ABSTRACT

Title of Dissertation:	PATTERNS OF HEALTH CARE UTILIZATION AMONG PATIENTS WITH ALZHEIMER'S DISEASE AND RELATED DEMENTIAS BEFORE AND DURING COVID-19
	Nianyang Wang, Doctor of Philosophy, 2023
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There are currently over 6.2 million people with Alzheimer's Disease and Related Dementias (ADRD) in the US and this population will grow to over 13 million by 2060. Patients with ADRD have high rates of health care utilization due to their complex health needs, which may have been impacted by the COVID-19 pandemic.

This dissertation examined the patterns of health care utilization during COVID-19 for the ADRD population. I used 2019-2020 claims data from Inovalon MORE^2 to identify emergency department (ED) visits, preventable ED visits, hospitalizations, potentially preventable hospitalizations (PPH), office/clinic visits, and telehealth visits and the Fall 2020 and Winter 2021 Medicare Current Beneficiary Survey COVID-19 Supplements to study telehealth access before and during COVID-19 and telehealth use during COVID-19.

The first aim examined patterns in health care utilization before and during COVID-19 using an interrupted time series analysis. The results showed that the total number of ED visits

decreased while the percent of preventable ED visits stayed the same, the total number of hospitalizations and the percent of PPH decreased, and office/clinic visits decreased while the percent of telehealth visits increased during COVID-19 for patients with ADRD.

The second aim examined the impact of COVID-19 on the rate of monthly PPH for Managed Medicaid enrollees with ADRD and Medicaid expansion status using a difference-in-differences design. The results showed that COVID-19 did not affect the rate of PPH for patients with ADRD by state Medicaid expansion status.

The third aim evaluated telehealth access and use for Medicare enrollees with a focus on enrollees with ADRD and Medicare Advantage within the context of COVID-19. Medicare enrollees with ADRD did not have different rates of telehealth access before or during COVID-19 or telehealth use during COVID-19 compared to their non-ADRD counterparts. The interaction of Medicare Advantage and ADRD was not significant in rates of telehealth access or use.

Findings from this dissertation provide policymakers with evidence on how to predict and prepare for the health care needs of future pandemics for vulnerable populations such as patients with ADRD.

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by

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Chapter 1: Introduction

Patients with Alzheimer's Disease and Related Dementias (ADRD) use health services at a high rate, as approximately 47% had at least one emergency department (ED) visit annually and 47% had at least one hospitalization annually, and these patterns were impacted by COVID-19.[1,2] Previous studies found that ED and hospital use decreased during the COVID-19 pandemic while office/clinical care at first decreased then stabilized and telehealth use increased throughout the pandemic.[3–6] ADRD is found to be correlated with greater risks surrounding COVID-19,[7] but little is known about the ADRD population's use of health services during the COVID-19 pandemic.

The overall objective of this dissertation is to examine the patterns of health services use among the ADRD population before and during the COVID-19 pandemic. This topic is significant since there is uncertainty whether health services use increased during COVID-19 due to the spread of COVID-19 or decreased due to changes in lifestyle and behavior that also result in fewer health services used. Chapter 2 provides a literature review on ADRD, health services, COVID-19, and health insurance as well as the conceptual framework for this dissertation. Chapter 3 examines patterns in health care utilization before and during COVID-19 for the ADRD population. I hypothesize that ED visits, hospitalizations, and office/clinic visits will decrease and the percent of preventable ED visits and PPHs will decrease while the percent of telehealth will increase during COVID-19.

Chapter 4 examines the impact of COVID-19 on the rate of monthly PPH for Managed Medicaid enrollees with ADRD by state Medicaid expansion status. I hypothesize that COVID-19 will impact PPH rates for Managed Medicaid enrollees with reductions in Medicaid expansion states. Chapter 5 evaluates telehealth access and use for Medicare enrollees with a focus on enrollees with ADRD and Medicare Advantage within the context of COVID-19. I hypothesize that enrollees with ADRD will use telehealth less and that the interaction of ADRD and Medicare Advantage is positive for telehealth access and use. Chapter 6 provides a summary of my findings and plans for future research.

Chapter 2: Background and Conceptual Model

Overview

In this section, I present the medical and public health literature on ADRD. Next, I explain the types of health care utilization that I am studying in this dissertation as well as background information about COVID-19. Finally, I explain the role of health insurance and the conceptual framework that guides this research.

Alzheimer's Disease and Related Dementias (ADRD)

Alzheimer's Disease and Related Dementias (ADRD) encompass a range of neurological disorders that describe cognitive decline.[8] These include Alzheimer's Disease, which results in memory loss and trouble with language and is the most common form of dementia;[9] frontotemporal degeneration (FTD) or Pick's Disease, which shrinks the frontal lobe of the brain that guides personality, behavior, language, and reasoning, and is the most common form of dementia for people under 60 years old;[8–10] Lewy body dementia (LBD), which is a buildup of Lewy body proteins in the brain and results in more frequent movement, sleep, and hallucination disorders;[11,12] and vascular dementias, which can occur after a stroke or other cerebrovascular disease and blocks blood flow to certain parts of the brain so that oxygen and nutrients are deprived which results in memory loss and poor balance is more common in the elderly.[9,13,14] In addition, most patients with ADRD experience behavioral and psychological symptoms of dementia (BPSD) which can lead to greater cognitive deterioration and require a multi-faceted treatment to ameliorate the conditions.[15]

The number of persons with Alzheimer's disease and related dementias (ADRD) in the United States is expected to reach 13.8 million by 2060, more than double from roughly 6.2 million persons in 2021.[11] The prevalence of ADRD varies greatly in the population, as the vast majority of people with ADRD are age 65 and older, and the percentage increases dramatically with age: 5.3 percent of people age 65-74, 13.8 percent of people age 75-84, and 34.6 percent of people age 85 or older have ADRD.[11] In 2012, more than 70% of the aging population with ADRD had a minimum of 3 co-occurring conditions.[16]

The prevalence of ADRD also varies among sociodemographics, as a study of Medicare fee-for-service beneficiaries shows that ADRD affects women beneficiaries at a higher percent than men beneficiaries (13.3% vs 9.2%), and also has a higher prevalence in Black beneficiaries (14.7%) and Hispanic beneficiaries (12.9%) compared to non-Hispanic White beneficiaries (11.3%) and Asian and Pacific Islander beneficiaries (10.1%).[17] Rural communities tend to underdiagnosis ADRD and also diagnosis at later stages, which results in shorter survival times compared to urban communities.[18] There is also a genetic component to ADRD, as 25% of people 55 years and older have a family history of dementia and the lifetime risk of dementia is double for people with a family history (20% vs 10%).[19]

Currently, there are no cures for ADRD, and various interventions have shown mixed effects. A randomized control study testing the effective of care management as performed by physicians for patients with ADRD showed improvements in the quality of care and in behavioral and psychological symptoms of dementia among the patients and their caregivers, but did not show improvements in

hospitalization or mortality rates.[20] Therefore, it is crucial to understand the medical needs of this vulnerable and growing population.

Health care utilization

Emergency Department (ED) Visits

The emergency department (ED) was visited over 74 million times and was responsible for over $64 billion of health care expenditures in 2017.[21] ED use has increased over time from 352.8 visits per 1,000 persons in 1997 to 448.2 visits per 1,000 persons in 2016 while also being an essential safety net source of health care for patients who are medically underserved and/or on Medicaid.[22,23] About half of all visits to the ED can be classified as preventable outside of the ED setting, and an estimated $4.4 billion can be saved annually if these preventable ED visits were treated at urgent care or retail clinics.[24,25] Another study showed that preventable ED visits for patients with ADRD are more common in rural counties compared to urban counties and that mental health professional shortages, comorbidities, and state effects explain much of the disparity.[26] In addition, patients with ADRD who go to a hospital affiliated with an accountable care organization (ACO) are less likely to have a preventable ED visit compared to non-ACO hospitals.[27] The rate of preventable ED visits increased from 2008 through 2012, which merits study into the determinants of preventable ED visits and reforms that can reduce the increasing trend.[28]

Previous research has shown that Medicaid Managed Care insurance can help reduce racial disparities in preventable ED visits.[29] However, recent research also found no difference in preventable ED visit rates between Medicaid Managed care and Medicaid FFS patients.[30] Older research shows that a disproportionate percent of

Black patients and patients who are uninsured or on Medicaid go to ED visits for chronic ambulatory care sensitive (ACS) conditions and also less likely to follow-up with a physician.[31] In addition, patients with dementia visited the ED more frequently, were hospitalized more often than patients without dementia, and had increased odds of returning to the ED within 30 days of an index ED visit compared with persons who never had a dementia diagnosis.[32]

Hospitalizations

Hospitalizations are defined as admission to hospital care as an inpatient and typically spending at least one night at the hospital. Similar to ED visits, hospitalizations can also be classified as preventable based on Prevention Quality Indicators (PQIs) or Ambulatory Care Sensitive Conditions (ACSCs), both as either acute or chronic conditions.[33] Preventable hospitalizations are often a sign of poor outpatient care access, as a study showed that rural health clinic use for older Medicare beneficiaries was associated with a significant increase in preventable hospitalizations and ED visits.[34] Preventable hospitalizations and ED visits were also more common among Medicare beneficiaries who were Black or who had multiple chronic conditions.[34] Dementia is found to be associated with increased hospitalizations and admissions for preventable conditions.[35]

Research using the National Inpatient Sample estimated a total of 9.27 million hospitalizations for patients with diagnosed dementia between 2012-2016 and that 3.72 million (40.1%) of these hospitalizations were for potentially preventable conditions, composed of 2.07 million for acute ACSCs, 0.76 million for chronic ACSCs, and 0.89 million for injuries.[36] While the incidence of all-cause

hospitalizations declined from 1.87 million to 1.85 million per year from 2012 to 2016, the incidence of potentially preventable hospitalizations increased from 0.75 million to 0.87 million per year in the same time period, with much of the increase coming from community-dwelling older adults, as 86.0% of hospitalized patients were admitted from the community but only 32.7% were discharged to the community.[36]

Hospitalizations for patients with ADRD are a growing concern, as previous research shows that even 3 years before an ADRD diagnosis, patients who eventually are diagnosed with Alzheimer's were more likely to have annual all-cause emergency department visits, all-cause hospitalizations, potentially avoidable hospitalizations, and falls than controls.[37] Patients with dementia are at an increased risk of hospital admission owing to physical health and behavioral problems, such as agitation and wandering, compared to patients without dementia.[38]

Healthy People 2030 has an objective of decreasing preventable hospitalizations for older adults with dementia by 2030, as 2013-2015 data showed that 23.5 percent of hospitalizations for this population were preventable.[39] As such, timely research is needed to study policies that can improve preventable hospitalization rates for patients with ADRD.

Office/Clinic Care

Office/clinic care is defined as the delivery of health services outside of hospitals and medical facilities and can be divided into primary care (physicians) and secondary care (specialists). Primary care providers are generally the first doctors to diagnose patients for ADRD and are crucial in creating an appropriate treatment

plan.[40] However, a survey showed that half of primary care providers believe that the medicine profession is not prepared for the increase in demand in the next five years, and 55% believe there are not enough specialists to receive referrals.[41] Other research shows a positive association between the proportion of primary care physicians to total physicians and reductions in ED visits and hospital admissions.[42] Primary care also affects the preventable ED visit rate, as research has shown that patients with cancer were almost twice more likely to have a preventable ED visit if they did not have a clinic appointment or phone call to the clinic on the day of ED.[43] Additional research has shown that about half of ED visits could have been treated in a primary care outpatient setting.[44]

The use of telehealth in outpatient care experienced exponential growth during COVID-19, as Medicare Part B telehealth visits saw an increase from 840,000 in 2019 to 52.7 million in 2020.[45] Previous research shows that telehealth has similar benefits to in-person care.[46] A study showed reduced ED visits after developing and implementing a telehealth care system for patients with dementia.[47] While there can be barriers to the use of telehealth for the ADRD population such as unfamiliarity with the technology and lack of telecommunications access, telehealth is generally well-received by patients with ADRD who have used it.[48] One study found that high-intensity exposure to telehealth reduced the rate of ED use for patients with dementia.[49]

Health Insurance Payer Types

ADRD care is paid by a few health insurance payer types that patients with ADRD can obtain based on age, disabilities, income/asset thresholds, and personal

preference. In this section, I describe the various health insurance options and their role in financing ADRD care.

Medicaid

Medicaid was started in 1965 to cover low-income adults, with coverage later expanded to children and "medically needy" (people who earned substantial amounts of money during their lifetime but have become impoverished by large medical expenses, available in 35 states).[50] The elderly and disabled are also able to become Medicaid-eligible through the Supplemental Security Income (SSI) program which has different income and asset thresholds for each state.

The cost of ADRD care to Medicaid is extensive, as Medicaid paid an estimated $44 billion on total direct health-care costs for individuals with ADRD in 2015.[51] Medicaid also covers long-term care such as nursing homes compared to limited coverage by Medicare and commercial insurance, and as such 62% of nursing home residents are primarily supported by Medicaid and 57% of the national spending on long-term services are paid by Medicaid as well as approximately 79% of total expenditures on nursing homes.[52,53] This supports evidence that Medicaid expenditures were substantially higher for patients with dementia than without ($50,270 vs. $21,966) while Medicare expenditures between patients with dementia and without dementia did not differ significantly.[54]

The use of Medicaid insurance for patients with ADRD has been explored in the past. Research shows that the implementation of treatment at the earliest onset of ADRD will delay institutionalization by 91 days, reducing Medicaid costs by $19,108 per institutionalized patient and overall annual Medicaid savings exceeding $1

billion.[55] Another study found that age, race, state of residence, and pharmacotherapy exposure were significant predictors of health care service utilization of the Medicaid patient populations with Alzheimer's Disease.[56]

Managed Medicaid (MM)

The concept of managed care arose in the 1930s as physicians and hospitals worked together to coordinate health care services and be paid a single rate.[57] Medicaid as a whole insures one out of every five Americans, and the percent of Medicaid recipients who are enrolled in MM rapidly increased from 14% in 1991 to 69% in 2018.[58–60] MM has shown improvements in quality of care and one state model (Oregon) was associated with reduced costs.[60] In California, the mandatory enrollment of seniors and persons with disabilities into MM showed an increase in ED visits as well as transfers between hospitals.[61] Auto-assignment into the lowest spending MM plan showed 30% less spending than the highest spending MM plan, but it also showed decreases in health services, including low-cost high-value care, and showed worse beneficiary satisfaction and health.[62] However, little research has been performed for MM enrollees with ADRD, which is a growing segment of the MM enrollee population and their health needs are more complex than other MM enrollees.

Traditional Medicare/Medicare fee-for-service (FFS)

Medicare was established in 1965, the same year as Medicaid, by President Lyndon B. Johnson to cover health services for the elderly and disabled. Staring in 2011, the Affordable Care Act added the Annual Wellness Visit (AWV) to Medicare, which can be used to diagnose ADRD at a higher prevalence and establish better

treatment regimes.[63] However, AWV use has only seen modest use (7.5% in 2011 to 15.6% in 2014) and faces disparities as White individuals, urban residents, those from higher-income areas, and with 1 or 2 comorbidities were more likely to receive an AWV.[64] Research has also shown that Medicare beneficiaries with ADRD were at a higher risk of potentially avoidable hospitalizations (PAHs) for certain uncontrolled comorbidities and incurred higher Medicare expenditures compared with matched controls without dementia, and that ADRD appears to make the management of some comorbidities more difficult and expensive.[65] Among Medicare beneficiaries, annual per-capita out-of-pocket healthcare spending was greater among individuals with ADRD compared to those without ADRD ($3,285 vs. $1,895), and home health and prescription drugs accounted for 52% of total out-of-pocket spending among individuals with ADRD.[66] Previous research of a primary care dementia treatment program for Medicare FFS beneficiaries showed no differences between treatment and control groups in terms of hospitalizations, emergency department visits, or 30-day readmissions.[67]

Previous research of the patterns of Medicare expenditures for individuals with newly diagnosed ADRD shows an increase at least 12 months before their diagnosis, peak during the first few months immediately after diagnosis, and decrease afterward but remain at a higher level than before diagnosis.[68] These findings highlight the importance of early diagnosis and indicate the need for complex case management to coordinate care transitions for individuals with ADRD.[68] Research has shown that higher levels of continuity of care are associated with lower rates of

hospitalization, emergency department visits, testing, and health care spending for Medicare FFS beneficiaries with dementia.[1]

Medicare Advantage (MA)

Managed care through Medicare is organized by Medicare Advantage (MA) which can limit provider networks but also supplement health care that Medicare FFS does not cover such as dental and vision care. Similar to MM, MA has sharply risen from 3% in the late 1980s to 48% in 2022.[69,70] Previous research shows that individuals who were forced out of MA plans due to plan exit saw significant increases in hospital utilization.[71] In addition, subsidies to MA have shown increases in consumer surplus through lower premiums and generous benefits.[72] Older research shows that among patients who are in a Medicare managed care organization, the costs were over $4,000 higher a year higher for patients with ADRD after controlling for comorbidities and other variables and that patients with ADRD and comorbidities had significantly higher costs compared to patients with the same comorbidities but without ADRD, with much of the higher cost attributed to higher inpatient and skilled nursing facility utilization.[73]

COVID-19

COVID-19 is a viral infection that spreads primarily through respiratory droplets. The COVID-19 pandemic was declared in the US on March 2020, which lead to many changes in health services delivery and utilization. The effects of the COVID-19 pandemic created additional disparities for patients with ADRD, as people with dementia are associated with an increased risk of having severe COVID-19 and associated mortality.[74] Early research found older adults ages 65 and above

amounted to 31% of cases, 45% of hospitalizations, 53% of ICU admissions, and 80% of deaths associated with COVID-19.[75] Seeking COVID-19 treatment in hospitals often results in elderly patients being placed in isolated rooms with a lack of visitation, resulting in an increased risk of developing delirium.[76] Overall, patients with Medicaid or Medicare-Medicaid dual eligibility saw a lower increase in ambulatory services between March 2020 and February 2021 compared to those insured by commercial, Medicare Advantage, or Medicare fee-for-service.[77] Previous research shows that the total weekly number of ED visits was down by 42% during the early period of the COVID-19 pandemic compared to the same period of the previous year.[3]

The same risk factors for dementia (age, obesity, cardiovascular disease, hypertension, and diabetes) are also the major risk factors for COVID-19, making persons with cognitive impairment particularly vulnerable to the SARS-CoV-2 infection, and quite likely making the disease more severe.[78] An analysis of a large EHR dataset found that Black patients with dementia had a higher risk of COVID-19 than White patients, and the 6-month mortality and hospitalization risks in patients with dementia and COVID-19 were 20.99% and 59.26%, respectively.[7] There are large variations in COVID-19 due to demographics, as males had higher COVID-19 severity and mortality than females,[79] older adults had more complications and mortality than younger adults,[80] and states with early COVID-19 mitigation policies had slower growth of COVID-19 cases.[81]

Patients with ADRD may have additional difficulties during the COVID-19 pandemic, such as remembering safeguard procedures to wearing masks or socially

distancing, and may require additional support to mitigate their health needs.[82] Another way that COVID-19 impacts patients with ADRD is the disruption in routinely scheduled appointments which have seen many cancellations and postponed, which can lead to greater specialist care or even hospitalizations.[83] These special circumstances for ADRD patients show that interventions are crucial during current times and to plan for future pandemics.

Conceptual Framework

Based on the above literature, I hypothesize that the COVID-19 pandemic resulted in sudden changes to the health services use patterns of patients with ADRD. I provide my aims and hypotheses below on what I expect to happen.

Aim 1 examines the relationship of the COVID-19 pandemic to health services use patterns for patients with ADRD. I hypothesize that patients with ADRD will undergo fewer ED visits, hospitalizations, and office/clinic visits and reductions in the percentage of preventable ED and PPH while and increase in the percentage of telehealth visits. This is supported by evidence that ED visits, hospitalizations, and office/clinic visits decreased during the COVID-19 pandemic for the general population,[3–5] even though patients with ADRD have complex health needs that may require more health services than the general population.

Aim 2 examines the impact of COVID-19 on PPH rates for MM enrollees with ADRD by state Medicaid expansion status. I hypothesize that COVID-19 will reduce the amount of PPHs for MM enrollees and expansion states will see greater reductions compared to non-expansion states. This is supported by research linking Medicaid expansion to reductions in PPH as well as recent research that shows the

benefits of Medicaid expansion on health outcomes during the COVID-19 pandemic.[84,85]

Aim 3 examines the factors that determine telehealth access and use for Medicare enrollees during COVID-19. I hypothesize that Medicare enrollees with ADRD will use telehealth less than enrollees without ADRD, and the interaction of MA for enrollees with ADRD is associated with greater telehealth use during COVID-19 compared to TM enrollees. This hypothesis is supported by evidence of barriers in telehealth use for patients with ADRD, while MA can cover additional benefits such as internet access that help with access and use of telehealth.[48,86]

Chapter 3: The Trends of Hospitalizations, Emergency Department Visits, and Office/Clinic Visits for Patients with Alzheimer's Disease and Related Dementias Before and During COVID-19

Abstract

Introduction: Patients with Alzheimer's Disease and Related Dementias (ADRD) have high medical care demands which were potentially obstructed during the COVID-19 pandemic. My objective is to examine whether health services utilization for patients with ADRD changed during the COVID-19 pandemic.

Methods: I conducted an interrupted time-series study that adjusted for seasonality using the Inovalon MORE^2 claims data from January 2019 through December 2020 of patients with ADRD. The primary outcomes were monthly ED visits, percent preventable ED visits, monthly hospitalizations, percent potentially preventable hospitalizations (PPH), monthly office/clinic visits, and percent telehealth visits.

Results: There were 165,988 patients with ADRD in the sample. ED visits had a decreasing trend before COVID-19 (-246.78 per month, 95% CI = -372.71; -120.86) and then experienced a sharp level decline during COVID-19 (-3,987.15, 95% CI = -5,896.53; -2,077.766), while preventable ED visit percent did not significantly change during COVID-19. Hospitalizations had a decreasing trend before COVID-19 (-166.56 per month, 95% CI = -216.84; -116.29) then the trend stabilized (101.01 per month, 95% CI = 4.64; 197.39) and experienced a level decline during COVID-19 (-771.54, 95% CI = -1,533.80; -9.28), while the PPH percent trend significantly decreased during COVID-19 (-0.303% per month, 95% CI = -0.590; -0.017). Finally,

office/clinic visits had a decreasing monthly trend before COVID-19 (-2,159.53 per month, 95% CI = -3,806.02; -513.03) and then experienced a sharp decline during COVID-19 (-41,439.71, 95% CI = -66,404.8; -16,474.7) while the trend switched to increasing (3,319.20 per month, 95% CI = 162.45; 6,475.96), and the percent of telehealth visits of total office/clinic visits had a sharp increase during COVID-19 (8.897%, 95% CI = 1.171; 16.623).

Conclusions: Most health services use for patients with ADRD decreased during COVID-19 except for telehealth. The preventable ED visit percent did not change during COVID-19 while the PPH percent decreased and the telehealth percent increased.

Introduction

Patients with ADRD have high levels of health care utilization, as a 2011 systematic review found an average of 0.4-0.75 annual emergency department (ED) visits, 0.32-0.83 mean annual hospitalizations, and 6.82-10.18 physician visits per year.[87] The COVID-19 pandemic drastically changed the delivery of health services, as a systematic review found that overall health care utilization decreased by one-third while noting large variations among patients as those with more severe illnesses had smaller reductions.[88] As such, it is vital to study the patterns of health care utilization for patients with ADRD.

The ED is an important source of health care for many patients with ADRD.[26,27] Previous shows that patients diagnosed with ADRD are more likely to have annual ED visits up to 3 years before ADRD diagnosis compared to controls.[37] In addition, the odds of having a preventable ED visit are 51% higher for community-dwelling residents who had dementia than for those who did not.[89] The potentially preventable use of the hospital can be an indicator of poor care management and inadequate access to high-quality ambulatory care.[90]

Patients with Alzheimer's Disease and Related Dementias (ADRD) have high levels of inpatient hospitalizations, as a 2019 systematic review found an average of 0.37-1.26 mean annual hospitalizations and a relative risk of 1.42 for patients with dementia compared to patients without dementia after adjusting for age, sex, and comorbidities.[91] In addition, ADRD is found to be associated with increased hospitalizations for preventable conditions,[35] and additional research shows that the annuals trends in all-cause hospitalizations of patients with ADRD decreased from

1.87 million to 1.85 million from 2012-2016 while the incidence of potentially preventable hospitalizations (PPHs) of patients with ADRD increased from 0.75 million to 0.87 million over the same time period.[36] PPHs are a major concern for public health, as Healthy People 2030 has an objective of decreasing preventable hospitalizations for older adults with dementia by 2030, as 2013-2015 data showed that 23.5 percent of hospitalizations for patients with ADRD were preventable.[39]

Office/clinic visits are the main source of receiving an ADRD diagnosis and ADRD disease management,[40] however, half of surveyed physicians say that they do not feel adequately prepared for future ADRD challenges.[41] Outpatient care has also shown promise in helping to reduce the rate of preventable ED visits and hospitalizations for patients with ADRD.[47] As primary care providers were redeployed to handle pandemic emergencies, less primary care was available to attend to ADRD-specific needs.[92] As the COVID-19 pandemic moved office/clinic visits away from a physical location, telehealth became a major source of health care for many patients to obtain primary care and is found to be generally beneficial and cost-effective.[93] While there are barriers to the use of telehealth for the ADRD population, telehealth was generally well-received by patients with ADRD and their care partners.[48] Previous research also shows that telehealth use for patients with ADRD is associated with reduced ED use.[47,49]

Previous studies found that ED and hospital use decreased during the COVID-19 pandemic while outpatient care decreased then stabilized and telehealth use increased.[3–6] In addition, the major risk factors for ADRD (age, obesity, hypertension, etc.) are also the major risk factors for COVID-19.[78] However, there is little literature

known about the health services use patterns of the ADRD population and potential changes during COVID-19. ADRD is found to be correlated with greater risks surrounding COVID-19,[7] and as such, there is a crucial need to study the health services use patterns for patients with ADRD during the COVID-19 pandemic.

