Are Provider-Insurer Integrations Associated with Preventable Care Utilization 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. Evidence remains limited because of variation in provider-insurer integrations and few prior empirical studies on this topic explore underlying mechanisms or clearly identify firm boundaries.

Combining 2015-2020 Wisconsin Medicaid claims data with self-collected information on provider-insurer integrations, I investigate the relationship between provider-insurer integrations and preventable care utilization and assess the extent to which care coordination may explain these relationships through a mediation analysis. Visit concentration and care density are two measures used to capture distinct aspects of care coordination.

Notable findings include that enrollees experiencing the highest degree of integration—those enrolled in an integrated health plan and whose predominant provider is affiliated with the same integrated system—have 4.3% fewer avoidable emergency department visits and 19%

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fewer contact days, a novel outcome intended to reflect quality, relative to those who experienced no integration (total associations). Mediation through care coordination is modest only for enrollees with the highest degree of integration, minimal for others. It can be opposite in sign to the total association and may vary in direction across care coordination measures.

The findings suggest that provider-insurer integrations are associated with reduced preventable care use and patient care burden. These integrations are associated with noticeable changes in care coordination within the same integrated system, while showing offsetting relationships across different care coordination aspects.

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

1. Introduction

Vertical integrations of health care organizations and insurance companies (hereafter referred to as "provider-insurer integrations" or "integrations") have arisen in multiple countries, including Chile, Greece, and the U.S. (Noton & Stenimachitis, 2022). This study focuses on provider-insurer integrations in the U.S. while the findings could be informative for other countries.

Provider-insurer integrations can be traced back to the nineteenth century in the U.S. (Liang & Mullahy, 2025). They have undergone several waves, with the latest driven by the paying-for-value initiatives prompted under the Affordable Care Act (ACA) (Allan Baumgarten, LLC, 2017). Enrollment in provider-integrated health plans—insurance products offered by provider-insurer integrated systems (hereafter referred to as "integrated systems")—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). By 2022, more than 30% of U.S. health systems were offering insurance products (Agency for Healthcare Research and Quality [AHRQ], Rockville, MD, 2024). Additionally, large insurance companies, such as UnitedHealth Group and Humana, have been expanding their businesses in care delivery (Rooke-Ley et al., 2024). The prominent integrated health system, Kaiser Permanente, is acquiring leading community-based health systems outside California (Kaiser Permanente, 2024). In light of these trends, it is increasingly important to understand the impacts of provider-insurer integrations and potential mechanisms.

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., 2011; Cuesta et al., 2024; De Stefano & Salinger, 2025). However, these integrations could also mitigate contractual problems, align incentives, facilitate care coordination, and eliminate double marginalization (Spengler, 1950; De Stefano & Salinger, 2025) between the integrated provider and insurer, all of which can improve care quality and reduce unnecessary care use (Spengler, 1950; Williamson, 1971; Holmstrom, 1999; Hart & Holmstrom, 2010; Eggleston et al., 2004; Enthoven & Baker, 2018; Agha et al., 2023).

This study examines the impact of provider-insurer integrations on preventable care utilization through care coordination, using mediation analysis, a method that has been applied in health economics to explore potential mechanisms (Andersen et al., 2022; Brewer et al., 2024). Care coordination is the deliberate organization of care involving multiple participants (McDonald et al., 2014). It facilitates the transition of care responsibilities and care information and plays a vital role in improving health outcomes and controlling health care costs (McDonald et al., 2014; Burns et al., 2021). Prior empirical research has found that provider-insurer integrations are associated with higher quality, lower mortality rates, and fewer intensive care unit (ICU) admissions (Frakt et al., 2013; Johnson et al., 2017; Meyers et al., 2020). However, few studies have investigated the extent to which care coordination may explain these associations, a gap to which this paper aims to contribute.

