Are Provider-Insurer Integrations Associated with Preventable Care Use and Contact Days Through Care Coordination?

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Abstract

Vertical integrations of healthcare organizations and insurance companies (provider-insurer integrations) are increasingly prominent in the U.S. Theoretically, they may raise anticompetitive concerns but can also reduce unnecessary care use and improve care quality by facilitating coordination. Over half of enrollment in health plans offered by these integrations was in Medicaid. However, evidence remains limited.

Combining 2015 – 2020 Wisconsin Medicaid claims data with self-collected integration information, I investigate the relationship between five degrees of provider-insurer integration and preventable care use, as well as contact days—a novel measure intended to reflect patient care burden. I further assess the extent to which care coordination, measured by visit concentration and care density, may mediate these relationships.

Key findings indicate that, relative to enrollees who experienced no integration, those enrolled in an integrated health maintenance organization (HMO) or attributed to an integrated health system were associated with 4-19% fewer contact days. Enrollees attributed to an integrated health system, regardless of whether they were with an integrated HMO, were associated with 8-11% more hospitalizations. Enrollees with an integrated HMO and attributed to an integrated health system owned by the same parent organization (the highest degree of integration) had 4% fewer avoidable emergency department visits. Mediation through care coordination was modest only for enrollees with the highest degree of integration, while minimal for others. The direction of mediated associations may vary across care coordination measures.

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These findings suggest that antitrust authorities should pay greater attention to inpatient services when evaluating provider-insurer integration cases. Leaders of provider-insurer integrated systems may benefit from tailoring care coordination strategies according to organizational goals.

Keywords: Vertical Integration, Provider-Insurer Integration, Contact Days, Care Coordination, Mediation Analysis.

Acknowledgments

The author gratefully acknowledges Marguerite Burns, John Mullahy, and Justin Sydnor for their support with data acquisition and for their insightful comments. The author also appreciates the helpful feedback from Rainer Kotschy, Dennis Lee, Kenneth Nieser, Yu-Chu Shen, Weiliang Tan, and participants in the Spring 2025 Health Economics PhD Seminar at Harvard Medical School's Department of Health Care Policy. The author further thanks the Institute for Research on Poverty at the University of Wisconsin–Madison for assistance with data organization.

The author also thanks the Wisconsin Department of Health Services and the Wisconsin Office of the Commissioner of Insurance for providing the data and information used in this study. However, these agencies do not certify the accuracy of the analyses presented. The author is solely responsible for the content therein.

1. Introduction

Vertical integrations of healthcare organizations and insurance companies (hereafter referred to as "provider-insurer integrations") have arisen in multiple countries, including Chile, Greece, and the U.S. (Noton & Stenimachitis, 2022). Driven by value-based payment reform, these integrations have become increasingly prominent in the U.S. (Allan Baumgarten, LLC, 2017; Abou-Atme et al., 2019). As of 2023, approximately 30% of U.S. health systems were offering insurance products (Agency for Healthcare Research and Quality [AHRQ], Rockville, MD, 2024). Large insurance companies, such as UnitedHealth Group and Humana, have been expanding their businesses in care delivery (Rooke-Ley et al., 2024).

Provider-insurer integrations raise concerns about inflating risk-adjusted government payments and steering patients from rivals to integrated insurers (or providers) (Rooke-Ley et al., 2024), but they also have the potential to facilitate care coordination and reduce unnecessary care use (Eggleston et al., 2004; Enthoven & Baker, 2018; Agha et al., 2023). The 2023 Merger Guidelines issued by the U.S. Department of Justice and the Federal Trade Commission convey a more skeptical impression of vertical integrations than previous guidelines, which may lead to greater scrutiny and more challenges to relevant cases (Carlton, 2024; Rooke-Ley et al., 2024). However, evidence on provider-insurer integrations remains limited. These integrations vary in the levels of care they own and the insurance markets in which they offer health plans. Most prior empirical studies identify these integrations based on a provider's participation in a single insurance market, such as Medicare Advantage. Few studies on this topic investigate the potential mechanisms or clearly reflect the role of firm boundaries (Frakt et al., 2013; Johnson et al., 2017; Howard et al., 2018; Meyers et al., 2020).

In this paper, I investigate the relationship between provider-insurer integrations and preventable care utilization, as well as contact days—an outcome intended to reflect patient care burden. I also assess the extent to which care coordination may explain these relationships through a mediation analysis. I use two measures—visit concentration and care density—to capture distinct aspects of care coordination. The findings can assist antitrust regulators in assessing the potential implications of provider–insurer

integration cases and help healthcare leaders make decisions on investments in care coordination strategies.

This study combines 2015-2020 claims data from Wisconsin Medicaid health maintenance organizations (HMOs) with self-collected information on various forms of provider-insurer integrations beyond Medicaid markets. Wisconsin has a long history of integrated health plans—insurance products offered by provider-insurer integrated systems— dating back to the 1970s (Security Health Plan of Wisconsin, 2021). Enrollment in these plans in Wisconsin ranked in the highest quartile in the U.S. as of 2014-2015 (Copeland et al., 2015; Johnson et al., 2017). The collected data include details on the levels of care (e.g., primary care, acute care, or long-term care) an integrated system owns and the insurance markets in which it competes (e.g., Medicare Advantage, Medicaid HMO, or Commercial).

The results show that, relative to enrollees who experienced no integration, enrollees either with an integrated HMO or attributed to an integrated health system were associated with 4.1-19.1% fewer contact days. An integrated health system is defined as one that belonged to a provider-insurer integrated system (see Section 3.2 for details). Enrollees attributed to integrated health systems, regardless of whether they were enrolled in an integrated HMO, were associated with 8.1-11.1% more hospitalizations. Enrollees with an integrated HMO and attributed to an integrated health system owned by the same parent organization—the highest degree of provider-insurer integration—had 4.3% fewer avoidable emergency department (ED) visits. Mediation through care coordination, measured by either visit concentration or care density, was modest only for enrollees with the highest degree of provider-insurer integration, while minimal for others. In addition, the direction of mediated associations may vary across care coordination measures.

Given the emphasis on care coordination, this paper differs from most prior studies in the literature on provider-insurer integrations in two aspects. First, I focus on integrations of primary or higher-level care providers and insurers rather than hospital-insurer integrations (Howard et al., 2018; La Forgia et al., 2018; Meyers et al., 2020; Park et al., 2023). This is because primary care providers play a crucial role in care coordination (Bodenheimer, 2008; Wagner et al., 2014; David et al., 2018). Second,

this paper distinguishes enrollees whose HMO and attributed health system were both owned by the same provider–insurer integrated system (hereafter referred to as the "integrated system" or "parent organization") from those whose HMO was owned by one integrated system, while their attributed health system was owned by a different integrated system. This distinction enables the analysis to more clearly capture firm boundaries and to incorporate the dynamics of mergers and acquisitions between integrated systems (Liang & Mullahy, 2025).

In addition, I use a novel outcome—contact days—intended to measure quality of care from a patient-centered perspective. Contact days are days on which a patient interacts with healthcare services outside the home. The number of contact days reflects how much of a patient's life is consumed by receiving healthcare. From a patient's perspective, fewer contact days may indicate a lower care burden (Burke et al., 2020; Ganguli, 2024; Gupta et al., 2025). Previous research has shown that contact days are significantly associated with care satisfaction with an inverted U-shaped distribution (Daley et al., 2025).

Although this study does not fully meet the no-confounding assumptions required for causal inference in mediation analysis (VanderWeele, 2015), it satisfies the temporal-ordering presuppositions and includes a rich set of covariates to mitigate potential confounding. Specifically, the study design ensures that enrollees' degree of provider-insurer integration (treatment) is settled before changes in care coordination (mediator), which in turn precede changes in preventable care use and contact days (outcomes). The analysis controls for individual enrollees' demographic and socioeconomic characteristics and their diagnosed chronic conditions. It also adjusts for health system admission volume and the number of operating states as proxies for operational features (Hedquist et al., 2024).

Additionally, I extend the analysis along two dimensions to address potential biases. The first extension repeats the main analysis with care coordination measured over various timeframes—from six months to twelve months—in a subgroup. The longer an enrollee stays in the same degree of provider-insurer integration (also referred to as "degree of integration"), the more likely that degree of integration affects the enrollee's care use through care coordination. This extension shows similar results to the main analysis (see Sections 5.2 and 6.2 for details). In the second extension, I divide the study period into four

subperiods based on the timing of two major events—a merger and an acquisition—which influenced the integration status for health systems that treat approximately 15–25% of the study sample, as well as the onset of the COVID-19 pandemic. This approach helps hold the composition of integrated health systems relatively constant within each period. Some variation in results across subperiods suggests that unobserved health system characteristics may have driven the association between integrated health systems and increased hospitalizations (see Sections 5.2 and 6.3 for details).

I also conduct several sensitivity analyses: (1) incorporating individual fixed effects, aiming to control for unobserved patient characteristics; (2) including HMO market share—measured at the state or regional level—as a proxy for health plan operational features that may affect care coordination; and (3) transforming numeric care density values into a "low/high" binary indicator to assess the robustness of results to the measurement construction.

The paper proceeds as follows. Section 2 briefly reviews the background of provider-insurer integrations and the role of care coordination in vertically integrated systems. Section 3 introduces the data used in the study and explains the identification of provider-insurer integrations. Section 4 describes the outcome and care coordination measures, as well as some descriptive statistics. Section 5 explains the empirical mediation analysis. Section 6 presents and discusses the results. Section 7 concludes.

2. Background

2.1. Provider-Insurer Integrations

Vertical integration refers to the ownership of two single-output production processes, where the output of one serves as (part or all of) the intermediate input for the other (Perry, 1989). Provider-insurer integrations can be classified into three main forms: a provider owns an insurer, an insurer owns a provider, or both are owned by the same parent company (Liang & Mullahy, 2025). These integrations may arise because providers seek greater control over the premium dollars or aim to defend against losing patients to other providers, while insurers may want to pay for quality rather than volume (Allan Baumgarten, LLC, 2017; Liang & Mullahy, 2025).

Provider-insurer integrations have a long history in the U.S. and have become increasingly important. These integrations can be traced back to the nineteenth century (Liang & Mullahy, 2025). They have undergone several waves, with the most recent driven by the pay-for-value initiatives prompted under the Affordable Care Act (ACA) (Allan Baumgarten, LLC, 2017). Enrollment in integrated health plans grew at an average of 6% annually from 2011 to 2017, which is twice the growth rate of the overall insurance market (Abou-Atme et al., 2019). From 2016 to 2022, approximately 40% of U.S. hospitals belonged to health systems offering insurance products (Liang & Mullahy, 2025). The prominent integrated health system, Kaiser Permanente, is acquiring leading community-based health systems outside California (Kaiser Permanente, 2024).

Economic models suggest that vertical integration can either increase or decrease welfare, depending on product, market and customer features (Liang & Mullahy, 2025). Provider-insurer integrations pose antitrust concerns, such as raising rivals' costs and creating barriers to market entry (Douven et al., 2014; Cuesta et al., 2025; De Stefano & Salinger, 2025). However, these integrations could also mitigate contractual problems, align incentives, facilitate care coordination, and eliminate double marginalization between the integrated provider and insurer (Spengler, 1950; De Stefano & Salinger, 2025; Williamson, 1971; Holmstrom, 1999; Hart & Holmstrom, 2010), all of which could improve care quality and reduce unnecessary care use (Eggleston et al., 2004; Enthoven & Baker, 2018; Agha et al., 2023).

This study adds to the literature on provider-insurer integrations by focusing on Medicaid populations, employing a novel outcome measure—contact days—and exploring potential mechanisms. Although more than half of provider-integrated health plan enrollments are in Medicaid markets (Abou-Atme et al., 2019), few studies have examined the impacts of integrated systems in these markets. Medicaid populations have historically exhibited high use of emergency department (ED) visits and potentially preventable hospitalizations (Kim et al., 2017; Cairns et al., 2023; Weissman et al., 1992), which can be reduced through improvements in care coordination (Bakshi et al., 2022; Katz et al., 2012; Nyweide et al., 2013). Prior empirical research has found that provider-insurer integrations may offer

higher quality health plans, and are associated with lower mortality rates and fewer intensive care unit (ICU) admissions (Frakt et al., 2013; Johnson et al., 2017; Meyers et al., 2020). The results on contact days from this study add insight into quality of care from a patient-centered perspective. Furthermore, few prior studies have investigated the potential pathways underlying these associations, which this paper aims to shed light on.

2.2. Care Coordination

In this paper, I focus on provider-insurer integrations' channel through care coordination because it plays a vital role in improving health outcomes and controlling health care costs (McDonald et al., 2014; Burns et al., 2021). Care coordination is the deliberate organization of care involving multiple participants, including the patient. It facilitates the transition of care responsibilities and care information and can help reduce patient wait times, transportation burdens, and unnecessary care use (McDonald et al., 2014; Dong et al., 2018; Bakshi et al., 2022; Oluyede et al., 2022).

Theoretically, provider-insurer integrations can facilitate the exchange of information and alignment of expectations between the integrated provider and insurer (Williamson, 1971). An insurer belonging to an integrated system may assist in transferring care information and responsibilities across care practitioners affiliated with the same integrated system. Moreover, vertical integration may improve the likelihood of adopting common standards between previously separate entities because of reduced concerns over uneven benefit distribution (Hart & Holmstrom, 2010). This could encourage care delivery redesign and reduce the need for preauthorization processes, both streamlining care and improving continuity (Steele & Dafny, 2016; Freese Decker & Lee, 2020).

Results of this study suggest that the mixed impacts of structural integrations on care coordination may result from their variable influence on different care coordination activities, which could counterbalance each other in terms of targeted outcomes. Prior research has shown that higher continuity of care is associated with lower rates of potentially preventable hospitalizations (Nyweide et al., 2013), and that care coordination programs can reduce repeated ED visits (Bakshi et al., 2022; Katz et al., 2012). However, the evidence supporting a causal link between structural integration and care coordination is

weak (Burns et al., 2021). This may be due to the multifaceted nature of care coordination, which can occur at various levels of healthcare systems—interpersonal and inter-organizational, among providers, or between patients and providers (Taplin & Rodgers, 2010; Weaver et al., 2018; Burns et al., 2021).

In this study, I use two measures—visit concentration and care density—to capture distinct aspects of care coordination. Visit concentration represents potential challenges a patient faces when seeking care from multiple providers, while care density reflects the likelihood of existing professional relationships between distinct providers a patient sees (Barnett et al., 2011; Pollack et al., 2013, 2016). A patient could have low visit concentration but high care density. Leaders in provider-insurer integrated systems may consider adjusting care coordination emphases in response to their goals.

3. Data and Study Setting

3.1. Wisconsin BadgerCare Plus

A main data source is the enrollment and claims data of Wisconsin BadgerCare Plus HMO adult enrollees from the Wisconsin Administrative Data Core, as shown in Table 1. BadgerCare Plus is a full-benefit Medicaid program in Wisconsin. During the study period, individuals eligible for BadgerCare Plus included former foster care youth under the age of 26; children and pregnant individuals with income below 306% of the federal poverty level (FPL); parents and caretakers, and childless adults with income below 100% of the FPL (BadgerCare Plus Handbook 15-01, 2015; BadgerCare Plus Handbook 22-01, 2022). With the exception of residents in a few counties,[2] most BadgerCare Plus beneficiaries were required to enroll in an HMO (ForwardHealth, 2016, 2019; Wisconsin Department of Health Services, 2016). From 2015 to 2020, BadgerCare Plus HMOs covered 60 – 65% of Medicaid beneficiaries in Wisconsin (Data.Medicaid.gov, 2024a, 2024b).

The enrollment data include demographic information (age, sex, race, and ethnicity), socioeconomic details (income, education, and county of residence), the HMO in which an individual was

[2] Buffalo, Richland (Jan 2015-Dec 2018), Menominee (Jan 2015-Dec 2020) counties.

enrolled, and the effective and end dates of HMO enrollment. The claims data include dates and diagnoses of emergency department visits, outpatient visits, and hospitalizations.

In this study, I focus on non-disabled individuals aged 19 – 64 who were enrolled in BadgerCare Plus HMOs from January 2015 to December 2020 and exclude enrollees residing in counties where BadgerCare Plus HMO enrollment was not mandatory from the analysis (hereafter referred to as "adult enrollees of BadgerCare Plus HMOs"), totaling more than 21.3 million person-months.

3.2. Identifying Provider-Insurer Integrations

Data for Identification

I define a provider-insurer integrated system as one that (1) is formed through vertical integration of an insurance company and a primary care or higher level care provider in Wisconsin, and (2) offers insurance products that cover individuals beyond the system's employees.

Provider-insurer integrated systems were identified by combining information from financial examination reports issued by the Wisconsin Office of the Commissioner of Insurance, Health System Compendium 2016–2021 data files from the AHRQ (hereafter referred to as the "AHRQ Compendium"); the 2017 Hospital Survey Data Set from the Wisconsin Hospital Association Information Center, as well as website descriptions of insurance companies and health systems, press releases, annual reports, and relevant news articles (listed in Table 1). This study standardizes the timing of ownership changes by assuming that changes take effect on the first day of the month in which the relevant announcement is released. This simplification is based on the fact that ownership changes—including mergers, acquisitions, and the introduction of new insurance products—typically take months or even years to fully implement.

Degree of Provider-Insurer Integration Experienced by an Individual

This study classifies adult enrollees of BadgerCare Plus HMOs into five mutually exclusive groups based on the degree of provider-insurer integration they experienced, using three binary criteria: (1) whether the enrollee was enrolled in an integrated HMO; (2) whether the enrollee's predominant care

provider was affiliated with an integrated health system (i.e., whether the enrollee was "attributed" to an integrated health system); and, conditional on both being integrated, (3) whether the enrollee's HMO and the attributed health system were partially or fully owned by the same parent organization—whether they were "integrated" with each other.

A greater number of "integrated" responses indicates a higher degree of provider-insurer integration experienced by the enrollee. For each enrollee, I denote the responses by (a_1, a_2, a_3), where $a_j = 1$ if the response to criterion j is "integrated", and $a_j = 0$ otherwise. By construction, a_3 can equal 1 only when both $a_1 = 1$ and $a_2 = 1$.

Therefore, as shown in Table 2, Group 0 represents enrollees with three "non-integrated" responses, denoted (0, 0, 0) and reflects no integration. Group 4 consists of enrollees with three "integrated" responses, denoted (1, 1, 1), representing the highest degree of provider-insurer integration. The intermediate categories are defined as follows: Group 1 corresponds to (0, 1, 0), representing a non-integrated HMO and an integrated health system; Group 2 corresponds to (1, 0, 0), representing an integrated HMO and a non-integrated health system; and Group 3 corresponds to (1, 1, 0), indicating an integrated HMO and an integrated health system that were not integrated with each other.

Identifying the Predominant Provider of an Enrollee

Following the methods of Bynum et al., (2007) and Landon et al.,(2013), I attribute enrollees to their predominant provider, defined as the provider with whom they had the plurality of evaluation and management (E/M) visits in outpatient settings each quarter. Providers are identified using National Provider Identifiers (NPIs) in claim data (see Appendix B for details).

This study focuses on E/M visits with providers whose primary or secondary practice locations are in Wisconsin or bordering states.[3]Approximately 2.6% of E/M claims were excluded due to the

[3] Wisconsin Medicaid only covers non-emergency care with enrolled care providers without pre-authorization in most cases, the enrolled care providers must be practicing or located in Wisconsin or border states for providing in-person care, they may located in a state that does not physically border Wisconsin but provides only telehealth services (see Appendix A for details).

restriction on practice location. Additionally, I treat individual providers and facilities as equivalent in the process (see Appendix B for details). Most E/M claims are associated with an individual clinician. However, because of incomplete information on the rendering provider and variation in billing behaviors, approximately 12% of E/M claims for adult enrollees of BadgerCare Plus HMOs are with facility providers. A provider's practice location and whether a provider is an individual or a facility are determined using information from the National Plan and Provider Enumeration System (NPPES) downloadable file released in March 2021.

Identifying the Integration Status of the Predominant Provider

I assign providers, either individual clinicians or non-hospital facilities, who treated adult enrollees of BadgerCare Plus HMOs in outpatient settings to the hospital where a plurality of their patients had admissions during a given semiannual period. Hospitals are then linked to health systems based on the AHRQ Compendium data files. I consider a provider affiliated with the health system to which their assigned hospital is linked. If a provider's health system is owned by an integrated system, the provider is considered affiliated with that integrated system (see Appendix C for details).

In this process, each patient's hospitalizations are counted only once per provider per hospital to reduce bias from patients with frequent hospitalizations. If an enrollee's predominant provider is a hospital, no assignment is needed. If a hospital is not linked to any health system in the AHRQ Compendium, it is treated as a health system itself. This study focuses on hospitals located in Wisconsin or bordering states that had annual admissions of BadgerCare Plus HMO adult enrollees above the 25th percentile among Wisconsin hospitals. This restriction excluded hospitals accounting for approximately 1.1% of admissions among adult enrollees of BadgerCare Plus HMOs.

In the end, approximately 73% of observations for adult enrollees of BadgerCare Plus HMOs are successfully attributed to a predominant provider whose hospital affiliation is linked to a health system. An enrollee is considered attributed to the health system with which their predominant provider is affiliated.

3.3. Inclusion Criteria

The unit of analysis in this study is the person-quarter. I apply inclusion criteria to ensure that, for both the current and previous calendar quarters (six months): (1) the enrollee[4] stayed in the same HMO and the HMO's integration status did not change; (2) the enrollee was attributed to an integrated health system, though the health system could vary across quarters; (3) the enrollee was classified into the same group in both quarters to maintain a consistent degree of provider-insurer integration; and (4) the enrollee visited two or more distinct providers in outpatient settings, requiring care coordination across providers. Applying these inclusion criteria results in a total of 1,489,523 person-quarters of observations (hereafter referred to as "included observations") (see a flowchart in Appendix D for details).

The inclusion criteria are based on several considerations: (1) this study hypothesizes that provider-insurer integrations could reduce preventable care use and contact days by providing better care coordination; and (2) requiring two consecutive quarters of enrollment in the same HMO, along with a consistent degree of provider-insurer integration, ensures that the study design meets the presupposed temporal ordering for mediation analysis—changes in the degree of provider-insurer integration (treatment) temporally precede changes in care coordination (mediator)[5], which temporally precede care use (outcome) (Lugo-Palacios et al., 2023; Rijnhart et al., 2021). This study assesses care coordination over two consecutive quarters—the current and previous quarters—while assessing outcomes in the current quarter.

3.4. Distribution of Enrollees by Degree of Integration

Distribution Over Time

As shown in Figure 1, 50 – 60% of the included observations are enrollees with a non-integrated HMO, Group 0 (0, 0, 0) and Group 1 (0, 1, 0). The proportions of Groups 0 – 3 changed significantly over

[4]This paper includes enrollees whose Case ID did not change within each quarter. The Case ID is likely a unique identifier used to manage a household's benefits. Among 99.9% of person-quarter observations of BadgerCare Plus adult HMO enrollees, the Case ID did not change within a quarter.

[5] BCP and Medicaid SSI Contract for January 1, 2020-December 31, 2021, requires HMO to make a best effort to conduct an initial screening of their new members within 90 days (Wisconsin Department of Health Services, 2020).

time. The first significant change occurred in Quarter 2 of 2016, and another occurred in Quarter 2 of 2018. In both quarters, the proportions of Group 1 (0, 1, 0) and Group 3 (1, 1, 0)—enrollees attributed to an integrated health system that was not integrated with their HMO—increased, while the proportions of Group 0 (0, 0, 0) and Group 2 (1, 0, 0)—enrollees attributed to a non-integrated health system—decreased. The first change was mainly driven by the acquisition of Wheaton Franciscan Healthcare, a non-integrated health system, by Ascension Health, an integrated health system, in March 2016. This acquisition affected approximately 15% of the included observations in Quarter 2 of 2016 (Supplementary 1.1, panels (c) - (d)). The second significant change was largely driven by the merger between Aurora Health Care, a non-integrated health system, and Advocate Health Care, an integrated health system, in March 2018. This merger affected approximately 25% of the included observations in Quarter 2 of 2018 (Supplementary 2, panel (a)).