The objective of the study is to study the community-dwelling ADRD population to examine changes in their health services use patterns before and during the COVID-19 pandemic. I hypothesize that ED visits and preventable ED will decrease, hospitalizations and PPH will decrease, and office/clinic visits will decrease while telehealth increases during COVID-19.

Methods

Data

The main dataset for this chapter is the 2019-2020 claims data from the Inovalon MORE^2 Registry, which contains longitudinal de-identified data on 348 million unique patients and 68 billion medical events for all 50 US states and DC.[94] This dataset includes place of service (POS) codes (inpatient, emergency room, office/clinic), patient diagnosis and procedure data using ICD-10 codes, and other relevant variables such as patient demographics, comorbidities, and health insurance payer (Commercial, Managed Medicaid, Medicare Advantage, Dual-Eligible). The MORE^2 dataset has been used to study opioid abuse across multiple years and the effect of health insurance coverage on providing access to abuse-deterrent formulations that can deter opioid abuse[95] as well as the risk of falls/fractures and hospitalizations for patients with dementia.[96]

Sample Selection

The sample in this study consists of patients with ADRD in 2019-2020. ADRD is defined in the claims data using ICD-10 codes provided by the Centers for Medicare & Medicaid Services (CMS) Chronic Conditions Warehouse (CCW) Chronic Codes Algorithm for Alzheimer's Disease and non-Alzheimer's Dementia[97] and are included in Appendix 3.1. Patient ADRD status was determined using CMS CCW guidelines of at least one ADRD diagnosis in their claims from an inpatient/skilled nursing facility/home health agency place of service or at least two ADRD diagnoses in their claims from a hospital outpatient place of service at least one day apart, with a reference period of two years from the latest diagnosis to earlier claims.[97]

To create the sample, first the ClaimCode file was used to identify claims from emergency department visits, hospital inpatient visits, and office/clinic visits that have an ADRD diagnosis using ICD-10 diagnosis codes. These claims contain data on the member identification number, service date start, service date end, diagnosis codes, procedure codes, and code values. Next, the data is merged using the claim id with the Claim file to obtain the provider id and discharge code. Then the data is merged using the member id with the Member file to obtain patient demographics of birth year, gender, and state. Then the data is merged using the provider id with the Provider file to obtain provider characteristics of the National Provider Identifier (NPI), taxonomy code, taxonomy type, taxonomy classification, and taxonomy specialization. Finally, the data is merged using the member id with the Enrollment file to obtain insurance characteristics such as the effective date (start

date of insurance policy), termination date (end date of insurance policy), and insurance payer. The final sample consists of 165,988 patients with ADRD.

Dependent Variables

The first set of dependent variables are the monthly count of hospitalizations, emergency department visits, and office/clinic visits. These are defined by the Place of Service (POS) codes provided in the MORE^2 data. The next set of dependent variables are the percentages of preventable hospitalization, preventable emergency department visit, and telehealth office/clinic visits.

Emergency Department visits are documented through the Place of Service (POS) group code categorized as the "Emergency Room". Preventable ED visits are calculated by analyzing the primary diagnosis code through the NYU-ED Algorithm, which was developed by a group of clinicians, medical coders, and researchers at New York University to establish the probability of a visit being preventable through accessing high-quality ambulatory care.[98] I use the primary diagnosis code for each claim and run the data through the patched NYU algorithm[99] and then sum the categories of nonemergent within 12 hours, emergent but primary care treatable within 12 hours, and emergent but preventable/avoidable if timely and effective ambulatory care had been received to receive a percentage probability. I use a threshold of ≥75% preventable to determine a binary preventable ED outcome based on previous literature.[100–102]

Hospitalizations are documented through the POS group code categorized as "Inpatient Acute". PPHs are calculated using Prevention Quality Indicators (PQIs) provided by the Agency for Healthcare Research and Quality, ICD-10-CM diagnosis

codes and ICD-10-PCS procedure codes were used to identify PPH conditions.[33] This study used the total composite scores for acute (PQI #91) and chronic (PQI #92) conditions created by the Agency for Healthcare Research and Quality. Acute PPHs were defined by hospital admissions due to a principal diagnosis of community acquired pneumonia or urinary tract infection. Chronic PPHs consist of hospital admissions due to diabetes with short-term complications, diabetes with long-term complications, chronic obstructive pulmonary disease (COPD), hypertension without a cardiac procedure, heart failure without a cardiac procedure, uncontrolled diabetes without complications, and lower-extremity amputation among patients with diabetes. One limitation of the MORE^2 dataset is that the PCS codes are missing for about 1/3 of the patients, and the remaining patients typically only have a few PCS codes, which may limit the inclusion and exclusion criteria.

Office/clinic visits are documented through the POS group code categorized as "Office/Clinic". All office/clinic visits are at least one day apart due to the CMS CCW methodology.[97] Telehealth is documented using a list of Current Procedural Terminology (CPT) codes, CPT Modifier Codes, Healthcare Common Procedure Coding System (HCPCS) codes, and POS codes and are listed in Appendix 3.2.

Independent Variable

The independent variable of interest is the COVID-19 pandemic, which was declared on March 1, 2020 in the US. The COVID-19 pandemic results in many changes to health care utilization for all patients due to the risk of contracting COVID-19 while receiving health care.

Conceptual Framework

I selected patient characteristics based on the Andersen Behavioral Model of Health Services Use.[103] The Andersen Model examines patient characteristics that are identified according to their predisposing factors (age, gender, and region of patient residence), enabling resources (insurance payer), and need characteristics (ADRD status). Age is a continuous variable from 50 to 90. Gender is classified as male or female. Region is classified as Northeast, South, Midwest, and West. Health insurance is classified as enrollment in Commercial, Managed Medicaid, Medicare Advantage, or Dual-Eligible status at the time of health service.

Statistical Analysis

This study used an interrupted time series analysis (ITSA) design to study the trends of the dependent variables. ITSA studies have been used in a variety of research to present timely results about the changes in the trends of health outcomes and health services use associated with COVID-19.[104–106] To model the ITSA, this study uses two equations for a linear-only analysis and a linear analysis with seasonality.

The first equation is the general linear model:

$$Y_m = \beta_0 + \beta_1 T + \beta_2 X_t + \beta_3 (T - T_0) * X_t + \varepsilon$$

Where Y_m is the monthly outcome, $T$is pre-COVID-19 monthly trend, $X_t$is the level change after the COVID-19 pandemic with a start time of March 2020, $(T - T_0) * X_t$ is the change in monthly trend after the beginning of COVID-19 (T_0), and ε is the error term.

The second equation is a general linear model that incorporates seasonality:

$$Y_m = \beta_0 + \beta_1 T + \beta_2 X_t + \beta_3 (T - T_0) * X_t + \beta_4 cos(2\pi t/12) + \beta_5 cos(2\pi t/6) + \beta_6 sin(2\pi t/12) + \beta_7 sin(2\pi t/6) + \varepsilon$$

Where Y_m is the outcome, $T$is pre-COVID-19 monthly trend, $X_t$is the level change after the COVID-19 pandemic with a start time of March 2020, $(T - T_0) * X_t$ is the change in monthly trend after the beginning of COVID-19 (T_0), $cos(2\pi t/12)$ is the cosine amplitude of an annual seasonal trend at time t, $cos(2\pi t/6)$ is the cosine amplitude of a semi-annual seasonal trend at time t, $sin(2\pi t/12)$ is sine amplitude of an annual seasonal trend at time t, $sin(2\pi t/6)$ is the sine amplitude of a semi-annual seasonal trend at time t, and ε is the error term. These $cosine$ and $sine$ pairs are Fourier terms that model seasonal variation and allow for more complex trend lines to be created.[107] Appendices 3.3-8 show the distribution, autocorrelation, and partial autocorrelation tests of the residuals that confirm the appropriate use of ITSA models.

All models are run using generalized linear models that allow for greater flexibility in model parameters compared to ordinary least squares models. All analysis was conducted in Stata 15/MP and was approved by the University of Maryland Institutional Review Board. I thank Bernal, Cummins, and Gasparrini for providing the example Stata code to create the ITSA graphs and analyses.[108]

Results

Table 3.1 shows the study population characteristics. There are more females than males in the data. About two-fifths of the patients are between 65-79 years old with equal parts aged 50-64 and 80-90. The data has almost one-third from the South while only about one-eighth from the West. Insurance payers are predominately by

Medicaid and Medicare with a smaller amount of patients with commercial insurance and dual-eligible for Medicaid and Medicare.

Figure 3.1 shows the changes in ED visits and preventable ED visit percentage. The graphs show that ED visits had a decreasing monthly trend before the COVID-19 pandemic and the level sharply declined after the beginning of the COVID-19 pandemic. There are some seasonal trends as the late summer months (June, July, August, and September) have a higher-than-expected number of ED visits and the late autumn/winter months (November, December, January, and February) have a lower-than-expected number of ED visits than a linear-only trend would predict. The counterfactual number of ED visits could converge to the actual data trends over time if there was no COVID-19. For the preventable ED visit rate, the monthly trend is stable before and during COVID-19 while there may be some seasonality as the winter months (January, February, March) are above the linear trend and the summer months (June, July, August) are below the linear trend. The counterfactual shows a stable line that does not undergo a decline after the beginning of the COVID-19 pandemic.

Figure 3.2 shows hospitalizations and PPH percentages. There is a decreasing monthly trend in the number of hospitalizations before COVID-19 which stabilizes during the COVID-19 pandemic. There is also a level decline after the beginning of the COVID-19 pandemic. There is no significant pattern of seasonality, and the counterfactual trend in the absence of COVID-19 converges to the actual results by the end of 2020. For PPH, the monthly trend is slightly increasing before COVID-19 and it reverses to decreasing after COVID-19, and there is a decline in the PPH

percentage after COVID-19. There is no consistent pattern of seasonality, and the counterfactual predicts that the PPH percent would be much higher in the absence of COVID-19.

Figure 3.3 shows office/clinic visits and telehealth percentage. There is a declining monthly trend before COVID-19 which turns into an increasing monthly trend after the beginning of the COVID-19 pandemic, and there is a steep level decline in office/clinic visits at the onset of the COVID-19 pandemic. There may be some seasonal trends as the late autumn/winter months (November, December, January, and February) are below the linear trend and the late summer/early autumn months (July, August, September, and October) are above the linear trend. The counterfactual shows that the predicted number of office/clinic visits would be higher in the absence of COVID-19. The percent of telehealth from office/clinic visits was almost 0% and stable before COVID-19, whereas there was a large increase in telehealth use right after the onset of the COVID-19 pandemic while the new monthly trend is stable. There may be some seasonal trends but the line showing the trend with seasonality does not appear to be in alignment with the data. The counterfactual shows that almost no change in the percentage of telehealth visits was predicted in the absence of COVID-19, which is significantly different from the actual results.

Table 3.2 shows the generalized linear regression results of the interrupted time series for the graphs depicted in Figures 3.1-3.3, with linear-only results and linear with seasonality results. ED visits had a decreasing trend before COVID-19 (-246.78 per month, 95% CI = -372.71; -120.86) and then experienced a sharp decline during COVID-19 (-3,987.15, 95% CI = -5,896.53; -2,077.77) while also having

significant seasonality throughout the seasons (Cosine($2\pi t/12$):-660.56*, 95% CI = -1,274.64; -46.47). The preventable ED visit rate did not significantly change during COVID-19 from 39% while there was significant seasonality (Cosine($2\pi t/12$): 0.855%, 95% CI = 0.216%; 1.494%) (Sine($2\pi t/12$): 0.704%, 95% CI = 0.066%; 1.343%). Hospitalizations had a decreasing trend before COVID-19 (-166.56 per month, 95% CI = -216.84; -116.29) and then experienced a decline during COVID-19 (-771.54, 95% CI = -1,533.80; -9.28) but the trend stabilized (101.01 per month, 95% CI = 4.62; 197.39), while the PPH percent monthly trend was stable before COVID-19 but significantly decreased during COVID-19 (-0.303% per month, 95% CI = -0.590%; -0.017%). Finally, office/clinic visits had a decreasing monthly trend before COVID-19 (-2,159.53 per month, 95% CI = -3,806.02; -513.03) and then the monthly trend switched to increasing (3,319.20 per month, 95% CI = 162.45; 6,475.96) alongside a sharp level decline during COVID-19 (-41,439.71, 95% CI = -66,404.80; -16,474.70). The percentage of telehealth visits as of total office/clinic visits had a sharp level increase during COVID-19 (8.897%, 95% CI = 1.171%; 16.623%) with no other significant variables.

Discussion

The COVID-19 pandemic resulted in many changes in the US health care system and the provision of health services for patients with ADRD. The results of this study show many changes in health services use for patients with ADRD, some of which can have long-lasting effects on the provision of health services such as increased telehealth use.

While most of my hypotheses were confirmed by the analyses, the rate of preventable ED visits did not decrease as I hypothesized. This may be due to difficulties accessing ambulatory care during COVID-19, which saw many close or reduce their care during COVID-19. While telehealth use increased in prevalence, the monthly number of total office/clinic visits decreased, it is unclear if there are remaining barriers to telehealth that prevent it from it being further incorporated into ADRD care.

There were some seasonal trends for ED visits and preventable ED visits rate. A previous study showed that older patients (age 71+) were more likely to frequently use ED services in the summer.[109] Previous research also saw that preventable ED visits for US adults had a higher prevalence in the first quarter months (January, February, and March) of 2019 compared to other quarters in the same year,[102] which matches the visualization in Figure 3.1. A recent paper found that ED visit rates in the US were significantly lower from the second quarter of 2020 through the first quarter of 2022 compared to 2019 levels,[110] further research can examine the long-term utilization rates of ED services for patients with ADRD. While Figure 3.3 shows some possible seasonal trends for office/clinic visits, the ITSA results do not confirm significant seasonality. One study that examined outpatient care utilization rates for the general US population showed that outpatient visits decreased sharply starting in March 2020, fell to their minimum in April 2020, and rebounded to pre-COVID-19 levels in August,[111] which matches the visualization in Figure 3.3. There is limited research on the seasonality of office/clinic visits, further research can examine time trends of when these services are used.

There are other health services that patients with ADRD may use, such as long-term care (LTC). A recent ITSA study of community-dwelling residents in Japan with ADRD showed that LTC use declined at the beginning of COVID-19 and stabilized later.[106] The Inovalon MORE^2 data does not provide information on LTC services, however, further research using data such as CMS Medicare claims can examine the impact of COVID-19 on LTC in the US population with ADRD.

There are some limitations to this study. First, the MORE^2 data does not contain information about patients with ADRD who have Medicare fee-for-service (FFS) or Medicaid FFS insurance and therefore we cannot infer the health care utilization patterns of these patients. Second, there may be errors in the data due to coding errors by the medical coders who entered the data. Third, the data cannot measure mortality which may be a cause for reductions in health services utilization. Finally, claims data may underdiagnose ADRD as there is no option for patients to self-report ADRD status, combining claims data with survey data can result in higher ADRD diagnosis accuracy.[112]

Conclusion

The COVID-19 pandemic resulted in health care disruptions for all people, but especially for vulnerable populations such as patients with ADRD. Many health services decrease in use during COVID-19. While the number of emergency department visits decreased, the percentage of preventable ED visits did not significantly change during COVID-19. The number of hospitalizations decreased and the percentage of preventable hospitalizations decreased during COVID-19. Finally, office/clinic visits decreased but the percentage of telehealth from total

office/clinic visits increased as a form of receiving outpatient care. Future research can research policies that affect the rate of health services use and the satisfaction of health services use during and after the COVID-19 pandemic.

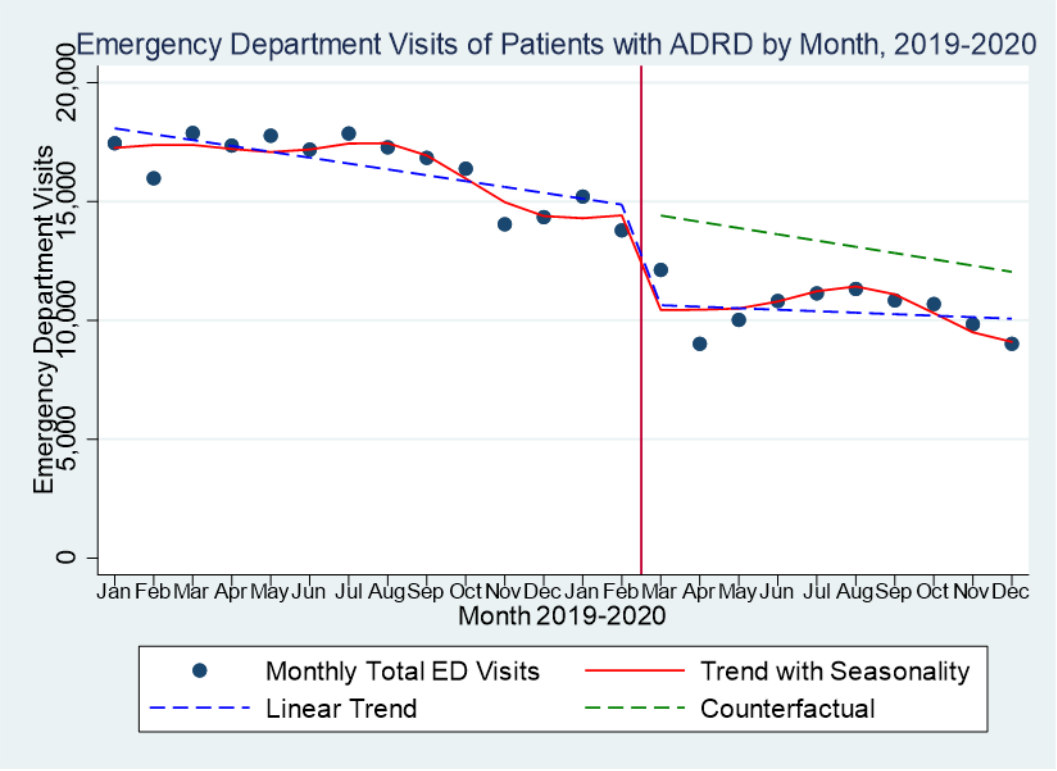
Chapter 3 Tables

Table 3.1. Study Population of Patients with ADRD Characteristics, 2019-2020

Variable	Frequency	Percent
Gender		
Female	96,460	58.11
Male	69,528	41.89
Age		
50-64	47,869	28.84
65-79	67,761	40.82
80-90	50,358	30.34
Region		
Northeast	43,685	26.32
South	54,958	33.11
Midwest	46,183	27.82
West	21,162	12.75
Insurance		
Commercial	9,955	6.00
Medicaid	65,009	39.16
Medicare	78,261	47.15
Dual	12,763	7.69

Notes: N=165,988. Source: Analyses of data from Inovalon MORE^2, 2019-2020.

Figure 3.1. Emergency Department Visits for Patients with ADRD, 2019-2020



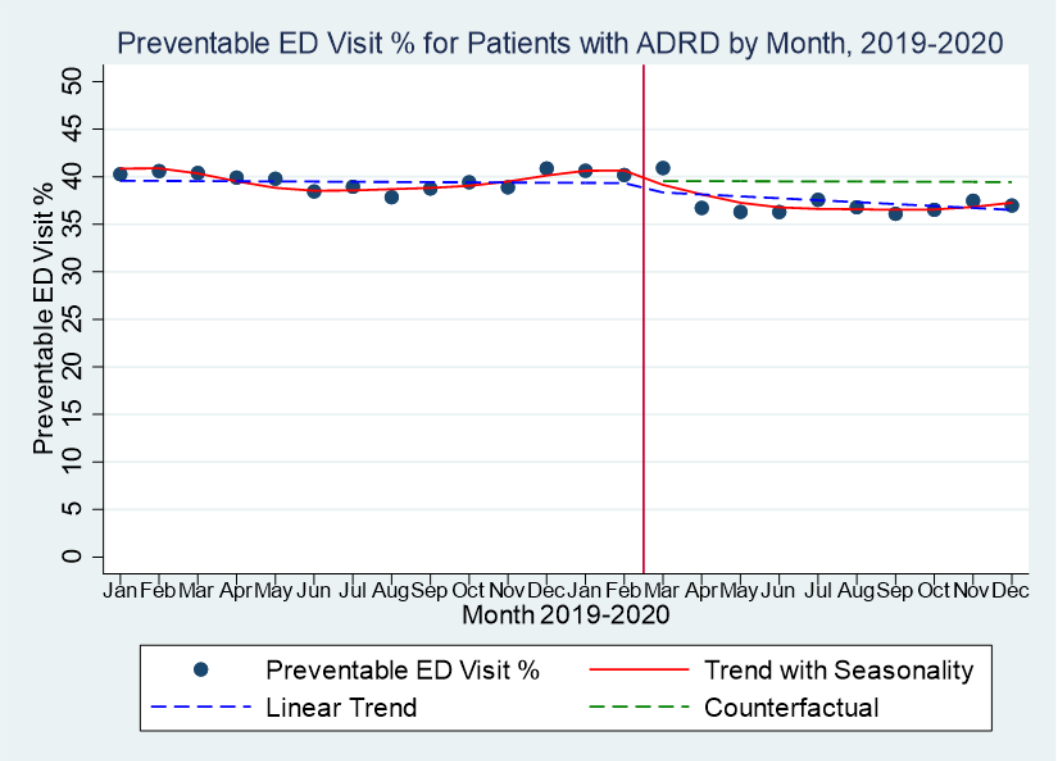
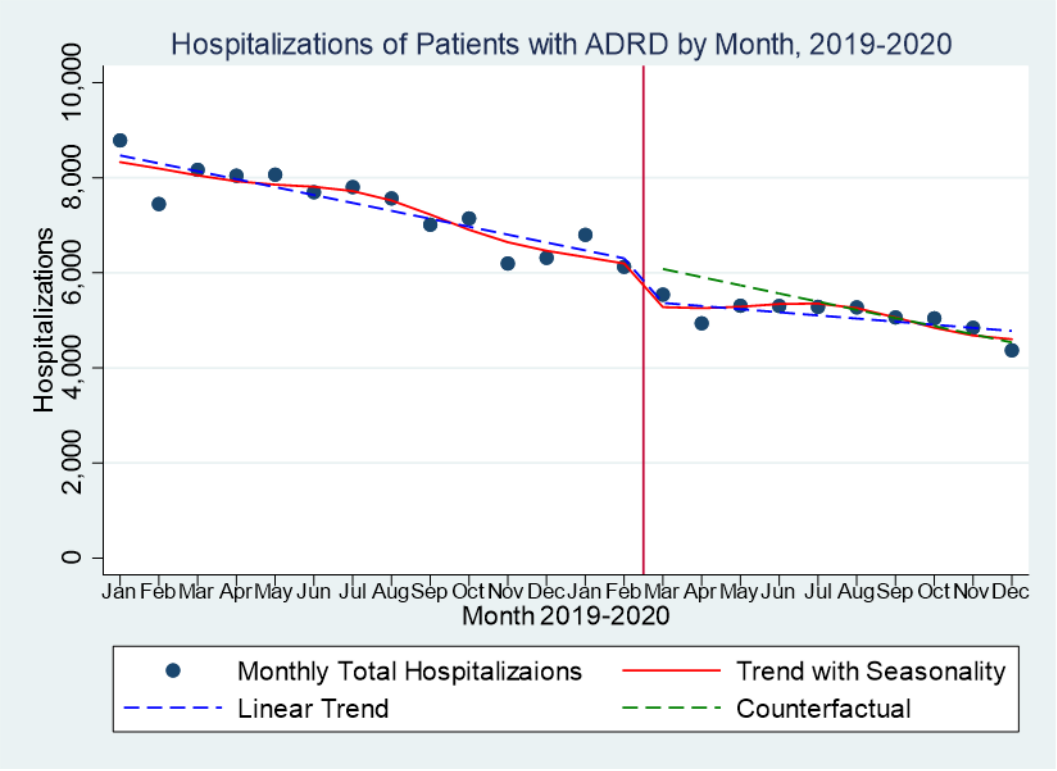


