)	.(.)	.(.)	.(.)
	1	63.6%	-0.05 (1.01)	40.9%	-4.65 (8.26)
	2	68.2%	-0.16 (0.83)	61.7%	-2.56 (6.69)
	3	49.0%	-0.12 (0.96)	51.2%	-2.62 (7.96)
	4+	61.4%	-0.10 (0.90)	58.7%	-1.90 (7.61)

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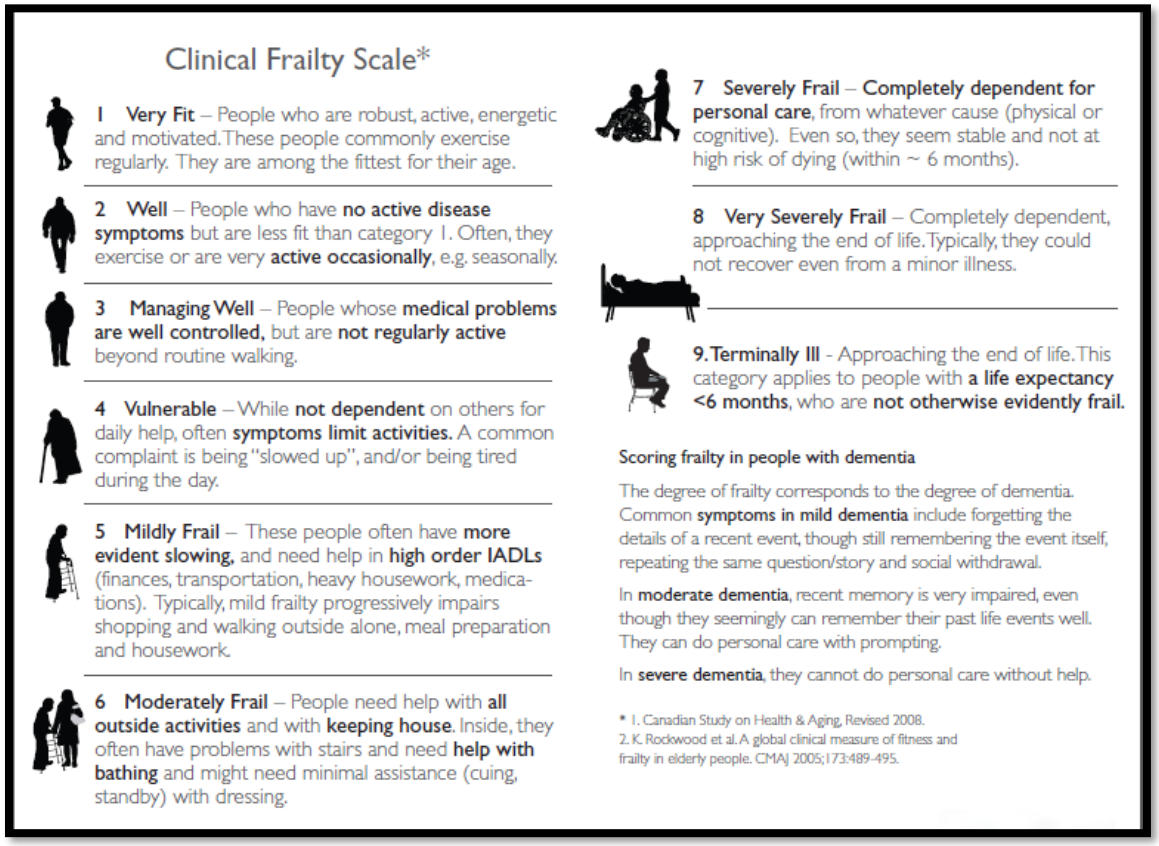
Appendix



Clinical Frailty Scale*

1 **Very Fit** – People who are robust, active, energetic and motivated. These people commonly exercise regularly. They are among the fittest for their age.

2 **Well** – People who have **no active disease symptoms** but are less fit than category 1. Often, they exercise or are very **active occasionally**, e.g. seasonally.

3 **Managing Well** – People whose **medical problems are well controlled,** but are **not regularly active** beyond routine walking.

4 **Vulnerable** – While **not dependent** on others for daily help, often **symptoms limit activities.** A common complaint is being "slowed up", and/or being tired during the day.

5 **Mildly Frail** – These people often have **more evident slowing,** and need help in **high order IADLs** (finances, transportation, heavy housework, medications). Typically, mild frailty progressively impairs shopping and walking outside alone, meal preparation and housework.

6 **Moderately Frail** – People need help with **all outside activities** and with **keeping house**. Inside, they often have problems with stairs and need **help with bathing** and might need minimal assistance (cuing, standby) with dressing.

7 **Severely Frail** – **Completely dependent for personal care**, from whatever cause (physical or cognitive). Even so, they seem stable and not at high risk of dying (within ~ 6 months).