Distribution by Region

Geographically, the proportions of enrollees in Group 1 (0, 1, 0) and Group 3 (1, 1, 0) increased notably in northeastern and southeastern Wisconsin[6] during the study period (see Figure 2). This was partially due to the acquisition of Wheaton Franciscan Healthcare and the merger between Aurora Health Care and Advocate Health (Supplementary 1.2 and Supplementary 2). Although the proportion of enrollees in Group 4 (1, 1, 1) did not change significantly over time (Figure 1), there were offsetting changes across regions: the proportion of Group 4 (1, 1, 1) increased in northern Wisconsin but decreased in counties bordering western and southern Wisconsin (Figure 2, Group 4). This increase was primarily driven by the expansion of Marshfield Clinic (Supplementary 3), while the decrease was due to Mayo Clinic's sale of the Health Tradition Health Plan, which had participated in the BadgerCare Plus HMO (Supplementary 4).

[6] This study follows the regions defined by the Atlas of Health Care in Wisconsin, developed by the Wisconsin Health Information Organization (WHIO) ("WHIO Atlas Health Care in Wisconsin," 2015).

This study also observed substantial overlap between the residences of enrollees in a given integrated HMO and those attributed to the health system owned by the same integrated system for six out of eleven "integrated" BadgerCare HMOs (Supplementary 5). Such overlap in residences suggests that the provider and insurance sides of an integrated system may potentially benefit from each other while serving the same geographic areas. However, enrollees in integrated HMOs did not always seek care from the health system owned by the same integrated system, such as enrollees of Network Health Plan. Approximately 5% of the included observations were enrolled in Network Health Plan, but only approximately 2% were attributed to the health systems with which it was integrated (Supplementary 1.1, panels (a)-(c)).

4. Measures

4.1. Outcome

In this study, I use potentially avoidable ED visits and potentially preventable hospitalizations to measure preventable care utilization. Another more patient-centered measure, contact days, reflects the frequency of interactions between a patient and the healthcare system. This measure has been used in various Dartmouth Atlas analyses (Bynum et al., 2024). Fewer contact days may indicate less patient care burden (Burke et al., 2020; Ganguli, 2024; Gupta et al., 2025).

Potentially Avoidable Emergency Department Visits

This study identifies avoidable ED visits using the New York University Emergency Department Algorithm (NYU-EDA) (NYU Center for Health and Public Service Research, 2022). An ED visit is considered potentially avoidable if the probability of its primary diagnosis code falling into one of the following categories exceeds 0.5 (Ballard et al., 2010): (1) non-emergent, (2) emergent, primary care treatable, (3) emergent, ED care needed, and preventable or avoidable with timely and effective ambulatory care.

Potentially Preventable Hospitalizations

This study considers a hospitalization potentially preventable (hereafter referred to as "preventable") if any of its first ten diagnosis codes indicate an Ambulatory Care Sensitive Condition (ACSC), which is used by the AHRQ to construct the overall composites of Prevention Quality Indicators (PQIs). PQIs are designed to reflect issues of access to and the quality of ambulatory care. PQI composites consist of groups of individual PQIs (Agency for Healthcare Research and Quality, Rockville, MD, 2024). This study follows the AHRQ PQIs released in July 2020 and uses SAS QI Software v4.5[7] and v2020 to identify preventable hospitalizations (Agency for Healthcare Research and Quality, Rockville, MD., 2022) (see Appendix E for PQI composites).

Contact Days

In this study, the number of contact days reflects the number of days an individual spends in an inpatient setting, has an in-person clinician visit in an outpatient setting, or has an emergency department visit (Equation 1). Each day is counted only once, even if a patient interacts with multiple care settings on the same day.

$$Contact\ Days_i = \sum_{j=1}^{p} Contact_{ij} \qquad (1)$$

where $Contact_{ij} = 1,$ if the individual i was in an inpatient setting or had an in-person outpatient or ED visits on day j. p is the number of days in an analytical period, with a quarter ranging from 90 to 92 days.

4.2. Mediator—Care Coordination

As mentioned earlier, care coordination activities include interactions between patients and care practitioners, as well as activities among care practitioners. This study uses outpatient visit concentration and care density to capture these two aspects of care coordination.

[7] Before October 1, 2015, diagnoses were coded using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) in the claims data. This study applied the specifications of the version released in May 2013 for ICD-9 codes. Although the Overall Composites included four additional PQIs in the May 2013 version compared to the July 2020 version, this study followed the Composite Measures in the July 2020 version for both ICD-9 and ICD-10 codes.

Visit Concentration

The concentration of a beneficiary's outpatient visits among distinct providers is measured using the Herfindahl–Hirschman Index (HHI) (Equation 2). It serves as an indicator of continuity of care, with values closer to zero reflecting greater potential challenges patients may face when receiving care from multiple providers.

$$HHI_i = \sum_{j=1}^{p_i} (\frac{n_{ij}}{n_i})^2 \qquad (2)$$

n_i is the total number of outpatient visits individual i had during an analytical period, n_{ij} is the number of visits individual i had with provider j, p_i is the total number of providers individual i visited during the analytical period. An individual may see multiple providers during a single outpatient visit, such as a nurse practitioner and a physician. Each visit is counted once per provider.

Care Density

Care density (Equation 3) captures care coordinating actions among distinct providers. It reflects the extent of patient sharing among individual providers. Physicians who share more patients are more likely to know one another through referrals and advice-seeking (Barnett et al., 2011). These physicians may be more likely to communicate and work with one another, potentially leading to better care coordination for their patients (Barnett et al., 2011; Burns et al., 2021).

$$Care\ Density_i = \frac{\sum_{p=1}^{m_i} \min(w_{ip}, 10)}{m_i}\ , where\ m_i = \frac{n_i(n_i - 1)}{2} \qquad (3)$$

Where n_i is the number of distinct providers (identified by NPIs) visited by patient i, m_i is the total number of possible provider pairs, and w_{ip} is the number of shared patients for each provider pair.

The numerator represents the total number of instances of patient sharing among a patient's providers over an analytical period. Previous research indicates that the probability of identifying a referral or information-sharing relationship between physicians increases as the number of shared patients rises in administrative data, peaking at 82% when nine patients are shared (Barnett et al., 2011). Accordingly, this study applies a cap of 10 for the contribution of instances from each provider pair to the

numerator. The denominator represents the total number of individual provider pairs for that patient (Pollack et al., 2013). Care density in this study ranges from 1 to 10.

Figure 3 illustrates the calculation of care density, as presented in Pollack et al. (2015). Four providers are represented by circles A through D, and three patients are represented by different line styles: solid, long-dashed, and short-dashed. The patient represented by the long-dashed line sees providers B, C, and D. Provider pair B and C share one patient, B and D share three, and C and D share one. The numerator is 5. The denominator is 3 provider pairs. The care density for the patient represented by the long-dashed line is 5 divided by 3, or 1.67.

In this study, both visit concentration and care density are calculated based on outpatient visits with providers whose primary practice location is in Wisconsin or a bordering state. This excludes approximately 1.9% of outpatient claims. The facility provider is used when an individual provider identifier is unavailable due to data limitations (see Appendix B.2 for details).

4.3. Covariates

In the main analysis, I control for two groups of covariates: enrollee and health system characteristics.

Enrollee Characteristics

This study controls for enrollees' demographics (age group, sex[8], race and ethnicity), socioeconomics (income level, education level, and region of residency), chronic conditions, and year and quarter fixed effects in the regression. Enrollees' behavior patterns, and pre-existing health conditions will likely affect their care coordination and care use (Bu & Fancourt, 2021). Previous research also shows

[8] Sex generally refers to a set of biological attributes that are associated with physical and physiological features such as chromosomal genotype, hormonal levels, internal and external anatomy. A binary sex categorization (male/female) is usually designated at birth ("sex assigned at birth") and is in most cases based solely on the visible external anatomy of a newborn. This binary categorization is the one used in this study. In reality, sex categorizations include people who are intersex/have differences of sex development (DSD).

geographic variation in care resource use ("WHIO Atlas Health Care in Wisconsin," 2015). Nine binary indicators are included in the model to represent enrollees' chronic conditions diagnosed in the past 12 months based on outpatient, inpatient, or emergency department visits. Eight binary indicators are constructed to reflect diagnoses of hypertension, diabetes, chronic obstructive pulmonary disease (COPD), asthma, heart disease, cancer, mental health issues, or substance use disorders. These eight conditions are selected because of their high prevalence among the Medicaid population or their high per-patient care costs (Chapel et al., 2017; Paltzer et al., 2017; Rosland et al., 2019). Another binary indicator is created to represent whether an enrollee is diagnosed with a chronic condition other than the eight specified conditions. This study uses the 2015 and 2024 versions of the Chronic Condition Indicator and Chronic Condition Classification Software, developed by AHRQ's Healthcare Cost and Utilization Project (HCUP), to identify chronic conditions (AHRQ & HCUP, 2024b, 2024a).

Health System Characteristics

I control for two health system factors: (1) whether a health system operates across multiple states, and (2) its admission volume in the current and previous quarters. These variables proxy a health system's scale, and organizational capacity, which may confound both an enrollee's degree of integration and care coordination. Previous research suggests that integrated health systems tend to be larger (Hedquist et al., 2024), thus, an enrollee is more likely to be attributed to an integrated health system. Health system scale may influence investments in care coordination, such as protocol design and care-navigator staffing (Simpson et al., 2022). It may also affect referral patterns—for example, referrals to internal rather than external specialists—thereby shaping the professional networks of clinicians (Sinaiko et al., 2023). Information on the number of operating states is obtained from the AHRQ Compendium. Admission volume is represented by the highest quartiles of admissions for adult enrollees of BadgerCare Plus HMOs. The predominant providers of the included observations were affiliated with 67 unique health systems.

4.4. Descriptive Statistics

Potential Mediation Pathway Trends

Table 3 summarizes the cross-sectional enrollee characteristics, care coordination measures, and outcome variables by their degree of provider-insurer integration, averaged across 2015 – 2020. It is worth noting that enrollees in Group 4 (1, 1, 1) had the lowest average rate of avoidable ED visits (153.1 per 1,000 person-quarters) and the fewest average contact days (5.1 per person-quarter). The cumulative distribution function of contact days by group also shows that Group 4 (1, 1, 1) first-order stochastically dominates Group 3 (1, 1, 0) and Group 1 (0, 1, 0); in turn, these groups first-order stochastically dominate Group 2 (1, 0, 0) and Group 0 (0, 0, 0). This ordering corresponds to progressively fewer contact days, moving from Group 0 (0, 0, 0) to Group 2 (1, 0, 0), Group 1 (0, 1, 0) , Group 3 (1, 1, 0), and finally Group 4 (1, 1, 1) (Appendix F).

The average visit concentration, reflected by the HHI, across groups was around 4,000 (Table 3). The average rates of all outcomes of interest decreased as the HHI increased up to 5,000. Beyond that point, the average rates of ED visits and avoidable ED visits remained at a plateau, while the rate of hospitalizations and the number of contact days increased as the HHI rose further. When the HHI exceeded 5,000, the trend in preventable hospitalizations differed slightly across groups (Appendix G).

The average care density of Groups 0-4 was approximately 3.7-4.0 (Table 3). The average rates of ED visits, avoidable ED visits, hospitalizations and preventable hospitalizations increased with care density up to 3-4, then decreased thereafter. However, the unadjusted number of contact days continued to rise when care density exceeded 4 (Appendix H). Previous research shows that the probability of providers having a professional relationship becomes approximately 56% or higher when they share four or more patients (Barnett et al., 2011). Therefore, this study also conducts a sensitivity analysis in which the mediator of continuous care density is replaced with a binary variable: “high” when care density is greater than 4 and “low” when care density is less than or equal to 4 (hereafter referred to as the “Care Density_Binary” analysis).

Enrollee and Health System Characteristics

It is notable that enrollees in Group 4 (1, 1, 1) were more likely to be white and less likely to have an education level below high school. Enrollees in Groups 0 (0, 0, 0) and 1 (0, 1, 0) were more likely to have an income below 50% of the FPL. Because this study focuses on enrollees who visited two or more distinct providers, more than 90% of the included observations had one or more chronic condition diagnoses in the past 12 months. Additionally, aligning with previous research, integrated health systems are larger (Hedquist et al., 2024)—Groups 1 (0, 1, 0), 3 (1, 1, 0), and 4 (1, 1, 1) were more likely to be attributed to the largest and multi-state health systems.

5. Mediation Analysis

5.1. Empirical Model

This study follows the approach of Hayes and Preacher (2014) to conduct a mediation analysis with a categorical treatment variable. The analysis examines the extent to which care coordination, as the mediator, explains the relationship between each provider-insurer integration degree and outcomes of interest. See Appendix I for the conceptual model.

This study uses Ordinary Least Squares (OLS) linear regressions to estimate Equations A, B, and C, with clustered standard errors at the individual level.

$$Y_{it} = c_0 + c_1 I_{1it} + c_2 I_{2it} + c_3 I_{3it} + c_4 I_{4it} + \boldsymbol{\beta} \boldsymbol{X}_{it} + \boldsymbol{\theta} \boldsymbol{T}_t + \varepsilon_{it} \quad (A)$$

$$M_{it} = a_0 + a_1 I_{1it} + a_2 I_{2it} + a_3 I_{3it} + a_4 I_{4it} + \boldsymbol{\alpha} \boldsymbol{X}_{it} + \boldsymbol{\gamma} \boldsymbol{T}_t + v_{it} \quad (B)$$

$$Y_{it} = c'_0 + c'_1 I_{1it} + c'_2 I_{2it} + c'_3 I_{3it} + c'_4 I_{4it} + b M_{it} + \boldsymbol{\beta}' \boldsymbol{X}_{it} + \boldsymbol{\theta}' \boldsymbol{T}_t + u_{it} \quad (C)$$

Where I_{jit} $(j = 1,\ 2,\ 3\ ,4)$ represents Group j during quarter $t - 1$ and quarter t (6-month), given Group 0 (0, 0, 0) is the reference group. M_{it} represents the mediator, care coordination, during quarter $t - 1$ and quarter t (6-month). $\boldsymbol{X}_{it}$ represents covariates in quarter t, including enrollees' demographics (age groups, sex, race and ethnicity), socioeconomic factors (income, education, region of residence), chronic

conditions, and health system characteristics. $\boldsymbol{T}_t$: the indicators of each year and quarter from 2015-2020 (see Appendix J for the timeframes of the variables).

Hayes and Preacher (2014) suggest using "relative" effects (or associations) when reporting results to emphasize that results may vary depending on the choice of reference group. This study aims to investigate the impacts of provider-insurer integrations and uses Group 0 (0, 0, 0) as the reference group intentionally. Therefore, the term "relative" is not emphasized below.

As shown in Appendix I, c_j represents the total associations between provider-insurer integrations and outcomes of interest. $a_j \times b$ from the OLS results represents the indirect associations (i.e., mediated associations), which capture the mediation through care coordination. Bootstrap procedures with 1,000 resamples are conducted to estimate the bias-corrected 95% confidence intervals for mediated associations. c'_j represents the direct associations, which are the associations not mediated through care coordination. The relationship among these associations is expressed as: $c'_j + a_j \times b = c_j$

This study meets the temporal ordering presupposition, however, its results can't be interpreted as causal inference because it does not fully satisfy the no-unmeasured confounding assumptions: causal inference from mediation analysis requires no-unmeasured-confounding assumptions between the treatment, mediator, and outcomes, as well as the assumption that no mediator–outcome confounder is affected by the treatment (VanderWeele, 2015).

There are two major sources of confounding in this study. The first arises from the possibility that enrollees with distinct care utilization patterns may self-select into a higher degree of integration compared to those experiencing no provider-insurer integration. To account for the potential bias, I control for a rich set of enrollee characteristics to mitigate the potential bias as described in Section 4.3. I also run a sensitivity analysis with individual fixed effects (hereafter referred to as the "Individual Fixed Effects" analysis).

The second major source of confounding comes from the fact that integrated health systems tend to be larger than non-integrated ones. Enrollees attributed to an integrated health system are more likely

to have a predominant care provider affiliated with a larger health system, which may have more investments in care coordination. I control for factors representing health system size in the analysis; however, there could nevertheless be unobservable health system factors affecting enrollees' degree of integration and care coordination. It is worth noting that I do not account for these unobserved features through health system fixed effects because health systems can undergo significant changes throughout the study period, such as mergers and acquisitions. Comparing results before and after changes in the integration status of large health systems could help examine the extent of bias in results due to unobservable health system factors. This leads to the second extension analysis of this study. See Section 5.2 for details.

5.2. Extension Analyses

I extend the analysis along two dimensions to address potential biases. The main analysis includes enrollees who stayed in the same degree of provider-insurer integration for at least six months, and measures care coordination in a six-month window. In the first extension, I narrow the sample to enrollees who stayed in the same degree of integration for twelve months or longer. I then repeat the analysis using care coordination measured over several timeframes—six-month, nine-month, and twelve-month windows (hereafter referred to as the "Various Timeframe" analysis). The benefits of care coordination often depend on sustained engagement over time (Ha et al., 2019). The longer an enrollee stays in the same degree of integration, the more likely that degree of integration impacts the enrollee's care use through care coordination.

In the second extension, I divide the study period into four subperiods based on the timing of two major events— the acquisition of Wheaton Franciscan Healthcare (March 2016), the merger between Aurora Health Care and Advocate Health (March 2018)—as well as the onset of the COVID-19 pandemic (March 2020) (hereafter referred to as the "Subperiods" analysis). I re-estimate the main analysis within each subperiod and compare the results across subperiods. The composition of integrated systems changed during the study period. If health systems with lower per patient care utilization were more likely to become integrated, such compositional shifts could bias estimates of the effect of integration when

pooling data across the entire study period. I aim to hold system composition relatively constant within each subperiod in this extension. This extension provides information on the extent to which unobservable health system characteristics may bias the results.

5.3. Sensitivity Analyses

In addition to the "Care Density_Binary" and "Individual Fixed Effects" analyses, I estimate specifications that adjust for HMO market share at either the state or region level. The HMO's market share is a proxy for insurer operational features, which may influence the provider network and information exchange process for its enrollees, thus affecting care coordination.

6. Results and Discussions

6.1. Main Results

Figure 4 and Appendix K show the estimates of total associations, indirect associations (mediation), and direct associations from the main analysis.

Total Associations with Care Utilization

In Figure 4, panels (a)–(e), grey bars—the first bar in each group—represent the total associations between outcomes of interest and Groups 1–4 relative to Group 0 (0, 0, 0)—those who experienced no integration. Notably, enrollees who experienced the highest degree of provider-insurer integration, Group 4 (1, 1, 1), were associated with 23.1 fewer ED visits and 8.1 fewer avoidable ED visits per 1,000 person-quarters (PQs) (column (1) of Appendix K) compared to Group 0 (0, 0, 0). These are equivalent to 6.4% fewer ED visits and 4.3% fewer avoidable ED visits relative to the average rates of Group 0 (0, 0, 0). Enrollees attributed to an integrated health system—Group 1 (0, 1, 0), Group 3 (1, 1, 0), and Group 4 (1, 1, 1)—were associated with 5.8-7.9 more hospitalizations per 1,000 PQs, representing an 8.1-11.1% higher rate of hospitalizations relative to the Group 0 (0, 0, 0) average. Although these enrollees were also associated with 0.4-0.7 higher rates of preventable hospitalizations, the association was insignificant for Group 4 (1, 1, 1). Moreover, enrollees who experienced provider-insurer integrations, Groups 1-4, had

0.24-1.1 fewer contact days per PQ, corresponding to 4.1-19.1% fewer contact days relative to the Group 0 (0, 0, 0) average, with Group 4 having the fewest.

The findings regarding contact days and avoidable ED visits align with previous research showing that provider-insurer integrations are associated with higher quality (Frakt et al., 2013; Johnson et al., 2017; Park et al., 2023) and lower utilization of intensive care units (ICUs) (Meyers et al., 2020). A higher rate of hospitalizations among enrollees attributed to an integrated health system may indicate that hospitals in these systems tend to fill more of their beds (Mendelson, 2018).

Associations with Care Coordination

This study uses outpatient visit concentration, measured by HHI, and care density to reflect care coordination. The associations between enrollees with various degrees of integration and these two care coordination measures are shown in columns (2) and (6) of Appendix K.

The results suggest that differences in care coordination are modest between enrollees with the highest degree of integration, Group 4 (1, 1, 1), and those with no integration, Group 0 (0, 0, 0), while differences between the intermediate groups and Group 0 (0, 0, 0) are relatively small. The findings show that Group 4 (1, 1, 1) was negatively associated with visit concentration, whereas positively associated with care density. Compared to Group 0 (0, 0, 0), enrollees in Group 4 (1, 1, 1), had a 150 lower HHI, representing a 3.6% difference relative to the average of Group 0 (0, 0, 0). Enrollees attributed to an integrated health system that was not integrated with their HMO—Group 1 (0, 1, 0) and Group 3 (1, 1, 0)—had a 34-36 lower HHI, corresponding to approximately a 0.8-0.9% difference relative to the Group 0 (0, 0, 0) average. Enrollees with an integrated HMO but attributed to a non-integrated health system, Group 2 (1, 0, 0), had a 27 higher HHI, approximately a 0.7% difference relative to the Group 0 (0, 0, 0) average. When care coordination is measured by care density, enrollees in Group 4 (1, 1, 1) exhibited a 0.53 higher care density, an approximately 14.1% difference relative to the Group 0 (0, 0, 0) average. Groups 1-3 exhibited a 0.04-0.08 higher care density, corresponding to approximately a 1.1-2.1% difference relative to the Group 0 (0, 0, 0) average.

This suggests that enrollees whose HMO and attributed health system are integrated with each other experience remarkably different care coordination than others. Specifically, this group of enrollees has lower visit concentration and higher care density. A plausible explanation is that the care responsibilities of these enrollees tend to be distributed across multiple clinicians, and their clinicians are more likely to have established professional relationships. This may be due to the formation of larger care teams, along with repeat interactions among a group of providers who are affiliated with an integrated system and included in the network of the HMO owned by the same integrated system (Agha et al., 2022, 2023; Sinaiko et al., 2023). Provider-insurer integrations being simultaneously associated with different aspects of care coordination in opposite directions can also be a potential reason for weak or mixed evidence in empirical research on the causal chain between structural integration and care coordination (Burns et al., 2021).

Indirect Associations: Mediation through Care Coordination

The second and third bars in Figure 4 for each group reflect estimates of indirect associations—mediation through visit concentration (HHI) (red filled) and care density (red unfilled). Echoing the findings that only enrollees with the highest degree of provider-insurer integration, Group 4 (1, 1, 1), had modest associations with either care coordination measure, the magnitude of the total associations mediated through care coordination was modest only in Group 4 (1, 1, 1) and minimal for Groups 1-3. Additionally, the direction of these mediated associations can vary by care coordination measure and can be opposite to that of total associations.

As shown in Figure 4, panels (a)-(d) and Appendix K, columns (4) and (8), when care coordination is measured by HHI, the mediation contributed to 6.4 more ED visits and 3.6 more avoidable ED visits per 1,000 PQs for Group 4 (1, 1, 1), representing differences of 1.8% and 1.9%, respectively, relative to the Group 0 (0, 0, 0) averages. When care coordination is measured by care density, mediation contributed to 3.6 fewer ED visits and 1.4 fewer avoidable ED visits per 1,000PQs for Group 4 (1, 1, 1), representing differences of approximately 1.0% and 0.8%, respectively, relative to the Group 0 (0, 0, 0)

averages. The opposing contributions arise because both ED visits and avoidable ED visits were negatively associated with either care coordination measure (as shown in columns (3) and (7) of Appendix K), while Group 4 (1, 1, 1) was associated with two care coordination measures in opposite directions.

Similarly, for Group 4, when care coordination is measured by HHI, the mediation contributed to 0.56 more hospitalizations and 0.02 more preventable hospitalizations per 1,000 PQs, corresponding to differences of 0.8% and 0.7%, respectively, relative to Group 0 (0, 0, 0) averages. When care coordination is measured by care density, the mediation showed no clear contribution to hospitalizations but 0.04 fewer preventable hospitalizations per 1,000 PQs, approximately a 1.2% difference relative to the Group 0 (0, 0, 0) average.