Figure 3.2. Hospitalizations of Patients with ADRD, 2019-2020



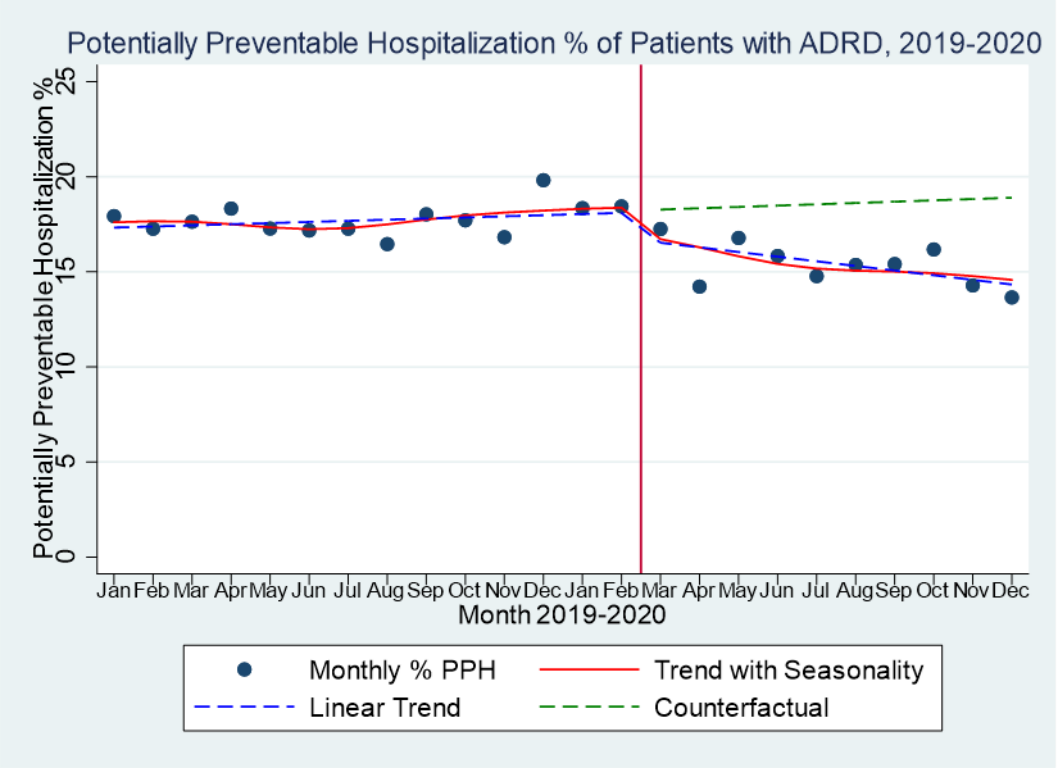
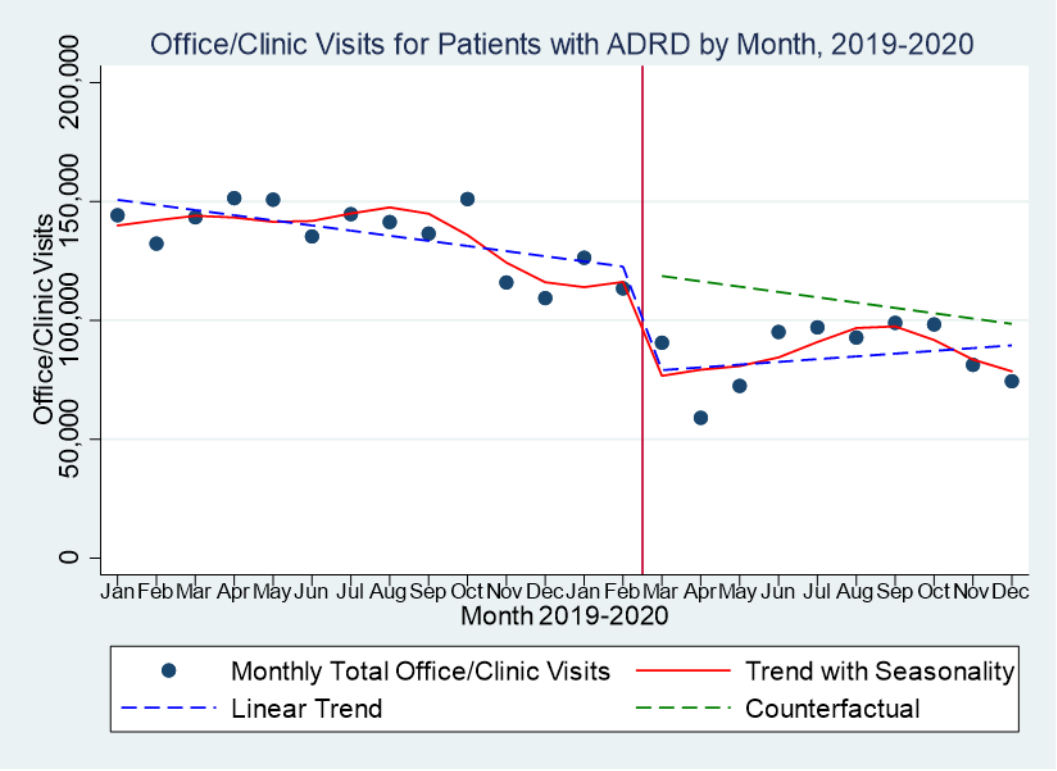


Figure 3.3. Office/Clinic Visits of Patients with ADRD, 2019-2020



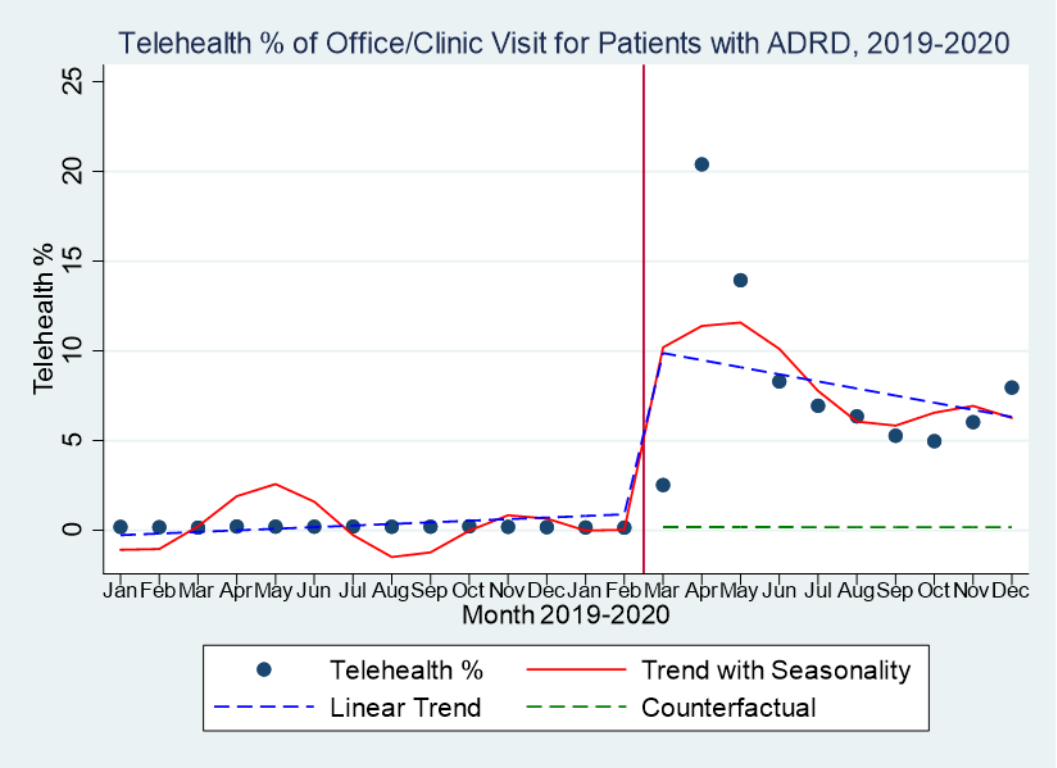


Table 3.2. Health Services Use Change During COVID-19

Variables	ED Visits	ED Visits	Preventable ED %	Preventable ED %
Pre-COVID-19	-263.21***	-246.78***	-0.012	-0.019
Monthly Trend	(-394.03; -132.38)	(-372.71; -120.86)	(-0.161; 0.136)	(-0.150; 0.112)
Post-COVID-19	-3,421.49***	-3,987.15***	-1.551	-0.972
Level Change	(-5,029.55; -1,813.43)	(-5,896.53; -2,077.77)	(-3.377, 0.275)	(-2.958; 1.015)
Post-COVID-19	150.55	183.87	-0.173	-0.184
Monthly Trend Change	(-103.05; 404.14)	(-57.56; 425.31)	(-0.461, 0.115)	(-0.435; 0.067)
Cosine($2\pi t/12$)		-660.56*		0.855**
		(-1,274.64; -46.47)		(0.216; 1.494)
Cosine($2\pi t/6$)		-315.94		-0.101
		(-810.17; 178.29)		(-0.616; 0.413)
Sine($2\pi t/12$)		-517.94		0.704*
		(-1,132.03; 96.14)		(0.066; 1.343)
Sine($2\pi t/6$)		193.18		0.271
		(-290.68; 667.03)		(-0.222; 0.764)
Constant	18,359.26***	18,327.19***	38.737***	39.603***
	(17,245.35; 19,473.18)	(17,286.08; 19,368.29)	(38.473; 41.002)	(38.520; 40.686)
Variables	Hospitalizations	Hospitalizations	PPH %	PPH %
Pre-COVID-19	-171.79***	-166.56***	0.069	0.059
Monthly Trend	(-214.66; -128.92)	(-216.84; -116.29)	(-0.048; 0.187)	(-0.090; 0.209)
Post-COVID-19	-623.00*	-771.54*	-1.924**	-1.627
Level Change	(-1,149.96; -96.04)	(-1,533.80; -9.28)	(-3.368, -0.479)	(-3.893; 0.640)
Post-COVID-19	91.44*	101.01*	-0.286*	-0.303*
Monthly Trend Change	(8.34; 174.54)	(4.62; 197.39)	(-0.513, -0.058)	(-0.590; -0.017)
Cosine($2\pi t/12$)		-173.62		0.313
		(-418.77; 71.54)		(-0.416; 1.042)
Cosine($2\pi t/6$)		-0.27		-0.068

		(-197.58; 197.03)		(-0.655; 0.519)
Sine$(2\pi t/12)$		-88.85		0.121
		(-334.00; 156.30)		(-0.608; 0.850)
Sine$(2\pi t/6)$		63.04		-0.022
		(-126.14; 252.21)		(-0.584; 0.540)
Constant	8,658.65***	8,637.25***	17.232***	17.268***
	(8,293.62; 9,023.68)	(8,221.62; 9,052.88)	(16.231; 18.233)	(16.032; 18.504)
Variables	Office/Clinic Visits	Office/Clinic Visits	Telehealth %	Telehealth %
Pre-COVID-19	-2,238.13**	-2,159.53**	-0.001	0.089
Monthly Trend	(-3,853.34; -622.92)	(-3,806.02; -513.03)	(-0.429; 0.418)	(-0.420; 0.599)
Post-COVID-19	-36,670.37***	-41,439.71***	10.979***	8.897*
Level Change	(-56,524.3; -16,816.4)	(-66,404.80; -16,474.70)	(5.824, 16.134)	(1.171; 16.623)
Post-COVID-19	3128.41	3,319.20*	-0.643	-0.484
Monthly Trend Change	(-2.59; 6259.40)	(162.45; 6,475.96)	(-1.456, 0.170)	(-1.461; 0.492)
Cosine$(2\pi t/12)$		-6,416.05		-0.738
		(-14,445.14; 1,613.04)		(-3.223; 1.747)
Cosine$(2\pi t/6)$		-4,526.25		0.679
		(-10,988.32; 1,935.82)		(-1.321; 2.679)
Sine$(2\pi t/12)$		-6.916.40		0.993
		(-14,945.50; 1,112.69)		(-1.491; 3.478
Sine$(2\pi t/6)$		520.9		-1.17
		(-3806.02; 6,716.56)		(-3.087; 0.748)
Constant	152,241.4***	152,888.3***	0.203	-0.354
	(138,488.4; 165,994.4)	(139,275.9; 166,500.7)	(-3.368; 3.774)	(-4.567; 3.859)

Notes. ED = Emergency Department. PPH = Potentially Preventable Hospitalization.

*** p<0.001, ** p<0.01, * p<0.05

Source: 2019-2020 Inovalon MORE2. N=165,988 patients.

Appendix Table 3.1. ADRD ICD-10 Diagnosis Codes

ICD-10 Code	Description
G30.0	Alzheimer's disease with early onset
G30.1	Alzheimer's disease with late onset
G30.8	Other Alzheimer's disease
G30.9	Alzheimer's disease, unspecified
F01.50	Vascular dementia, unspecified severity, without behavioral disturbance, psychotic disturbance, mood disturbance, and anxiety
F01.51	Vascular dementia, unspecified severity, with behavioral disturbance
F02.80	Dementia in other diseases classified elsewhere, unspecified severity, without behavioral disturbance, psychotic disturbance, mood disturbance, and anxiety
F02.81	Dementia in other diseases classified elsewhere, unspecified severity, with behavioral disturbance
F03.90	Unspecified dementia, unspecified severity, without behavioral disturbance, psychotic disturbance, mood disturbance, and anxiety
F03.91	Unspecified dementia, unspecified severity, with behavioral disturbance
F05	Delirium due to known physiological condition
G13.8	Systemic atrophy primarily affecting central nervous system in other diseases classified elsewhere
G31.01	Frontotemporal dementia: Pick's disease
G31.09	Frontotemporal dementia: Other frontotemporal neurocognitive disorder
G31.1	Senile degeneration of brain, not elsewhere classified
G31.2	Degeneration of nervous system due to alcohol
G31.83	Neurocognitive disorder with Lewy bodies
G94	Other disorders of brain in diseases classified elsewhere
R41.81	Age-related cognitive decline

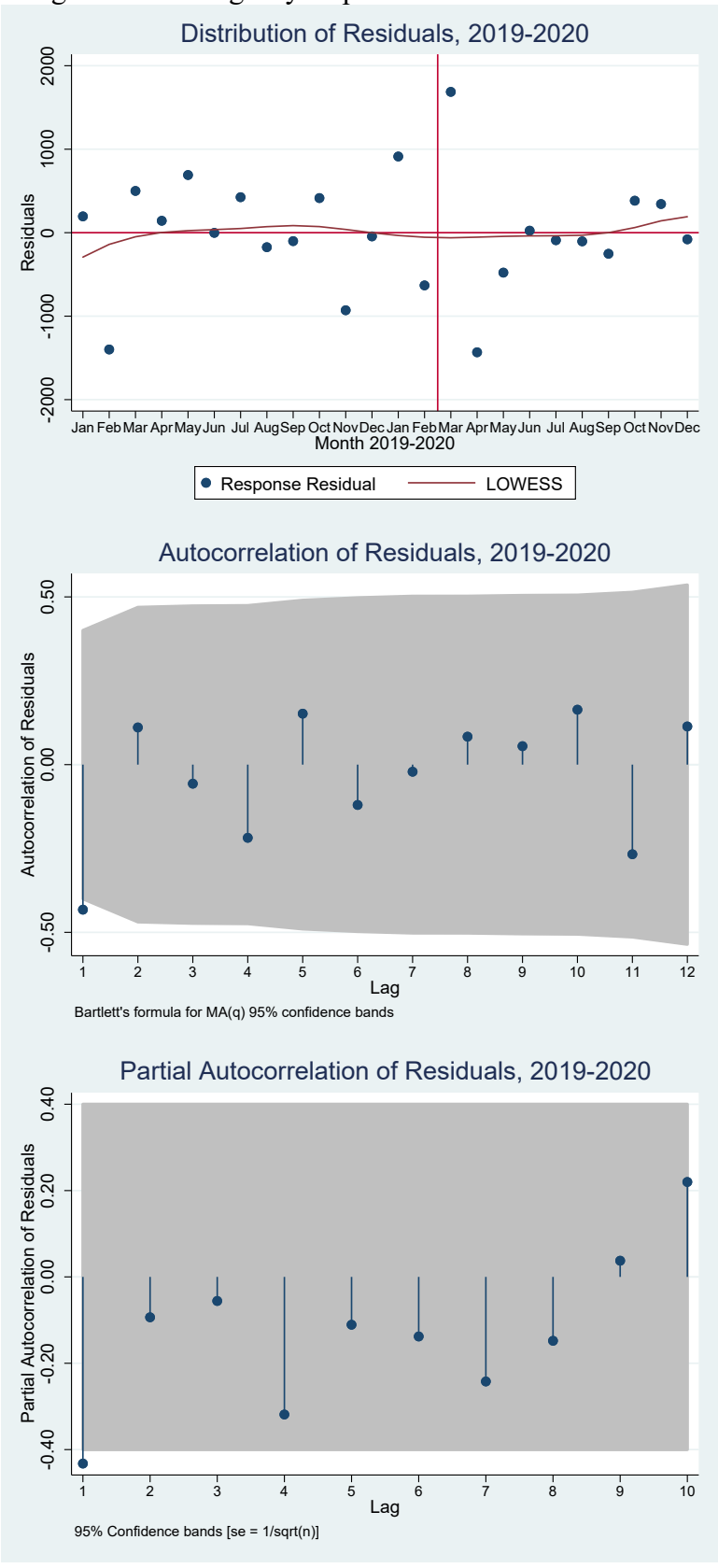
Sources: https://www2.ccwdata.org/documents/10280/86658989/chr-cond-algo-alzdisease.pdf, https://www2.ccwdata.org/documents/10280/86658989/chr-cond-algo-nonalzh.pdf

Appendix Table 3.2. Telehealth Codes

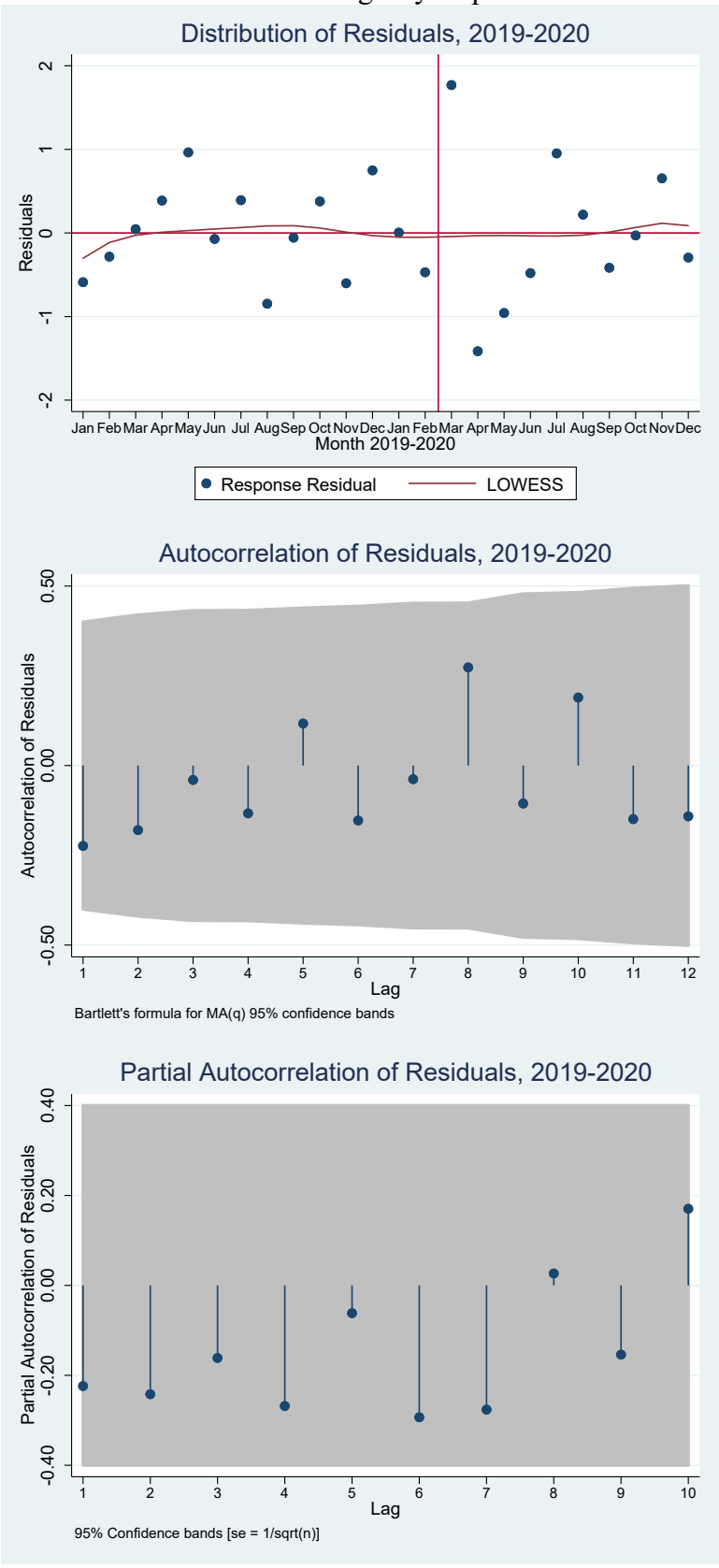
Type of Code	Code Value	Definition
CPT	99441	Telephone E/M service; 5-10 minutes of medical discussion
CPT	99442	Telephone E/M service; 11-20 minutes of medical discussion
CPT	99443	Telephone E/M service; 21-30 minutes of medical discussion
CPT Modifier	GT	Interactive audio and video telecommunications systems
CPT Modifier	GQ	Asynchronous telecommunications system
CPT Modifier	95	Synchronous telemedicine service rendered via a real-time interactive audio and video telecommunications system
CPT Modifier	G0	Telehealth services for diagnosis, evaluation or treatment of symptoms of an acute stroke
HCPCS	Q3014	Hospital provides services via telehealth to a registered outpatient of the hospital
POS	02	Telehealth provided other than in patient's home

Notes. CPT=Current Procedural Terminology. HCPCS=Healthcare Common Procedure Coding System. POS=Place of Service. E/M=evaluation and management.