Different from prior empirical research that was cautious in classifying integrations of insurers and primary care providers into “integrated” (Howard et al., 2018; La Forgia et al., 2018; Meyers et al., 2020; Park et al., 2023), this paper identifies this form of integration as “integrated”. The identification strategy aligns with the framework and taxonomy proposed by Liang & Mullahy (2025), which highlighted the variation in levels of care owned by integrated systems. It is also based on the research question—assessing the impacts of integrations through

care coordination, in which primary care providers play a crucial role (Bodenheimer, 2008; Wagner et al., 2014; David et al., 2018).

This paper differentiates between integrated health plan enrollees whose predominant provider is affiliated with the same integrated system and those whose predominant provider is affiliated with a different integrated system. The former group is considered to have experienced the highest degree of integration. Previous research on care utilization has not clearly distinguished between these two groups (Meyers et al., 2020). This distinction enables the analysis to recognize the boundaries of firms more clearly and to incorporate the dynamics of mergers and acquisitions between integrated systems.

This paper also contributes to the literature on Medicaid populations. More than half of provider-integrated health plan enrollments are in Medicaid markets (Abou-Atme et al., 2019), yet few studies has examined the impacts of integrated systems in these markets. This study uses longitudinal claims data of Wisconsin Medicaid Health Maintenance Organizations (HMOs) from 2015-2020. Wisconsin has a long history of integrated health plans dating back to the 1970s (Security Health Plan of Wisconsin, 2021). Its enrollment of integrated health plans ranked in the highest quartile in the U.S. as of 2014-2015 (Copeland et al., 2015; Johnson et al., 2017). This context provides an ideal setting for research on provider-insurer integrations.

Medicaid populations have historically exhibited high use of preventable care services, such as emergency department (ED) visits, and potentially preventable hospitalizations (Basu et al., 2004; Kim et al., 2017; Cairns et al., 2023). Studies have shown ED-based care coordination plans can reduce repeated ED visits, (Bakshi et al., 2022; Katz et al., 2012) and higher continuity of care is associated with lower rates of potentially preventable hospitalizations in some settings (Nyweide et al., 2013). In addition to avoidable ED visits and potentially preventable

hospitalizations, this study also documents the association between the number of contact days and the degree of provider-insurer integration experienced by enrollees. The number of contact days with the healthcare system is a measure intended to reflect care burden and care quality (Burke et al., 2020; Ganguli, 2024), and it has been used in various Dartmouth Atlas analyses (Bynum et al., 2024).

The results suggest that enrollees experiencing the highest degree of provider-insurer integrations have the fewest avoidable ED visits and contact days, compared to those experiencing no integrations. Associations mediated through care coordination are modest in the group with the highest degree of integration but minimal in other groups. The direction of mediated associations may differ from that of the total associations and can vary depending on the measure of care coordination.

The rest of the paper is structured as follows. Section 2 introduces the data used in this study. Section 3 explains the identification of provider-insurer integrations. Section 4 describes the outcome and care coordination measures. Section 5 presents the empirical mediation analysis and results. Section 6 discusses the findings. Section 7 concludes.

2. Data

This study focuses on non-disabled individuals aged 19-64 who were enrolled in BadgerCare Plus HMOs from January 2015 to December 2020 (hereafter referred to as "BadgerCare Plus HMO adult enrollees"), totaling 21,323,342 person-months. 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 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). This study excludes enrollees residing in counties where BadgerCare Plus HMO enrollment was not mandatory.

This study uses comprehensive longitudinal enrollment and claims data on BadgerCare Plus HMO adult enrollees from the Wisconsin Administrative Data Core. The enrollment data includes demographic information (age, sex, race, and ethnicity), socioeconomic details (income, education, and county of residence), the HMO in which an individual was enrolled, and the effective and end dates of HMO enrollment. The claims data includes dates and diagnoses of emergency department visits, outpatient visits, and hospitalizations.