Different from the first four care use outcomes, mediation through both care coordination measures contributed to more contact days for Group 4—0.12 more days per PQ if measured by HHI, and 0.27 more days per PQ if measured by care density, approximately 2.1% and 4.7% relative differences relative to the Group 0 (0, 0, 0) average as shown in Figure 4, panel(e) and Appendix K, columns (4) and (8). This is because the number of contact days was negatively associated with visit concentration but positively associated with care density (Appendix K columns (3) and (7)).

6.2. Various Timeframe Analysis Results

In the Various Timeframe analysis, I narrow the sample to enrollees who remained in the same degree of integration for twelve months or longer. I then repeat the analysis using care coordination measured over several timeframes—six-month, nine-month, and twelve-month windows. Results are shown in columns (2)-(4) in each table of Appendices L, M, N, and O.

Associations between enrollees with the highest degree of integration, Group 4 (1, 1, 1), and all outcomes of interest, as well as the two care coordination measures, remained consistent with those in the main analysis. The magnitude of associations with fewer ED visits, fewer avoidable ED visits, and fewer contact days became larger. There were two noticeable changes related to mediated associations: the mediated association with more preventable hospitalizations through visit concentration became

insignificant as the timeframe for care coordination extended, while the mediation through care density established a contribution to fewer hospitalizations in this extension.

Compared to the main analysis, enrollees attributed to an integrated health system that was not integrated with their HMO, Group 1 (0, 1, 0) and Group 3 (1, 1, 0), continued to be associated with more hospitalizations and fewer contact days. However, they also exhibited some changes in the results. They had stronger associations with fewer ED visits, in terms of either statistical significance or magnitude. Meanwhile, their positive association with preventable hospitalizations became statistically insignificant. Their associations with care coordination measures also changed: the negative association with visit concentration decreased in statistical significance, while their association with care density changed from positive to negative as the care coordination timeframe extended (Appendix M, columns (2)-(4)). Changes in the corresponding mediated associations followed, with magnitudes remaining much smaller than those of Group 4 (Appendices N and O, columns (2)-(4)).

Enrollees with an integrated HMO but attributed to a non-integrated health system, Group 2 (1, 0, 0), remained associated with fewer contact days, with a slightly larger association (Appendix L, columns (2)-(4)). This group continued to show a positive association with visit concentration, while its association with care density became negative rather than positive (Appendix M, columns (2)-(4)). Therefore, mediated associations through visit concentration persisted, except for those with preventable hospitalizations. Mediated associations through care density changed direction accordingly. The magnitude of these mediated associations remained minimal in most cases (Appendices N and O, columns (2)-(4)).

These findings suggest that: (1) enrollees who stay in the highest degree of integration longer may be associated with even larger reductions in ED visits, avoidable ED visits, and contact days; (2) although enrollees attributed to integrated health systems in the narrowed sample were consistently associated with increased hospitalizations, they were no longer associated with increased preventable hospitalizations; (3) Except for enrollees with the highest degree of integration, other groups' associations with either visit concentration or care density changed in direction or decreased in significance levels in this extended

analysis. This strengthens the distinctiveness of care coordination among enrollees with the highest degree of integration.

6.3. Subperiods Analysis Results

In the Subperiods analysis, I divide the study period into four subperiods, re-estimate Equations A – C within each subperiod, and compare the results across subperiods. The corresponding results are reflected in columns (5)-(8) in each table of Appendices L, M, N, and O. Compared to the main analysis, associations between enrollees with the highest degree of integration, Group 4 (1, 1, 1), and outcomes of interest show some variations, except for the association with contact days. Specifically, the association between Group 4 (1, 1, 1) and fewer ED visits became statistically insignificant in the first subperiod. The association between Group 4 and fewer avoidable ED visits became statistically insignificant in the first three subperiods, and its association with more hospitalizations was significant only in the second subperiod.

Group 4 (1, 1, 1) was consistently negatively associated with visit concentration across all subperiods and positively associated with care density except for the first subperiod. The mediated associations through each care coordination measure were consistent with those in the main analysis, with a few exceptions. The mediated associations through visit concentration contributed to more preventable hospitalizations only in the second and fourth subperiods. Mediated associations through care density with all outcomes of interest became insignificant in the first subperiod; the mediated association through care density with preventable hospitalizations also became insignificant in the fourth subperiod.

Estimates for Groups 1-3 exhibited temporal variations. Variations in enrollees of Group 1 (0, 1,0) and Group 3 (1, 1, 0)—those attributed to an integrated health system that was not integrated with their HMO—were similar. Except for a consistent negative association with contact days, associations between either group and other outcomes of interest changed markedly, especially starting from the third subperiod when the merger of Aurora Health Care occurred. Associations between either group and both care coordination measures varied in sign across subperiods but were consistent from the second to third subperiods. Therefore, their mediated associations showed consistency in these two subperiods in many

cases. The magnitudes of these mediated associations were much larger in the second subperiod compared to those in the main analysis, though still smaller than those for Group 4.

The association between Group 2 (1, 0, 0)—enrollees with an integrated health plan but attributed to a non-integrated health system—and fewer contact days was statistically significant only during the second and third subperiods. Its associations with care coordination measures also varied across subperiods. Group 2 (1, 0, 0) was associated with higher visit concentration only during the first two subperiods, and its association with care density switched from negative in the second subperiod to positive in the third and subsequent subperiod. The mediated associations thus follow the corresponding variations. Although the magnitude of these mediated associations in certain subperiods was larger than the corresponding ones in the main analysis, they remained less than half of those for Group 4 in the same subperiods.

There are three takeaways from the Subperiods analysis: (1) The negative associations between Groups 1-4 and contact days remained in most cases before the onset of COVID-19, and remained for Group 4 (1, 1, 1) after the onset of COVID-19. (2) Considering there were also compositional changes in Group 4 (1, 1, 1) (see Distribution by Region in Section 3.4), the consistency in associations between Group 4 (1, 1, 1) and care coordination measures, as well as the corresponding mediated associations in most cases, emphasizes differences in care coordination between enrollees with the highest degree of provider–insurer integration and others. (3) The timing and direction of the observed shifts in total associations and mediated associations for Groups 1-3 suggest that ED visits, hospitalizations, and care coordination in newly integrated systems may differ from those in previously established integrated systems. Plausible explanatory factors include ongoing adjustments following integration (Klinga et al., 2018) and unobserved health system characteristics.

6.4. Robustness

Individual Fixed Effects

As shown in column (9) of the tables included in Appendices L, M, N, and O, after adding individual fixed effects to control for unobservable individual characteristics, only the positive associations between Group 1 (0, 1, 0), Group 3 (1, 1, 0) and Group 4 (1, 1, 1)—enrollees attributed to an integrated health system—and hospitalizations persisted. Moreover, the magnitude approximately doubled in size. Only Group 4 (1, 1, 1)—enrollees with the highest degree of provider-insurer integration—remained negatively associated with visit concentration and positively associated with care density. Associations between Groups 1-3 and visit concentration became statistically insignificant. Associations between Groups 1-3 and care density even switched from positive to negative, though Group1's was statistically insignificant. The mediated associations through care coordination measures followed accordingly. It is worth mentioning that Group 4 (1, 1, 1)'s mediated association through care density with fewer hospitalizations changed from statistically insignificant to significant, while the mediated association with fewer preventable hospitalizations changed in the opposite direction.

The changes in results after adding individual fixed effects indicate that, except for hospitalizations, the observed associations between provider-insurer integrations and other outcomes of interest may be due to unobservable individual characteristics. However, the observed differences in care coordination between enrollees with the highest degree of integration and others were robust after adjusting for individual characteristics.

It is also worth mentioning that there are 386,250 unique individuals among the included observations. Only 27% of them experienced different degrees of integration during the study period. This small portion of individuals had 3.5 quarters longer accumulated enrollment in BadgerCare Plus HMO, and their change in degree of integration was not due to geographic mobility (see Appendix P for details). This suggests that findings from the individual fixed effects specification may not be representative of all included observations.

Other Specifications

Compared to those of the main analysis, results were similar after adding HMO market share at either the state or region level (see columns (10)-(11) of the tables in Appendices L, M, N, and O). In the Care Density_Binary analysis, most findings remained after replacing numeric care density with the binary level indicator, except for the mediated associations through care density with hospitalizations for Group 3 (1, 1, 0) and Group 4 (1, 1, 1) (see column (12) of Table M.2 in Appendix M, and column (12) of Appendix O).

7. Conclusions

Vertical integrations of healthcare organizations and insurance companies are increasingly prominent in the U.S. More evidence is needed to weigh their potential efficiency benefits against anti-competitive concerns. In this study, I examine the associations between five degrees of provider-insurer integration and preventable care utilization, as well as patient care burden. I also assess the extent to which care coordination may explain these associations.

I find that enrollees who were either enrolled in an integrated HMO or attributed to an integrated health system were associated with fewer contact days—a novel measure reflecting patient care burden. Enrollees attributed to integrated health systems were associated with a higher rate of hospitalizations. Enrollees with the highest degree of integration—those with an integrated HMO and attributed to an integrated health system, both owned by the same parent company—were also associated with fewer avoidable ED visits. The observed reduction in contact days may be partially due to patient selection, while the higher hospitalization rate could be driven by unobserved health system characteristics. The lower rate of avoidable ED visits may result from both.

Enrollees with the highest degree of provider-insurer integration experienced distinct patterns of care coordination, as measured by visit concentration and care density. These enrollees had lower visit concentration but the providers they saw were more likely to have professional relationships. In addition,

these patterns hold under both extended analyses and all sensitivity analyses, with one exception—during the first subperiod when care coordination is measured by care density.

Mediated associations were modest and relatively consistent across extended and sensitivity analyses only among enrollees with the highest degree of integration. For these enrollees, mediated associations can vary in direction across care coordination measures and can be in the opposite direction of the total associations. Among those with lower degrees of integration, mediated associations were smaller and more variable across analyses.

This study has several limitations. First, it focuses on the Medicaid population in Wisconsin, which limits the generalizability of the findings. However, Wisconsin provides an ideal setting for this research, given its long history of provider-insurer integrations and the high prevalence of enrollees covered by these integrations. Second, despite efforts to collect comprehensive information on provider-insurer integrations, misclassification of integration status is still possible. Third, because the portion of individuals who switched the degree of integration during the study period is small, estimates from the analysis including individual fixed effects may not be fully representative of the included observations. Nonetheless, the findings provide important insights for future research.

The U.S. 2023 Merger Guidelines appear to have a more skeptical attitude toward vertical integration compared to previous ones (Carlton, 2024; Rooke-Ley et al., 2024), which can lead to greater scrutiny and more challenges to provider-insurer integration cases. In this study, I find that provider-insurer integrations were associated with reduced contact days, and in specific scenarios, fewer avoidable ED visits, suggesting potential benefits to patients. However, the higher rate of hospitalizations associated with integrated health systems may raise concerns regarding increases in healthcare costs. These findings suggest that regulators may need to give particular attention to inpatient care services when evaluating provider-insurer integration cases.

Provider–insurer integrations may influence various aspects of care coordination within integrated health systems, but these influences may contribute a limited share of changes in unnecessary care

utilization and patient care burden. Leaders of these systems may consider investing in additional care coordination strategies to fulfill their organizational goals. For example, they might implement campaigns to foster professional relationships among care practitioners while shifting more care responsibilities to non-physician practitioners. They could work on streamlining referral processes and establishing protocols to reduce unnecessary care utilization in the meantime.

8. Declaration of AI-assisted technologies in the writing process

During the preparation of this work, the author used OpenAI's ChatGPT to check grammatical and improve clarity. All content, analysis, and writing were developed by the author. After using ChatGPT, the author reviewed and edited the content as needed and takes full responsibility for the content of the published article.

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Table 1. Data Source

Data Source	Year(s)
Wisconsin BadgerCare Plus HMO enrollment information and claims (inpatient, outpatient, and emergency department)	Jan 2015-Dec 2020
Wisconsin Office of the Commissioner of Insurance examination reports	2015-2020*
Agency for Healthcare Research and Quality (AHRQ) Health System Compendium	2016-2021
Annual Hospital Survey Data Set from Wisconsin Hospital Association (WHA) Information Center	2017
Other publicly available information (e.g., organizational websites, news reports)	2015-2020*
National Plan and Provider Enumeration System (NPPES) downloadable file.	Mar 2021

Note: HMO—Health Maintenance Organization. *The Wisconsin Office of the Commissioner of Insurance examines insurance companies domiciled in Wisconsin and publishes publicly accessible market conduct and financial examination reports. This study uses information from these reports and other collected materials for the period Jan 2015–Dec 2020.

Table 2. Classification of Enrollees by Degree of Provider-Insurer Integration

HMO a_1	Health System a_2	Same Parent Organization a_3	
0	0	0	Group 0
0	1	0	Group 1
1	0	0	Group 2
1	1	0	Group 3
1	1	1	Group 4
Integrated =1; non-integrated =0			

Note: HMO—Health Maintenance Organization. a_1 indicates whether the enrollee was enrolled in an integrated HMO; a_2 indicates whether the enrollee was attributed to an integrated health system. Conditional on both being integrated, a_3 indicates whether the enrollee's HMO and attributed health system were partially or fully owned by the same parent organization—that is, whether they were "integrated" with each other. By construction, a_3 can equal 1 only when both $a_1 = 1$ and $a_2 = 1$.

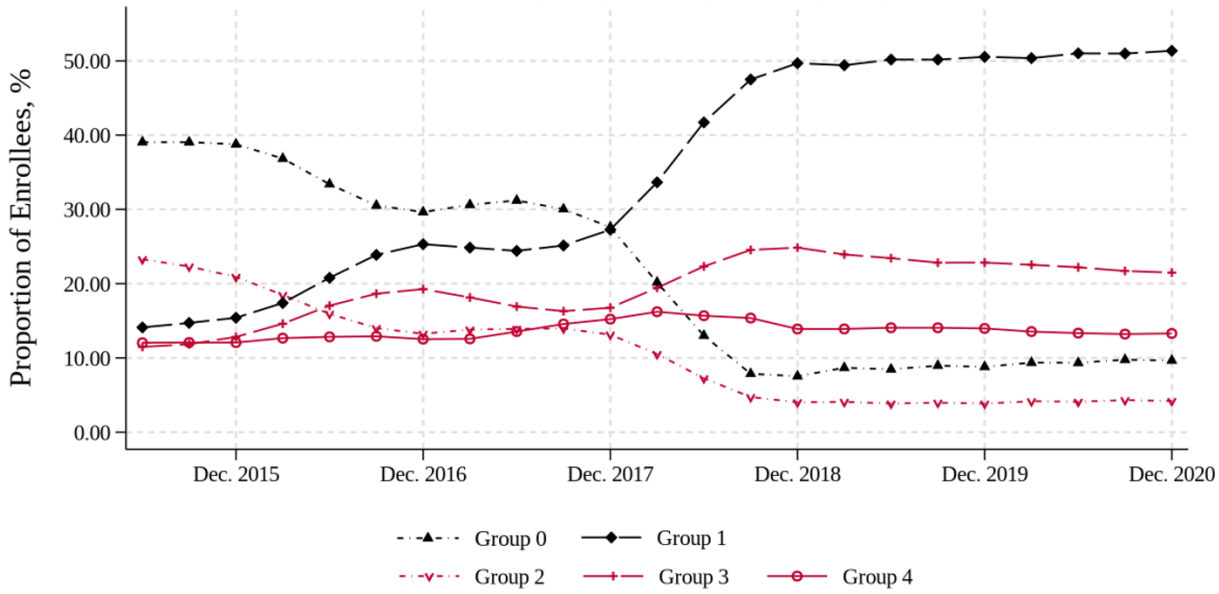
Table 3. Descriptive Statistics

	Group 0	Group 1	Group 2	Group 3	Group 4
n=1,489,523 person-quarters	308,907	534,928	152,703	290,456	202,529
	20.74	35.91	10.25	19.5	13.6
Individual Characteristics					
Residence[1]					
Northeastern	28.21	25.49	8.75	7.26	6.90
Northern	3.12	5.65	6.03	24.98	6.55
Southeastern	50.65	46.87	63.08	49.33	9.67
Southern	9.91	5.41	17.33	11.10	58.19
Western	8.11	16.59	4.81	7.34	18.69
	39.24	38.98	37.54	37.98	39.30
Age	(11.84)	(12.06)	(10.89)	(11.34)	(11.79)
Female (%)	68.31	68.22	73.05	73.36	69.82
Race					
White (%)	67.61	62.31	60.05	57.86	76.63
Black (%)	17.32	21.37	20.82	23.55	9.94
Hispanic (%)	5.96	6.33	8.68	8.10	3.60
Other (%)	9.12	10.00	10.45	10.50	9.83
Education					
Unknown (%)	23.90	24.04	18.08	18.36	27.46
Lower than high school (%)	30.07	27.91	32.30	27.40	22.11
High school diploma or equivalency (%)	34.80	36.82	37.44	41.20	38.44
Post high school without diploma (%)	7.94	7.68	8.68	8.84	7.89
Higher education with diploma (%)	3.29	3.56	3.50	4.20	4.10
Income[2]					
<=50% of FPL	64.23	62.78	61.21	57.74	59.87
(50%,100%] of FP	29.38	28.83	31.06	32.41	31.23
(100%,306%] of FPL	6.34	8.25	7.68	9.73	8.77
>306% of FPL	0.05	0.14	0.05	0.12	0.12
Chronic Conditions					
Any Chronic Conditions (Yes=1), %	92.61	92.65	91.30	91.88	92.68
Hypertension (Yes=1), %	25.93	25.87	22.80	23.43	20.95
Diabetes (Yes=1), %	11.43	11.98	10.46	11.00	10.89
COPD (Yes=1), %	4.83	4.41	3.59	3.60	3.77
Asthma (Yes=1), %	14.81	15.01	14.58	15.62	13.89
Heart Diseases (Yes=1), %	8.04	8.59	6.53	7.51	7.65
Cancer (Yes=1), %	2.24	2.84	1.63	2.50	2.71
Mental Issues (Yes=1), %	55.06	51.03	52.74	49.24	54.22
Substance Use Disorders (Yes=1), %	36.81	36.29	34.53	32.82	34.96
Other Chronic Conditions (Yes=1), %	14.86	15.50	17.04	17.50	16.30
Health System Characteristics					
Number of Health Systems=67					
Multi-State Operation [3]					
One States (%)	82.51	16.78	82.73	13.14	11.77
Two States (%)	1.66	40.49	2.28	37.27	36.40
Three or more States (%)	15.82	42.73	14.99	49.59	51.83
Quartile by Number of Admissions					
1st	1.28	0.00	0.64	0.00	0.00
2nd	4.94	0.03	9.88	0.00	0.00
3rd	15.80	8.34	18.31	1.67	3.89
4th	77.97	91.62	71.18	98.32	96.10
Care Utilization					
# of ED visits	361.90	335.06	363.08	324.74	297.30
(per 1000 person-quarters)	(921.80)	(886.18)	(895.10)	(855.25)	(800.43)

# of Avoidable ED visits (per 1000 person-quarters)	187.37 (578.65)	169.37 (546.92)	196.38 (579.38)	170.24 (547.42)	153.09 (508.15)
# of Hospitalizations (per 1000 person-quarters)	71.16 (295.56)	72.16 (294.23)	72.23 (297.51)	71.13 (288.32)	68.86 (285.73)
# of Preventable Hospitalizations [4] (per 1000 person-quarters)	3.13 (62.97)	2.99 (60.97)	2.67 (56.93)	3.01 (62.60)	2.89 (62.86)
# of Contact Days (per person-quarters)	5.77 (10.31)	5.68 (11.28)	5.33 (8.91)	5.23 (10.13)	5.10 (10.24)
Care Coordination					
HHI	4141 (1580)	4156 (1588)	4213 (1573)	4175 (1572)	3972 (1517)
Care Density	3.76 (2.76)	3.71 (2.86)	4.03 (2.87)	3.81 (2.88)	3.75 (2.68)

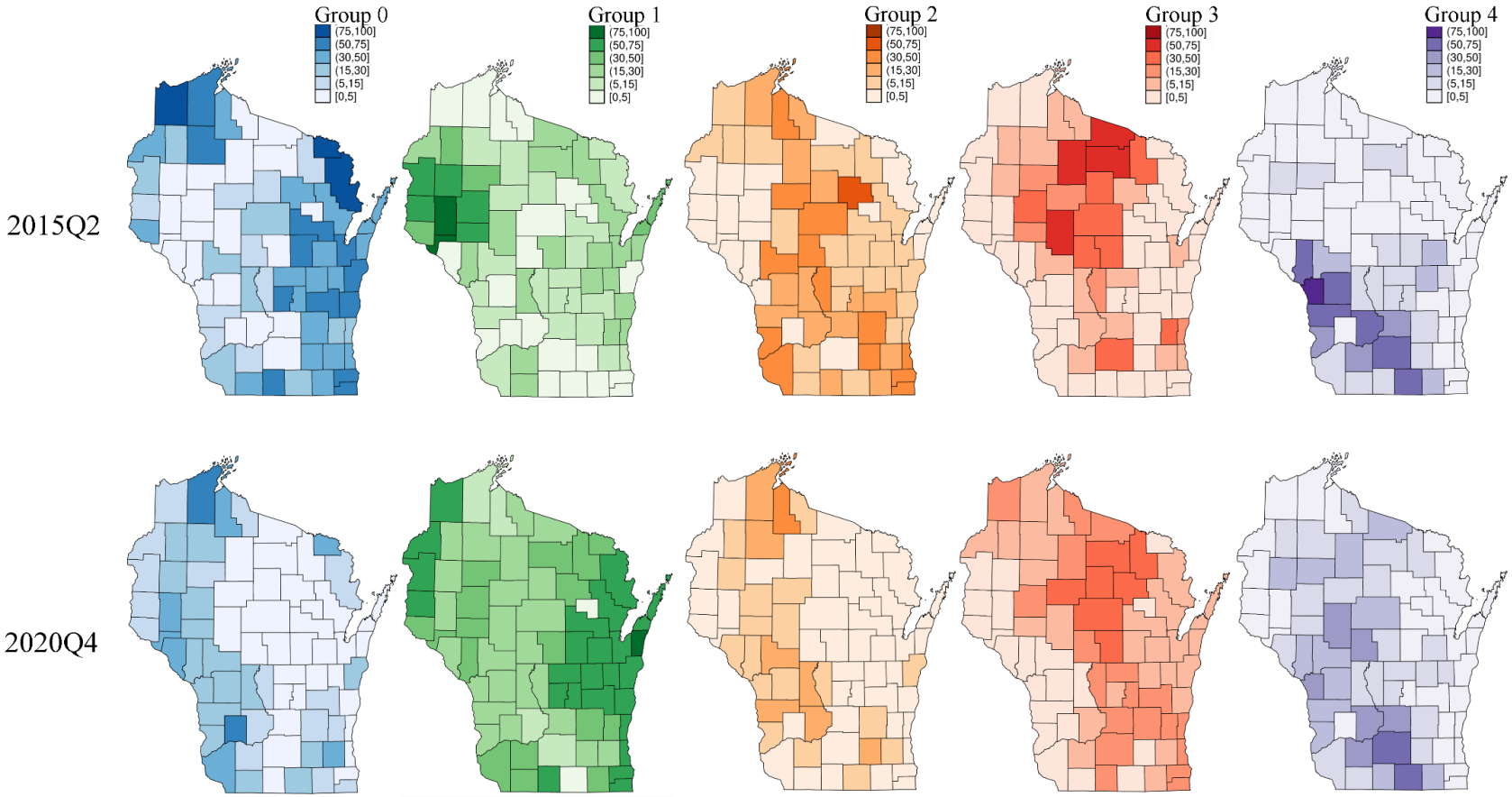
Note: number of missing observations=[1]104,672; [2]39; [3]3,357. [4]With the exception of the number of preventable hospitalizations (p=0.1819), all other variables were significantly different across Groups 0-4 ($p<0.001$). The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO–Health Maintenance Organization. COPD—chronic obstructive pulmonary disease. Group classifications and care coordination indicators for quarter t are constructed using information from the current (t) and previous (t–1) quarters. Health system characteristics for quarter t are derived using the mode value across the current (t) and previous (t–1) quarters; in cases of ties, the maximum value is selected. Individual characteristics and care utilization values are based solely on the current quarter (t).