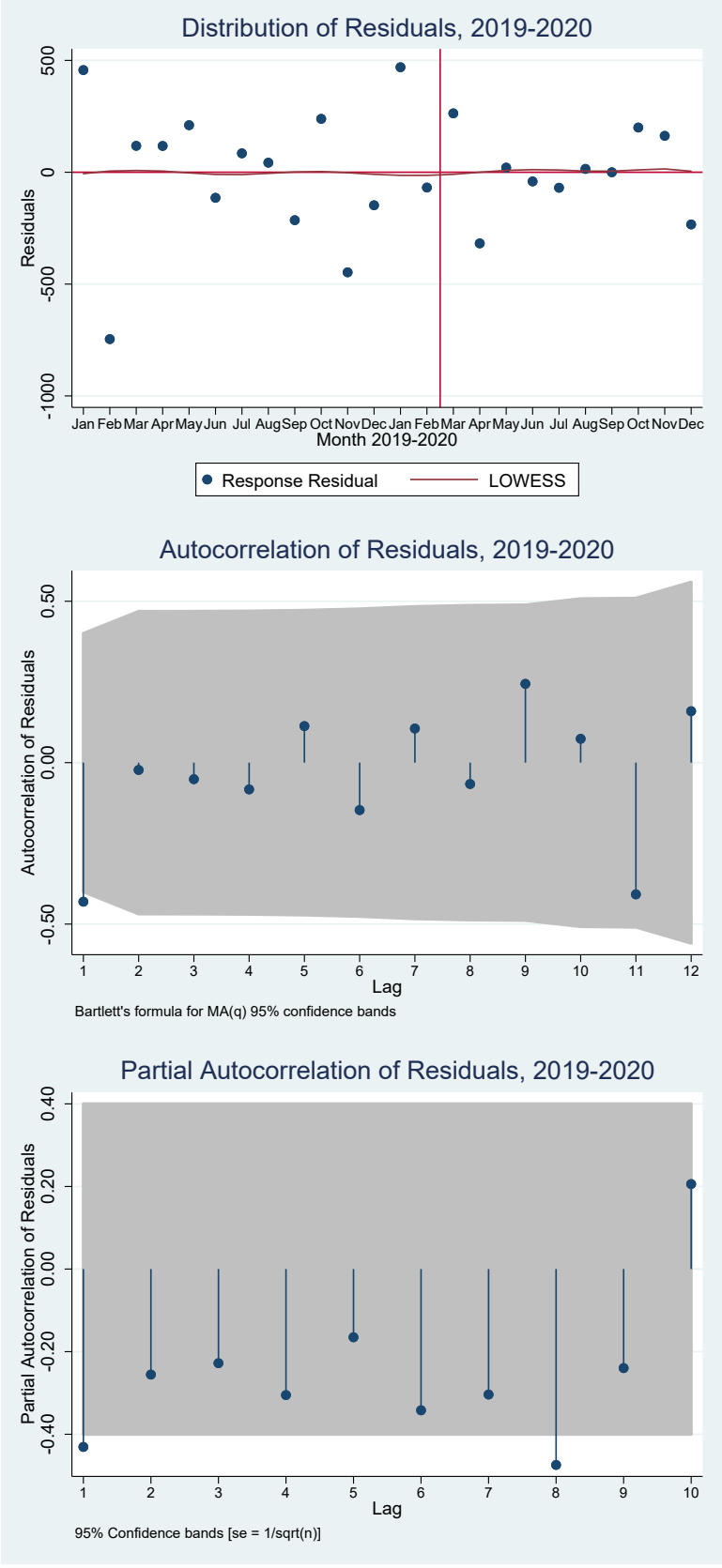
Appendix Figure 3.3. Emergency Department Visits Model Residual Graphs



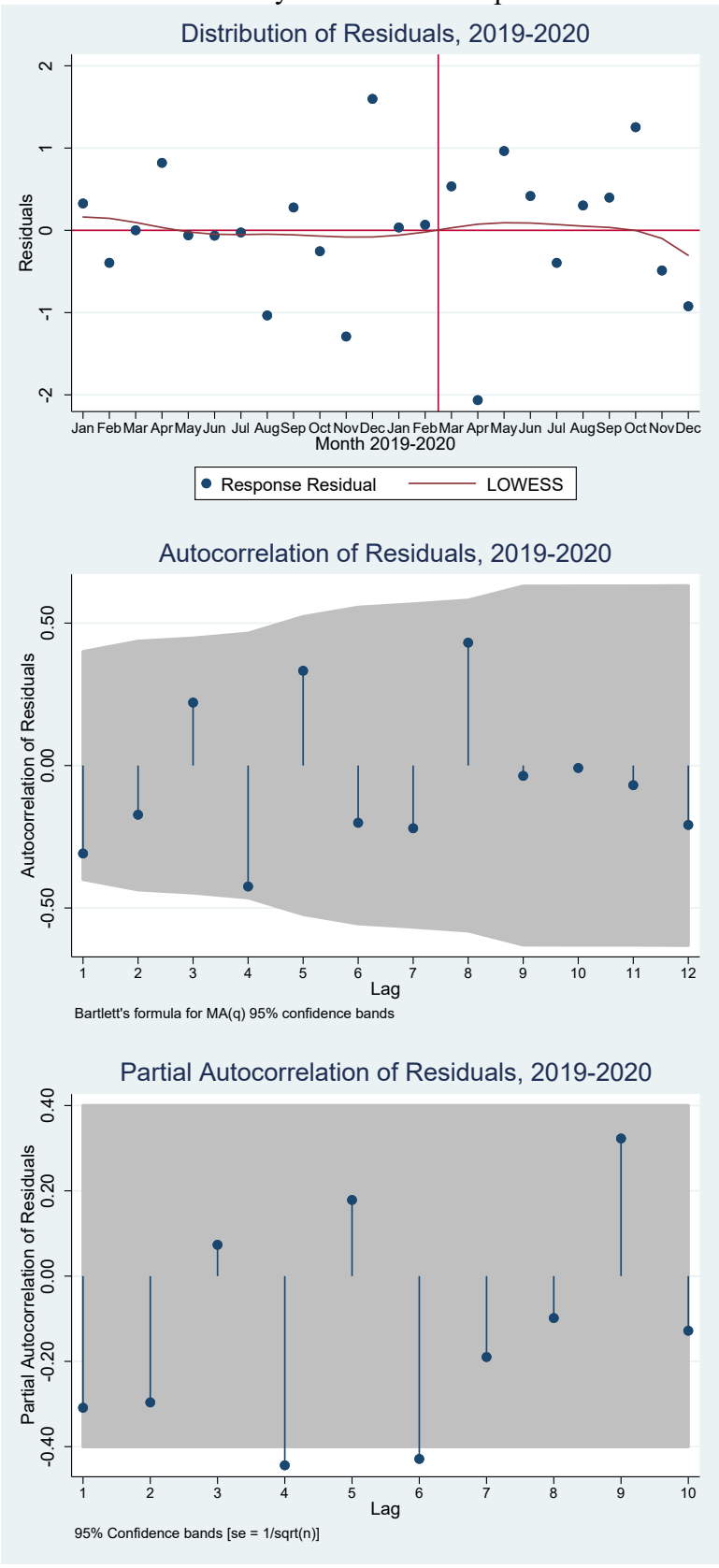
Appendix Figure 3.4. Percent Preventable Emergency Department Visit Model Residual Graphs



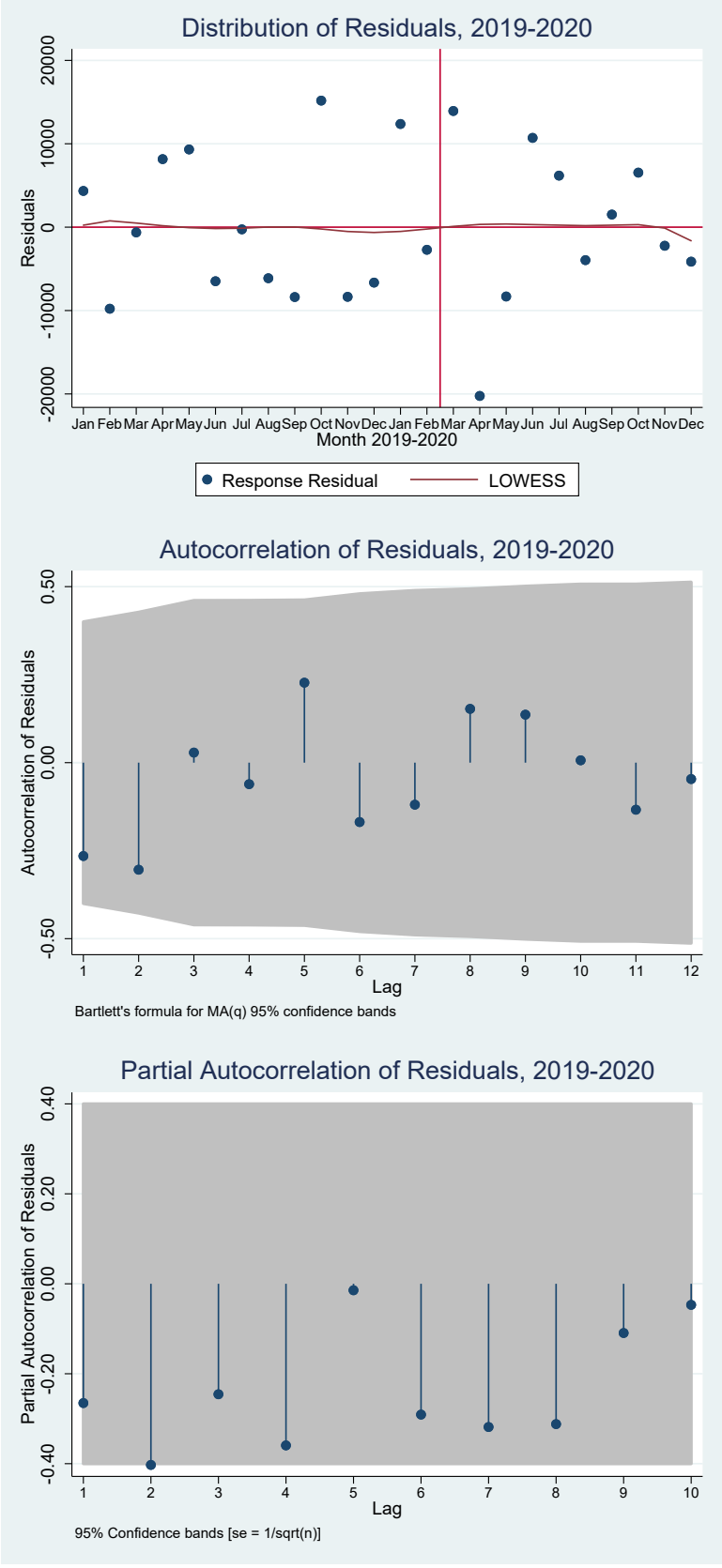
Appendix Figure 3.5. Hospitalizations Model Residual Graphs



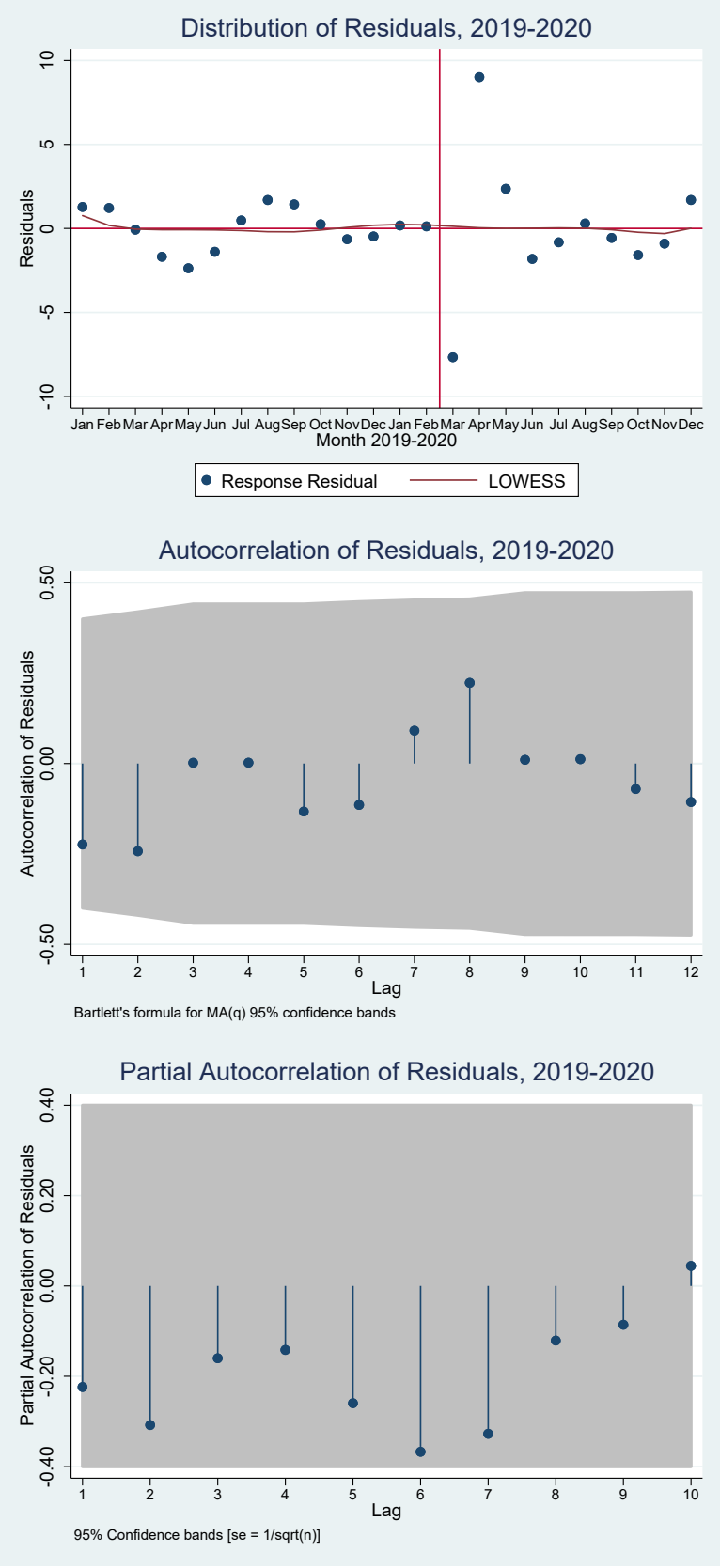
Appendix Figure 3.6. Percent Potentially Preventable Hospitalization Model Residual Graphs



Appendix Figure 3.7. Office/Clinic Visits Model Residual Graphs



Appendix Figure 3.8. Percent Telehealth of Total Office/Clinic Visits Model Residual Graphs



Chapter 4: The Impact of the COVID-19 Pandemic on Potentially Preventable Hospitalizations for Patients with Alzheimer's Disease and Related Dementias by State Medicaid Expansion Status

Abstract

Introduction: This study estimates the impact of the COVID-19 pandemic on potentially preventable hospitalizations (PPH) for Managed Medicaid enrollees with Alzheimer's Disease and Related Dementias (ADRD) by state Medicaid expansion status.

Methods: The 2019-2020 Inovalon MORE^2 claims dataset is used to obtain enrollee information. The sample included Managed Medicaid enrollees aged 50 and above who have a diagnosis of ADRD using the Center for Medicare and Medicaid Services' Chronic Condition Data Warehouse (CCW) algorithm of a two-year reference period (2019-2020) of ADRD diagnoses from inpatient and outpatient sources of care. I used prevention quality indexes (PQIs) to define overall, acute, and chronic PPHs. I performed a difference-in-differences analysis to compare changes in PPH rates due to the COVID-19 pandemic in Medicaid expansion states versus non-expansion states.

Results: Managed Medicaid enrollees who are living in Medicaid expansion states had lower rates of PPH compared to their counterparts living in non-Medicaid expansion states. The general rate of PPHs decreased during COVID-19 (overall PPH:-1.31%; 95% CI: -1.68, -0.94), (acute PPH:-0.38%; 95% CI: -0.51, -0.28),

(chronic PPH: -0.94%; 95% CI: -1.24, -0.65). However, the interaction of the COVID-19 pandemic with Medicaid expansion states was not associated with a significant change in overall, acute, and chronic PPH rates compared to enrollees in non-Medicaid expansion states.

Conclusion: The COVID-19 pandemic is not associated with significant decreases in PPH for Managed Medicaid patients with ADRD by state Medicaid expansion status.

Introduction

The number of persons with Alzheimer's Disease and Related Dementias (ADRD) in the United States is expected to reach 13.8 million by 2060, more than double from roughly 6.2 million persons in 2021.[113] Patients with ADRD have high levels of inpatient hospitalizations, as a systematic review found an average of 0.37-1.26 mean annual hospitalizations and a relative risk of 1.22 for patients with dementia compared to patients without dementia after adjusting for age, sex, and comorbidities.[91] In addition, the odds of having a preventable hospitalization were 74% higher for community-dwelling residents who had dementia than for those who did not.[89] These potentially preventable use of the hospital can be an indicator of poor care management and inadequate access to high-quality ambulatory care.[90] The rate of potentially preventable hospitalizations (PPHs) for patients with ADRD is a major concern for public health, as Healthy People 2030 has an objective of decreasing preventable hospitalizations for older adults with dementia by 2030, as 2013-2015 data showed that 23.5 percent of hospitalizations for patients with ADRD were preventable.[39]

The COVID-19 pandemic can result in worse health outcomes for patients with ADRD, as many patients might have difficulty adhering to public health recommendations and be at a higher risk due to their age and comorbidities.[92] COVID-19 is associated with physical and mental health deterioration as well as difficulties in accessing health services for older adults[114] while also having the potential to contribute to cognitive impairment and ADRD.[115] In addition, the COVID-19 pandemic resulted in many sudden changes to the needs of patients with

ADRD and the US health care system. Previous research showed that non-COVID hospital admissions went down by over 20% from February to April 2020 compared to the same time period in 2019.[4] However, it was also found that patients with dementia had the highest rate of hospitalization for COVID-19 compared to 21 other chronic conditions.[113] Less is known about the rate of preventable hospitalizations, and as such, there is a crucial need to study the patterns of hospital use for patients with ADRD during the COVID-19 pandemic.

Medicaid expansion is associated with better health outcomes, as a previous study showed a protective association of Medicaid expansion for better health outcomes during COVID-19.[85] About 24% of patients with dementia have Medicaid coverage, which is double the percentage of older adults without dementia.[113,116] Medicaid for older adults is notable for covering long-term care such as nursing homes, as 57% of long-term services and support in the US are paid for by Medicaid.[53] In addition, home health is covered by Medicaid through the home and community-based services program.[117] A study of 2016 data shows that 80% of dual-eligible (Medicaid and Medicare) patients with ADRD used long-term services.[118]

The Affordable Care Act mandated all states to expand Medicaid coverage in the year 2014 to all adults with incomes up to 138% of the FPL with the federal government providing matching funds for the cost of expansion, but in 2012 the Supreme Court ruled that Medicaid expansion could not be mandatory but up to each state's discretion.[119,120] As of January 1, 2020, 36 states and DC had adopted Medicaid expansion while 14 states had not adopted Medicaid expansion. Many states also incorporate managed care into Medicaid, in which the state contracts with

Medicaid care organizations with the goal of optimizing cost and utilization by paying a set payment per month for delivering covered health services.[59] About 72% of all Medicaid enrollees are covered through privately managed care plans in 2022 as 41 states plus DC have adopted Managed Medicaid (MM) as the dominant form of Medicaid.[121]

State Medicaid expansion affected both patients with MMC and Traditional Medicaid (also known as Medicaid fee-for-service [FFS]), as 31 of 38 states that implemented Medicaid expansion by July 2021 used MM to cover newly-eligible enrollees.[59] One study found that Medicaid expansion increased enrollment in MM but did not result in any erosion of care quality[122], while another study found that Medicaid expansion resulted in over 70% of MM plans expanding their provider network to cover newly-eligible enrollees.[123] Previous research shows that state Medicaid expansion is associated with reductions in preventable hospitalizations[84], while other studies showed lower uninsured rates in addition to better reported health and higher flu vaccination rates due to Medicaid expansion during COVID-19.[85,124] MM has also been associated with fewer preventable ED visits for Black and Hispanic patients relative to White patients.[29] One study saw increases in outpatient visits but no difference in inpatient visits for older Medicaid enrollees with chronic conditions after Medicaid expansion compared to their counterparts in non-Medicaid expansion states.[125] A previous literature review found that MM implementation is associated with a wide range of positive, neutral, and negative outcomes in cost, access, and quality of care, with many studies focusing on solely one state or

population.[126] Nevertheless, the literature is limited regarding MM enrollees with ADRD.

Little is known about the impact of COVID-19 on the health services use of MM enrollees with ADRD. While Traditional Medicaid covers long-term care such as skilled nursing facilities, MM coverage of long-term services and support programs are present in only 24 states as of 2021. This can create disparities in health access and outcomes of the Medicaid-insured ADRD population since dual-eligible beneficiaries (both Medicaid and Medicare) who use long-term services covered by Medicaid have higher survival rates than Medicare-only beneficiaries.[127,128] As MM continues to grow in prevalence among Medicaid beneficiaries, the amount of covered services that MM beneficiaries are eligible for is important for understanding the health outcomes of having MM coverage. While there is much literature about Medicaid FFS, there is much less research about MM even though MM comprises the majority of Medicaid enrollees.

The objective of the study is to study the impact of COVID-19 on the community-dwelling ADRD population with MM to examine differences in the prevalence of preventable hospitalizations between enrollees in Medicaid expansion states to enrollees in non-Medicaid expansion states. The COVID-19 pandemic resulted in health services disruptions for patients with ADRD even though this population has a high average rate of 6.82-16.9 physician visits per year. Expanded access to MM under the Medicaid expansion can enable greater continuous access to outpatient care which can reduce PPHs for people with ADRD.[87] Hence, I hypothesize that COVID-19 was associated with a reduction in the rate of PPHs for

MM enrollees with ADRD and with greater reductions in Medicaid expansion states. The rationale for this study is that the COVID-19 pandemic resulted in health services disruptions for patients with ADRD even though this population has a high average rate of 2.94-10.18 physician visits per year, and expanded access to MM for patients with ADRD can enable greater continuous access to outpatient care which can reduce PPHs.[87]

Methods

Data Source

The main dataset for this chapter is the 2019-2020 claims data from the Inovalon MORE^2 Registry, which contains longitudinal de-identified data on 348 million unique patients and 68 billion medical events for all 50 US states and DC.[94] This dataset includes place of service (hospital, emergency room, office/clinic, outpatient/ambulatory), patient diagnosis and procedure data using ICD-10 codes, and other relevant variables such as patient demographics, comorbidities, and health insurance payer (Managed Medicaid, dual-eligible). The MORE^2 dataset has been used to study patients with acquired thrombotic thrombocytopenic purpura, a rare blood disease, and found that Managed Medicaid and Medicare Advantage had lower costs compared to similar patients with Medicare fee-for-service.[129] The data set has also been used to study medication and the risk of falls/fractures and hospitalizations for patients with dementia.[96]

Sample Selection

The sample in this study consists of patients with ADRD and at least one hospitalization. Patient ADRD status was determined using CMS CCW guidelines of at least one ADRD diagnosis in their claims from an inpatient/skilled nursing facility/home health agency place of service or at least two ADRD diagnoses in their claims from a hospital outpatient place of service at least one day apart, with a reference period of two years from the latest diagnosis to earlier claims.[97] ADRD is defined using ICD-10 diagnosis codes as provided by the CMS Chronic Conditions Warehouse (CCW) Chronic Codes Algorithm for Alzheimer's Disease and non-Alzheimer's Dementia[97] and is included in Appendix 4.1. Hospitalizations were defined as having an acute inpatient place of service in the Inovalon MORE^2 Registry. All Managed Medicaid enrollees were consistently enrolled in MMC plans for two whole years from January 1, 2019 to December 31, 2020. To determine dual-eligible patients, the CMS Medicare-Medicaid Coordination Office (MMCO) definition of dual-eligible was used in that a patient was enrolled with both Medicare and Medicaid for at least one month over a calendar year.[130]

To create the sample, the ClaimCode file was used to identify which claims have an ADRD diagnosis using ICD-10 diagnosis codes. Each data point on the ClaimCode file only contains information about the claim ID and one data value regarding the place of service, diagnosis, or procedure code. As such, the next step is to identify all ClaimCode claims with inpatient visits were identified. Then these two files were matched by the claim ID and combined to identify all inpatient acute claims with an ADRD diagnosis. Afterwards, all inpatient acute claims with an

ADRD diagnosis are obtained to acquire the relevant data (member ID, service date start, service date end, diagnosis codes, procedure codes, and code value) that matches the claim ID. Then the data is merged using the claim ID with the Claim file to obtain the provider ID and discharge code. Then the data is merged using the member ID with the Member file to obtain patient demographics of birth year, gender, and state. Eleven states are excluded (Alabama, Alaska, Connecticut, Idaho, Maine, Montana, North Carolina, Oklahoma, South Dakota, Vermont, and Wyoming) since there are no Managed Medicaid plans in these states before 2021 as they only utilized Medicaid FFS.[59] Finally, the data is merged using the member ID with the Enrollment file to obtain insurance characteristics such as the effective date (start date of insurance policy), termination date (end date of insurance policy), and payer.

Then, the PQI algorithm was enacted for exclusion criteria. First, the algorithm excludes visits for cystic fibrosis and anomalies of the respiratory system (COPD), cardiac procedure (hypertension & heart failure), dialysis access with stage 1-4 or unspecified chronic kidney disease (hypertension), sickle cell or Hemoglobin S disease (pneumonia), an immunocompromised state (pneumonia & urinary tract infection), kidney or urinary tract disorder (urinary tract infection), or traumatic amputation of the lower extremity (lower-extremity amputation) to ensure that the algorithm is accurate in measuring each condition without overlap with other related conditions.[131] Next, the PQI exclusion rules excluded ungroupable DRG (Diagnosis Related Group) and missing gender, age, quarter, year, and principal diagnosis

codes.[131] The final sample consists of 27,007 Managed Medicaid enrollees with ADRD and identifiable PQI status for a total of 648,168 enrollee-months.

Dependent Variable

The dependent variables of interest are the rate of PPH, acute PPH, and chronic PPH per enrollees per month (also known as patient-month) as the unit of analysis according to AHRQ's PQI guidelines. ICD-10-CM diagnosis codes and ICD-10-PCS procedure codes were used to identify PPH conditions[33] using the Prevention Quality Indicators (PQIs) developed by the Agency for Healthcare Research and Quality (AHRQ). This study used the composite scores for acute (PQI #91) and chronic (PQI #92) conditions. Acute PPHs were defined by hospital admissions due to a principal diagnosis of community-acquired pneumonia or urinary tract infection. Chronic PPHs consist of hospital admissions due to diabetes with short-term complications, diabetes with long-term complications, chronic obstructive pulmonary disease (COPD), hypertension without a cardiac procedure, heart failure without a cardiac procedure, uncontrolled diabetes without complications, and lower-extremity amputation among patients with diabetes. One limitation of the MORE^2 dataset is that the ICD-10 PCS codes are not available for about 1/3 of the patients which may limit the effectiveness of the inclusion and exclusion criteria.