8 **Very Severely Frail** – Completely dependent, approaching the end of life. Typically, they could not recover even from a minor illness.

9. **Terminally Ill** - Approaching the end of life. This category applies to people with **a life expectancy <6 months**, who are **not otherwise evidently frail.**

Scoring frailty in people with dementia

The degree of frailty corresponds to the degree of dementia. Common **symptoms in mild dementia** include forgetting the details of a recent event, though still remembering the event itself, repeating the same question/story and social withdrawal.

In **moderate dementia**, recent memory is very impaired, even though they seemingly can remember their past life events well. They can do personal care with prompting.

In **severe dementia**, they cannot do personal care without help.

* 1. Canadian Study on Health & Aging, Revised 2008.
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Figure 1: The CFS[66] © revised in 2008

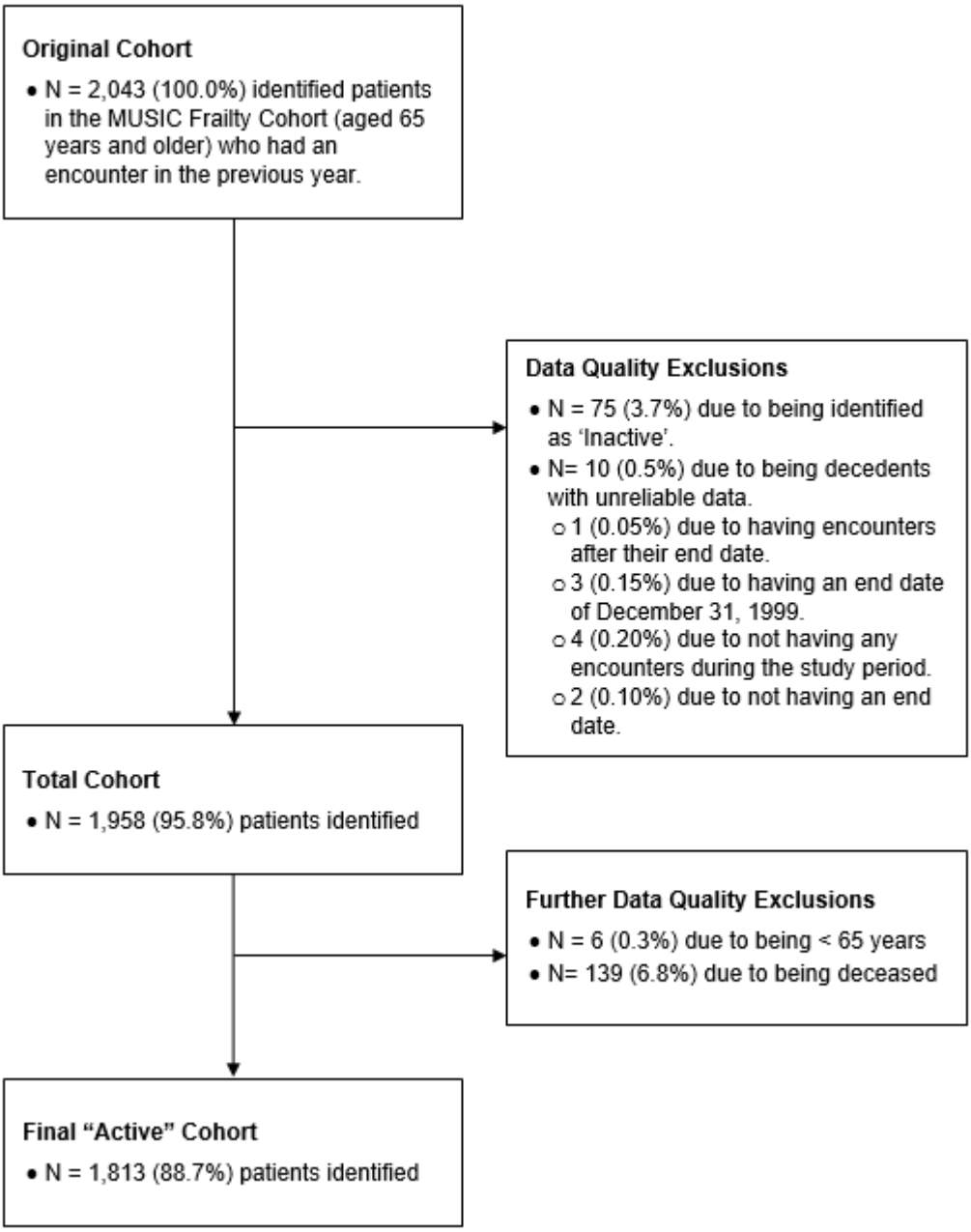

Figure 2: Cohort Creation Flow Diagram