Figure 1. Proportion of Enrollees by Degree of Provider-Insurer Integration (n=1,489,523 person-quarters)



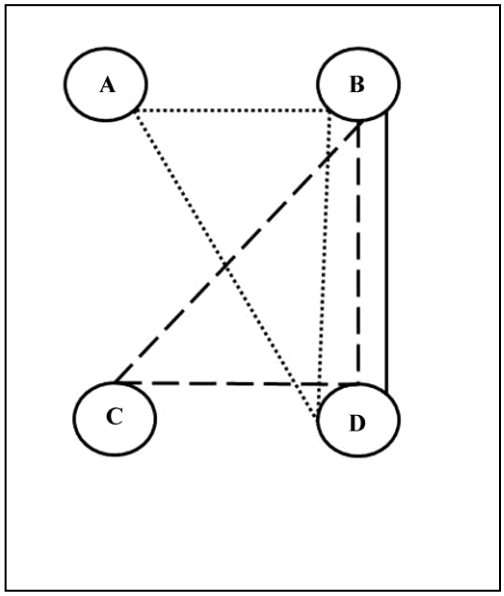
Note: Figure 1 plots three-quarter moving averages of enrollee proportions. The five curves correspond to mutually exclusive groups defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO—Health Maintenance Organization.

Figure 2. Proportion of Enrollees by Degree of Provider-Insurer Integration by County (n=1,384,851person-quarters)



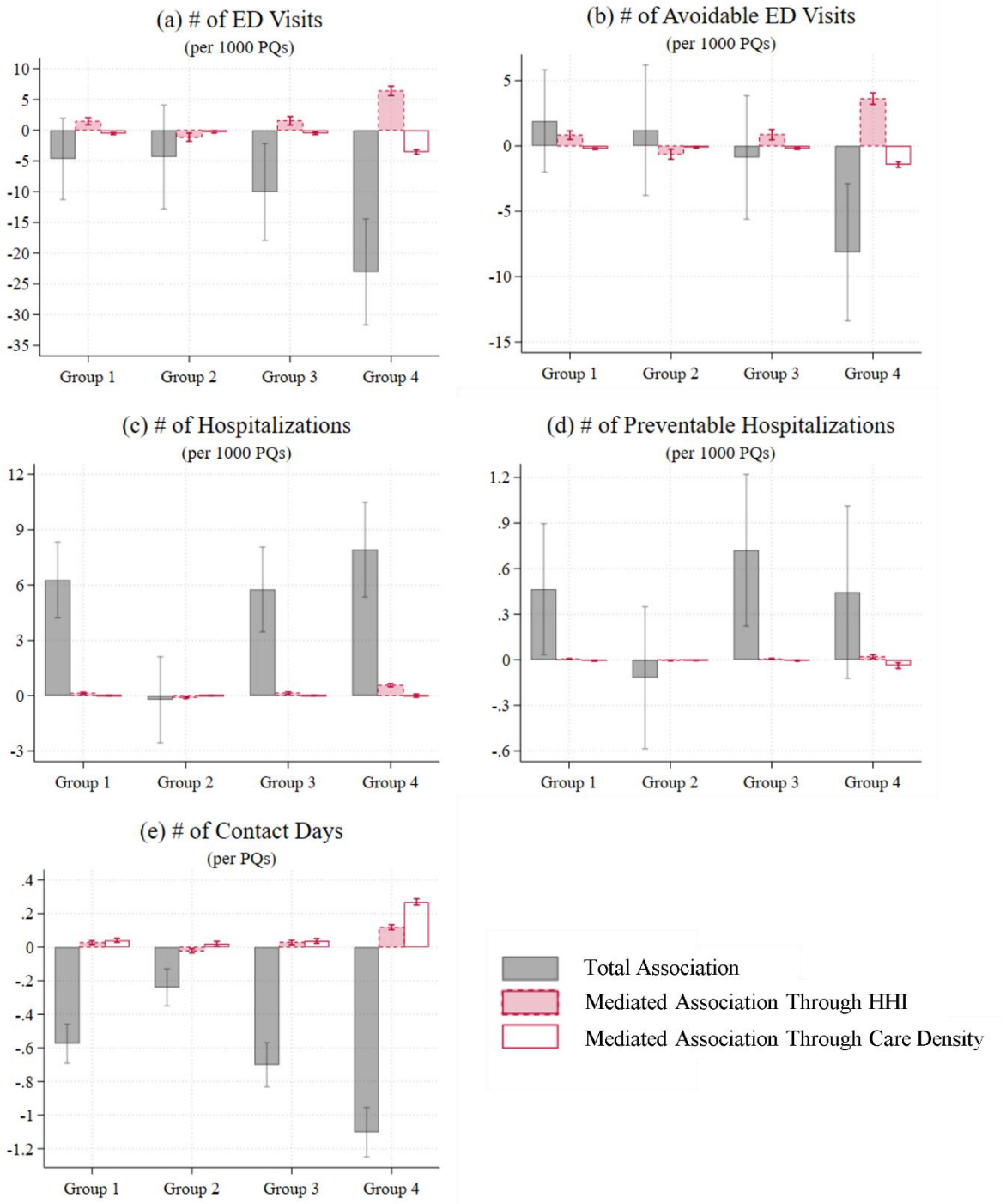
Note: 104,672 person-quarters out of 1,489,523 person-quarters lack information on residency. However, this missingness does not change the shape of the trend in Figure 1. The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO–Health Maintenance Organization. Map lines delineate study areas and do not necessarily depict accepted national boundaries.

Figure 3. An Example Illustrates the Calculation of Care Density Given by Pollack et al. (2015)



Note: Four providers are represented by circles A through D, and three patients are represented by different line styles: solid, long-dashed, and short-dashed. The patient represented by the long-dashed line sees providers B, C, and D. Provider pair B and C share one patient, B and D share three, and C and D share one. The numerator is 5. The denominator is 3 pairs of doctors. Care density for the patient represented by the long-dashed line is 5 divided by 3, or 1.67.

Figure 4. Total and Mediated Associations of Degrees of Provider–Insurer Integration



Note: HHI—Herfindahl–Hirschman Index. The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO—Health Maintenance Organization.

Appendix A. Wisconsin Medicaid Provider Enrollment

Wisconsin Medicaid only covers medical services provided by enrolled providers, unless it is an emergency, a health-endangering condition if treatment was postponed, or pre-authorized non-emergency situation in most cases (Wisconsin Department of Health Services, 2022; Wisconsin Department of Health Services, 2024b).

Both providers within Wisconsin and those outside of Wisconsin can be enrolled providers. A provider located outside of Wisconsin may be enrolled in Wisconsin Medicaid as a "border-status" provider, if the provider is in a state that either physically borders Wisconsin, or if the provider is in a state that does not physically border Wisconsin but provides only telehealth services. Providers may need to verify that it is common practice for members in a particular area of Wisconsin to seek their medical services (Wisconsin Department of Health Services, 2024a; Wisconsin State Legislature, 2023).

Appendix B. Identifying the Predominant Provider of an Enrollee

B.1. Evaluation and Management Visits

This study identifies Evaluation and Management (E/M) Visits using CPT codes 99201-99499 (American Medical Association [AMA], 2023, 2024; ForwardHealth, 2021) in the outpatient claims data. The outpatient claims file includes visits that meet the following inclusion criteria:

(1) In-person, telephone, or online contact between any type of clinician (e.g., Doctor of Medicine [MD], Registered Nurse [RN], Nurse Practitioner [NP], Licensed Social Worker [LSW], psychologist, dietitian, dentist, etc.) and a patient, or the patient's guardian/custodian on behalf of the patient.

(2) For the purposes of assessment, consultation, diagnosis, or treatment.

(3) Treatment includes services that are not strictly medical in nature, such as care coordination services, case management, peer support services, and health education.

(4) Claims for services that exclusively collect data to inform diagnoses and treatment (e.g., laboratory tests, x-ray services, physiologic monitoring, audiology tests, etc.) are excluded.

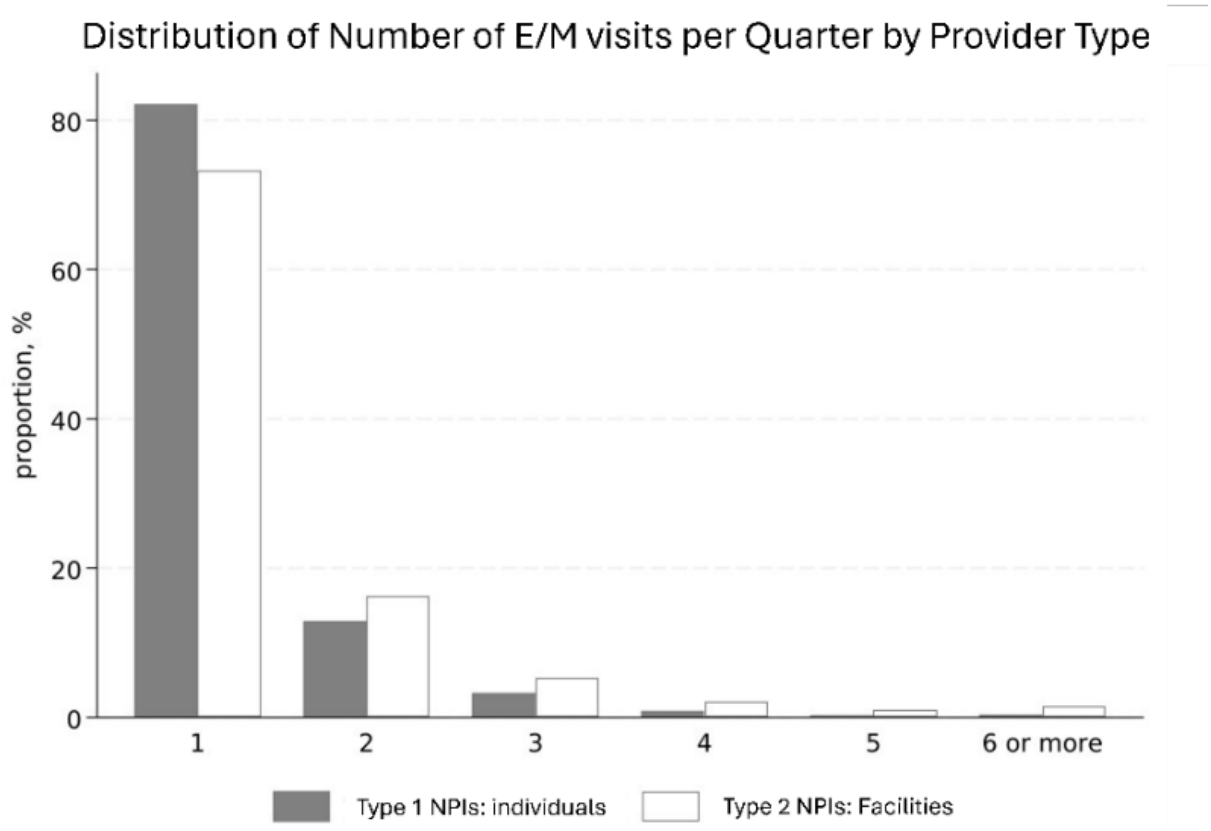
B.2. Treating Individual and Facility Providers as Equivalent in Attribution

Predominant providers are identified using National Provider Identifiers (NPIs) from outpatient claims files, where each claim is a unique combination of patient, NPI, and service date. NPIs may represent either individual providers (Type 1) or facilities (Type 2). Due to incomplete information on the rendering provider and variation in billing behaviors, approximately 19% of the outpatient claims and 12% of E/M claims for BadgerCare Plus Health Maintenance Organizations (HMOs) adult enrollees are with NPIs representing facilities during the study period.

This study treats individual providers (Type 1) and facilities (Type 2) as equivalent. The first reason is due to data limitations. In the claims data, rendering providers, identified by NPIs, were prioritized in determining the provider for outpatient visits. If the rendering provider was missing, then the billing provider was used. Secondly, as shown in Table B.2.1, the difference in the average number of E/M visits between a Type 1 (individual provider) and a Type 2 (facility) is relatively small—approximately 0.2 per person-quarter. Thirdly, as illustrated in Figure B.2.1, 70%-80% of enrollee-provider combinations had only one E/M visit per quarter, regardless of whether the provider had a Type 1 or Type 2 NPI. Therefore, this study treats both types of NPIs as equivalent in attribution.

Table B.2.1						
		Number of E/M visits per provider per quarter				
NPI	Unique combination of enrollee, provider, and quarter (WI/WI-border/missing)	Mean	SD	1th percentile	99th percentile	max
Type 1, individual	6,270,011	1.261604	0.7750933	1	4	92
Type 2, facility	733,538	1.490165	1.229999	1	6	79
Missing	42,216	1.451038	0.890935	1	5	15
Total	7,045,765					
Note: after excluding E/M claims with providers outside of Wisconsin and its border states, there were 7,045,765 unique enrollee-provider-quarter combinations for enrollees who had at least one E/M visit in a given quarter.						

Figure B.2.1



B.3. Breaking Ties and Imputation

This study breaks ties based on the assumption that an enrollee is unlikely to frequently change their predominant provider. Type 1 NPIs are prioritized, and if ties remain, primary care providers are given precedence.

If an enrollee did not have an E/M visit in a given quarter, this study imputes a provider based on the enrollee's providers from the previous and following quarters, provided that the enrollee remained in the same HMO during these periods. The provider from the previous quarter is given priority.

However, if there is a gap in HMO enrollment of more than two quarters between the last (or the next) attributed predominant provider and the quarter requiring imputation, the study does not impute across this gap. This is because enrollees who were previously enrolled in an HMO but experienced a disenrollment period of six months or more will undergo the same enrollment process as newly enrolled members, who have up to three months to change HMOs (Wisconsin Department of Health Services, 2015; Wisconsin Department of Health Services, 2022).

For example, if beneficiary A was enrolled in Dean Health Plan in 2015Q4 and attributed to Provider 1 during that quarter, but then disenrolled from 2016Q1 to 2016Q3 (three quarters) before re-enrolling in 2016Q4, this study does not impute the predominant provider for 2016Q4 based on 2015Q4. However, if the re-enrollment occurred in 2016Q3, the study may impute the predominant provider for 2016Q3 based on 2015Q4.

Additionally, if the imputed provider did not serve any BadgerCare Plus HMO adult enrollees in a given quarter, or if the imputed provider represents a hospital with a number of admissions below the 25th percentile among Wisconsin hospitals, this study considers the predominant provider to be missing.

As shown in Table B.3.1, among the 21,323,342 person-month observations for BadgerCare Plus HMO adult enrollees, 48% are attributed to a predominant provider based on E/M visits. However, 4.3% of them still have ties after breaking ties and imputation. In the end, approximately 80% of observations for BadgerCare Plus HMO adult enrollees are successfully attributed to a predominant care provider without ties, including approximately 6% of observations that are attributed to type 2 providers.

Table B.3.1							
Predominant Provider Imputation Status	Type of Predominant Provider (NPI)					Total	Proportion, %
	ties	type1	type 2	Unknown type	missing		
assigned based on E/M visits	918,470	8,682,191	626,386	68,795	0	10,295,842	48.28
imputed, based on assignment from previous quarters	0	5,122,547	389,771	38,066	0	5,550,384	26.03
imputed, based on assignment from later quarters	0	1,729,214	153,602	13,878	0	1,896,694	8.89
not assigned, not imputed	0	0	0	0	3,321,808	3,321,808	15.58
had been assigned/imputed, but reverse to missing	0	234,803	16,222	7,589	0	258,614	1.21
Total person-months	918,470	15,768,755	1,185,981	128,328	3,321,808	21,323,342	100
Proportion, %	4.31	73.95	5.56	0.60	15.58	100.00	
Note: An enrollee is assigned to a predominant provider each calendar quarter. The unknown type refers to NPIs that are no longer active in the National Plan and Provider Enumeration System (NPPES) downloadable file released in March 2021.							

B.4. Primary Care Providers:

Following the BadgerCare Plus and Medicaid SSI Contract for January 1, 2020-December 31, 2021(Wisconsin Department of Health Services, 2020), this study identified Primary Care Providers through specialty codes. These providers include adult and pediatric primary care providers, mental health and substance abuse providers, as well as Obstetrics and Gynecology (OB/GYN) providers. See the following tables for reference.

Primary Care Provider	**Mental Health and Substance Abuse Providers**	**OB/GYN**
080 – Federally Qualified Health Center (HealthCheck related)	112 – Licensed Psychologist (PhD)	095 – Nurse Practitioner/Nurse Midwife
090 – Certified Pediatric Nurse Practitioners	117 – Psychiatric Nurse	212 – Nurse Midwife
092 – Certified Family Nurse Practitioners	120 – Licensed Psychotherapist	316 – Family Practice
093 – Other Nurse Practitioners	121 – Licensed Psychotherapist with SAC	318 – General Practice
100 – Physician Assistants	122 – Alcohol & Other Drug Abuse Counselor	328 – OB/Gynecologists
316 – Family Practice	123 – Certified Psychotherapist with SAC	350 – Licensed Midwife
318 – General Practice	124 – Certified Psychotherapist	
322 – Internal Medicine	126 – Qualified Treatment Trainee (QTT)	
345 – Pediatricians	339 – Psychiatry	
734 – Screener (HealthCheck)	532 – Registered Alcohol & Drug Counselor	
735 – Screener/Case Management (HealthCheck)	740 – Mental Health	

Appendix C. Identifying the Integration Status of the Predominant Provider

C.1. Breaking Ties and Imputation

There are 276,222 observations at the Type 1 NPI (individual provider)–semiannual period level. These NPIs represent providers who treated BadgerCare Plus HMO adult enrollees in an outpatient setting and had a primary or secondary practice location in Wisconsin or bordering states during the study period. Before imputations, approximately 63% of these providers could be linked to hospitals, as their patients were admitted to at least one hospital within a semiannual period. However, 14% had ties, meaning that the hospitals admitting the highest and second-highest numbers of a provider's patients admitted the same number.

This study resolves ties based on the assumption that enrollees are unlikely to frequently change their affiliated hospitals. For individual providers whose patients had not been admitted to any hospitals, affiliated hospitals are imputed based on those in previous and subsequent semiannual periods, with priority given to previous periods. If a provider was assigned to a hospital with admissions below or equal to the 25th percentile among Wisconsin hospitals, their hospital affiliation was considered missing. This is because these hospitals are excluded from the analysis. In the end, approximately 83% of provider-semiannual observations were assigned to hospitals, 5% still had ties, and 12% remained unassigned. See Table C.1.1 for details.

There are 11,164 observations at the non-hospital Type 2 NPI (non-hospital facility)–semiannual period level. These NPIs represent non-hospital facilities that treated BadgerCare Plus HMO adult enrollees in an outpatient setting and had a primary or secondary practice location in Wisconsin or a bordering state during the study period. Before imputations, approximately 52% of these facilities could be linked to hospitals, as their patients were admitted to at least one hospital within a semiannual period. However, 12% had ties, where the hospitals

admitting the highest and second-highest number of a provider's patients admitted the same number.

This study follows a similar process to resolve ties and complete imputation for non-hospital facilities as for individual providers. In the end, approximately 66% of non-hospital facility-semiannual observations are assigned to a hospital, 5% still have ties, and 29% remain unassigned. See Table C.1.2 for details.

Table C.1.1						
Affiliated hospital imputation status	missing	One hospital	ties	missing, %	One hospital %	ties, %
initial linkage	29,129	157,783	15,090	10.55	57.12	5.46
imputed, based on previous/later periods		71,292	0		25.81	
Imputed but considered missing	2,928		0	1.06		
Total individual provider-semiannual periods			276,222	11.61	82.93	5.46

Table C.1.2						
Affiliated hospital imputation status	missing	One hospital	ties	missing, %	One hospital %	ties, %
initial linkage	2,965	5,159	594	26.56	46.21	5.32
imputed, based on previous/later periods		2,180	0		19.53	
Imputed but considered missing	266		0	2.38		
Total individual provider-semiannual periods			11,164	28.94	65.74	5.32

C.2. Summary of Enrollee Attribution to Hospitals

As shown in Table C.2.1, approximately 73% of BadgerCare Plus HMO adult enrollee observations are successfully attributed to a predominant provider, and their dominant provider is assigned to a hospital.

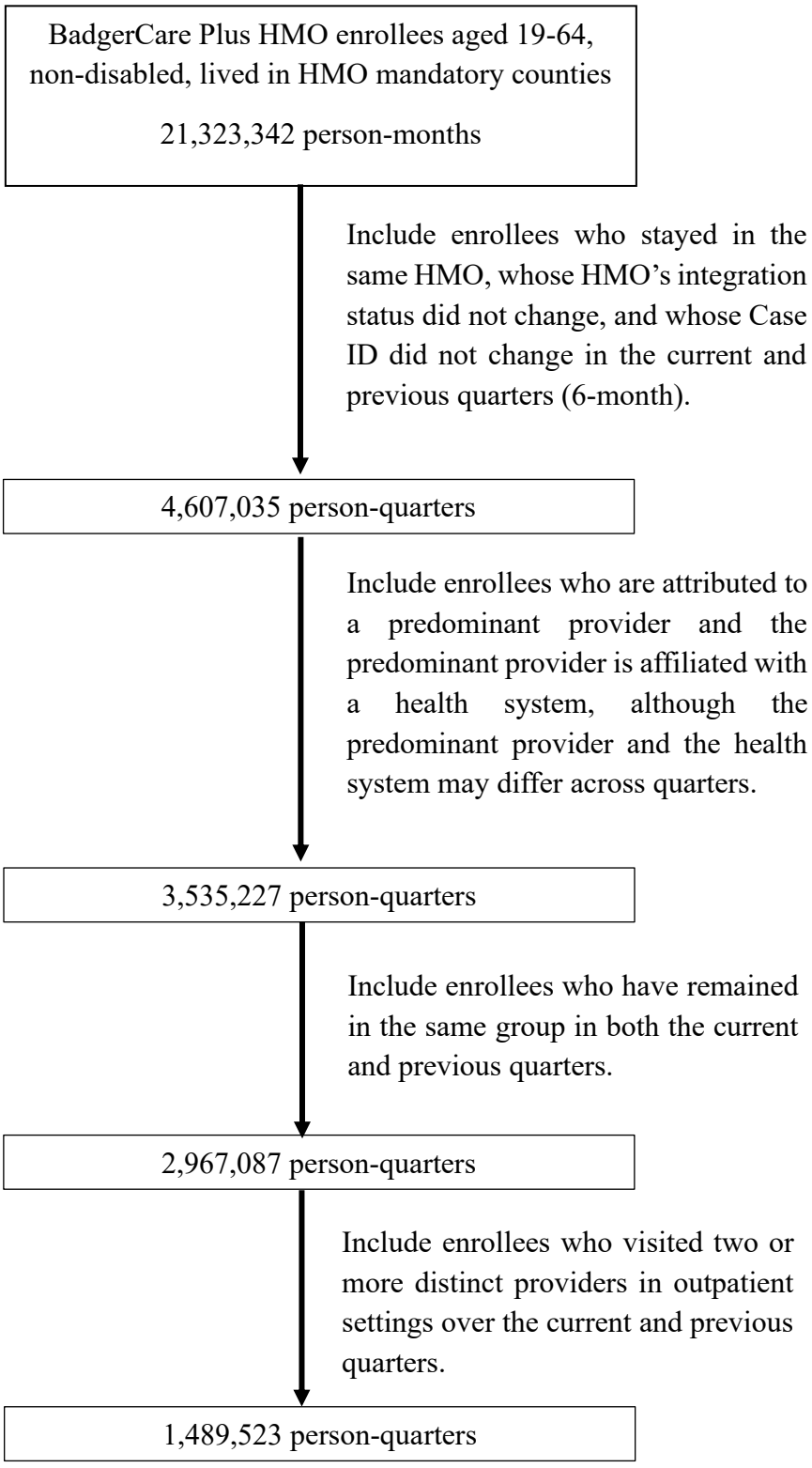
Table C.2.1

Predominant Provider of An Enrollee	Hospital of A Predominant Provider	Person-Months	Proportion, %
Ties		918,470	4.31
Missing		3,580,422	16.79
Attributed	Ties	990,444	4.64
	Missing	212,029	0.99
	Assigned	15,621,977	73.26
Total		21,323,342	100.00

C.3. Rationale for Using a Semiannual Period

This study assigns providers to hospitals on semiannual rather than quarterly basis, since a higher fraction of providers can be assigned when using semiannual periods, as patients seen in one quarter may be admitted to hospitals in the next.