Independent Variable

The independent variable of interest is the interaction between the COVID-19 pandemic and state Medicaid expansion. The COVID-19 pandemic started on March 1, 2020 in the US, while the treatment and control groups are determined by the state's Medicaid expansion status. Among the states that provide MMC plans as of

January 1, 2020, 29 states plus DC had expanded Medicaid while 11 states had not (Appendix 4.2 shows state Medicaid expansion status).

Conceptual Framework and Covariates

The conceptual framework for this study used the Andersen Behavioral Model of Health Services Use, a well-established framework for health services research, to select covariates.[103] The Andersen Model examines patient characteristics that are identified according to the dynamics of the external environment (state Medicaid expansion status), predisposing factors (age, gender, and state of patient residence), enabling resources (insurance payer), and need characteristics (Elixhauser comorbidities). Age is a continuous variable from 50 to 90. Gender is classified as male or female. Health insurance is classified as enrollment in Managed Medicaid with robustness checks for dual-eligible enrollees. Comorbidities were calculated using the Elixhauser Comorbidity Software Refined for ICD-10-CM, v2022.1.[132] The Elixhauser Comorbidity Software allows for the calculation of up to 38 comorbidities, however, since the MORE^2 dataset does not have present on admission (POA) indicators which are necessary for 18 comorbidities to establish if comorbidity occurred prior to admission or if it occurred during the hospital stay, this study produces the results of the 20 comorbidities that are considered pre-existing prior to admission and acceptable to calculate using only diagnosis codes (e.g., diabetes, AIDS). Each comorbidity is based on the ICD-10 diagnosis codes and is provided an index weight from a range of -2 to 11 which establishes the 30-day all-cause readmission risk.[132]

While a variable for race and ethnicity is available in the MORE^2 dataset, it is missing for about half of all patients and therefore was decided to not be included. In addition, mortality and the point of origin (whether the patient had a routine visit or was transferred from a hospital or other health care facility) could not be measured in the MORE^2 dataset. Also, patients with commercial insurance were excluded due to their small number in the sample (4,233). Finally, costs could not be measured in this dataset since the Inovalon MORE^2 data agreement had to choose between provider information or costs for data extraction and provider information was chosen.

Statistical Analysis

A difference-in-differences (DID) design was estimated to study the impact of COVID-19 on the probability of the three PPH outcomes. DID studies have been well used to study the impact of COVID-19 for a variety of health and economic outcomes.[133–135] The difference-in-differences model of the rate of having a PPH, acute PPH, and chronic PPH per enrollee-month was estimated using the following equation:

$$y_{ist} = \alpha + \beta_1 COVID19_t + \beta_2 MedicaidExpansion_{st} + \beta_3 COVID19 * MedicaidExpansion_{st} + \gamma State_s + \delta Month_t + \eta X_{ist} + \epsilon_{ist}$$

Where y_{ist} is the dependent variable for individual i in state s at time t, $COVID19_t$ indicates the impact of COVID-19, $MedicaidExpansion_{st}$ indicates if the state expanded Medicaid, $COVID19 * MedicaidExpansion_{st}$ indicates the interaction of COVID-19 and state Medicaid expansion, $State_s$ is the state fixed effect, $Month_t$ is the month fixed effect, and X_{ist} is a vector of individual-level covariates. Since a patient may have multiple hospitalizations in a month, the

estimated number of hospitalizations per enrollee-month is slightly lower than the total number of hospital discharges. To test for parallel pre-trends in the outcomes between the control and treatment groups, the interaction of Medicaid expansion and months was tested for the months before COVID-19 (January 2019-February 2020). Previous literature found parallel trends in hospitalization rate between expansion and non-expansion states before Medicaid expansion.[136–138]

An event study was performed for each outcome to test for sensitivity in treatment and control group differences by each time unit (month) compared to the start time of COVID-19 (t=0 at March 2020). The specification is as follows:

$$y_{ist} = Expansion_s \times \sum_{\substack{r=-13 \\ r\neq -1}}^{10} \beta_r I(t - t_s = r) + \beta_t + \beta_s + \epsilon_{ist}$$

Where $Expansion_s$ is equal to 1 if living in a Medicaid expansion state and 0 otherwise, r is the relative month to the beginning of COVID-19 (with a range of 13 months before to 10 months after), $I(t - t_s = r)$ measures the effect of time relative to implementation, β_t is the month fixed effect, and β_s is the state fixed effect. The event study design omits the time period right before the start of COVID-19 (February 2020) to set the baseline coefficient that all other time periods will be compared to. The specification is adjusted for the covariates listed above. An F-test was conducted for each outcome to determine if the treatment effects in the pre-period (before the COVID-19 pandemic) were jointly equal to zero.

Since there are differences in the covariates that predict treatment status, an analysis using propensity score matching regression was performed to match the control and treatment groups by their covariates. This study used inverse probability

weighting (IPW), which creates weights based on the propensity score to create a sample where the covariates are equally distributed and not based on the treatment.[139] The propensity score was created using the following model:

$$ln\frac{P(MedicaidExpansion_{ist}=1)}{1-P(MedicaidExpansion_{ist}=1)} = \beta_0 + \beta_1 X_{ist} + \epsilon_{ist}$$

Where $P(MedicaidExpansion_{ist} = 1)$ is the probability of being in a Medicaid expansion state and X_{ist} is the vector of covariates listed above. Next, IPWs were estimated using the following model:

$$IPW = \frac{E}{ps} + \frac{1-E}{1-ps}$$

Where E is the expansion status (equals 1 if in a Medicaid expansion state and 0 if in a non-Medicaid expansion state) and ps is the estimated propensity score. Finally, the IPWs were weighted in the difference-in-differences and event study specifications stated above.

Supplementary Analysis

The first supplementary analysis (Appendix Table 4.1) shows the results of the Gardner two-stage difference-in-differences since the traditional difference-in-differences results may be biased due to differences in treatment timing. The first stage of the Gardner two-stage difference-in-differences estimates the group and time fixed effects of only the observations in non-Medicaid expansion states, then the second stage subtracts these estimated effects from the outcome as residuals, and finally estimates the second stage regression of the residualized outcome by state Medicaid expansions status.[140] In addition, robustness checks of dual-eligible enrollees were analyzed to test if any changes in PPH are correlated with state

Medicaid expansion on these populations (Appendix Figure 4.2). All analysis was conducted in Stata 15/MP and was approved by the University of Maryland Institutional Review Board.

Results

Table 4.1 consists of the Managed Medicaid study population characteristics based on Medicaid expansion status. MM enrollees with ADRD and living in Medicaid expansion states were more likely to be younger, male, and have a higher average Elixhauser comorbidity index compared to their counterparts in non-expansion states.

Figure 4.1 shows the trends of the unadjusted PPH rate over time by Medicaid expansion status. The vertical line in the unadjusted PPH graphs represents before and during COVID-19 started (March 2020). These graphs show that the trends are parallel for Medicaid expansion versus non-Medicaid expansion states before and after COVID-19.

Table 4.2 shows the results of the difference-in-differences analysis of the impact of COVID-19 on the PPH outcomes while adjusting for the established covariates and state and month fixed effects. Males had significantly lower rates of overall (-.272%; 95%CI: -.345, -.199), acute (-.137%; 95%CI: -.178, -.095), and chronic PPH (-.138%; 95%CI: -.188, -.089) compared to females. A 1 score increase in the Elixhauser comorbidity index was associated with a significant increase in overall (.130%; 95%CI: .113, .148), acute (.022; 95%CI: .015, .030), and chronic PPH (.110%; 95%CI: .097, .122). Older age is associated with higher rates of overall (.010%; 95%CI: .005, .014) and acute PPH (.022%; 95%CI: .015, .030). Finally, the

interaction of COVID-19 and state Medicaid expansion status is not significant for overall (-.036%; 95%CI: -.300, .199), acute (.017%; 95%CI: -.032, .066), and chronic PPH (-.047%; 95%CI: -.286, .191). Overall, the sign of the interaction between the COVID-19 pandemic and state Medicaid expansion status was negative for all the outcomes but was not significant for the preventable hospitalizations rate of the ADRD population enrolled in MM.

Figure 4.2 shows the event study coefficients using the two-way fixed effects estimator. The graphs show null results of differential trends in the pre-COVID-19 period between Medicaid expansion and non-Medicaid expansion states. In the post-COVID-19 period, the graphs show mostly null results which is consistent with the findings from the difference-in-differences analysis that the PPH outcomes for MMC enrollees with ADRD were not impacted by the COVID-19 pandemic by state Medicaid expansion status.

Figure 4.3 shows the event-study graphs using the IPWs, the results are similar to the unweighted sample with a null finding on the impact of COVID-19 on the study population. This means that after using propensity scores to mitigate patient differences in the Medicaid expansion and non-expansion subpopulations, the results reconfirm null results regarding the effect of COVID-19 on PPH rates for MMC enrollees with ADRD by state Medicaid expansion status.

Appendix Table 4.3 shows the pre-period (January 2019-February 2020) trends test for the Managed Medicaid population. The results show that the interaction is not significant for all three PPH outcomes, which states that the parallel lines assumption is likely to hold for these outcomes and the difference-in-differences

analysis can proceed. Appendix Table 4.4 shows the two-stage difference-in-differences analysis, the results show that the main interaction of COVID-19 and Medicaid expansion is not significant for any of the three outcomes, which is consistent with previous results, and shows that the main difference-in-differences results are not significantly biased that would affect the interpretation of these results. Appendix Table 4.5 shows the study sample characteristics when weighted by IPWs. After applying the IPWs, the covariates are not significantly different between the treatment and control groups. Appendix Figure 4.1 shows the dual-eligible population event study robustness check, the graphs show non-significant coefficients which suggests that parallel trends will hold and that COVID-19 did not significantly affect the PPH rates for the dual-eligible population by state Medicaid status.

Discussion

The COVID-19 pandemic brought sudden changes to health services and health behavior that affected health outcomes such as PPH. To my knowledge, this is the first study to provide estimates for the ADRD population that uses MMC and looks at the crucial outcome of PPH within the context of COVID-19. The results of this study suggested a negative trend in the impact of COVID-19 on PPH rates among the ADRD population with Managed Medicaid by state Medicaid expansion status, although the negative reduction was not statistically significant.

The results of this study regarding the impact of COVID-19 on PPHs match previous research that saw similar reductions without controlling for state Medicaid expansion status.[141] This study examines the ADRD population enrolled in MMC which tends to be older and has more comorbidities compared to MMC enrollees

without ADRD. As MMC is the dominant form of Medicaid, which is the primary insurance source for lower-income residents, it is important to design MMC plans that address high-risk populations such as enrollees with ADRD. State Medicaid expansion, as examined in this study, may not be sufficient to address the health needs of vulnerable populations such as enrollees with ADRD.

PPH is used as a quality measure of ambulatory care access. I speculate that the lack of change in PPH rate could be possibly attributed due to limited ambulatory care access for patients with ADRD during COVID-19[142], as many ambulatory health care facilities switched to telemedicine due to the risk of infection during in-person appointments.[92] Even though ambulatory telemedicine emerged as an option during COVID-19, the rates of telemedicine use are lower for older adults and it is possible that older adults with ADRD have additional difficulties utilizing telemedicine compared to non-ADRD older adults due to their neurological status.[143] Before COVID-19, each state had its own policies for telehealth, and while there is much state interest for telehealth coverage in MMC plans, there may be barriers to telehealth use for MMC enrollees such as low access to telehealth-compatible technology and MMC requirements that can reduce the profitability of telehealth service providers.[144]

One potential policy implication of this study is a possible deficit in health care supplier-based acceptance of Medicaid, as Medicaid tends to pay doctors significantly lower fees than Medicare, which can limit access to care for Medicaid enrollees.[145] A Kaiser Family Foundation study showed that managed care plans used a variety of strategies such as financial incentives and direct outreach to providers but

had more problems recruiting specialists compared to primary care providers.[146] Another study found that physicians in MM provider networks only see a marginal number of MM beneficiaries in a year which may mean that the physicians are not willing to serve Medicaid patients.[147] The data in this study does not state whether a provider accepts Medicaid, which can be a determinant of access to health care. I speculate that the supply of Medicaid providers can affect the health outcomes of Medicaid patients, detailed geographic data about access to care is needed to investigate this hypothesis. Additional research into Managed Medicaid plan acceptance is important to establish policies to ensure that patients with Managed Medicaid have equal access to health care and especially outpatient care compared to other types of insurance.

We acknowledged that due to limitations with the dataset, this study did not include the ADRD population with Medicaid FFS. One important distinction is that all Medicaid FFS plans cover long-term services and support such as skilled nursing facilities that can be beneficial for enrollees with ADRD while Managed Medicaid plans do not always cover these services. [148] Nevertheless, MMC remains an important insurer for ADRD needs as 24% of patients with ADRD in the Inovalon MORE^2 data have MMC.

Limitations

There are some limitations to this study. First, as previously acknowledged the MORE^2 data does not contain information about Traditional Medicare or Traditional Medicaid beneficiaries and therefore I cannot infer the health care utilization patterns of these beneficiaries with other insurances. Future studies may estimate the spill-

over effects of the MMC on these populations. Second, even though the MORE^2 dataset contains data from all 50 states plus DC, the dataset is not stated to be nationally representative and may have undercounting in certain areas. Third, there may be omitted variable bias due to the lack of variables such as county-based social determinants of health and patient satisfaction that may influence the tested outcomes. Race and ethnicity were not well measured in the provided variable, as over half of the patient sample's race and ethnicity is missing or unknown. This is important for analyzing the impact of MMC, as recent research shows poorer care experiences for Black and Hispanic enrollees in MMC compared to White enrollees.[149] Future claims data collection and cleaning should emphasize the usability quality of key demographic variables. Another limitation of this study is that the data does not have the ability to accurately detect the severity of ADRD if the diagnosis is outside of the scope of the data timeframe of 2019-2020. This is important as previous research shows that the all-cause hospitalization and potentially avoidable hospitalization rate increased every year for three years preceding an ADRD diagnosis.[37] Further analysis of a longer time frame is needed to examine long-term trends in ADRD hospitalization rates at the population and individual levels.

Conclusion

The COVID-19 pandemic resulted in health care disruptions for all people, but especially for vulnerable populations such as patients with ADRD. Medicaid enrollees with ADRD have complex health needs that may be impacted during COVID-19. The results of this study showed that during the COVID-19 pandemic, COVID-19 was associated with a small reduction in PPHs for the ADRD population

with Managed Medicaid by state Medicaid expansion status, but the reductions were not significant.

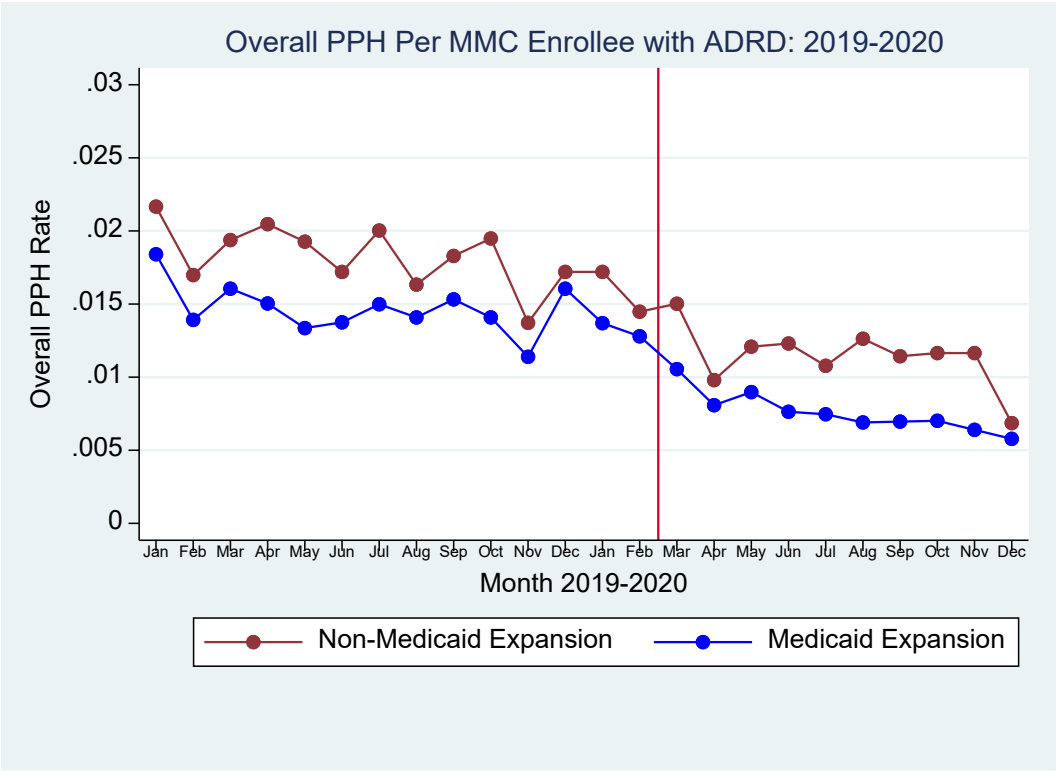
Chapter 4 Tables

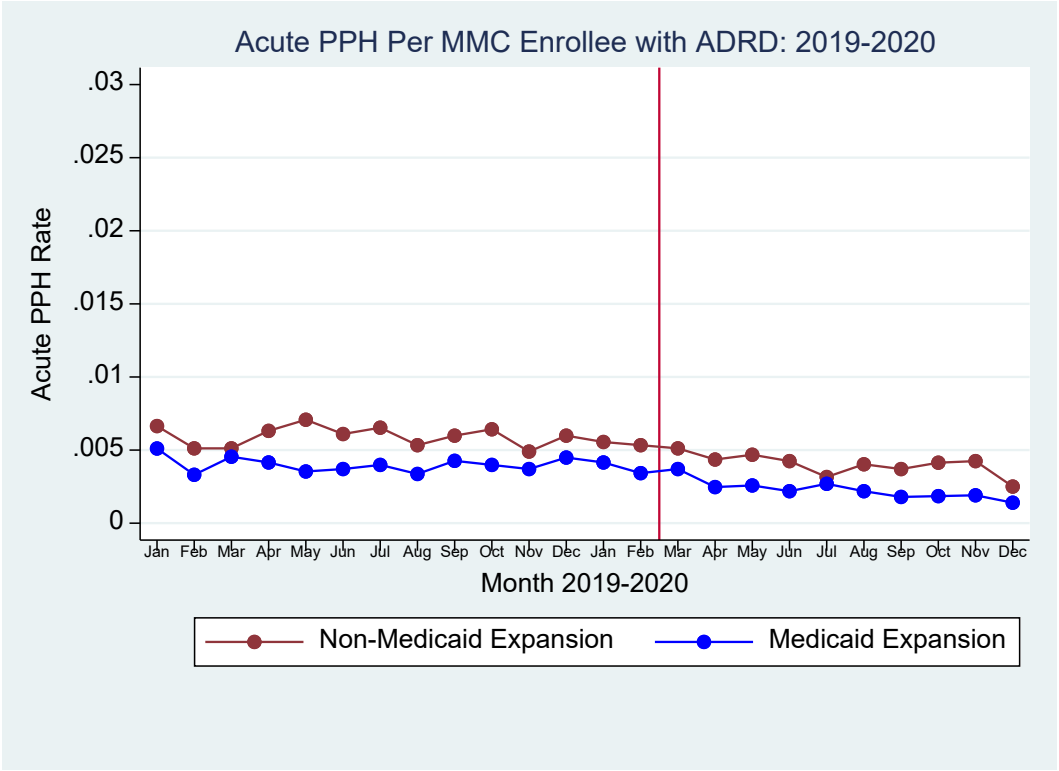
Table 4.1. Managed Medicaid Enrollees with ADRD Characteristics by Medicaid Expansion Status

Variable	Non-Medicaid Expansion (%)	Medicaid Expansion (%)	P-Value
Gender			<0.001
Female	5,117 (55.70)	9,127 (51.22)	
Male	4,070 (44.30)	8,693 (48.78)	
Age			<0.001
50-64	4,380 (47.68)	11,605 (65.12)	
65-79	2,854 (31.07)	4,026 (22.59)	
80+	1,953 (21.26)	2,189 (12.28)	
Mean Elixhauser Index (SE)	4.02 (0.04)	4.88 (0.03)	<0.001
Total Sample	9,187	17,820	

Notes. Sample consists of Managed Medicaid enrollees with ADRD based on claims data diagnosis in states with Managed Medicaid. N=27,007. Numbers may not add up to 100 due to rounding. SE=standard error.
Source: Analyses of data from Inovalon MORE^2, 2019–2020.

Figure 4.1. Unadjusted Difference-in-Differences Graphs of PPH Rates for Managed Medicaid Enrollees with ADRD, 2019-2020. Source: Analyses of data from Inovalon MORE^2, 2019–2020.




Acute PPH Per MMC Enrollee with ADRD: 2019-2020
Acute PPH Rate
.03
.025
.02
.015
.01
.005
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month 2019-2020
Non-Medicaid Expansion
Medicaid Expansion

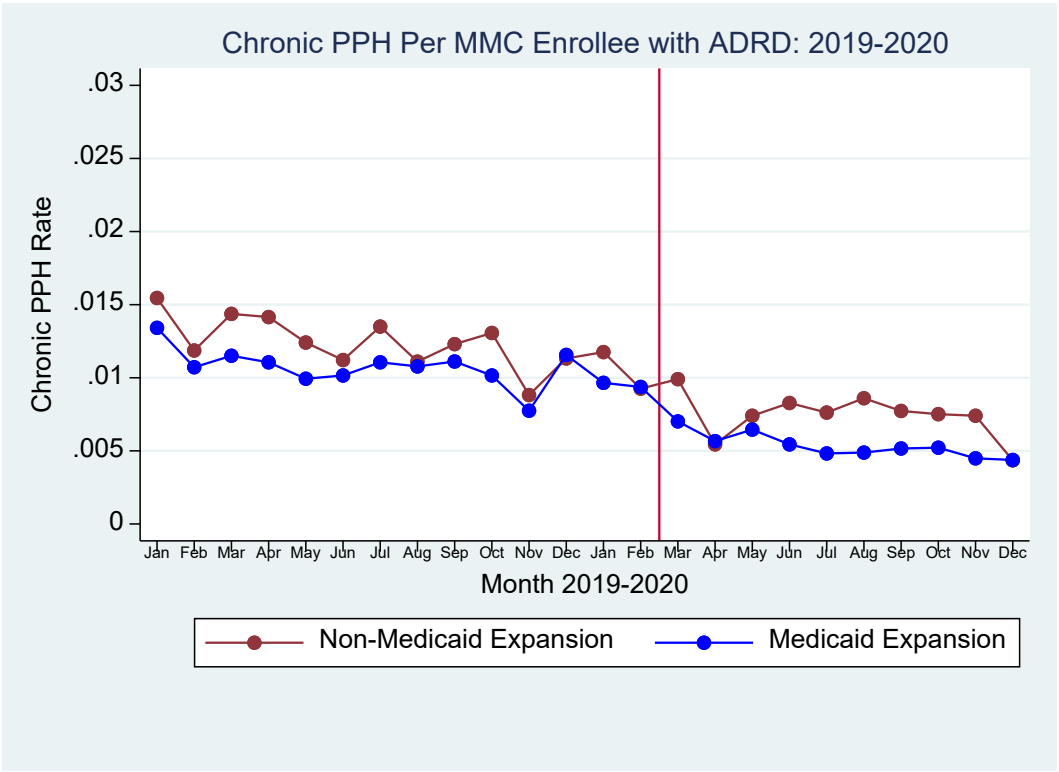
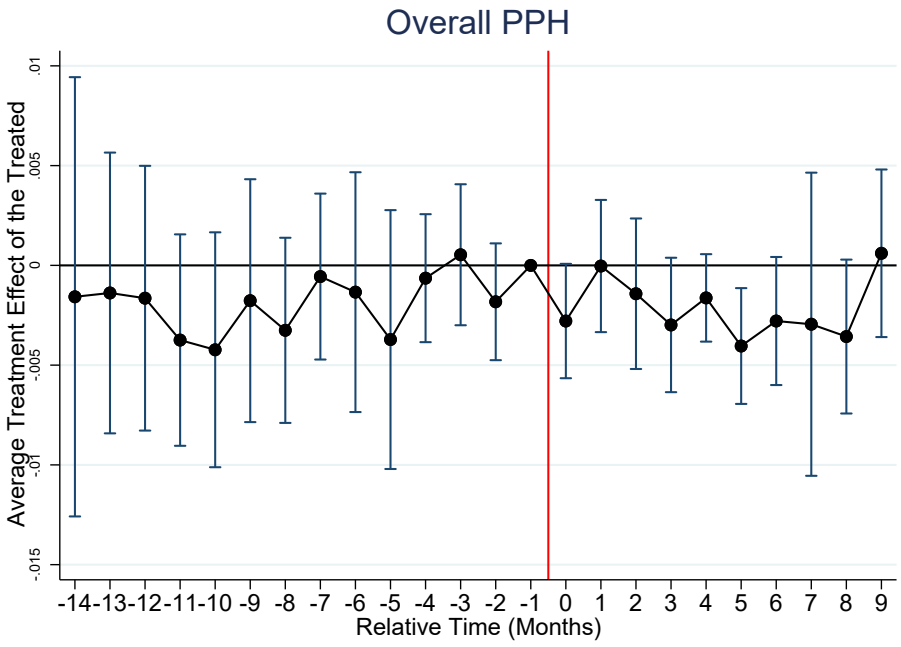