Appendix D. Inclusion Criteria



Note: HMO—Health Maintenance Organization

Appendix E. Prevention Quality Indicators (PQI) Composite Measures*

PQI 90 PREVENTION QUALITY OVERALL COMPOSITE

PQI 1 Diabetes Short-Term Complications Admission Rate
PQI 3 Diabetes Long-Term Complications Admission Rate
PQI 5 Chronic Obstructive Pulmonary Disease (COPD) or Asthma in Older Adults Admission Rate
PQI 7 Hypertension Admission Rate
PQI 8 Heart Failure Admission Rate
PQI 11 Community Acquired Pneumonia Admission Rate
PQI 12 Urinary Tract Infection Admission Rate
PQI 14 Uncontrolled Diabetes Admission Rate
PQI 15 Asthma in Younger Adults Admission Rate
PQI 16 Lower-Extremity Amputation among Patients with Diabetes Rate

PQI 91 PREVENTION QUALITY ACUTE COMPOSITE

PQI 11 Community Acquired Pneumonia Admission Rate
PQI 12 Urinary Tract Infection Admission Rate

PQI 92 PREVENTION QUALITY CHRONIC COMPOSITE

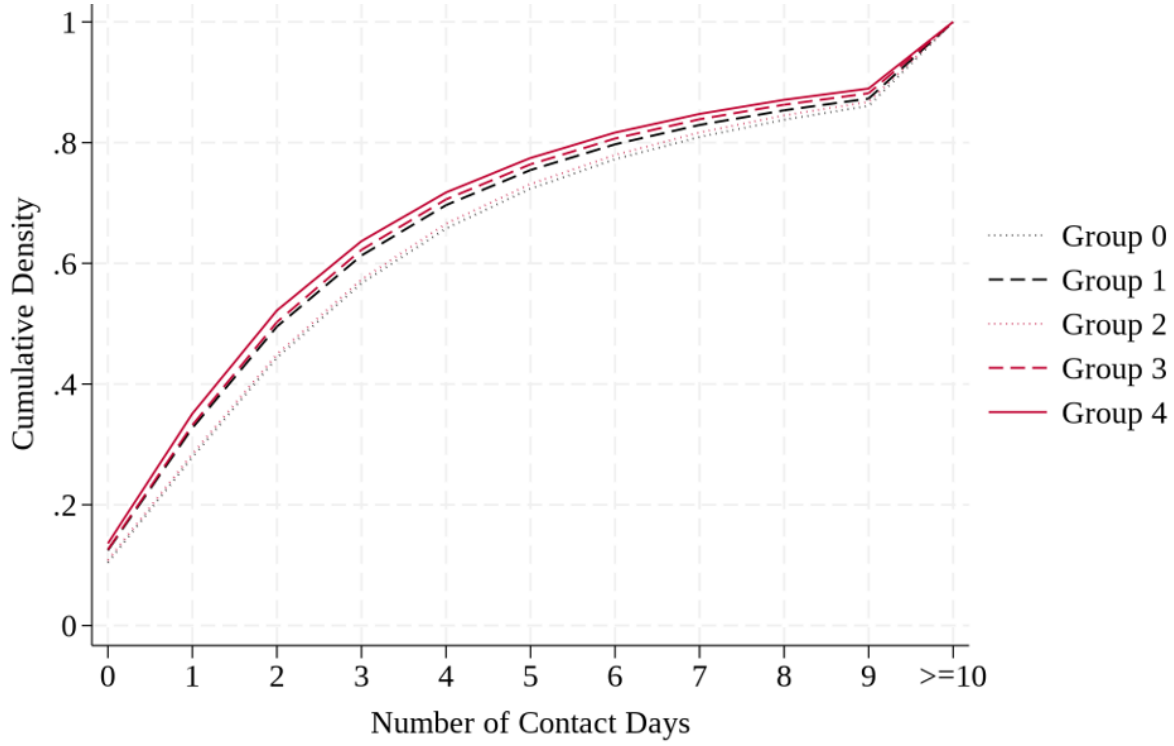
PQI 1 Diabetes Short-Term Complications Admission Rate
PQI 3 Diabetes Long-Term Complications Admission Rate
PQI 5 Chronic Obstructive Pulmonary Disease (COPD) or Asthma in Older Adults Admission Rate
PQI 7 Hypertension Admission Rate
PQI 8 Heart Failure Admission Rate
PQI 14 Uncontrolled Diabetes Admission Rate
PQI 15 Asthma in Younger Adults Admission Rate
PQI 16 Lower-Extremity Amputation among Patients with Diabetes Rate

PQI 93 PREVENTION QUALITY DIABETES COMPOSITE

PQI 1 Diabetes Short-Term Complications Admission Rate
PQI 3 Diabetes Long-Term Complications Admission Rate
PQI 14 Uncontrolled Diabetes Admission Rate
PQI 16 Lower-Extremity Amputation among Patients with Diabetes Rate

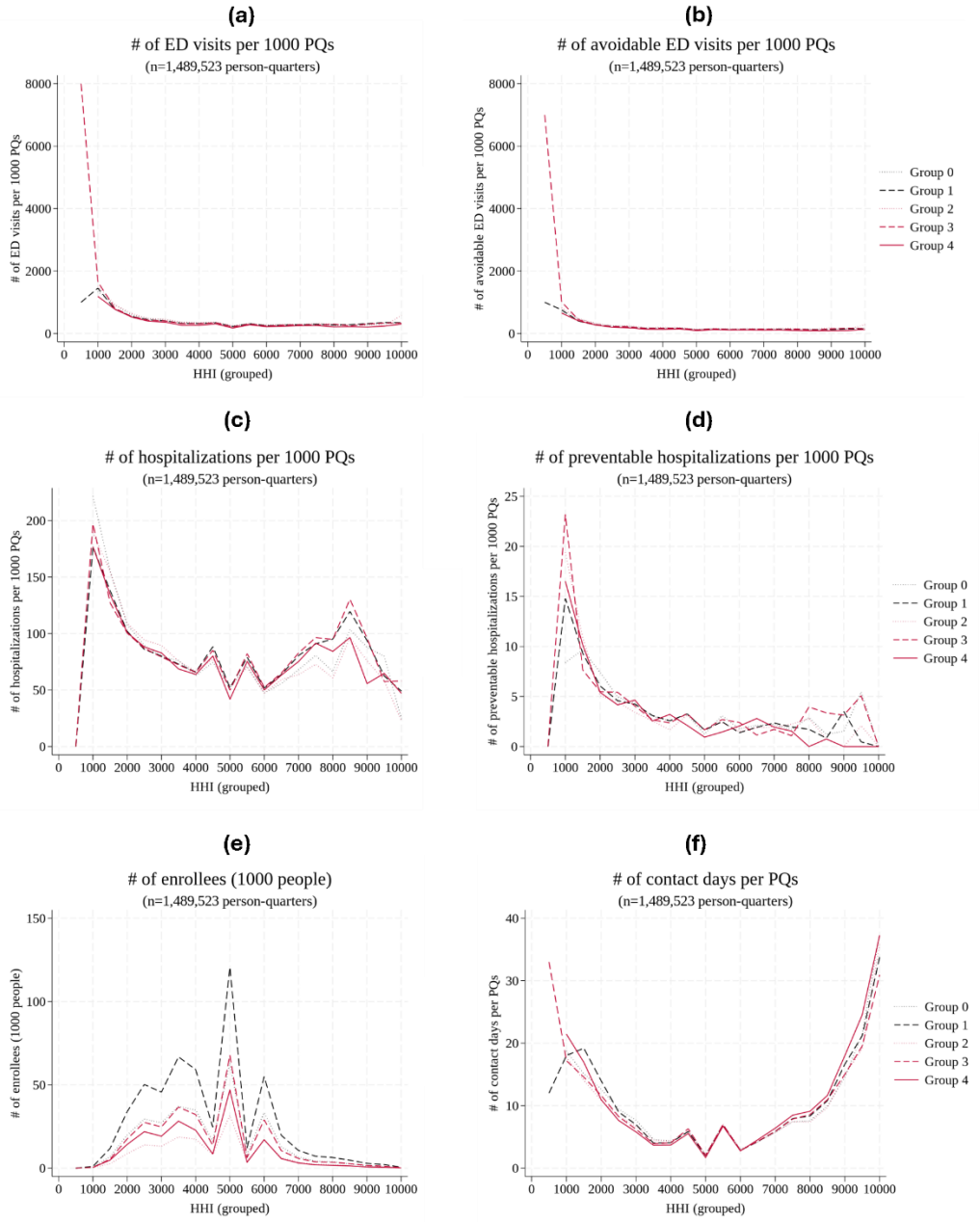
*None of the PQI composite measures are endorsed by the National Quality Forum.
*From Quality Indicator User Guide: Prevention Quality Indicators (PQI) Composite Measures version 2020, https://qualityindicators.ahrq.gov/Downloads/Modules/PQI/v2020/PQI_Composite_Development.pdf

Appendix F. Cumulative Density for Number of Contact Days by Group (n=1,489,523 person-quarters)



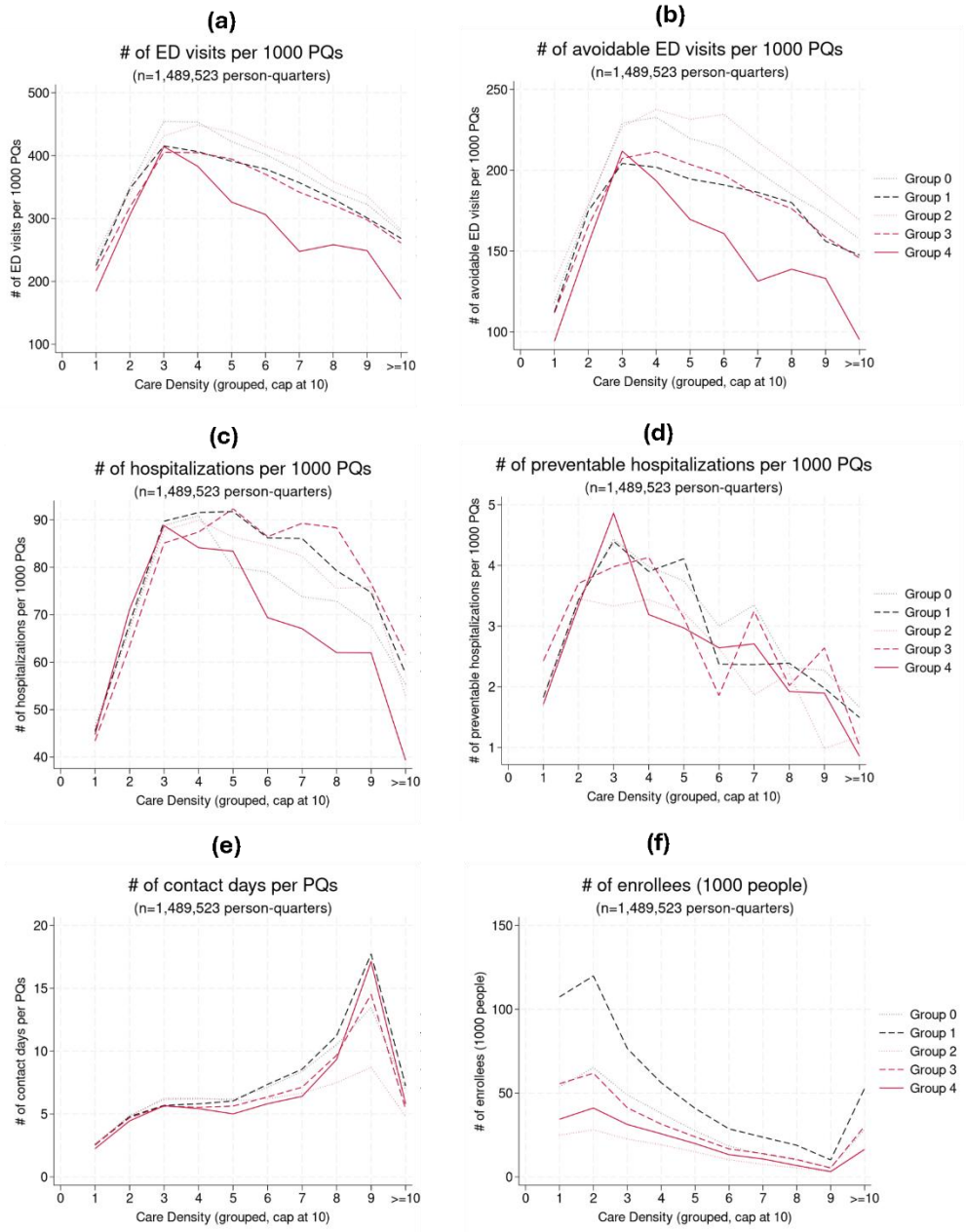
Note: The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO–Health Maintenance Organization.

Appendix G. Unadjusted Average Outcomes by the Herfindahl-Hirschman Index (HHI) for Each Degree of Provider-Insurer Integration



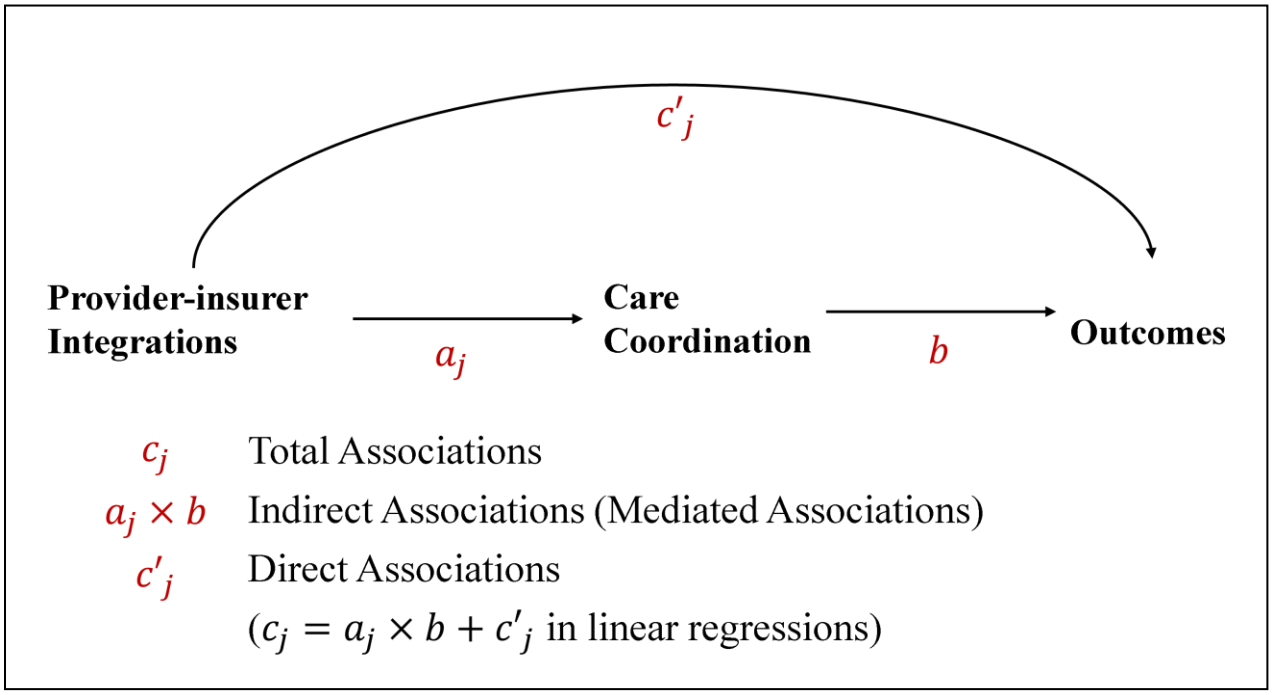
Note: PQs--person-quarters. Observations (person-quarters) are grouped into categories based on HHI values. For example, enrollees with a HHI greater than 1000 but less than or equal to 1500 are classified into the "HHI 1500" category (x-axis). The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO–Health Maintenance Organization.

Appendix H. Unadjusted Average Outcomes by Care Density for Each Degree of Provider-Insurer Integration



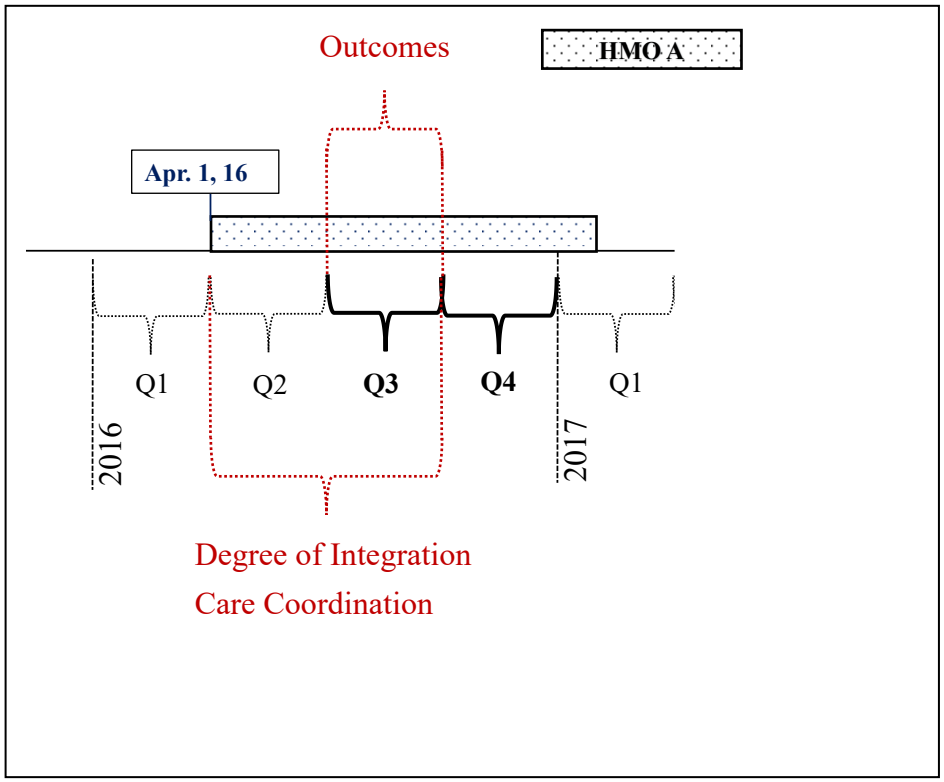
Note: PQs—person-quarters. Observations (person-quarters) are grouped into categories based on care density values. For example, enrollees with a care density greater than 2 but less than or equal to 3 are classified into the 'Care Density 3' category (x-axis). The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO–Health Maintenance Organization.

Appendix I. Conceptual Model of Mediation Analysis



Note: $\boldsymbol{j = 1, 2, 3, 4}$: representing Groups $\boldsymbol{j}$. Group 0 is the reference group. This study follows the mediation analysis in Hayes and Preacher (2014) paper. The paper refers to total, indirect, and direct effects (or associations) as "relative" total, indirect, and direct effects, because results would change if a different reference group were chosen. Here, the term "relative" is not emphasized, since the reference group is intentionally selected.

Appendix J. Timeframes of the Variables



Appendix K. Mediation Analysis Results—Main Analysis

	(1) Equation A		(2) Equation B	(3) Equation C	(4)	(5)		(6) Equation B	(7) Equation C	(8)	(9)
	TA (c_j)		HHI/10000 (a_j)	DA (b or c'_j)	IA (a_j*b)	[Bootstrap BC 95% CI]		Care Density (a_j)	DA (b or c'_j)	IA (a_j*b)	[Bootstrap BC 95% CI]
# of ED visits per 1000 person-quarters											
Group 1	-4.659		-0.0034***	-6.129	1.470	[0.877 2.041]		0.079***	-4.125	-0.534	[-0.693 -0.377]
Group 2	-4.349		0.0027***	-3.196	-1.153	[-1.795 -0.448]		0.042**	-4.068	-0.282	[-0.459 -0.088]
Group 3	-10.039*		-0.0036***	-11.592**	1.553	[0.829 2.220]		0.073***	-9.548*	-0.491	[-0.691 -0.327]
Group 4	-23.056***		-0.0150***	-29.468***	6.412	[5.621 7.175]		0.532***	-19.501***	-3.556	[-3.920 -3.179]
Mediator (b)				-426.598***					-6.680***		
R-square	0.065300		0.054405	0.070838				0.099486	0.065715		
# of Avoidable ED per 1000 person-quarters (PQs)											
Group 1	1.904		-0.0034***	1.076	0.828	[0.489 1.148]		0.079***	2.121	-0.216	[-0.285 -0.149]
Group 2	1.202		0.0027***	1.851	-0.650	[-1.021 -0.253]		0.042**	1.316	-0.114	[-0.184 -0.036]
Group 3	-0.886		-0.0036***	-1.761	0.875	[0.466 1.251]		0.073***	-0.687	-0.199	[-0.276 -0.129]
Group 4	-8.142**		-0.0150***	-11.754***	3.613	[3.176 4.051]		0.532***	-6.700*	-1.441	[-1.650 -1.231]
Mediator (b)				-240.363***					-2.708***		
R-square	0.045148		0.054405	0.049604				0.099486	0.045321		
# of Hospitalizations per 1000 person-quarters											
Group 1	6.272***		-0.0034***	6.143***	0.129	[0.077 0.180]		0.079***	6.274***	-0.002	[-0.015 0.013]
Group 2	-0.223		0.0027***	-0.121	-0.101	[-0.161 -0.042]		0.042**	-0.222	-0.001	[-0.009 0.007]
Group 3	5.759***		-0.0036***	5.622***	0.136	[0.076 0.200]		0.073***	5.760***	-0.002	[-0.014 0.012]
Group 4	7.923***		-0.0150***	7.360***	0.563	[0.479 0.651]		0.532***	7.935***	-0.012	[-0.094 0.085]
Mediator (b)				-37.482***					-0.023		
R-square	0.036843		0.054405	0.037222				0.099486	0.036843		
# of Preventable Hospitalizations per 1000 person-quarters											
Group 1	0.465*		-0.0034***	0.460*	0.005	[0.002 0.009]		0.079***	0.471*	-0.006	[-0.009 -0.003]
Group 2	-0.118		0.0027***	-0.115	-0.004	[-0.007 -0.001]		0.042**	-0.115	-0.003	[-0.006 -0.001]
Group 3	0.721**		-0.0036***	0.716**	0.005	[0.002 0.010]		0.073***	0.726**	-0.005	[-0.009 -0.002]
Group 4	0.445		-0.0150***	0.425	0.020	[0.009 0.034]		0.532***	0.482	-0.037	[-0.057 -0.019]
Mediator (b)				-1.361**					-0.069***		
R-square	0.015085		0.054405	0.015096				0.099486	0.015094		
# of Contact Days per person-quarter											
Group 1	-0.574***		-0.0034***	-0.602***	0.027	[0.016 0.038]		0.079***	-0.615***	0.040	[0.029 0.053]
Group 2	-0.239***		0.0027***	-0.218***	-0.021	[-0.034 -0.008]		0.042**	-0.260***	0.021	[0.007 0.035]
Group 3	-0.701***		-0.0036***	-0.729***	0.029	[0.015 0.041]		0.073***	-0.738***	0.037	[0.023 0.051]
Group 4	-1.102***		-0.0150***	-1.221***	0.119	[0.104 0.133]		0.532***	-1.371***	0.269	[0.252 0.288]
Mediator (b)				-7.905***					0.505***		
R-square	0.075998		0.054405	0.089435				0.099486	0.092788		

Note: n = 1,381,628. HHI—Herfindahl–Hirschman Index, TA—Total Associations, DA—Direct Associations, IA—Indirect Associations (mediated associations). BC 95% CI—bias-corrected 95% confidence interval. j = 1, 2, 3, 4 denotes Group j. Pooled Ordinary Least Squares (OLS) regressions are used for estimating parameters of Equations A, B, and C, with variance clustered at the individual level. These regressions also control for individuals' demographics (age, sex, race), socioeconomics (income, education), chronic conditions, residency by region in Wisconsin, year and quarter aggregated effects, and hospital features (multi-state status and quantile of admissions). Reference: * p<0.05, ** p<0.01, ***p<0.001. The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO–Health Maintenance Organization.