Chronic PPH Per MMC Enrollee with ADRD: 2019-2020
Chronic PPH Rate
.03
.025
.02
.015
.01
.005
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month 2019-2020
Non-Medicaid Expansion
Medicaid Expansion

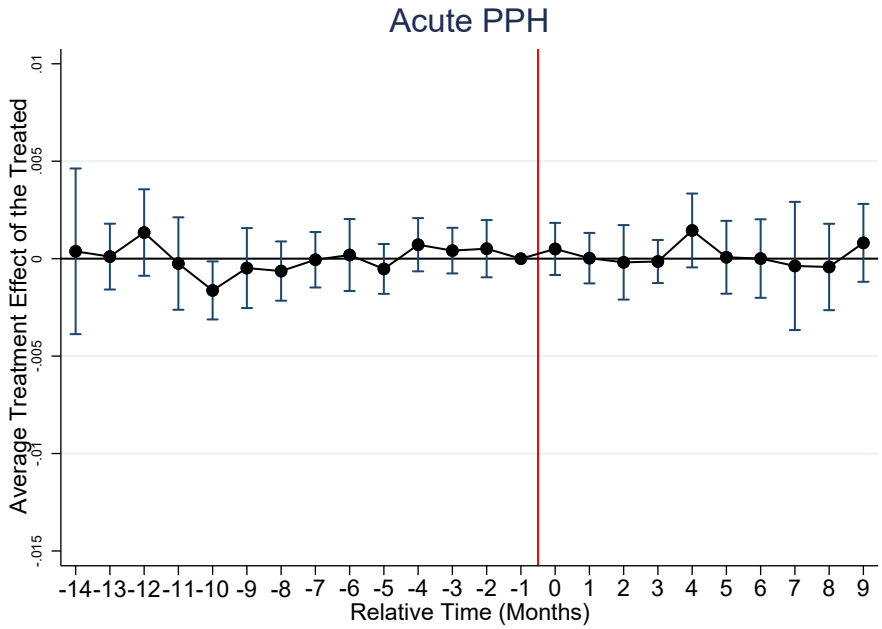
Table 4.2. Impact of COVID-19 by Medicaid Expansion Status Difference-in-Differences Effects

VARIABLES	(1) Overall PPH	(2) Acute PPH	(3) Chronic PPH
Post-COVID	-.0131***	-.00396***	-.00943***
	(-.0168, -.00941)	(-.00512, -.00281)	(-.0124, -.00649)
Medicaid Expansion	-.0158***	-.00423***	-.0117***
	(-.0171, -.0145)	(-.00466, -.00379)	(-.0128, -.0106)
Post-COVID*Medicaid Expansion	-.000361	.000167	-.000473
	(-.00300, .00228)	(-.000323, .000657)	(-.00286, .00191)
Male	-.00272***	-.00137***	-.00138***
	(-.00345, -.00199)	(-.00178, -.000951)	(-.00188, -.000885)
Age	.000097***	.000087***	.000010
	(.000050, .000144)	(.000062, .000113)	(-.000039, .000058)
Elixhauser Comorbidities Index	.00130***	.000223***	.00110***
	(.00113, -.00148)	(.000147, .000299)	(.000967, .00122)
Constant	.00258	-.00159	.00426**
	(-.00146, .00662)	(-.00407, .000894)	(.00138, .00714)
Total Enrollee-Months	648,168	648,168	648,168

Notes. Eleven states that do not use Managed Medicaid before 2021 were excluded (Alabama, Alaska, Connecticut, Idaho, Maine, Montana, North Carolina, Oklahoma, South Dakota, Vermont, and Wyoming). The models are adjusted for state and month fixed effects. Robust confidence intervals in the parentheses. Source: 2019-2020 Inovalon MORE^2.
*** p<0.001, ** p<0.01, * p<0.05

Figure 4.2. Event Studies of Adjusted PPH Rates
Adjusted rate of PPH outcomes for Managed Medicaid Enrollees with ADRD as estimated by event study models that omit the period before COVID-19 (February 2020) as the reference category. The error bars indicate the 95% confidence interval of the estimates. Source: 2019-2020 Inovalon MORE^2.





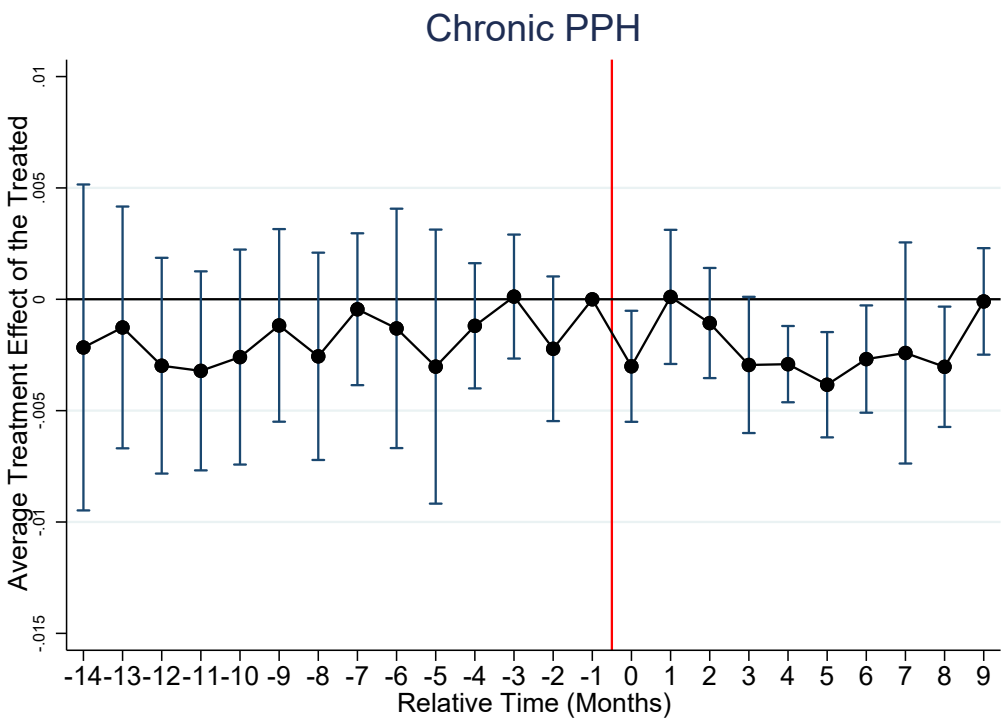
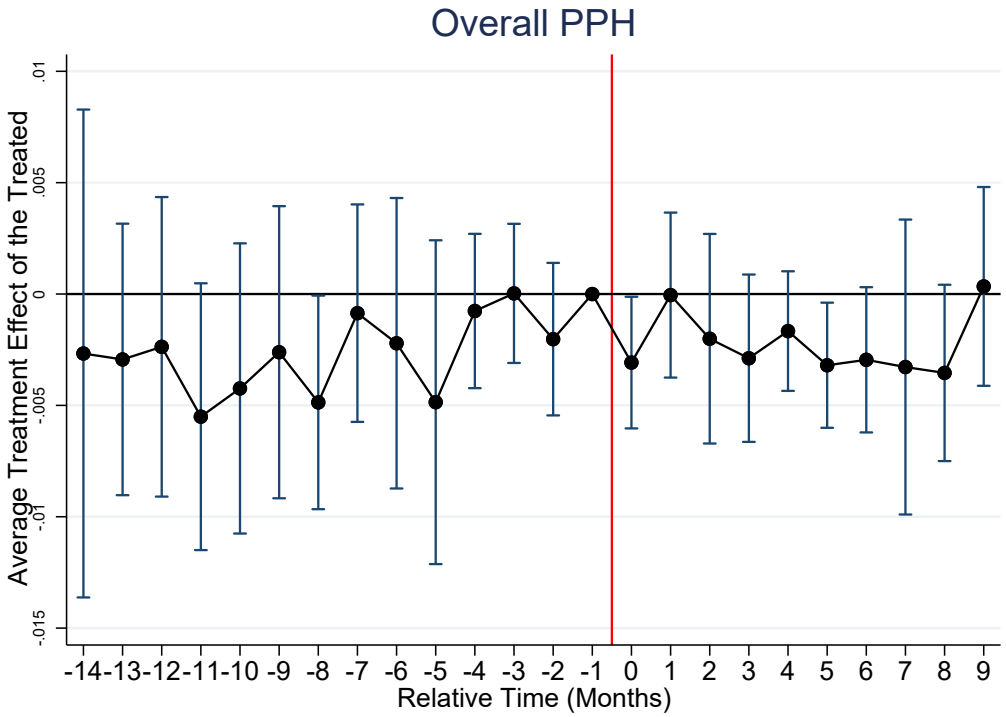
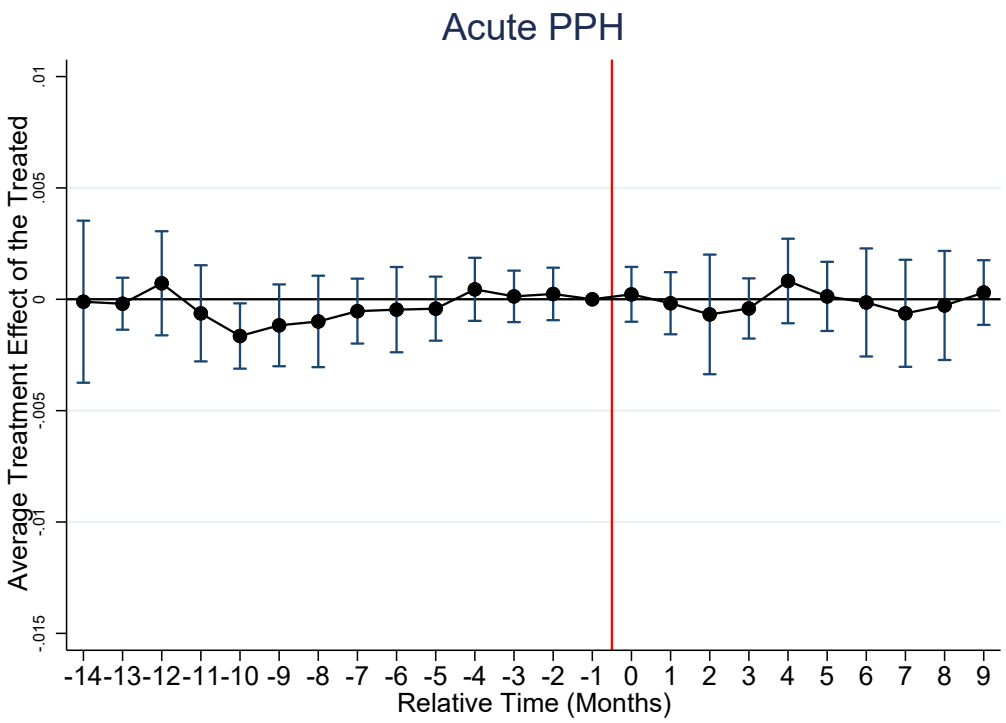
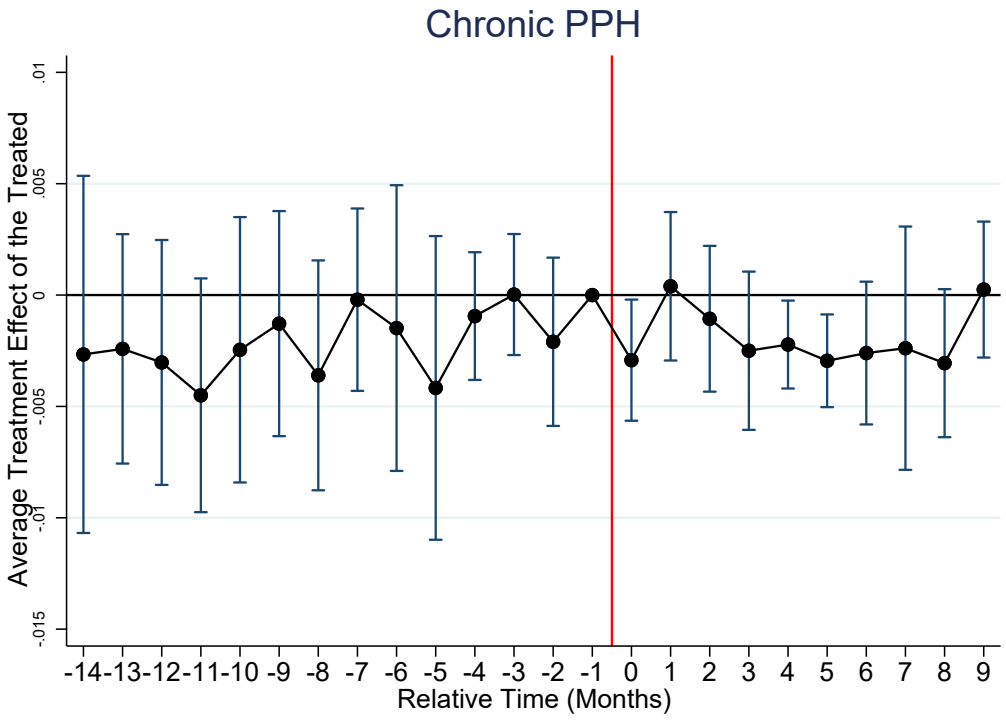

Chronic PPH
Average Treatment Effect of the Treated
.01
.005
0
-.005
-.01
-.015
-14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9
Relative Time (Months)

Figure 4.3. Inverse Probability Weighted Event Studies
Adjusted rate of PPH outcomes for Managed Medicaid Enrollees with ADRD as estimated by event study models using that inverse probability weighted propensity scores. The period before COVID-19 (February 2020) is omitted as the reference category. The error bars indicate the 95% confidence interval of the estimates. Source: 2019-2020 Inovalon MORE^2.




Acute PPH
Average Treatment Effect of the Treated
.01
.005
0
-.005
-.01
-.015
-14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9
Relative Time (Months)


Chronic PPH
Average Treatment Effect of the Treated
.01
.005
0
-.005
-.01
-.015
-14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9
Relative Time (Months)

Appendix Table 4.1. ADRD ICD-10 Diagnosis Codes

ICD-10 Code	Description
G30.0	Alzheimer's disease with early onset
G30.1	Alzheimer's disease with late onset
G30.8	Other Alzheimer's disease
G30.9	Alzheimer's disease, unspecified
F01.50	Vascular dementia, unspecified severity, without behavioral disturbance, psychotic disturbance, mood disturbance, and anxiety
F01.51	Vascular dementia, unspecified severity, with behavioral disturbance
F02.80	Dementia in other diseases classified elsewhere, unspecified severity, without behavioral disturbance, psychotic disturbance, mood disturbance, and anxiety
F02.81	Dementia in other diseases classified elsewhere, unspecified severity, with behavioral disturbance
F03.90	Unspecified dementia, unspecified severity, without behavioral disturbance, psychotic disturbance, mood disturbance, and anxiety
F03.91	Unspecified dementia, unspecified severity, with behavioral disturbance
F05	Delirium due to known physiological condition
G13.8	Systemic atrophy primarily affecting central nervous system in other diseases classified elsewhere
G31.01	Frontotemporal dementia: Pick's disease
G31.09	Frontotemporal dementia: Other frontotemporal neurocognitive disorder
G31.1	Senile degeneration of brain, not elsewhere classified
G31.2	Degeneration of nervous system due to alcohol
G31.83	Neurocognitive disorder with Lewy bodies
G94	Other disorders of brain in diseases classified elsewhere
R41.81	Age-related cognitive decline

Sources: https://www2.ccwdata.org/documents/10280/86658989/chr-cond-algo-alzdisease.pdf, https://www2.ccwdata.org/documents/10280/86658989/chr-cond-algo-nonalzh.pdf

Appendix Table 4.2. States by Medicaid Expansion Status as of January 1, 2019	
Expansion	**Non-Expansion**
Arizona	Florida
Arkansas	Georgia
California	Kansas
Colorado	Mississippi
District of Columbia	Missouri
Delaware	Nebraska
Hawaii	South Carolina
Illinois	Tennessee
Indiana	Texas
Iowa	Wisconsin
Kentucky	
Louisiana	
Maryland	
Massachusetts	
Michigan	
Minnesota	
Nevada	
New Hampshire	
New Jersey	
New Mexico	
New York	
North Dakota	
Ohio	
Oregon	
Pennsylvania	
Rhode Island	
Utah	
Virginia	
Washington	
West Virginia	

Source: https://www.kff.org/medicaid/issue-brief/status-of-state-medicaid-expansion-decisions-interactive-map/, https://www.kff.org/medicaid/issue-brief/10-things-to-know-about-medicaid-managed-care/. Ten states are excluded (Alabama, Alaska, Connecticut, Idaho, Maine, Montana, North Carolina, Oklahoma, South Dakota, Vermont, and Wyoming) due to no Managed Medicaid plans offered in these states before 2021, only Medicaid FFS.

Appendix Table 4.3. Managed Medicaid Pre-Period Trends Test: January 2019-February 2020			
	(1)	(2)	(3)
VARIABLES	Overall PPH	Acute PPH	Chronic PPH
Medicaid Expansion	-.0045314	-.0020057	-.0025742
	(-.0112621, .0021994)	(-.0041327, .0001214)	(-.0083203, .0031718)
Month	-.0003454	-.0000419	-.0003132
	(-.0008609, .0001700)	(-.0002511, .0001674)	(-.0006694, .0000431)
Medicaid Expansion*Month	.00014	.0000134	.0001302
	(-.0004465, .0007265)	(-.0002072, .0002339)	(-.0002864, .0005469)
Constant	.0205666***	. 0061996***	.0145320***
	(.0145115, .0266216)	(.0041915, .0082078)	(.0094577 .0196063)
Observations	378,098	378,098	378,098

Notes. Eleven states that do not use Managed Medicaid before 2021 were excluded (Alabama, Alaska, Connecticut, Idaho, Maine, Montana, North Carolina, Oklahoma, South Dakota, Vermont, and Wyoming). Robust confidence intervals are included in the parentheses.

*** p<0.001, ** p<0.01, * p<0.05

Source: 2019-2020 Inovalon MORE^2.

Appendix Table 4.4. Managed Medicaid Two-Stage Difference-in-Differences			
	(1)	(2)	(3)
VARIABLES	Overall PPH	Acute PPH	Chronic PPH
Post-COVID*Medicaid Expansion	-.000361	.0001672	-.0004727
	(-.0028392, .0021172)	(-.0002856, .0006199)	(-.0027649, .0018196)
Observations	648,168	648,168	648,168

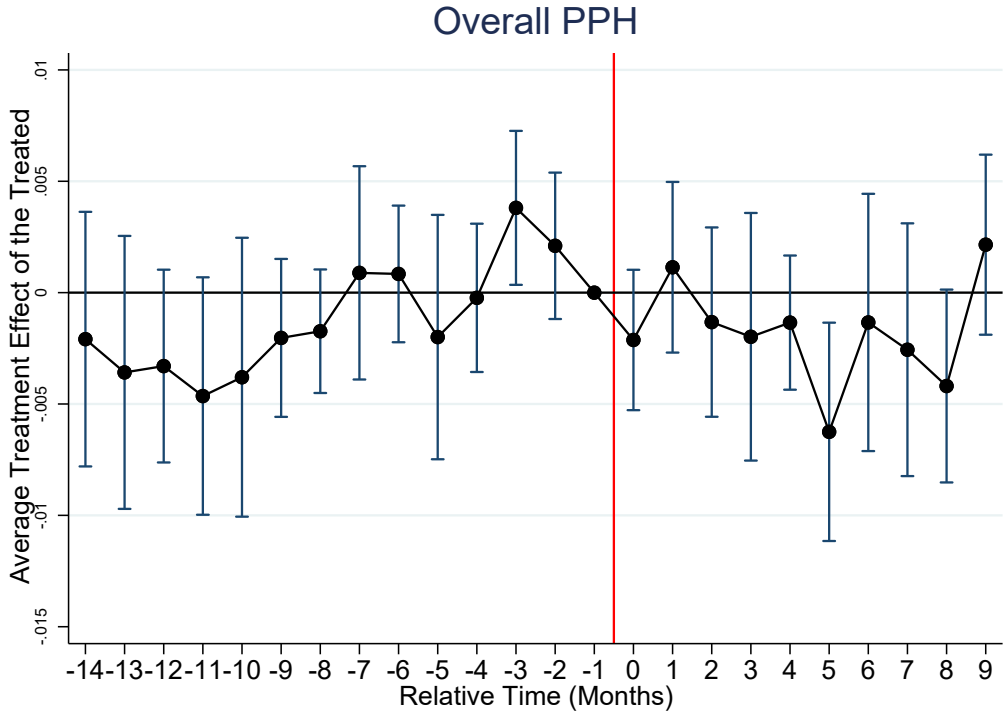
Notes. Eleven states that do not use Managed Medicaid before 2021 were excluded (Alabama, Alaska, Connecticut, Idaho, Maine, Montana, North Carolina, Oklahoma, South Dakota, Vermont, and Wyoming). The models are adjusted for state and month fixed effects. Robust 95% confidence intervals are in parentheses.
Source: 2019-2020 Inovalon MORE^2.

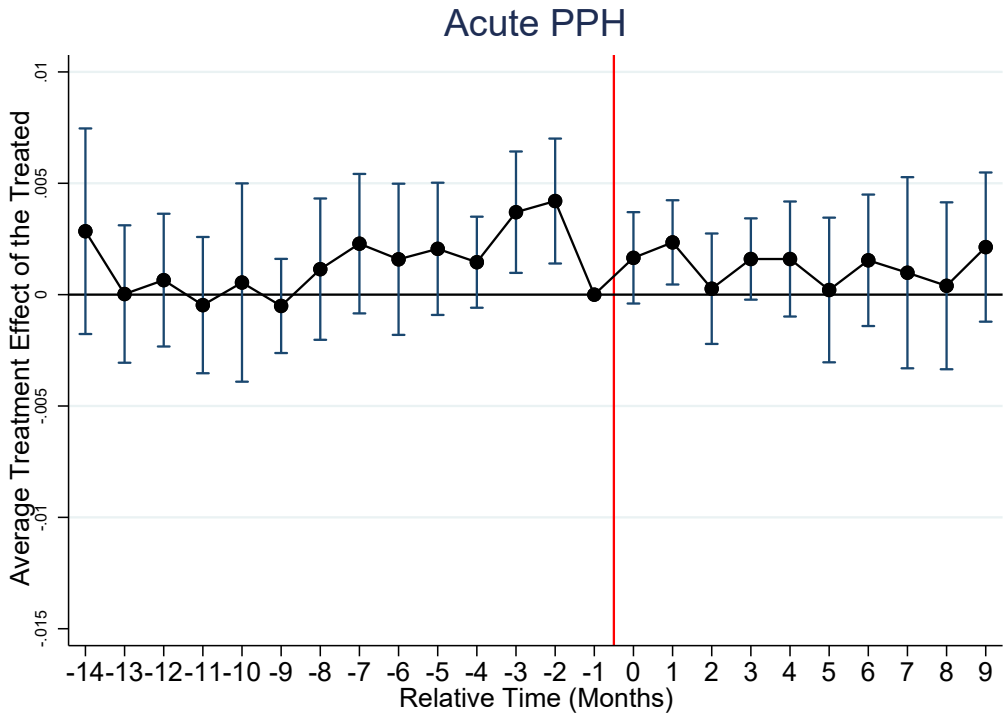
Appendix Table 4.5. Managed Medicaid Inverse Probability Weighted Population Characteristics

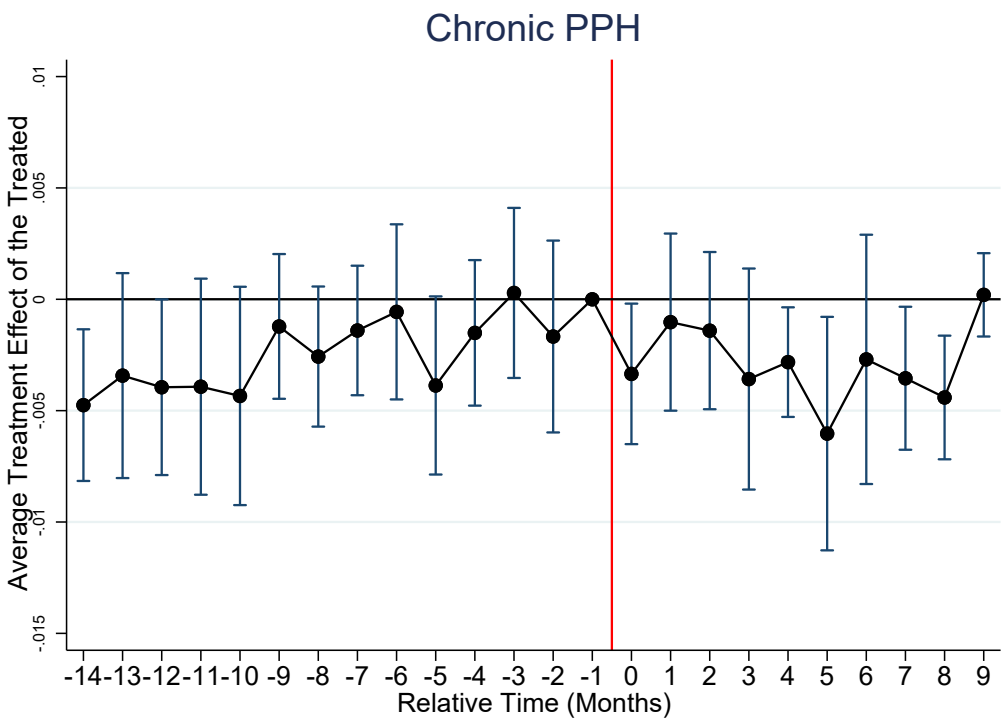
Variable	Non-Medicaid Expansion (%)	Medicaid Expansion (%)	P-Value
Gender			0.9140
Female	9,180 (51.4)	9,127 (51.2)	
Male	8,677 (48.6)	8,693 (48.8)	
Age			0.7814
50-64	11,380 (63.7)	11,605 (65.1)	
65-79	4,485 (25.1)	4,026 (22.6)	
80+	1,992 (11.2)	2,189 (12.3)	
Mean Elixhauser Index (SE)	5.02 (0.38)	4.88 (0.42)	0.7390
Total Weighted Sample	17,857	17,820	

Notes. N=35,677. Numbers may not add up to 100 due to rounding. Eleven states that do not use Managed Medicaid before 2021 were excluded (Alabama, Alaska, Connecticut, Idaho, Maine, Montana, North Carolina, Oklahoma, South Dakota, Vermont, and Wyoming).
Source: 2019-2020 Inovalon MORE^2.