Appendix L. Total Associations (TA)--Sensitivity Analyses

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Main	VT_6mon	VT_9mon	VT_12mon	1st Subperiod	2nd Subperiod	3rd Subperiod	4th Subperiod	Individual_FE	HMO_MS_State	HMO_MS_Region
	TA (c_j)	TA (c_j)	TA (c_j)	TA (c_j)	TA (c_j)	TA (c_j)	TA (c_j)	TA (c_j)	TA (c_j)	TA (c_j)	TA (c_j)
obs (person-quarters)	1,381,628	508,073	508,077	508,077	236,069	459,987	472,415	213,157	1,381,628	1,381,628	1,381,628
# of beneficiaries									371,684		
# of ED visits per 1000 person-quarters											
Group 1	-4.659	-23.065***	-17.671**	-16.745**	-12.007	-11.276	5.419	13.546	-6.643	-5.52	-5.022
Group 2	-4.349	3.649	3.098	2.8	0.427	-4.167	-13.589	-3.74	4.13	-7.186	-4.312
Group 3	-10.039*	-22.776***	-17.235*	-16.047*	-30.309***	-22.054**	7.268	9.765	0.975	-12.492**	-8.856*
Group 4	-23.056***	-33.924***	-28.742***	-27.442***	-6.566	-24.547**	-20.213**	-20.539*	4.473	-29.583***	-22.663***
R-square	0.065	0.062	0.062	0.062	0.07	0.068	0.066	0.055	0.011	0.065	0.065
# of avoidable ED per 1000 person-quarters											
Group 1	1.904	-7.539*	-5.649	-5.656	-9.367	4.534	6.332	5.139	-3.396	1.654	1.903
Group 2	1.202	7.055	6.796	6.585	2.081	4.059	-7.649	-3.434	-0.076	0.516	0.662
Group 3	-0.886	-7.294	-5.349	-5.25	-20.588***	-3.027	8.393	4.214	-5.526	-1.575	-0.97
Group 4	-8.142**	-13.909**	-12.362**	-11.777**	-6.018	-4.38	-7.835	-12.22*	-0.124	-9.147**	-8.152**
R-square	0.045	0.044	0.044	0.044	0.049	0.047	0.044	0.034	0.006	0.045	0.045
# of hospitalizations per 1000 person-quarters											
Group 1	6.272***	4.054*	3.319*	3.715*	5.754*	8.414***	-3.798	1.812	11.921***	6.147***	6.177***
Group 2	-0.223	1.706	1.822	1.836	0.994	-1.954	-2.09	0.459	0.125	-0.545	-0.006
Group 3	5.759***	8.054***	7.287***	7.671***	7.529*	9.522***	-4.421	-1.248	13.997***	5.393***	6.107***
Group 4	7.923***	6.179**	5.535**	5.825**	2.312	9.127***	0.747	3.502	19.105***	6.417***	8.038***
R-square	0.037	0.038	0.038	0.038	0.042	0.038	0.036	0.034	0.016	0.037	0.037
# of preventable hospitalizations per 1000 person-quarters											
Group 1	0.465*	0.19	0.059	0.134	-0.767	1.263**	0.26	0.946*	0.051	0.442*	0.455*
Group 2	-0.118	-0.049	-0.035	-0.04	-0.503	-0.193	0.044	1.627*	0.94	-0.204	-0.096
Group 3	0.721**	0.741	0.6	0.683	0.441	0.891	0.963*	0.749	1.04	0.653*	0.761**
Group 4	0.445	-0.139	-0.251	-0.189	-0.547	1.043	0.592	0.136	0.657	0.22	0.464
R-square	0.015	0.015	0.015	0.015	0.018	0.014	0.016	0.015	0.003	0.015	0.015
# of contact days per person-quarter											
Group 1	-0.574***	-0.447***	-0.451***	-0.436***	-0.377***	-1.034***	-0.759***	-0.122	-0.011	-0.562***	-0.573***
Group 2	-0.239***	-0.378**	-0.377**	-0.374**	0.01	-0.505***	-0.536**	-0.083	-0.069	-0.194***	-0.232***
Group 3	-0.701***	-0.604***	-0.608***	-0.595***	-0.358***	-1.016***	-0.939***	-0.164	-0.103	-0.666***	-0.701***
Group 4	-1.102***	-1.288***	-1.278***	-1.283***	-0.457***	-1.406***	-1.351***	-0.775***	-0.07	-1.048***	-1.1***
R-square	0.076	0.082	0.082	0.082	0.089	0.081	0.087	0.075	0.012	0.076	0.076

Note: HMO—Health Maintenance Organization. TA—Total Associations. Main—the main analysis. VT—Various Timeframes. Individual_FE—Individual Fixed Effects. HMO_MS_State (or Region)—HMO Market Size sensitivity analysis with market at the state (or region) level. References: *** p<0.001, ** p<0.01, * p<0.05. The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization.

Appendix M. Associations Between Provider-Insurer Integrations and Care Coordination—Sensitivity Analyses

Table M.1. HHI/10000

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Main	VT_6mon	VT_9mon	VT_12mon	1st Subperiod	2nd Subperiod	3rd Subperiod	4th Subperiod	Individual_FE	HMO_MS_State	HMO_MS_Region
	(a_j)	(a_j)	(a_j)	(a_j)	(a_j)	(a_j)	(a_j)	(a_j)	(a_j)	(a_j)	(a_j)
person-quarters	1,381,628	508,073	508,077	508,077	236,069	459,987	472,415	213,157	1,381,628	1,381,628	1,381,628
# of beneficiaries									371,684		
Group 1	-0.0034***	-0.0015	-0.0037**	-0.0024	0.0007	-0.0077***	-0.0033*	0.0072***	-0.0013	-0.0038***	-0.0036***
Group 2	0.0027***	0.0042**	0.0035*	0.0039*	0.0027*	0.0048***	0.0007	0.004	-0.0004	0.0017*	0.003***
Group 3	-0.0036***	-0.001	-0.0034*	-0.0021	-0.0022	-0.0111***	-0.0029*	0.0101***	0	-0.0046***	-0.0031***
Group 4	-0.0150***	-0.0131***	-0.0162***	-0.0142***	-0.0097***	-0.0159***	-0.0178***	-0.0076***	-0.0074***	-0.0166***	-0.0149***
R-square	0.054	0.057	0.060	0.061	0.064	0.055	0.054	0.046	0.011	0.055	0.055

Table M. 2. Care Density

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Main	VT_6mon	VT_9mon	VT_12mon	1st Subperiod	2nd Subperiod	3rd Subperiod	4th Subperiod	Individual_FE	HMO_MS_State	HMO_MS_Region	CD_Binary
	(a_j)	(a_j)	(a_j)	(a_j)	(a_j)	(a_j)	(a_j)	(a_j)	(a_j)	(a_j)	(a_j)	(a_j)
person-quarters	1,381,628	508,073	508,077	508,077	236,069	459,987	472,415	213,157	1,381,628	1,381,628	1,381,628	1,381,628
# of beneficiaries									371,684			
Group 1	0.079***	0.169***	-0.038	-0.12***	-0.413***	0.276***	0.381***	0.057	-0.002	0.085***	0.071***	0.014***
Group 2	0.042**	-0.131***	-0.12***	-0.129***	-0.032	-0.059**	0.348***	0.269***	-0.058*	0.04**	0.06***	0.009***
Group 3	0.073***	0.14***	-0.069**	-0.154***	-0.264***	0.348***	0.338***	-0.012	-0.066*	0.086***	0.105***	0.016***
Group 4	0.532***	0.75***	0.455***	0.327***	0.047	0.383***	1.026***	0.654***	0.372***	0.494***	0.54***	0.099***
R-square	0.099	0.103	0.107	0.111	0.117	0.116	0.100	0.096	0.010	0.100	0.101	0.082

Note: HHI—Herfindahl–Hirschman Index. HMO—Health Maintenance Organization. Main—the main analysis. VT—Various Timeframes. Individual_FE—Individual Fixed Effects. HMO_MS_State (or Region)—HMO Market Size sensitivity analysis with market at the state (or region) level. CD_Binary—Care Density_Binary. References: *** p<0.001, ** p<0.01, * p<0.05. The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization.

Appendix N. Indirect Associations (Mediated Associations) Through Visit Concentration—Sensitivity Analyses

	HHI/10000										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Main	VT_6mon	VT_9mon	VT_12mon	1st Subperiod	2nd Subperiod	3rd Subperiod	4th Subperiod	Individual_FE	HMO_MS_State	HMO_MS_Region
	(a_j*b)	(a_j*b)	(a_j*b)	(a_j*b)	(a_j*b)	(a_j*b)	(a_j*b)	(a_j*b)	(a_j*b)	(a_j*b)	(a_j*b)
person-quarters	1,381,628	508,073	508,077	508,077	236,069	459,987	472,415	213,157	1,381,628	1,381,628	1,381,628
# of beneficiaries									371,684		
# of ED visits per 1000 person-quarters											
Group 1	1.47	0.564	1.152	0.69	-0.379	3.607	1.186	-2.535	0.396	1.622	1.536
Group 2	-1.153	-1.597	-1.113	-1.099	-1.53	-2.234	-0.263	-1.387	0.132	-0.705	-1.276
Group 3	1.553	0.391	1.078	0.599	1.218	5.179	1.048	-3.52	0	1.972	1.333
Group 4	6.412	5.005	5.123	4.025	5.435	7.405	6.466	2.642	2.321	7.084	6.358
# of avoidable ED per 1000 person-quarters											
Group 1	0.828	0.324	0.678	0.418	-0.219	1.963	0.682	-1.391	0.181	0.914	0.865
Group 2	-0.65	-0.916	-0.655	-0.665	-0.883	-1.216	-0.151	-0.761	0.06	-0.397	-0.719
Group 3	0.875	0.224	0.634	0.362	0.703	2.819	0.603	-1.932	0	1.111	0.751
Group 4	3.613	2.87	3.014	2.437	3.136	4.031	3.72	1.45	1.064	3.991	3.581
# of hospitalizations per 1000 person-quarters											
Group 1	0.129	0.051	0.058	0.029	-0.032	0.33	0.09	-0.284	0.091	0.142	0.135
Group 2	-0.101	-0.144	-0.056	-0.047	-0.129	-0.204	-0.02	-0.156	0.03	-0.062	-0.112
Group 3	0.136	0.035	0.054	0.026	0.103	0.473	0.079	-0.395	0	0.173	0.117
Group 4	0.563	0.451	0.257	0.172	0.457	0.676	0.49	0.296	0.534	0.62	0.559
# of preventable hospitalizations per 1000 person-quarters											
Group 1	0.005	0.0028	0.0008	-0.0015	0	0.0149	0.003	-0.0164	0.0018	0.0052	0.0049
Group 2	-0.004	-0.0079	-0.0008	0.0024	0	-0.0092	-0.0007	-0.009	0.0006	-0.0023	-0.0041
Group 3	0.005	0.0019	0.0007	-0.0013	0	0.0213	0.0027	-0.0227	0	0.0063	0.0043
Group 4	0.02	0.0246	0.0036	-0.0089	0	0.0305	0.0164	0.0171	0.0103	0.0227	0.0204
# of contact days per person-quarter											
Group 1	0.027	0.014	0.026	0.015	-0.002	0.066	0.033	-0.044	0.003	0.03	0.028
Group 2	-0.021	-0.04	-0.026	-0.023	-0.008	-0.041	-0.007	-0.024	0.001	-0.013	-0.024
Group 3	0.029	0.01	0.025	0.013	0.006	0.095	0.029	-0.061	0	0.036	0.025
Group 4	0.119	0.127	0.117	0.086	0.028	0.135	0.182	0.046	0.02	0.131	0.118

Note: HHI—Herfindahl–Hirschman Index. HMO—Health Maintenance Organization. Main—the main analysis. VT—Various Timeframes. Individual_FE—Individual Fixed Effects. HMO_MS_State (or Region)—HMO Market Size sensitivity analysis with market at the state (or region) level. CD_Binary—Care Density_Binary. The borders of a cell indicate that the IA's bias-corrected bootstrap 95% confidence interval contains 0. Thus, it is unclear whether these IAs are significantly different from 0. The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization.

Appendix O. Indirect Associations (Mediated Associations) Through Care Density—Sensitivity Analyses

	Care Density											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Main	VT_6mon	VT_9mon	VT_12mon	1st Subperiod	2nd Subperiod	3rd Subperiod	4th Subperiod	Individual_FE	HMO_MS_State	HMO_MS_Region	CD_Binary
	(a_j*b)	(a_j*b)	(a_j*b)	(a_j*b)	(a_j*b)	(a_j*b)	(a_j*b)	(a_j*b)	(a_j*b)	(a_j*b)	(a_j*b)	(a_j*b)
person-quarters	1,381,628	508,073	508,077	508,077	236,069	459,987	472,415	213,157	1,381,628	1,381,628	1,381,628	1,381,628
# of beneficiaries									371,684			
# of ED visits per 1000 person-quarters												
Group 1	-0.534	-1.084	0.212	0.683	2.985	-1.894	-2.529	-0.306	0.014	-0.569	-0.482	-0.538
Group 2	-0.282	0.838	0.673	0.736	0.232	0.403	-2.309	-1.449	0.47	-0.268	-0.41	-0.33
Group 3	-0.491	-0.897	0.388	0.881	1.907	-2.391	-2.242	0.063	0.538	-0.574	-0.714	-0.592
Group 4	-3.556	-4.814	-2.561	-1.863	-0.341	-2.635	-6.803	-3.519	-3.031	-3.303	-3.684	-3.715
# of avoidable ED per 1000 person-quarters												
Group 1	-0.216	-0.403	0.074	0.245	1.05	-0.802	-1.079	-0.119	0.006	-0.23	-0.195	-0.226
Group 2	-0.114	0.312	0.237	0.264	0.081	0.171	-0.985	-0.565	0.207	-0.108	-0.166	-0.139
Group 3	-0.199	-0.334	0.137	0.315	0.671	-1.013	-0.957	0.024	0.237	-0.232	-0.29	-0.248
Group 4	-1.441	-1.792	-0.901	-0.667	-0.12	-1.116	-2.903	-1.372	-1.333	-1.335	-1.493	-1.56
# of hospitalizations per 1000 person-quarters												
Group 1	-0.002	-0.129	0.028	0.127	0.079	-0.16	0.157	0.012	0.001	-0.003	-0.003	0.016
Group 2	-0.001	0.1	0.089	0.137	0.006	0.034	0.143	0.058	0.028	-0.001	-0.002	0.01
Group 3	-0.002	-0.107	0.051	0.163	0.05	-0.202	0.139	-0.003	0.032	-0.003	-0.004	0.018
Group 4	-0.012	-0.573	-0.34	-0.345	-0.009	-0.222	0.422	0.141	-0.181	-0.017	-0.021	0.11
# of preventable hospitalizations per 1000 person-quarters												
Group 1	-0.006	-0.0157	0.0029	0.0108	0.0198	-0.0267	-0.0313	-0.0015	0.0001	-0.0059	-0.005	-0.0064
Group 2	-0.003	0.0121	0.0091	0.0116	0.0015	0.0057	-0.0286	-0.0073	0.0029	-0.0028	-0.0043	-0.0039
Group 3	-0.005	-0.013	0.0052	0.0139	0.0127	-0.0337	-0.0277	0.0003	0.0033	-0.0059	-0.0074	-0.007
Group 4	-0.037	-0.0698	-0.0345	-0.0294	-0.0023	-0.0372	-0.0841	-0.0177	-0.0186	-0.0341	-0.0383	-0.0439
# of contact days per person-quarter												
Group 1	0.04	0.106	-0.021	-0.061	0.0603	0.1222	0.2816	0.0461	-0.0001	0.0429	0.0358	0.0402
Group 2	0.021	-0.082	-0.067	-0.066	0.005	-0.026	0.257	0.218	-0.004	0.02	0.03	0.025
Group 3	0.037	0.088	-0.039	-0.079	0.039	0.154	0.25	-0.009	-0.005	0.043	0.053	0.044
Group 4	0.269	0.471	0.256	0.167	-0.007	0.17	0.757	0.53	0.028	0.249	0.274	0.278

Note: HHI—Herfindahl–Hirschman Index. HMO—Health Maintenance Organization. Main—the main analysis. VT—Various Timeframes. Individual_FE—Individual Fixed Effects. HMO_MS_State (or Region)—HMO Market Size sensitivity analysis with market at the state (or region) level. CD_Binary—Care Density_Binary. The borders of a cell indicate that the IA's bias-corrected bootstrap 95% confidence interval contains 0. Thus, it is unclear whether these IAs are significantly different from 0. The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization.

Appendix P. Statistics at the Enrollee Level

Whether Degree of Provider-Insurer Integration Changed	Unchanged	Changed
n=386,250 enrollees	280,973	105,277
proportion of enrollees, %	72.74	27.26
Interval Between the First and Last Quarter (Quarters)		
mean	4.66	14.66
(sd)	(5.24)	(5.73)
smallest	1	1
25 percentile	1	10
50 percentile	2	15
75 percentile	6	20
largest	23	23
Cumulative Enrollment (Quarters)		
mean	2.90	6.40
(sd)	(2.62)	(3.60)
smallest	1	2
25 percentile	1	4
50 percentile	2	6
75 percentile	4	8
largest	23	22
Average Income Relative to FPL (%)		
mean	43.34	38.58
(sd)	(51.39)	(37.56)
smallest	0	0
25 percentile	0	1
50 percentile	31	32
75 percentile	75	65
largest	3,599	1,581
Number of Regions Stayed*		
n=372,110 enrollees	270,498	101,612
mean	1.01	1.05
(sd)	(0.10)	(0.22)
1	267,981	96,804
2	2,492	4,710
3	25	97
4	0	1

Note:*number of missing=14,140. This table reflects enrollee-level statistics. FPL—federal poverty level.

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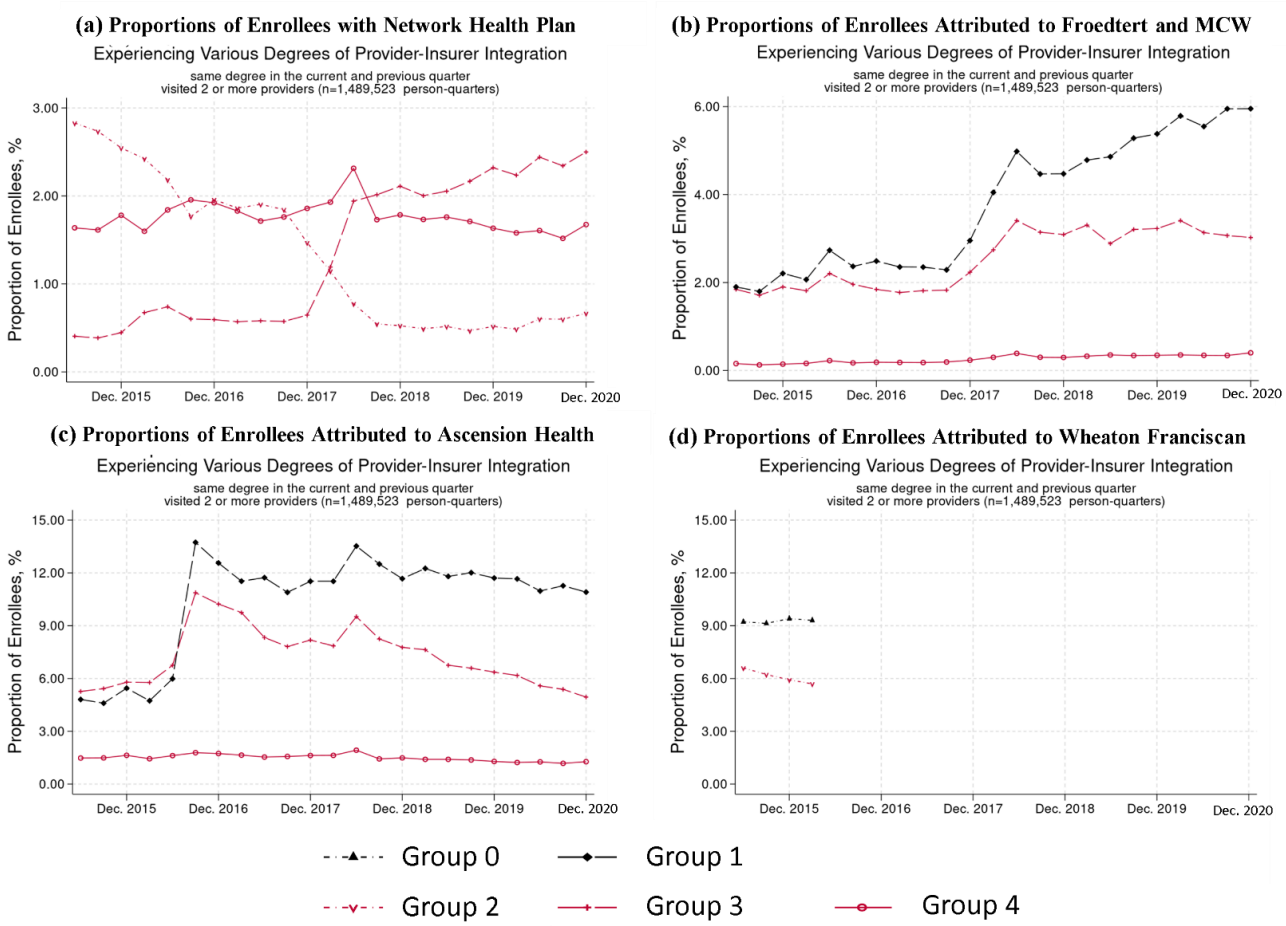
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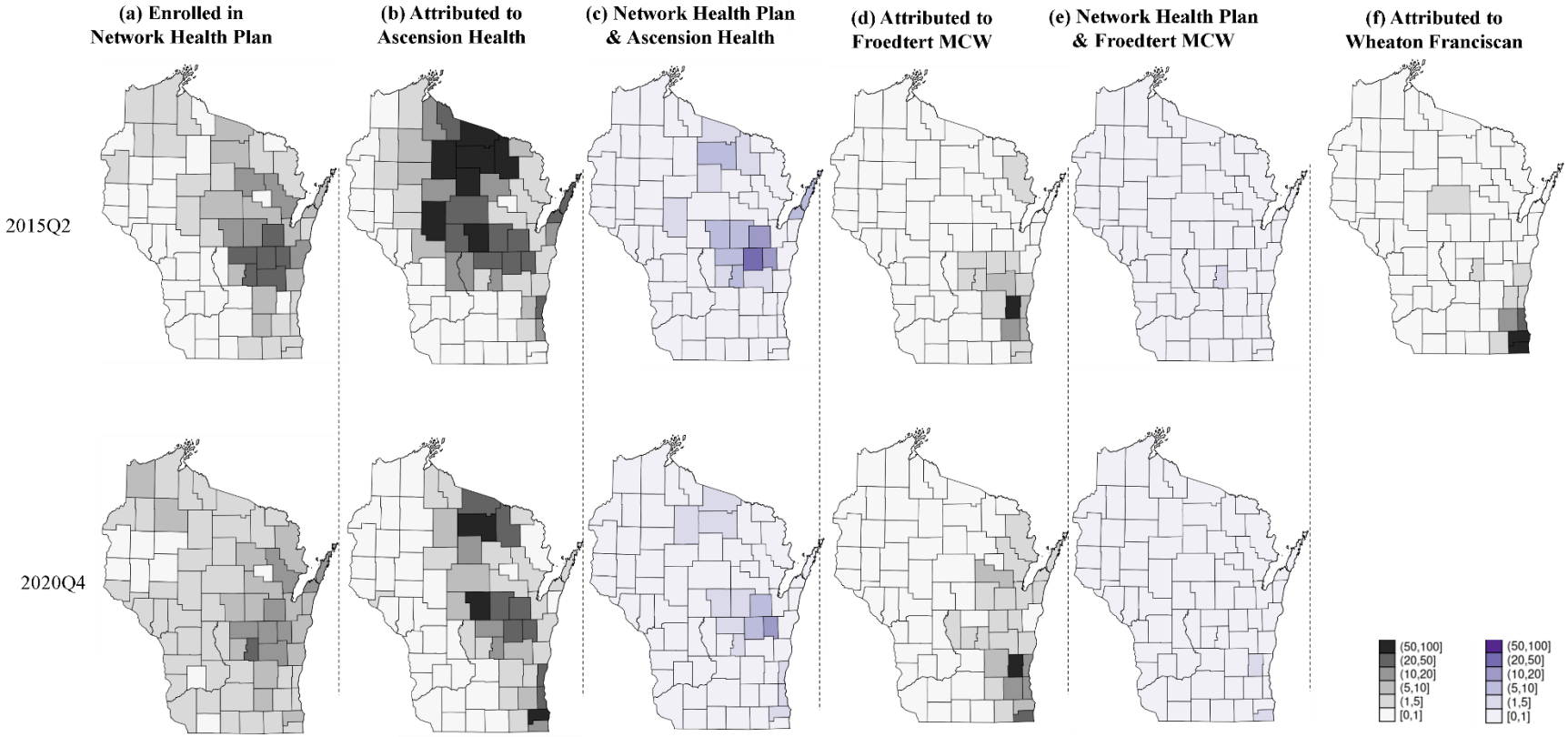
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Supplementary 1.1. Network Health Plan—Proportion of Enrollment