Appendix Figure 4.1. Adjusted Event Study Robustness Check Graphs of PPH Rates for Dual-Eligible Enrollees with ADRD, 2019-2020. Source: Analyses of data from Inovalon MORE^2, 2019–2020.






Chronic PPH
Average Treatment Effect of the Treated
.01
.005
0
-.005
-.01
-.015
-14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9
Relative Time (Months)

Chapter 5: The Trends of Telehealth Access and Use for Medicare Enrollees by Alzheimer's Disease and Related Dementias Status and Medicare Plans During COVID-19

Abstract

Introduction: The COVID-19 pandemic resulted in a sharp increase in telehealth use for delivering health services, however, some patients such as older adults with Alzheimer's Disease and Related Dementias (ADRD) may have difficulties accessing and using telehealth. My objective is to examine the differences in telehealth access and use between ADRD and non-ADRD Medicare enrollees during the COVID-19 pandemic with an interaction of Medicare Advantage.

Methods: I examined the Medicare Current Beneficiary Survey (MCBS) Fall 2020 & Winter 2021 COVID-19 Supplement Public Use Files. The primary outcomes were telehealth access during COVID-19, telehealth access before COVID-19, and telehealth use, while adjusting for demographics, access and use of technology, COVID-19 preventive behaviors, comorbidities, Medicare Advantage, and ADRD.

Results: There were 13,770 enrollees (75,141,661 survey-weighted) Medicare enrollees in the sample. Medicare enrollees with ADRD were more likely to be older (75+), Non-White, low-income, have Medicare Advantage, dual-eligible, and not have internet access. Medicare Advantage enrollees were more likely to be Non-White, low-income, dual-eligible, and have ADRD while less likely to access the internet and own telehealth-relevant technology. Telehealth access during COVID-19

is positively associated with enrollees with higher income (3.00pp; 95%CI:0.57,5.43), internet access (9.96pp; 95%CI:6.74,13.18), and own telehealth-related technology (5.33; 95%CI:2.21,8.44) while negatively associated with enrollees who are Black Non-Hispanic (-8.72pp; 95%CI:-12.70,-4.74) or live in a non-metro area (-9.04pp; 95%CI:-13.41,-4.68). Telehealth access before COVID-19 is positively associated with enrollees who are Black Non-Hispanic (8.73pp; 95%CI:3.37,14.08) and have Medicare Advantage (4.78pp; 95%CI:1.70,7.86) while negatively associated with enrollees who are Hispanic (-8.90pp; 95%CI:-14.78,-3.03), female (-6.96pp; 95%CI:-9.48,-4.44), and dual-eligible (-5.21pp; 95%CI:-9.39,-1.03). Telehealth use is positively associated for enrollees who are Black Non-Hispanic (6.52pp; 95%CI:2.97,10.08) and engage in an above-median number of preventive behaviors (5.62pp; 95%CI:3.55,7.70) and negatively associated with age 75+ (-5.97pp; 95%CI:-10.85,-1.09) and female (-5.04pp; 95%CI:-7.34,-2.75).

Conclusions: Medicare enrollees with ADRD had similar telehealth access and use compared to non-ADRD counterparts. Medicare Advantage enrollees had more access to telehealth before COVID-19 but not during COVID-19 and did not use telehealth more during COVID-19. The interactions of ADRD and MA were not significant in telehealth access or use.

Introduction

Telehealth is the delivery of health services using communications technology such as live video conferencing, mobile phone apps, and remote patient monitoring.[150] Telehealth became a major source of health care during the COVID-19 pandemic due to the risk of contracting COVID-19 if meeting in-person, as the CDC reported a 154% increase in telehealth use in the last week of March 2020 compared to the same week in 2019.[151] While telehealth use increased for the general population during COVID-19, there may be barriers to telehealth access use for vulnerable populations such as older adults living at home and with ADRD.[152]

Medicare provides insurance for US adults age 65 and above or with debilitating disabilities such as end-stage renal disease or amyotrophic lateral sclerosis.[153] Medicare enrollees have two options to choose from, a fee-for-service option also known as Traditional Medicare (TM), or a managed care option of Medicare Advantage (MA). MA may be more efficient in containing health expenditures while maintaining value due to unique features such as capitation which pays a set amount per period for a patient's health services and prior authorization of medical services by insurers before implementation, as well as providing care coordination and flexibility in covering additional services such as internet access that TM does not.[154–157] The Creating High-Quality Results and Outcomes Necessary to Improve Chronic (CHRONIC) Care Act of 2017 provided a provision for MA plans to cover social determinants of health such as internet costs starting in 2020, which coincidentally aligns with the beginning of COVID-19 in the US.[86,158] In 2022, 48%

of all Medicare beneficiaries were enrolled in MA, and the trend is growing for MA penetration.[70]

Before COVID-19, TM only covered telehealth for rural areas and the patient could not use telehealth at home but rather had to go to an approved facility to receive telehealth services, while MA plans had more flexibility to offer telehealth coverage.[159] On March 6, 2020, the Centers for Medicare & Medicaid Services (CMS) released the 1135 waiver authority from the Coronavirus Preparedness and Response Supplemental Appropriations Act which expanded telehealth access for TM enrollees.[160] Recent research found that during COVID-19, TM and MA enrollees had similar rates of telehealth use (44% and 45%, respectively).[159] However, another publication found that Medicare beneficiaries also have different levels of access to telehealth based on demographic and access factors such as older age, race, sex, and access to telehealth-related technology.[161]

Previous research found no significant differences between TM and MA enrollees with ADRD in care satisfaction or health status in 2010-2016 despite MA enrollees using fewer health services.[162] However, little is known about the differences in telehealth access and use for Medicare enrollees with ADRD in the context of COVID-19. In this study, I examine differences in telehealth access before and during COVID-19 and telehealth use during COVID-19 for Medicare enrollees. I hypothesize that Medicare enrollees with ADRD will use less telehealth than non-ADRD enrollees due to barriers in the usage of telehealth technology, and that the interaction of MA with ADRD was associated with greater use of telehealth during

COVID-19 compared to enrollees with TM due to the flexibility of MA plans to provide additional coverage of services such as internet access.

Methods

Data

This study uses the Fall 2020 and Winter 2021 Medicare Current Beneficiary Survey (MCBS) COVID-19 Supplements.[163,164] The MCBS is an annual nationally representative survey of community-dwelling Medicare beneficiaries with information on demographics, health status, and care status. The survey is conducted three times a year (Winter: January, February, March, and April; Summer: May, June, July, and August; and Fall: September, October, November, and December). The MCBS produced a series of COVID-19 supplements to collect information regarding health status and health care access during COVID-19. The first COVID-19 Supplement was collected in the Spring of 2020; however, this dataset does not contain certain variables of interest such as TM/MA status and COVID-19 preventive behaviors.

Sample Selection

This study consists of the study sample with a defined ADRD status (yes or no) with full-year TM or MA and knows if their PCP offers telehealth appointments (yes or no). For the combined Fall 2020 and Winter 2021 MCBS COVID-19 Supplements, there are 13,770 full-year TM and MA enrollees for a survey-weighted population of 75,141,661.

Dependent Variables

This study examines three dependent variables: telehealth access during COVID-19, telehealth access before COVID-19, and telehealth use. Telehealth access during COVID-19 is defined by if the sampled person's primary care provider (PCP) offers telehealth appointments. Telehealth access before COVID-19 is defined if the PCP offered telehealth before COVID-19. Telehealth use is defined by if the sampled person had used telehealth since the last survey wave (since 7/1/20 in Fall 2020 and since 11/1/2020 in Winter 2021).

Independent Variable

The independent variable of interest is the enrollee's ADRD status and the interaction of ADRD and MA. ADRD status is defined by whether the enrollee self-reports that they have ever been diagnosed with ADRD. MA status is determined by if the enrollee has either full-year MA or TM enrollment and excludes partial-year enrollment.

Conceptual Framework and Covariates

I selected enrollee characteristics based on the Andersen Behavioral Model of Health Services Use.[103] The Andersen Model examines enrollee characteristics that are identified according to their predisposing factors (age, sex, race and ethnicity, metro area residence, region, survey wave time period, COVID-19 preventive behaviors), enabling resources (insurance payer, dual-eligible status, income, speak language other than English at home, internet access, telehealth-related technology access), and need characteristics (ADRD status and comorbidities).

Age is categorized as 50-64, 65-74, and 75+ years old. Sex is given as male or female. Race and ethnicity is provided as White Non-Hispanic, Black Non-Hispanic, Hispanic, and Other/Unknown. Income is divided as <$25,000 and ≥$25,000 per year. Metro residence is defined by the core-based statistical area (CBSA) as living in a metro or non-metro area. Region is categorized as Northeast, Midwest, South, and West. Dual eligible status is determined by if the sample person was eligible for Medicaid benefits. Speaking a language other than English at home is defined if the sampled person states that a language other than English is spoken at home. Survey wave is defined as Fall 2020 or Winter 2021. Internet access is defined as if the sampled person has access to the internet. Use video or voice calls is defined as whether the sample person used video or voice calls. Telehealth-related technology access is defined by if the sampled person owns a computer, smartphone, or tablet. Comorbidities are defined by ever having a heart condition, hypertension/high blood pressure, stroke, high cholesterol, cancer, osteoporosis/broken hip, emphysema/asthma/COPD (chronic obstructive pulmonary disease), diabetes/high blood sugar, depression, or a weak immune system.

There is an index of 15 preventive behaviors that the survey asks if the respondents do because of COVID-19 (washed hands, used sanitizer, avoided touching their face, coughed/sneezed on tissue and/or sleeve, wore a facemask, cleaned common areas, avoided contact with sick people, kept six feet distance, avoided large groups, sheltered-in-place, bought extra food, bought extra cleaning supplies, bought extra medicines, consulted with their medical provider, avoided other people). The median number of preventative behaviors was 12, I created a

binary index of ≥12 as an above-median number of preventative behaviors and <12 as a below-median number of preventative behaviors. Previous research found no differences between TM and MA enrollees in the amount of preventative behaviors.[165]

Statistical Analysis

This study used linear regressions to model the outcomes. The following model was used:

$$Y_i = \beta_0 + \beta_1 ADRD + \beta_2 MA + \beta_3 ADRD * MA + \beta_4 X_i + \varepsilon$$

Where Y_i is the outcome for individual i, $ADRD$ is the ADRD status, MA is the MA enrollment status, $ADRD * MA$ is the interaction of ADRD and MA, X_i is the vector of covariates, and ε is the error term.

This study is a cross-sectional analysis that uses the complex survey design of the MCBS. Balanced repeated replication (BRR) using Fay's adjustment of 0.3 is used to estimate variances as recommended by the MCBS designers. This method uses a series of replicate weights to generate the standard errors. Chi-squared tests were used for categorical variables and reported with a significance level of 0.05. Person-weights and replicate weights are pooled to account for multiple waves of data. All analysis is performed using Stata 15/MP and was approved by the University of Maryland Institutional Review Board.

Results

Table 5.1 shows the differences between Medicare enrollees with ADRD and without ADRD. Enrollees with ADRD are more likely to be older (75+), Non-White,

an income below $25,000, have Medicare Advantage, are dual-eligible, speak a language other than English at home, while also less likely to access the internet, use video or voice calls, own telehealth-related technology, and engage in an above-median amount of COVID-19 preventive behaviors. Enrollees with ADRD are also more likely to ever have depression, heart condition, hypertension, diabetes, osteoporosis/broke hip, asthma/COPD, and stroke.

Table 5.2 shows the differences between TM and MA enrollees. MA enrollees are more likely to have ADRD, be 75+ years old, Non-White, have an income below $25,000, live in a metro area, are dual-eligible, speak a language other than English at home, and be represented in the Winter 2021 survey while also less likely to access the internet, use video or voice calls, and own telehealth-related technology. MA enrollees are more likely to have hypertension, diabetes, and high cholesterol while less likely to have a weak immune system.

Table 5.3 shows the regression for telehealth access during COVID-19. Telehealth access during COVID-19 is positively associated with enrollees with income ≥$25,000 (3.00pp [percentage points]; 95%CI:0.57,5.43), have internet access (9.96pp; 95%CI:6.74,13.18), use video or voice calls (5.64pp; 95%CI:4.00,7.27), own a computer/smartphone/tablet (5.33pp; 95%CI:2.21,8.44), engage in an above-median number of preventive behaviors (3.48pp; 95%CI:1.81,5.15), and are immunocompromised (2.22pp; 95%CI:0.14,4.31), while negatively associated with enrollees who are Black Non-Hispanic (-8.72pp, 95%CI:-12.70,-4.74), other race and ethnicity (-5.14pp; 95%CI:-9.23, -1.04), live in the South (-3.33pp; 95%CI:-6.65,-

0.00), live in a non-metro area (-9.05pp; 95%CI:-13.41,-4.68), participate in the Winter 2021 survey (-2.65pp; 95%CI:-4.23,-1.07).

Table 5.4 shows the regression for telehealth access before COVID-19. Telehealth access before COVID-19 is positively associated with enrollees who are Black Non-Hispanic (8.73pp; 95%CI:3.37,14.08) and have Medicare Advantage (4.78pp; 95%CI:1.70,7.86), age 65-74 (5.51pp; 95%CI:0.96,10.07), age 75+ (7.33pp; 95%CI:2.91,11.75), Midwest (6.19pp; 95%CI:2.08,10.31), West (13.93pp; 95%CI:5.65,22.20), Winter 2021 survey wave (5.07pp;95%CI:2.98,7.17), while negatively associated with enrollees who are Hispanic (-8.90pp; 95%CI:-14.78,-3.03), female (-6.96pp; 95%CI:-9.48,-4.43), dual-eligible (-5.21pp; 95%CI:-9.39,-1.03), and have depression (-3.20pp;95%CI:-6.02,-0.38).

Table 5.5 shows the regression for telehealth use. Telehealth use is positively associated with enrollees who are Black Non-Hispanic (6.52pp; 95%CI:2.97,10.08), live in the West region (5.68pp; 95%CI:0.98,10.39), use video or voice calls (16.57pp; 95%CI:14.10,19.03), engage in an above-median number of preventive behaviors (5.62pp; 95%CI:3.55,7.70), have depression (5.63pp; 95%CI:3.40,7.85), heart disease (4.32pp; 95%CI:1.70,6.94), cancer (9.48pp; 95%CI:6.65,12.31), hypertension (3.30pp; 95%CI:0.57,6.02), diabetes (5.25pp, 95%CI:2.72,7.78), osteoporosis/broke hip (4.45pp; 95%CI:1.92,6.98), asthma/COPD (4.21pp; 95%CI:1.12,7.29), and immunocompromised (10.53pp; 95%CI:7.59,13.48) and negatively associated with age 65-74 (-11.17pp; 95%CI:-15.78,-6.56), age 75+ (-5.97pp; 95%CI:-10.85,-1.09) and female (-5.04pp; 95%CI:-7.34,-2.75).

Supplementary analysis was conducted regarding the three outcomes while removing the use of video or voice calls as a covariate and are presented in Appendix Tables 5.1-5.3. All variables in the model retain their significance.

Discussion

Patients with ADRD may have difficulties adjusting to the sudden changes in health care delivery during the COVID-19 pandemic. This study did not find significant differences between ADRD and non-ADRD Medicare enrollees in their access to or use of telehealth. This study also showed that MA enrollees had greater access to telehealth before COVID-19 but no difference in access or use of telehealth during the COVID-19 pandemic. This shows that the policy reforms to increase telehealth coverage for TM enrollees worked well to cover the TM/MA disparity in telehealth access that was present before COVID-19. While MA plans have the potential to engage in improving social determinants of health, the MA sample in this study has characteristics that may suggest they are more vulnerable (higher rates of dual-eligible, income <$25,000, more likely to have ADRD and diabetes, lower access to internet and technology) than the TM sample. Further analysis can examine if reforms such as the CHRONIC Act are functioning to their desired outcomes for improving social determinants of health for MA enrollees.

However, one limitation of this study is that it does not track Medicare plan switching between TM and MA. Previous research of the 2006-2012 MCBS showed that newly diagnosed patients with ADRD had high rates of switching from TM into MA and low rates of switching out of MA plans,[166] while more relatively recent data shows that MA enrollees with ADRD are more likely to disenroll into TM than MA

enrollees without ADRD, which may reflect that MA is not meeting the medical needs of all patients with ADRD.[167] Further longitudinal research is needed to examine causal differences in care quality between these two Medicare plans.

While ADRD was not a significant factor in telehealth use, other comorbidities such as depression and diabetes were significantly associated with greater use of telehealth. These comorbidities have a higher prevalence in the ADRD versus non-ADRD population, which means that many patients with ADRD have co-existing conditions that need to be treated alongside ADRD to ensure good health outcomes and quality of life. In particular, depression was present in almost half of the ADRD sample and has been identified as a modifiable risk factor for ADRD,[168] therefore it is crucial to ensure medical services such as telehealth are available to treat both conditions.

Race and ethnicity was a significant factor for all three outcomes, as Black Non-Hispanic Medicare enrollees were less likely to have telehealth access during COVID-19, more likely to have telehealth access before COVID-19, and more likely to use telehealth during COVID-19 compared to White Non-Hispanic enrollees. These results may seem contradictory but this supports previous research that shows that Black Non-Hispanic Medicare enrollees had higher rates of telehealth access than White Non-Hispanic enrollees before COVID-19, but during COVID-19 telehealth coverage increased the most for White Non-Hispanic enrollees and increased the least for Black Non-Hispanic enrollees, which lead to a disparity in telehealth coverage.[169] Previous research also shows that despite lower access during COVID-19, Black Medicare enrollees were more likely to use telehealth during COVID-19 than White

enrollees,[159] while other research shows that Black patients were more likely to use audio-only telehealth compared to video visits during COVID-19.[170] Further research can study telehealth satisfaction and type of telehealth used by race and ethnicity to examine disparities in telehealth access and quality.

This study used the MCBS PUFs, which is limited in the scope of study variables compared to the MCBS Limited Data Set (LDS).[171] The LDS contains data on additional demographic variables such as household composition and activities of daily living, health services utilization (ER, inpatient, drugs, etc.) for both TM and MA enrollees, monthly insurance enrollment data, payment for health care costs including those not covered by Medicare, such as co-payments, deductibles, uncovered services, and other sources such as retiree benefits, Medigap, and VA benefits. In addition, the LDS allows for longitudinal analysis across four years and can be linked to CMS Medicare claims for more detailed analyses of health care use patterns. There is also a possibility of undercounting ADRD in survey data as previous research shows improvements in identifying neuropsychiatric disorders by combining survey data with claims data.[172] Further analysis of the MCBS LDS can be combined with geographic data such as county-level MA enrollment to instrument for possible advantageous selection in MA.[162]

Conclusion

COVID-19 produced many changes in health care access and utilization for vulnerable populations such as patients with ADRD. My analysis shows that Medicare beneficiaries with ADRD did not see significant differences in telehealth access or use compared to their non-ADRD counterparts. Further longitudinal

analysis can show changes over time in how Medicare enrollees with ADRD fared during COVID-19.

Chapter 5 Tables

Table 5.1. Study Population Demographics by Alzheimer's Disease and Related Dementias (ADRD) Status

Variable	ADRD	Non-ADRD	P-value
Age			<0.0001
50-64 years	33 (0.0966)	2,095 (0.1342)	
65-74 years	75 (0.2464)	5,032 (0.5404)	
75+ years	410 (0.6570)	6,125 (0.3254)	
Female	313 (0.5814)	7,209 (0.5410)	0.1933
Race and Ethnicity			0.0038
White NH	341 (0.6870)	9,890 (0.7551)	
Black NH	51 (0.1001)	1,294 (0.0977)	
Hispanic	98 (0.1507)	1,375 (0.0856)	
Other	28 (0.0622)	693 (0.0616)	
Non-metro residence	89 (0.1486)	2,847 (0.1825)	0.1896
Region			0.4921
Northeast	89 (0.1480)	2,483 (0.1856)	
Midwest	105 (0.2053)	2,832 (0.2060)	
South	208 (0.4181)	5,047 (0.3837)	
West	116 (0.2286)	2,890 (0.2247)	
Income ≥$25,000	264 (0.5488)	8,626 (0.7148)	<0.0001
Medicare Advantage	262 (0.4640)	5,784 (0.3944)	0.0378
Dual-eligible	163 (0.2630)	2,518 (0.1384)	<0.0001
Speak language other than English at home	125 (0.2039)	1,646 (0.1148)	<0.0001
Winter 2021	288 (0.5190)	7,224 (0.5176)	0.9404
Access to Internet	303 (0.6295)	10,960 (0.8668)	<0.0001
Use video or voice calls	170 (0.3360)	6,100 (0.5062)	<0.0001
Own computer/smartphone/tablet	230 (0.5204)	10,953 (0.8691)	<0.0001
Above median preventive behaviors (≥12)	183 (0.3757)	5,825 (0.4494)	0.0034

Comorbidities			
Depression	237 (0.4592)	3,523 (0.2656)	<0.0001
Heart Condition	229 (0.4252)	4,570 (0.3237)	0.0014
Cancer	116 (0.2194)	2,738 (0.2015)	0.4692
Hypertension	382 (0.7173)	8,676 (0.6421)	0.0231
Diabetes	193 (0.3979)	4,372 (0.3394)	0.0463
Osteoporosis/broke hip	161 (0.2861)	2,834 (0.2077)	0.0004
Asthma/COPD	135 (0.2729)	2,628 (0.1933)	0.0015
Stroke	139 (0.2758)	1,242 (0.0878)	<0.0001
High cholesterol	368 (0.7248)	8,768 (0.6626)	0.0562
Immunocompromised	94 (0.1993)	2,396 (0.1902)	0.7019
Total Unweighted	518	13,252	13,770

Notes: Source: 2020 Fall and 2021 Winter Medicare Current Beneficiary Survey COVID-19 Supplements.
Total weighted population: 75,141,661. COPD: Chronic obstructive pulmonary disease.
ADRD: Alzheimer's Disease and Related Dementias. NH: Non-Hispanic.