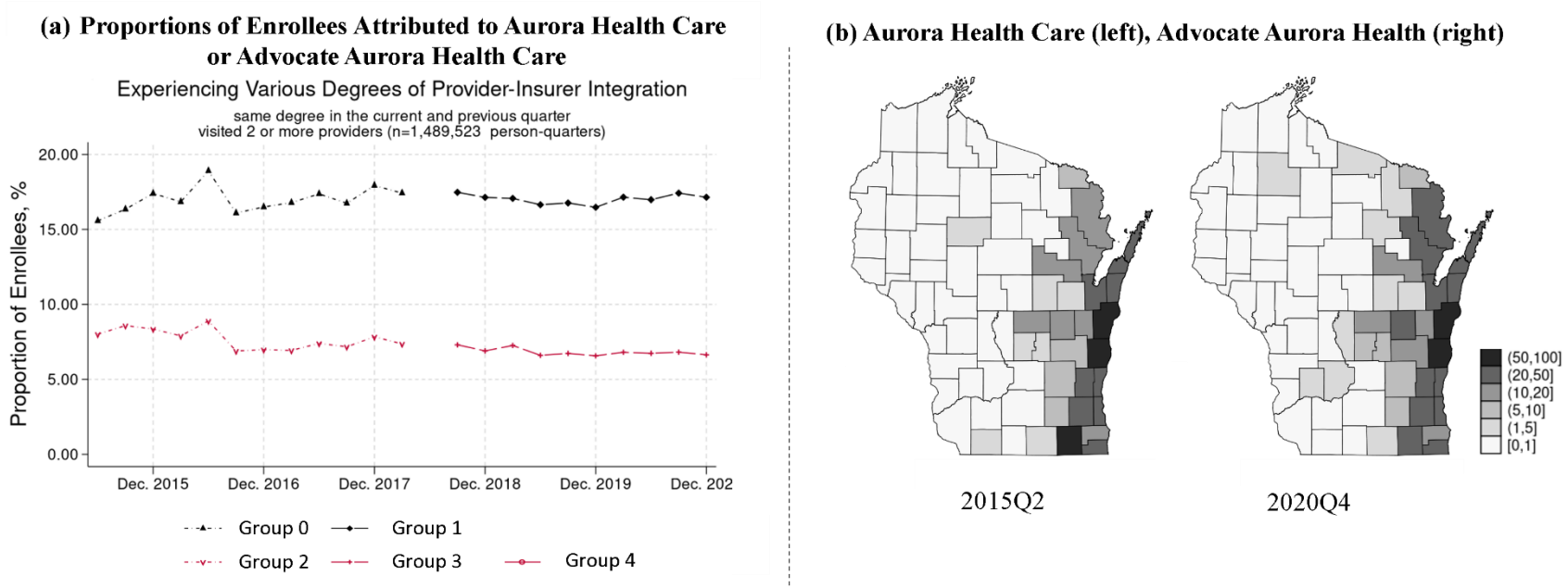
Note: Network Health Plan, a BadgerCare Plus Health Maintenance Organization (HMO), was equally owned by Froedtert and the Medical College of Wisconsin (Froedtert and MCW) and Ascension Health from January 2015 to December 2020 (Ascension Health, 2022; Network Health, 2022; Wisconsin Office of the Commissioner of Insurance, 2021c). In March 2016, Ascension Health purchased Wheaton Franciscan Healthcare (PR Newswire, 2016). The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO–Health Maintenance Organization.

Supplementary 1.2. Network Health Plan—Geographic Distribution



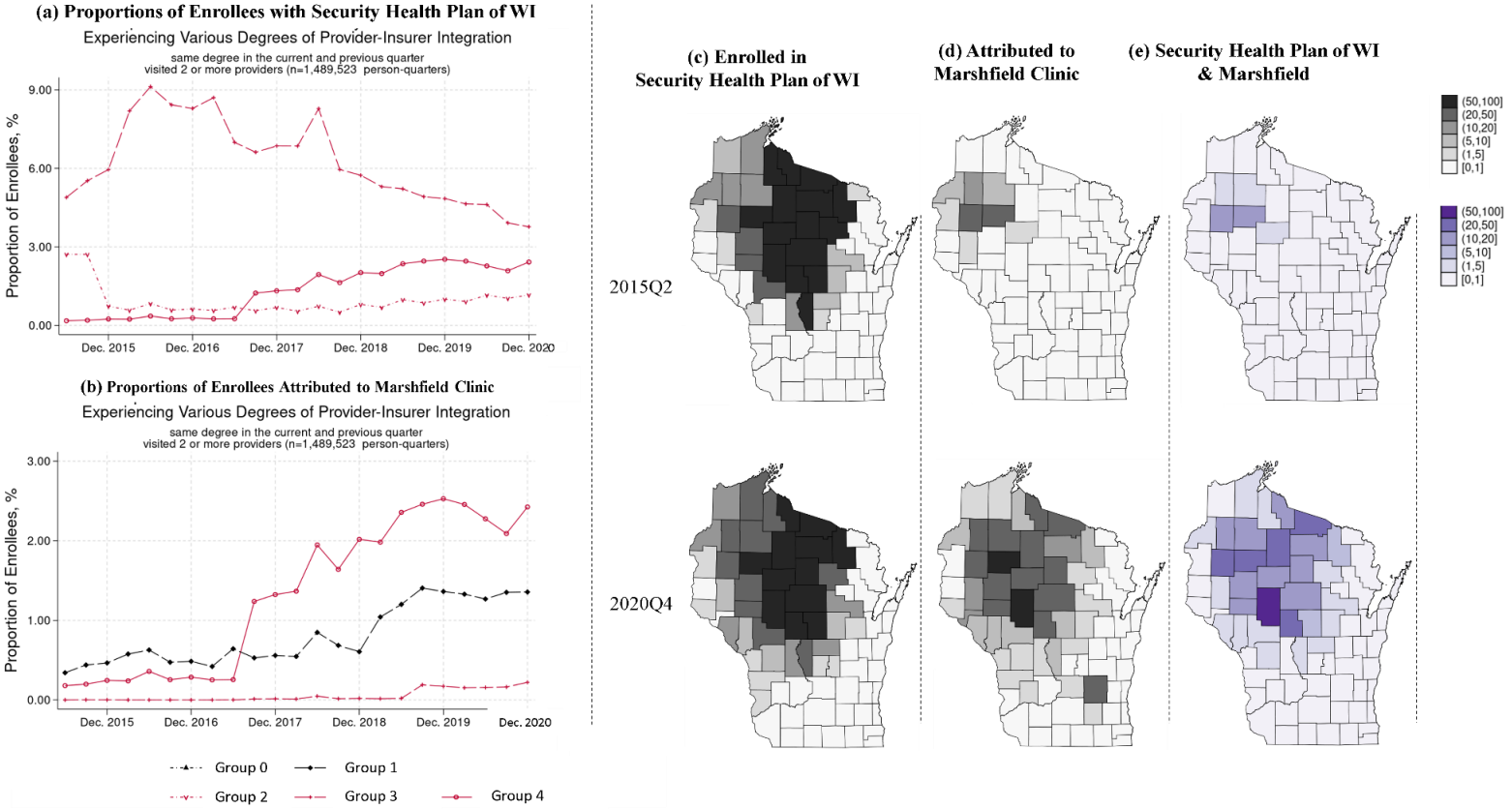
Note: Observations with missing residency information are excluded from these maps. Of the included observations (1,489,523 person-quarters), 104,672 person-quarters lack residency information. Excluding those without residency information does not affect the shape of the curves in Supplementary 1.1. Map lines delineate study areas and do not necessarily depict accepted national boundaries. Ascension Health, Froedtert and the Medical College of Wisconsin (Froedtert MCW), and Wheaton Franciscan were three health systems. Panel (a) reflects the proportion of enrollees with Network Health Plan in each county. Panel (b) reflects the proportion of enrollees attributed to Ascension Health in each county. Panel (c) reflects the proportion of enrollees with Network Health Plan and attributed to Ascension Health in each county. Panel (d) reflects the proportion of enrollees attributed to Froedtert MCW in each county. Panel (d) reflects the proportion of enrollees with Network Health Plan and attributed to Froedtert MCW in each county. Panel (f) reflects the proportion of enrollees attributed to Wheaton Franciscan in each county.

Supplementary 2. Advocate Aurora Health



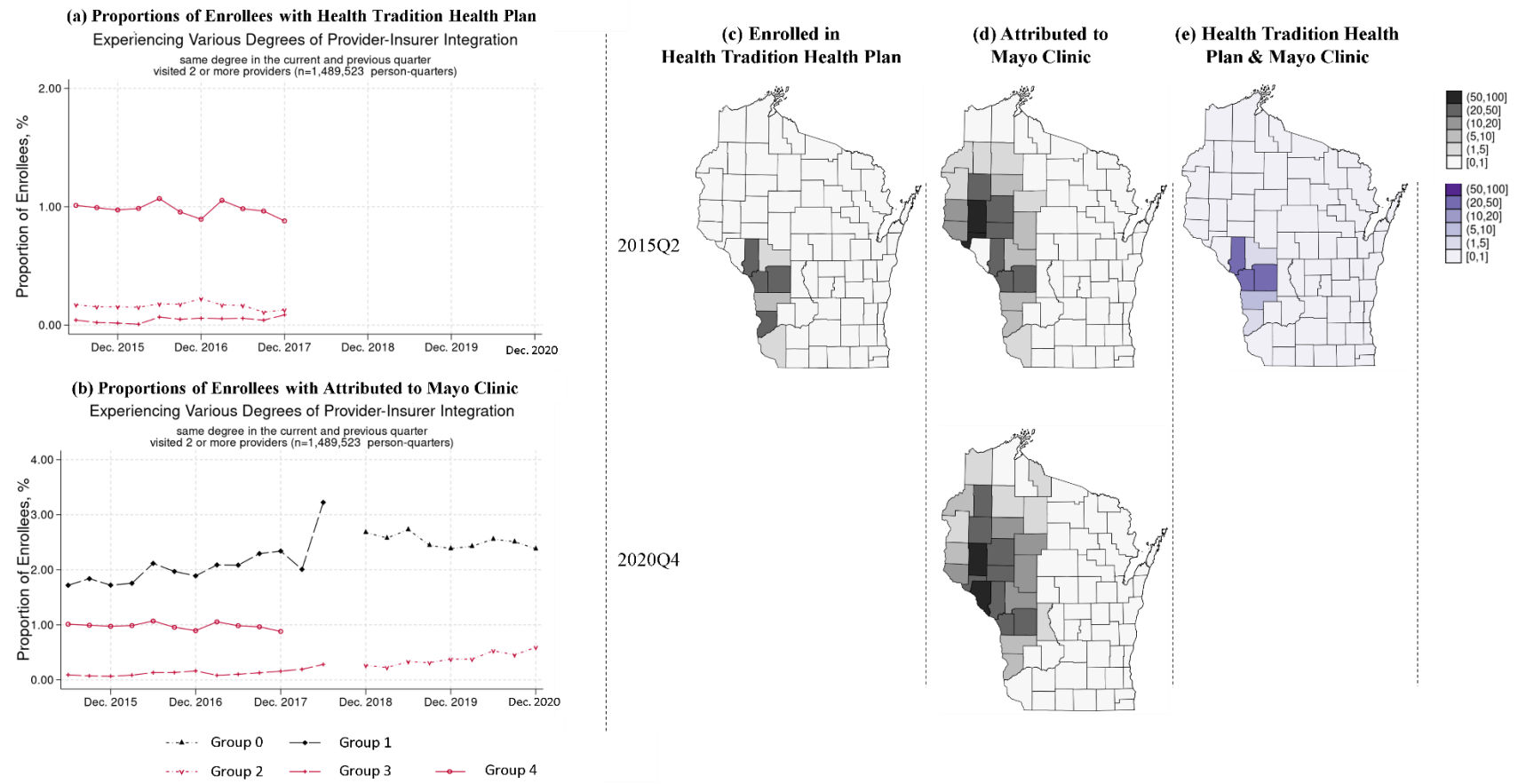
Note: Observations with missing residency information are excluded from these maps. Of the included observations (1,489,523 person-quarters), 104,672 person-quarters lack residency information. Excluding those without residency information does not affect the shape of the curves in panel (a). Map lines delineate study areas and do not necessarily depict accepted national boundaries. Aurora Health Care is considered non-integrated from January 2015 to February 2018. In March 2018, it merged with Advocate Health Care of Illinois to form Advocate Aurora Health (Wisconsin Office of the Commissioner of Insurance, 2018a). Advocate Health Care and Blue Cross and Blue Shield of Illinois launched BlueCare Direct in 2015, an HMO offered to individuals and small businesses both on and off the Illinois Health Insurance Exchange (Illinois Health Agents, 2015). They also launched Medicare Advantage plan named Blue Medicare Advocate Health in October 2020 (Blue Cross and Blue Shield of Illinois, 2020). Thus, Advocate Health Care, as well as Advocate Aurora Health are considered integrated from March 2018-December 2020. Panel (b) reflects the proportion of enrollees (among included observations) attributed to Aurora Health Care or Advocate Aurora Health in each county. The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO–Health Maintenance Organization.

Supplementary 3. Security Health Plan of WI



Note: Observations with missing residency information are excluded from these maps. Of the included observations (1,489,523 person-quarters), 104,672 person-quarters lack residency information. Excluding those without residency information does not affect the shape of the curves in panels (a)-(b). Map lines delineate study areas and do not necessarily depict accepted national boundaries. This study considers the Security Health Plan of Wisconsin (WI) to be wholly owned by Marshfield Clinic (later Marshfield Clinic Health System, Inc.) from January 2015 to December 2020 (*Our History*, 2022; Wisconsin Office of the Commissioner of Insurance, 2019e). Panel (c) reflects the proportion of enrollees (among included observations) with Security Health Plan of WI in each county. Panel (d) reflects the proportion of enrollees attributed to Marshfield Clinic (a health system) in each county. Panel (e) reflects the proportion of enrollees with Security Health Plan of WI and attributed to Marshfield Clinic in each county. The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO–Health Maintenance Organization.

Supplementary 4. Health Tradition Health Plan



Note: Observations with missing residency information are excluded from these maps. Of the included observations (1,489,523 person-quarters), 104,672 person-quarters lack residency information. Excluding those without residency information does not affect the shape of the curves in panels (a)-(b). Map lines delineate study areas and do not necessarily depict accepted national boundaries. Health Tradition Health Plan was wholly owned by Mayo Clinic from January 2015 to July 2018 (Wisconsin Office of the Commissioner of Insurance, 2021b). In August 2018, it was sold to WEA Insurance Corporation (Wisconsin Office of the Commissioner of Insurance, 2018b). Thus, this study considers both Health Tradition Health Plan and Mayo Clinic to be integrated from January 2015 to July 2018 but non-integrated from August 2018 to December 2020. Additionally, there have been no BadgerCare Plus beneficiaries enrolled in Health Tradition Health Plan since January 2018. Panel (c) reflects the proportion of enrollees (among included observations) with Health Tradition Health Plan in each county. Panel (d) reflects the proportion of enrollees attributed to Mayo Clinic in each county. Panel (e) reflects the proportion of enrollees with Health Tradition Health Plan and attributed to Mayo Clinic in each county. The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3**

(1, 1, 0), integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO–Health Maintenance Organization.

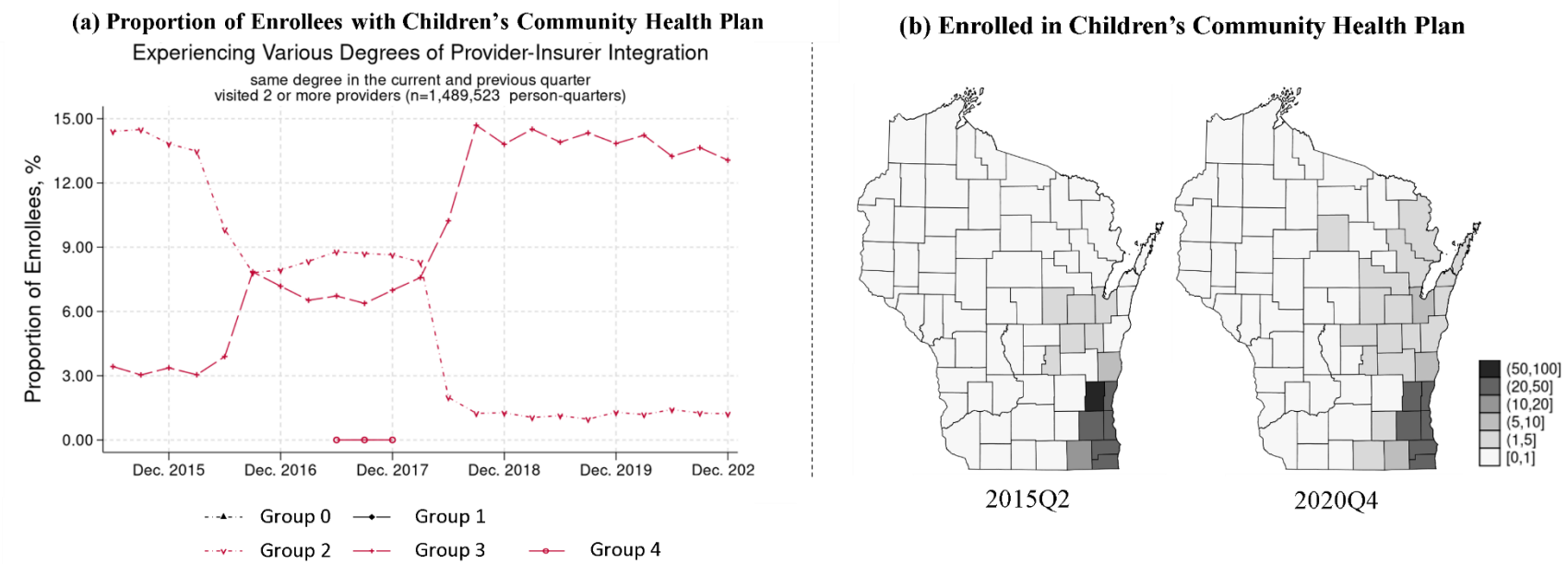
Supplementary 5. BadgerCare Plus HMOs from Jan 2015-Dec 2020

	WI Medicaid BadgerCare Plus HMO*	Whether Integrated with primary care or higher level of care providers in WI** (1/0-Yes/No)	Whether Integrated with hospital in WI** (1/0-Yes/No)
1	Anthem	0	n/a
2	Children's Community Health Plan	1	1
3	Compcare	0	n/a
4	Dean Health Plan	1	1
5	Group Health Cooperative of Eau Claire	0	n/a
6	Group Health Cooperative of South Central Wisconsin	1	0
7	Gundersen Health Plan	1	1
8	Health Tradition Health Plan	1	1
9	Independent Care Health Plan	0	n/a
10	Mercy Care Insurance Company	1	1
11	MHS of Wisconsin	0	n/a
12	Molina Healthcare of Wisconsin	0	n/a
13	Network Health Plan	1	1
14	Physicians Plus Insurance Corporation	1	1
15	Quartz	1	1
16	Security Health Plan of Wisconsin	1	1
17	Trilogy Health Insurance	1	0
18	UnitedHealthcare Community Health Plan	0	n/a
19	Unity Health Plans Insurance Corporation	1	1

Note: HMO—Health Maintenance Organization. An HMO offered by an insurer is referred to by the insurer's name. *HMOs that had ever participated in the BadgerCare Plus program between January 2015 and December 2020. **Reflects whether, during January 2015–December 2020, the HMO had ever been integrated with primary care or higher-level care providers in Wisconsin, and if so, whether it had integrated with hospitals. Quartz was formed through a series of acquisitions involving Gundersen Health Plan, Physicians Plus Insurance Corporation, and Unity Health Plans Insurance Corporation. Although Quartz is listed in the table, this study does not consider it a separate integrated HMO (see Supplementary 8 for details). Therefore, this study considers there to have been eleven integrated HMOs throughout the study period.

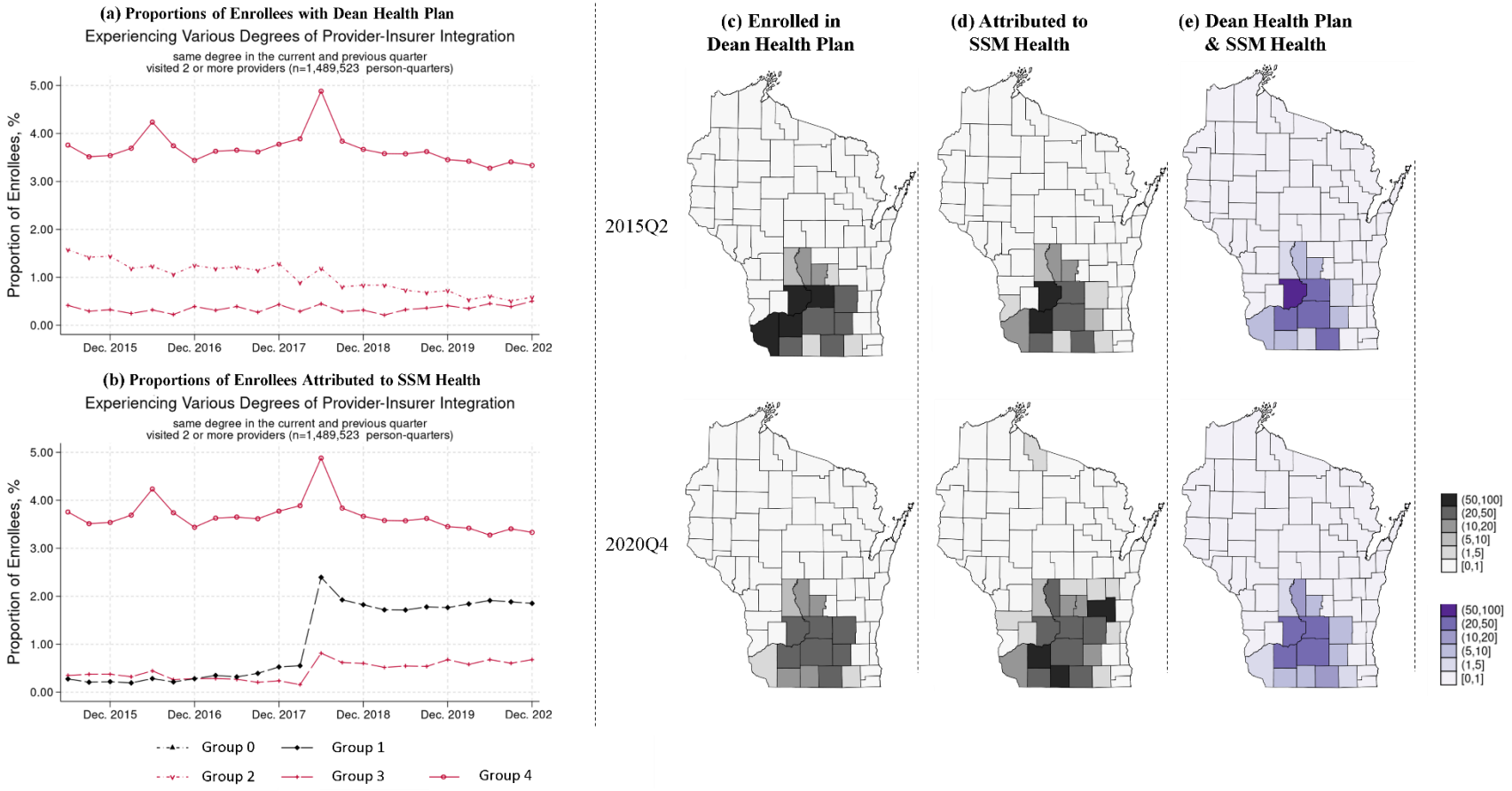
This study observes a large overlap between the residence of enrollees in a given integrated HMO and the residence of those attributed to the health system owned by the same integrated system for six of the eleven integrated HMOs: Network Health Plan, partially owned by Ascension Health (Supplementary 1.2 panels (a)-(b)); Security Health Plan of Wisconsin, owned by Marshfield Clinic (Supplementary 3 panels (c)-(d)); Dean Health Plan, owned by SSM Health (Supplementary 7, panels (c)-(d)), Gundersen Health Plan and Unity Health Plan, owned by Gundersen Health System and UW Health (Supplementary 8.2, panels (b)-(c) and Supplementary 8.3, panels (b)-(c)), as well as Mercy Care Insurance Company (Supplementary 9 panels (c)-(d)).

Supplementary 6. Children's Community Health Plan



Note: Observations with missing residency information are excluded from these maps. Of the included observations (1,489,523 person-quarters), 104,672 person-quarters lack residency information. Excluding those without residency information does not affect the shape of the curves in panel (a). Map lines delineate study areas and do not necessarily depict accepted national boundaries. This study considers Children's Community Health Plan (renamed to Chorus Community Health Plan effective Sept 1, 2022 (Children's Wisconsin, 2022)) a part of Children's Hospital and Health System, Inc. (a.k.a. Children's Wisconsin) from January 2015 to December 2020 (Chorus Community Health Plans, 2024; Wisconsin Office of the Commissioner of Insurance, 2019a). Panel (b) reflects the proportion of enrollees (among included observations) with Children's Community Health Plan in each county. The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO–Health Maintenance Organization.

Supplementary 7. Dean Health Plan



Note: Observations with missing residency information are excluded from these maps. Of the included observations (1,489,523 person-quarters), 104,672 person-quarters lack residency information. Excluding those without residency information does not affect the shape of the curves in panels (a)-(b). Map lines delineate study areas and do not necessarily depict accepted national boundaries. In September 2013, SSM Health Care Corporation became the ultimate controlling parent organization of Dean Health Plan (Wisconsin Office of the Commissioner of Insurance, 2019b). Thus, this study considers Dean Health Plan to be integrated with SSM Health from January 2015 to December 2020. Panel (c) reflects the proportion of enrollees (among included observations) with Dean Health Plan in each county. Panel (d) reflects the proportion of enrollees attributed to SSM Health in each county. Panel (e) reflects the proportion of enrollees with Dean Health Plan and attributed to SSM Health in each county. The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO–Health Maintenance Organization.

Supplementary 8. Quartz

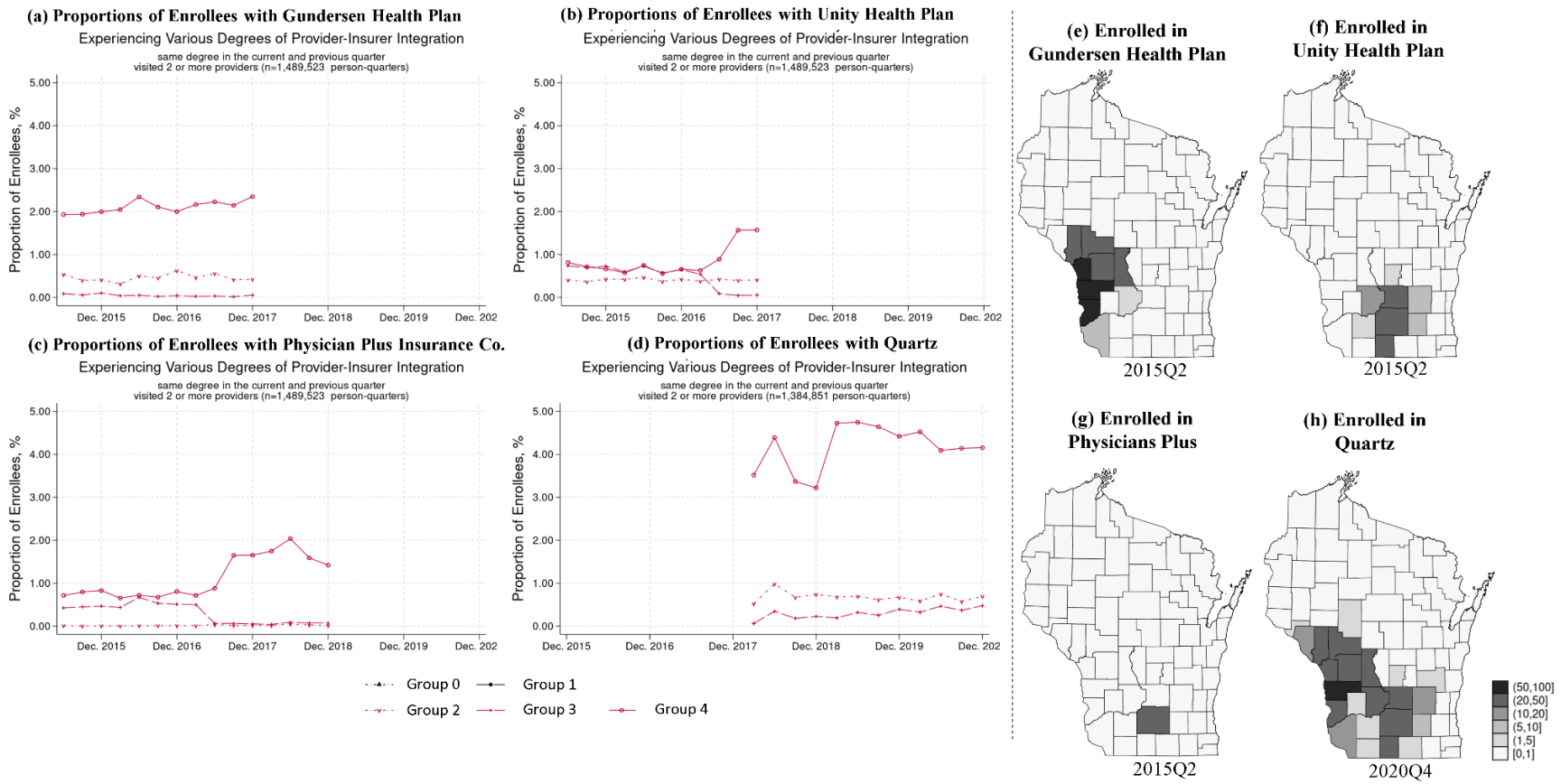
Gundersen Health Plan (GHP) was incorporated in Wisconsin on March 13, 1995, by Gundersen Clinic, Ltd. (the Clinic) and Gundersen Lutheran Medical Center, Inc. (the Hospital). On January 1, 2000, Gundersen Lutheran, Inc., an affiliation created by the Clinic and the Hospital in 1996, became the new parent of Gundersen Health Plan, replacing the Clinic and the Hospital. On March 26, 2013, Gundersen Lutheran, Inc., changed its legal name to Gundersen Health System (Wisconsin Office of the Commissioner of Insurance, 2019c).

Unity Health Plans Insurance Corporation is incorporated as HMO of Wisconsin on October 31, 1983. On November 1, 1994, United Wisconsin Services, Inc. acquired HMO of Wisconsin as well as the insurance business of U-Care HMO, Inc. And HMO of Wisconsin assumed both the benefit and provider contracts of U-Care HMO, Inc. On April 1, 1995, HMO of Wisconsin changed its name to Unity Health Plans Insurance Corporation. On January 1, 2005, Unity Health Plans Insurance Corporation was acquired by University Health Care, Inc. (UHC) as a wholly-owned subsidiary, where UW Health is the parent of UHC (UW Health, 2022; Wisconsin Office of the Commissioner of Insurance, 2019f).

Physicians Plus Insurance Corporation is a life, accident, and health (LAH) insurance company. The company was incorporated on July 17, 1986. On December 31, 2013, Meriter Health Services, Inc., purchased 100% of Physicians Plus Insurance Corporation stock. On February 1, 2014, Meriter Health Services, Inc., sold its shares to Iowa Health System d/b/a Unity Point Health (UPH), a provider of health-related services that operates in Iowa and Northern Illinois (Wisconsin Office of the Commissioner of Insurance, 2019d).

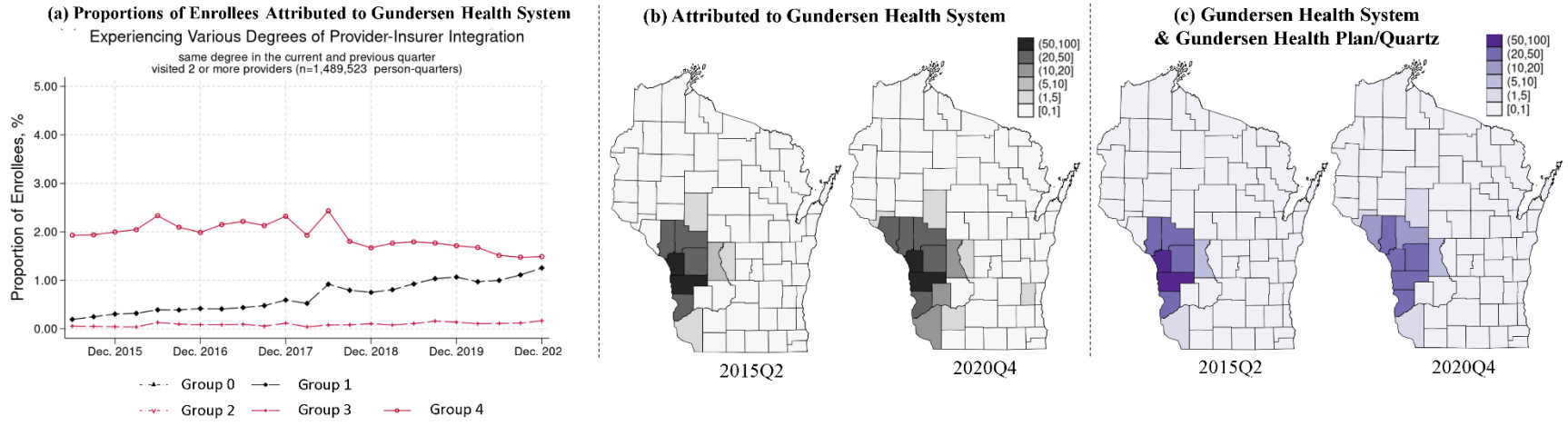
On April 21, 2016, acquisitions of Gundersen Health Plan by University Health Care (a subsidiary of UW Health) and Unity Health Plans by Gundersen Lutheran got approved (Quartz 2016 transaction). As a result, each of Gundersen Health Plan and Unity Health Plans became co-owned by Gundersen Health System and UW Health (UW Health, 2022; Wisconsin Office of the Commissioner of Insurance, 2016). On June 29, 2017, the application regarding the transaction to add Physician Plus Insurance Corporation into the structure built by the Quartz 2016 transaction got approved. Quartz Holding Company was created in the 2017 transaction. Consequently, Gundersen Health Plan, Unity Health Plans Corporation and Physician Plus Insurance Corporation were all co-owned by Gundersen Health System, UW Health, and UnityPoint Health, but these health systems remained independent of each other after the 2017 transaction (Wisconsin Office of the Commissioner of Insurance, 2021a).Quartz has undergone additional changes afterward (Quartz, 2024).

Supplementary 8.1. Development of Quartz



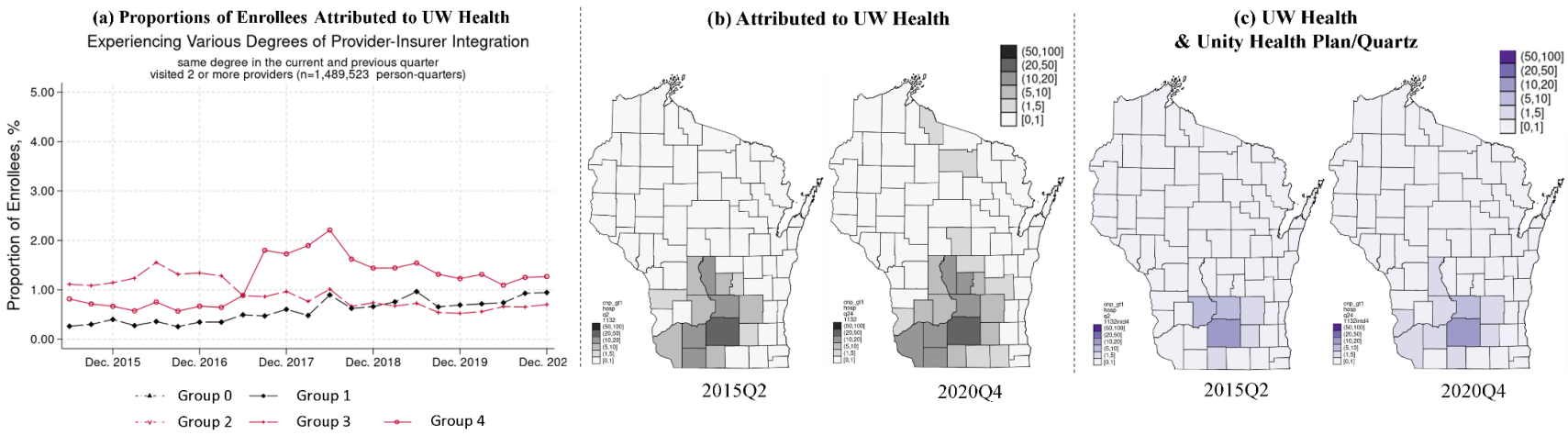
Note: Observations with missing residency information are excluded from the maps. Of the included observations (1,489,523 person-quarters), 104,672 person-quarters lack residency information. Excluding those without residency information does not affect the shape of the curves in panels (a)-(d). Map lines delineate study areas and do not necessarily depict accepted national boundaries. Panels (e)-(h) reflect the proportion of enrollees (among included observations) with Gundersen Health Plan, Unity Health Plan, Physicians Plus Insurance, Quartz, in each county, respectively. The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO–Health Maintenance Organization.

Supplementary 8.2. Gundersen Health System



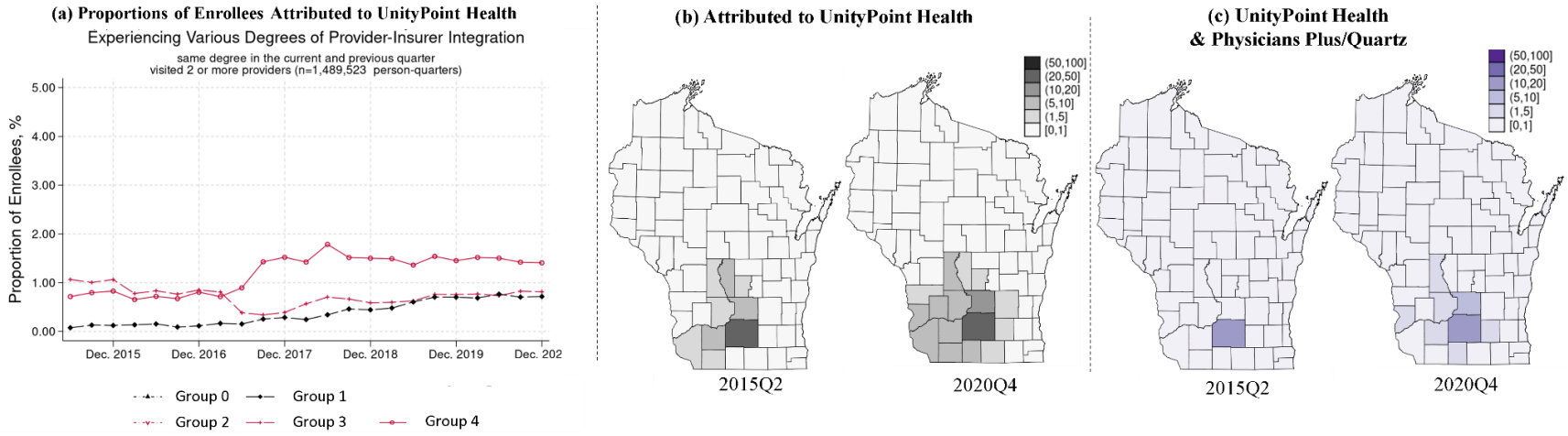
Note: Observations with missing residency information are excluded from the maps. Of the included observations (1,489,523 person-quarters), 104,672 person-quarters lack residency information. Excluding those without residency information does not affect the shape of the curves in panel (a). Map lines delineate study areas and do not necessarily depict accepted national boundaries. Panel (b) reflects the proportion of enrollees (among included observations) attributed to Gundersen Health System in each county. Panel (c) reflects the proportion of enrollees with Gundersen Health Plan or Quartz and attributed to Gundersen Health System in each county. The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO–Health Maintenance Organization.

Supplementary 8.3. UW Health



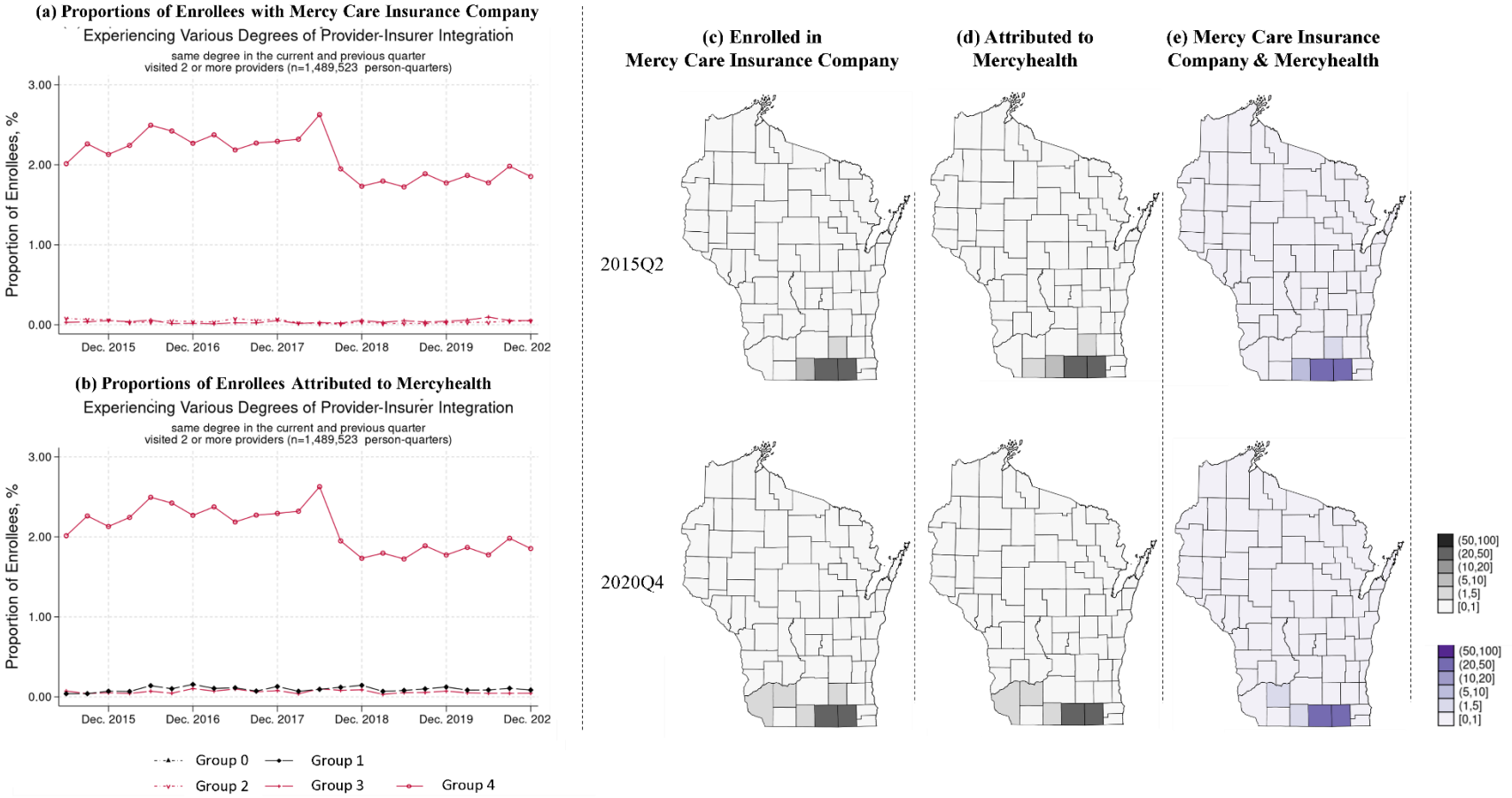
Note: Observations with missing residency information are excluded from the maps. Of the included observations (1,489,523 person-quarters), 104,672 person-quarters lack residency information. Excluding those without residency information does not affect the shape of the curves in panel (a). Map lines delineate study areas and do not necessarily depict accepted national boundaries. Panel (b) reflects the proportion of enrollees (among included observations) attributed to UW Health in each county. Panel (c) reflects the proportion of enrollees with Unity Health Plan or Quartz and attributed to UW Health in each county. The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO–Health Maintenance Organization.

Supplementary 8.4. UnityPoint Health



Note: Observations with missing residency information are excluded from the maps. Of the included observations (1,489,523 person-quarters), 104,672 person-quarters lack residency information. Excluding those without residency information does not affect the shape of the curves in panel (a). Map lines delineate study areas and do not necessarily depict accepted national boundaries. Panel (b) reflects the proportion of enrollees (among included observations) attributed to UnityPoint Health in each county. Panel (c) reflects the proportion of enrollees with Physicians Plus Insurance or Quartz and attributed to UnityPoint Health in each county. The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),** integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO–Health Maintenance Organization.

Supplementary 9. Mercy Care Insurance Company



Note: Observations with missing residency information are excluded from the maps. Of the included observations (1,489,523 person-quarters), 104,672 person-quarters lack residency information. Excluding those without residency information does not affect the shape of the curves in panels (a)-(b). Map lines delineate study areas and do not necessarily depict accepted national boundaries. This study considers Mercy Care Insurance Company to be integrated with Mercy Health System (a.k.a. Mercyhealth) from January 2015 to December 2020 (Wisconsin Office of the Commissioner of Insurance, 2015, 2020). Panel (c) reflects the proportion of enrollees (among included observations) with Mercy Care Insurance Company HMO in each county. Panel (d) reflects the proportion of enrollees attributed to Mercyhealth in each county. Panel (e) reflects the proportion of enrollees with Mercy Care Insurance Company HMO and attributed to Mercyhealth in each county. The five mutually exclusive groups are defined by the degree of provider–insurer integration: **Group 0 (0, 0, 0),** non-integrated HMO and non-integrated health system; **Group 1 (0, 1, 0),** non-integrated HMO and integrated health system; **Group 2 (1, 0, 0),** integrated HMO and non-integrated health system; **Group 3 (1, 1, 0),**

integrated HMO and integrated health system that owned by different parent organizations; and **Group 4 (1, 1, 1),** integrated HMO and integrated health system owned by the same parent organization. HMO–Health Maintenance Organization.

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IRB Approval

This study was approved by the Minimal Risk Research Institutional Review Board at the University of Wisconsin—Madison on January 19, 2022 (#2021-1463).