Table 5.2. Study Population Demographics by Medicare Plan Type

Variable	Traditional Medicare	Medicare Advantage	P-value
ADRD	256 (0.0240)	262 (0.0316)	0.0378
Age			0.0046
50-64 years	1,286 (0.1349)	842 (0.1305)	
65-74 years	2,880 (0.5457)	2,227 (0.5123)	
75+ years	3,558 (0.3194)	2,977 (0.3572)	
Female	4,124 (0.5308)	3,398 (0.5594)	0.0585
Race and Ethnicity			<0.0001
White NH	6,139 (0.7921)	4,092 (0.6939)	
Black NH	604 (0.0796)	741 (0.1254)	
Hispanic	554 (0.0650)	919 (0.1215)	
Other	427 (0.0633)	294 (0.0592)	
Non-metro residence	1,998 (0.2132)	938 (0.1334)	<0.0001
Region			0.1367
Northeast	1,503 (0.1953)	1,069 (0.1681)	
Midwest	1,686 (0.2063)	1,251 (0.2054)	
South	3,010 (0.3913)	2,245 (0.3746)	
West	1,525 (0.2071)	1,481 (0.2519)	
Income ≥$25,000	5,389 (0.7650)	3,501 (0.6271)	<0.0001
Dual-eligible	1,271 (0.1123)	1,410 (0.1866)	<0.0001
Speak language other than English at home	728 (0.0935)	1,043 (0.1533)	<0.0001
Winter 2021	4,158 (0.5081)	3,354 (0.5321)	0.0022
Access to Internet	6,516 (0.8817)	4,747 (0.8280)	<0.0001
Use video or voice calls	3,697 (0.5263)	2,573 (0.4640)	<0.0001
Own computer/smartphone/tablet	6,456 (0.8795)	4,727 (0.8293)	<0.0001
Above median preventive behaviors (≥12)	3,383 (0.4503)	2,625 (0.4429)	0.5473
Comorbidities			

Depression	2,085 (0.2659)	1,675 (0.2784)	0.2359
Heart Disease	2,772 (0.3320)	2,027 (0.3180)	0.2361
Cancer	1,637 (0.2072)	1,217 (0.1939)	0.1738
Hypertension	4,931 (0.6302)	4,127 (0.6654)	0.0089
Diabetes	2,430 (0.3263)	2,135 (0.3633)	0.0094
Osteoporosis/broke hip	1,678 (0.2099)	1,317 (0.2097)	0.9835
Asthma/COPD	1,544 (0.1943)	1,219 (0.1973)	0.7463
Stroke	771 (0.0914)	610 (0.0951)	0.6144
High cholesterol	5,012 (0.6546)	4,124 (0.6789)	0.0486
Immunocompromised	1,474 (0.2004)	1,016 (0.1752)	0.0030
Total Unweighted	7,724	6,046	13,770

Notes: Source: 2020 Fall and 2021 Winter Medicare Current Beneficiary Survey COVID-19 Supplements.
Total weighted population: 75,141,661. COPD: Chronic obstructive pulmonary disease.
ADRD: Alzheimer's Disease and Related Dementias. NH: Non-Hispanic.

Table 5.3. Linear Regression of Access to Telehealth During COVID-19, Fall 2020-Winter 2021

Variable	Estimate	SE	P-value	95% CI	
ADRD	0.02205	0.03334	0.510	-0.04411	0.08821
Medicare Advantage	0.01119	0.00984	0.258	-0.00833	0.03071
ADRD*Medicare Advantage	0.02160	0.03457	0.533	-0.04698	0.09019
Age (ref 50-64 years)					
65-74 years	0.02875	0.01508	0.059	-0.00117	0.05868
75+ years	-0.01140	0.01647	0.491	-0.04408	0.02129
Female	0.00516	0.00823	0.532	-0.01118	0.02150
Race and Ethnicity (ref=White NH)					
Black NH	-0.08723	0.02006	<0.001	-0.12704	-0.04743
Hispanic	-0.02430	0.02380	0.310	-0.07153	0.02293
Other	-0.05137	0.02063	0.014	-0.09231	-0.01044
Non-metro residence	-0.09046	0.02201	<0.001	-0.13413	-0.04679
Region (ref=Northeast)					
Midwest	0.00714	0.01985	0.720	-0.03226	0.04653
South	-0.03329	0.01675	0.050	-0.06652	-0.00006
West	0.02811	0.02170	0.198	-0.01495	0.07117
Income ≥$25,000	0.03002	0.01224	0.016	0.00573	0.05430
Dual-eligible	-0.00295	0.01404	0.834	-0.03081	0.02492
Speak language other than English at home	-0.02140	0.02171	0.327	-0.06449	0.02169
Winter 2021	-0.02649	0.00794	0.001	-0.04225	-0.01072
Has internet access	0.09961	0.01625	<0.001	0.06737	0.13184
Use video or voice calls	0.05635	0.00822	<0.001	0.04004	0.07265
Own computer/smartphone/tablet	0.05326	0.01570	0.001	0.02210	0.08441
Above median preventive behaviors (≥12)	0.03481	0.00841	<0.001	0.01813	0.05148
Comorbidities					
Depression	-0.01716	0.00869	0.051	-0.03440	0.00008

Heart Disease	0.01003	0.00946	0.292	-0.00875	0.02881
Cancer	0.00139	0.00951	0.884	-0.01748	0.02027
Hypertension	-0.00009	0.00919	0.992	-0.01833	0.01815
Diabetes	0.01819	0.00966	0.063	-0.00097	0.03735
Osteoporosis/broke hip	0.00097	0.00967	0.920	-0.01822	0.02016
Asthma/COPD	0.01092	0.01049	0.300	-0.00989	0.03173
Stroke	0.00777	0.01370	0.572	-0.01941	0.03495
High cholesterol	0.00342	0.00855	0.690	-0.01355	0.02039
Immunocompromised	0.02224	0.01051	0.037	0.00138	0.04310
Constant	0.64174	0.02946	<0.001	0.58329	0.70019

Notes: Source: 2020 Fall and 2021 Winter Medicare Current Beneficiary Survey COVID-19 Supplements.
Total weighted population: 75,141,661. COPD: Chronic obstructive pulmonary disease.
ADRD: Alzheimer's Disease and Related Dementias. NH: Non-Hispanic. SE: Standard error.

Table 5.4. Linear Regression of Access to Telehealth Before COVID-19

Variable	Estimate	SE	P-value	95% CI	
ADRD	-0.01572	0.04989	0.753	-0.11471	0.08326
Medicare Advantage	0.04776	0.01552	0.003	0.01696	0.07856
ADRD*Medicare Advantage	0.01448	0.08107	0.859	-0.14638	0.17534
Age (ref 50-64 years)					
65-74 years	0.05514	0.02294	0.018	0.00962	0.10067
75+ years	0.07330	0.02227	0.001	0.02911	0.11749
Female	-0.06957	0.01271	<0.001	-0.09479	-0.04435
Race and Ethnicity (ref=White NH)					
Black NH	0.08727	0.02699	0.002	0.03371	0.14082
Hispanic	-0.08904	0.02962	0.003	-0.14781	-0.03027
Other	0.03292	0.02696	0.225	-0.02058	0.08642
Non-metro residence	-0.00043	0.02145	0.984	-0.04298	0.04212
Region (ref=Northeast)					
Midwest	0.06194	0.02072	0.004	0.02083	0.10306
South	0.01146	0.02063	0.580	-0.02948	0.05240
West	0.13926	0.04171	0.001	0.05650	0.22202
Income ≥$25,000	0.03220	0.01817	0.080	-0.00386	0.06826
Dual-eligible	-0.05206	0.02106	0.015	-0.09385	-0.01027
Speak language other than English at home	0.04021	0.02915	0.171	-0.01763	0.09805
Winter 2021	0.05072	0.01056	<0.001	0.02977	0.07167
Has internet access	-0.03554	0.02574	0.170	-0.08663	0.01554
Use video or voice calls	-0.02138	0.01174	0.072	-0.04468	0.00193
Own computer/smartphone/tablet	0.01160	0.02253	0.608	-0.03310	0.05630
Above median preventive behaviors (≥12)	0.01531	0.01233	0.217	-0.00916	0.03977
Comorbidities					
Depression	-0.03200	0.01421	0.027	-0.06020	-0.00380

Heart Disease	-0.02721	0.01620	0.096	-0.05934	0.00493
Cancer	-0.00643	0.01504	0.670	-0.03626	0.02341
Hypertension	-0.02094	0.01213	0.087	-0.04500	0.00312
Diabetes	-0.01729	0.01353	0.204	-0.04414	0.00957
Osteoporosis/broke hip	-0.01161	0.01527	0.449	-0.04191	0.01869
Asthma/COPD	0.00931	0.01543	0.548	-0.02131	0.03994
Stroke	0.04107	0.02231	0.069	-0.00320	0.08534
High cholesterol	-0.01889	0.01455	0.197	-0.04776	0.00999
Immunocompromised	-0.00515	0.01526	0.736	-0.03542	0.02512
Constant	0.21699	0.04806	<0.001	0.12164	0.31235

Notes: Source: 2020 Fall and 2021 Winter Medicare Current Beneficiary Survey COVID-19 Supplements.
Total weighted population: 42,441,634. COPD: Chronic obstructive pulmonary disease.
ADRD: Alzheimer's Disease and Related Dementias. NH: Non-Hispanic. SE: Standard error.

Table 5.5. Linear Regression of Telehealth Use During COVID-19, Fall 2020-Winter 2021

Variable	Estimate	SE	P-value	95% CI	
ADRD	-0.01065	0.04768	0.824	-0.10526	0.08396
Medicare Advantage	-0.01561	0.01301	0.233	-0.04143	0.01021
ADRD*Medicare Advantage	0.00212	0.06464	0.974	-0.12614	0.13039
Age (ref 50-64 years)					
65-74 years	-0.11173	0.02324	<0.001	-0.15784	-0.06561
75+ years	-0.05966	0.02460	0.017	-0.10847	-0.01086
Female	-0.05044	0.01156	<0.001	-0.07337	-0.02750
Race and Ethnicity (ref=White NH)					
Black NH	0.06521	0.01791	<0.001	0.02966	0.10076
Hispanic	0.05595	0.02946	0.060	-0.00249	0.11440
Other	0.00783	0.02622	0.766	-0.04420	0.05986
Non-metro residence	-0.02584	0.02586	0.320	-0.07715	0.02548
Region (ref=Northeast)					
Midwest	-0.03442	0.02750	0.214	-0.08898	0.02014
South	0.00796	0.02203	0.719	-0.03575	0.05166
West	0.05681	0.02371	0.018	0.00977	0.10385
Income ≥$25,000	-0.01442	0.01646	0.383	-0.04709	0.01824
Dual-eligible	0.03469	0.02449	0.160	-0.01389	0.08328
Speak language other than English at home	-0.01931	0.02530	0.447	-0.06950	0.03088
Winter 2021	-0.00455	0.01077	0.673	-0.02591	0.01681
Has internet access	-0.00355	0.02074	0.865	-0.04471	0.03761
Use video or voice calls	0.16566	0.01241	<0.001	0.14103	0.19029
Own computer/smartphone/tablet	-0.02995	0.02213	0.179	-0.07386	0.01397
Above median preventive behaviors (≥12)	0.05623	0.01046	<0.001	0.03548	0.07698
Comorbidities					
Depression	0.05626	0.01122	<0.001	0.03399	0.07852

Heart Disease	0.04319	0.01319	0.001	0.01702	0.06936
Cancer	0.09476	0.01427	<0.001	0.06645	0.12306
Hypertension	0.03297	0.01373	0.018	0.00573	0.06021
Diabetes	0.05251	0.01275	<0.001	0.02722	0.07780
Osteoporosis/broke hip	0.04449	0.01277	0.001	0.01916	0.06983
Asthma/COPD	0.04206	0.01556	0.008	0.01119	0.07292
Stroke	0.01498	0.02052	0.467	-0.02574	0.05570
High cholesterol	0.01092	0.01105	0.325	-0.01099	0.03284
Immunocompromised	0.10534	0.01485	<0.001	0.07587	0.13482
Constant	0.33371	0.04064	<0.001	0.25307	0.41436

Notes: Source: 2020 Fall and 2021 Winter Medicare Current Beneficiary Survey COVID-19 Supplements.
Total weighted population: 60,966,722. COPD: Chronic obstructive pulmonary disease.
ADRD: Alzheimer's Disease and Related Dementias. NH: Non-Hispanic. SE: Standard error.

Appendix Table 5.1. Linear Regression of Access to Telehealth During COVID-19, Fall 2020-Winter 2021

Variable	Estimate	SE	P-value	95% CI	
ADRD	0.022810	0.033446	0.497	-0.04355	0.08917
Medicare Advantage	0.009820	0.009850	0.321	-0.00973	0.02936
ADRD*Medicare Advantage	0.021870	0.034626	0.529	-0.04684	0.09058
Age (ref 50-64 years)					
65-74 years	0.028702	0.015214	0.062	-0.00149	0.05889
75+ years	-0.016304	0.016441	0.324	-0.04893	0.01632
Female	0.007574	0.008394	0.369	-0.00908	0.02423
Race and Ethnicity (ref=White NH)					
Black NH	-0.087631	0.019987	<0.001	-0.12729	-0.04797
Hispanic	-0.025983	0.023760	0.277	-0.07313	0.02116
Other	-0.051217	0.020494	0.014	-0.09188	-0.01055
Non-metro residence	-0.096877	0.022616	<0.001	-0.14175	-0.05200
Region (ref=Northeast)					
Midwest	0.005664	0.020397	0.782	-0.03481	0.04614
South	-0.035990	0.016979	0.037	-0.06968	-0.00230
West	0.030080	0.022098	0.177	-0.01377	0.07393
Income ≥$25,000	0.038722	0.012341	0.002	0.01424	0.06321
Dual-eligible	-0.002687	0.014084	0.849	-0.03063	0.02526
Speak language other than English at home	-0.021689	0.021424	0.314	-0.06420	0.02082
Winter 2021	-0.023182	0.007984	0.005	-0.03902	-0.00734
Has internet access	0.112948	0.016063	<0.001	0.08108	0.14482
Own computer/smartphone/tablet	0.064307	0.016030	<0.001	0.03250	0.09611
Above median preventive behaviors (≥12)	0.037717	0.008500	<0.001	0.02085	0.05458
Comorbidities					
Depression	-0.017344	0.008800	0.052	-0.03481	0.00012
Heart Disease	0.009939	0.009324	0.289	-0.00856	0.02844

Cancer	0.002906	0.009449	0.759	-0.01584	0.02165
Hypertension	-0.001782	0.009060	0.844	-0.01976	0.01620
Diabetes	0.016960	0.009711	0.084	-0.00231	0.03623
Osteoporosis/broke hip	0.001125	0.009728	0.908	-0.01818	0.02043
Asthma/COPD	0.009139	0.010451	0.384	-0.01160	0.02988
Stroke	0.006838	0.013739	0.620	-0.02042	0.03410
High cholesterol	0.003257	0.008696	0.709	-0.01400	0.02051
Immunocompromised	0.024784	0.010440	0.020	0.00407	0.04550
Constant	0.644144	0.029104	<0.001	0.58639	0.70189

Notes: Source: 2020 Fall and 2021 Winter Medicare Current Beneficiary Survey COVID-19 Supplements.
Total weighted population: 75,141,661. COPD: Chronic obstructive pulmonary disease.
ADRD: Alzheimer's Disease and Related Dementias. NH: Non-Hispanic. SE: Standard error.

Appendix Table 5.2. Linear Regression of Access to Telehealth Before COVID-19

Variable	Estimate	SE	P-value	95% CI	
ADRD	-0.01661	0.04986	0.740	-0.11554	0.08232
Medicare Advantage	0.04807	0.01550	0.003	0.01732	0.07883
ADRD*Medicare Advantage	0.01509	0.08128	0.853	-0.14618	0.17637
Age (ref 50-64 years)					
65-74 years	0.05514	0.02285	0.018	0.00980	0.10049
75+ years	0.07524	0.02211	0.001	0.03136	0.11912
Female	-0.07035	0.01269	<0.001	-0.09554	-0.04516
Race and Ethnicity (ref=White NH)					
Black NH	0.08745	0.02700	0.002	0.03389	0.14101
Hispanic	-0.08903	0.02959	0.003	-0.14773	-0.03032
Other	0.03357	0.02719	0.220	-0.02038	0.08752
Non-metro residence	0.00197	0.02149	0.927	-0.04067	0.04460
Region (ref=Northeast)					
Midwest	0.06208	0.02074	0.003	0.02093	0.10322
South	0.01215	0.02074	0.559	-0.02900	0.05330
West	0.13872	0.04185	0.001	0.05568	0.22175
Income ≥$25,000	0.02888	0.01825	0.117	-0.00733	0.06510
Dual-eligible	-0.05235	0.02107	0.015	-0.09416	-0.01054
Speak language other than English at home	0.04059	0.02925	0.168	-0.01745	0.09863
Winter 2021	0.04929	0.01070	<0.001	0.02805	0.07052
Has internet access	-0.04066	0.02554	0.114	-0.09134	0.01001
Own computer/smartphone/tablet	0.00761	0.02213	0.732	-0.03630	0.05152
Above median preventive behaviors (≥12)	0.01438	0.01222	0.242	-0.00987	0.03863
Comorbidities					
Depression	-0.03227	0.01422	0.025	-0.06049	-0.00405
Heart Disease	-0.02711	0.01626	0.099	-0.05937	0.00514

Cancer	-0.00684	0.01501	0.650	-0.03662	0.02294
Hypertension	-0.02002	0.01203	0.099	-0.04389	0.00384
Diabetes	-0.01689	0.01347	0.213	-0.04362	0.00983
Osteoporosis/broke hip	-0.01163	0.01537	0.451	-0.04212	0.01887
Asthma/COPD	0.01023	0.01530	0.505	-0.02013	0.04059
Stroke	0.04169	0.02226	0.064	-0.00248	0.08585
High cholesterol	-0.01870	0.01461	0.203	-0.04769	0.01028
Immunocompromised	-0.00616	0.01532	0.688	-0.03656	0.02423
Constant	0.21562	0.04816	<0.001	0.12006	0.31118

Notes: Source: 2020 Fall and 2021 Winter Medicare Current Beneficiary Survey COVID-19 Supplements.
Total weighted population: 42,441,634. COPD: Chronic obstructive pulmonary disease.
ADRD: Alzheimer's Disease and Related Dementias. NH: Non-Hispanic. SE: Standard error.

Appendix Table 5.3. Linear Regression of Telehealth Use During COVID-19, Fall 2020-Winter 2021

Variable	Estimate	SE	P-value	95% CI	
ADRD	-0.00286	0.04873	0.953	-0.09956	0.09384
Medicare Advantage	-0.01848	0.01309	0.161	-0.04445	0.00749
ADRD*Medicare Advantage	-0.00715	0.06462	0.912	-0.13537	0.12107
Age (ref 50-64 years)					
65-74 years	-0.11199	0.02307	<0.001	-0.15777	-0.06622
75+ years	-0.07441	0.02427	0.003	-0.12256	-0.02625
Female	-0.04396	0.01183	<0.001	-0.06743	-0.02050
Race and Ethnicity (ref=White NH)					
Black NH	0.06402	0.01834	0.001	0.02763	0.10041
Hispanic	0.05388	0.03054	0.081	-0.00672	0.11447
Other	0.00557	0.02653	0.834	-0.04708	0.05822
Non-metro residence	-0.04367	0.02681	0.107	-0.09687	0.00953
Region (ref=Northeast)					
Midwest	-0.03832	0.02940	0.195	-0.09665	0.02001
South	0.00157	0.02374	0.948	-0.04554	0.04867
West	0.06231	0.02480	0.014	0.01309	0.11153
Income ≥$25,000	0.01305	0.01644	0.429	-0.01956	0.04566
Dual-eligible	0.03813	0.02462	0.125	-0.01072	0.08699
Speak language other than English at home	-0.02122	0.02560	0.409	-0.07202	0.02958
Winter 2021	0.00621	0.01055	0.557	-0.01472	0.02715
Has internet access	0.03619	0.02091	0.087	-0.00529	0.07768
Own computer/smartphone/tablet	0.00274	0.02207	0.902	-0.04106	0.04653
Above median preventive behaviors (≥12)	0.06406	0.01053	<0.001	0.04317	0.08495
Comorbidities					
Depression	0.05707	0.01138	<0.001	0.03450	0.07965

Heart Disease	0.04271	0.01278	0.001	0.01736	0.06805
Cancer	0.09807	0.01393	<0.001	0.07043	0.12571
Hypertension	0.02730	0.01374	0.050	0.00004	0.05455
Diabetes	0.04718	0.01248	<0.001	0.02241	0.07195
Osteoporosis/broke hip	0.04482	0.01278	0.001	0.01948	0.07017
Asthma/COPD	0.03708	0.01565	0.020	0.00603	0.06813
Stroke	0.01328	0.02038	0.516	-0.02715	0.05372
High cholesterol	0.01086	0.01123	0.336	-0.01142	0.03313
Immunocompromised	0.11267	0.01489	<0.001	0.08312	0.14221
Constant	0.34047	0.04165	<0.001	0.25784	0.42310

Notes: Source: 2020 Fall and 2021 Winter Medicare Current Beneficiary Survey COVID-19 Supplements.
Total weighted population: 60,966,722. COPD: Chronic obstructive pulmonary disease.
ADRD: Alzheimer's Disease and Related Dementias. NH: Non-Hispanic. SE: Standard error.

Chapter 6: Conclusion and Future Studies

This dissertation presents timely evidence on health services use patterns for patients with ADRD within the context of COVID-19. Here I review the research and provide guidelines for future studies.

Chapter 3 examined the change in trends of health care utilization that arise from COVID-19. The number of monthly ED visits declined by almost 4,000 at the beginning of COVID-19, however, the monthly trend during COVID-19 flattened compared to a declining trend before COVID-19. This matches previous research that saw a decline in ED visits when COVID-19 started but then the trend also flattened over time.[173] However, there was no change in preventable ED rate during COVID-19, which is different from other research which shows a decrease in preventable ED visits during COVID-19 for the general population.[174,175] Since this study examined the ADRD population, this finding emphasizes that patients with ADRD are vulnerable to using the ED for preventable purposes during a pandemic even when the general population is less likely to have a preventable ED visit. Future research can examine the specific diagnoses that lead to excessive rates of preventable ED visits for patients with ADRD.

In addition, the number of monthly hospitalizations had a modest decline during COVID-19, although the monthly trend flattened during COVID-19 whereas it was decreasing before COVID-19. This shows that the beginning of COVID-19 saw a significant decline but stabilized due to the need for all-purpose hospital services despite the heightened risk of COVID-19 transmission in these settings. The rate of

PPH saw a decline after COVID-19 began and the trend changed from increasing to decreasing, this shows that hospitalizations for acute and chronic conditions decreased possibly due to patients wanting to avoid the risk of prolonged exposure to COVID-19 and other diseases if they can avoid the hospital for potentially preventable conditions. Future work can examine the specific types of PPH that saw reductions during COVID-19 for patients with ADRD.

Finally, office/clinic visits had a decreasing trend before COVID-19 and declined at the beginning of COVID-19 but the trend after COVID-19 became increasing. This shows that there is still a large demand for office/clinic visits during a pandemic and doctors are needed to be available for patients with ADRD and other complex health needs. The rate of telehealth visits rapidly increased immediately after COVID-19 and then remained between 5-10% for the rest of the year even though it was almost 0% before COVID-19. This shows that telehealth is an important aspect of delivering health services that merits future research into the best practices for telehealth delivery for patients with ADRD. Further research can determine if patients with ADRD want to continue the use of telehealth as a medium to obtain health services after the COVID-10 pandemic.

Chapter 4 examined the rate of PPH for Managed Medicaid enrollees with ADRD before and during COVID-19 with a focus on Medicaid expansion. MM enrollees in expansion states had lower rates of PPH, and the PPH rate was lower during COVID-19 compared to before, however, the difference in PPH rates between expansion and non-expansion states during COVID-19 did not change, which suggests that Medicaid expansion was not associated with improved health care

access or outcomes for the ADRD population during COVID-19. This may suggest that Medicaid expansion is not adequate to ensure access to ambulatory care during COVID-19, which is the main implication of PPHs. Future work can determine if other reforms to Medicaid such as increasing provider acceptance of Medicaid or increasing payments to providers to match Medicare payments will help Medicaid enrollees with ADRD receive additional benefits to their quality and access to health care.

Chapter 5 examined telehealth access before and during COVID-19 and telehealth use during COVID-19 for Medicare enrollees with a focus on the ADRD population and enrollees by TM or MA. The results did not show a difference between ADRD and non-ADRD counterparts in access to or use of telehealth, this may show that telehealth is useful for ADRD disease management. However, there were some racial and regional disparities in access to telehealth during COVID-19. This is crucial for policymakers to create targeted reforms to promote equitable access to telehealth and also determinants of telehealth such as internet and technology access. Future analysis can also examine the needs of patients with ADRD patients who have additional comorbidities such as diabetes and depression to examine if telehealth is adequately providing these services as these conditions may have been exacerbated during the COVID-19 pandemic.

Overall, this dissertation showed that patients with ADRD used fewer health services in all forms except for telehealth during COVID-19. Future analysis can examine the role of additional social determinants of health such as county-level access to doctors to study additional factors that affect health services use. In

addition, future analysis can study the sociodemographic and health care access factors that contribute to patient mortality during COVID-19 to ensure that vulnerable patients can receive adequate health care during a period of limited health services.

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