3. Identifying Provider-Insurer Integrations

3.1. Data for Identification

This study investigates the vertical integrations of providers and insurers through ownership, either full or partial, rather than collaboration. This study defines 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 generated by the Wisconsin Office of the Commissioner of Insurance, Health System Compendium 2016–2021 data files from the AHRQ (hereafter referred

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

to as the “AHRQ Compendium”), the Wisconsin Hospital Association 2017 Survey data, as well as website descriptions of insurance companies and health systems, press releases, annual reports, and relevant news articles. This study standardizes the timing of ownership changes by assuming they 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.

3.2. Degree of Provider-Insurer Integration Experienced by an Individual

This study categorizes BadgerCare Plus HMO adult enrollees into five groups based on the degree of provider-insurer integration they experienced. Specifically, it poses three questions to determine this degree: (1) Was the enrollee’s HMO offered by a provider-insurer integrated system? (2) Was the enrollee’s predominant care provider affiliated with a provider-insurer integrated system? If the answer to both was ‘Yes’, (3) were the enrollee’s HMO and their predominant care provider’s affiliation, partially or fully, owned by the same system? The more ‘Yes’ responses for an enrollee, the higher the degree of provider-insurer integration the enrollee experienced.

Therefore, Group 0 represents enrollees with three “No” responses and Group 4 consists of enrollees with three ‘Yes’ responses, reflecting the highest degree of provider-insurer integration. The intermediate categories are defined as follows: Group 1 corresponds to “No, Yes, No” responses; Group 2 reflects “Yes, No, No”; and Group 3 corresponds to ‘Yes, Yes, No’, as shown in Table 1.

Table 1. Groups of Enrollees by the Degree of Provider-Insurer Integration They Experience

HMO (1)	Predominant Provider (2)	Same System (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
	0-No; 1-Yes		

Note: HMO—Health Maintenance Organizations. (1) Was the enrollee's HMO offered by a provider-insurer integrated system? (2) Was the enrollee's predominant care provider affiliated with a provider-insurer integrated system? If the answer to both was 'Yes', (3) were the enrollee's HMO and their predominant care provider's affiliation, partially or fully, owned by the same system

Identifying the Predominant Provider of an Enrollee

Following the methods of Bynum et al., (2007) and Landon et al.,(2013), this study attributes 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.

Because of incomplete information on rendering provider and variation in billing behaviors, approximately 12% of E/M claims for BadgerCare Plus HMO adult enrollees are with facility providers, rather than individual providers. This study treats individual providers and facilities as equivalent (see Appendix B for details). Additionally, 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 this restriction. Providers are identified using National Provider Identifiers (NPIs) in claims files. Whether a provider is an individual or a facility and its practice location were determined using information from the National Plan and Provider Enumeration System (NPPES) Downloadable File released in March 2021.

In cases where an enrollee had ties with multiple providers or did not have any E/M visits in a given quarter, this study resolves ties or imputes the enrollee's predominant provider based on their predominant provider in the previous or subsequent quarters, with individual providers and primary care providers being prioritized (see Appendix B for additional details on the attribution process).

[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).

Identifying the Integration Status of the Predominant Provider

This study assigns providers, either individual clinicians or non-hospital facilities, who treated BadgerCare Plus HMO adult enrollees in outpatient settings to the hospital where a plurality of their patients had medical admissions during a given semiannual period. Hospitals are then linked to health systems based on the AHRQ Compendium data files. A provider is considered affiliated with the health system to which their assigned hospital is linked in that semiannual period. If a provider's health system is owned by an integrated system, the provider is considered affiliated with that integrated system.

In this process, each patient's hospitalizations are counted only once per provider per hospital. 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 BadgerCare Plus HMO adult enrollees.

Similarly, in cases where a provider had ties with multiple hospitals or if their patients had no hospitalizations in a semiannual period, this study resolves ties or imputes the provider's hospital affiliation based on their affiliation in the previous or subsequent semiannual periods. If a provider was assigned to an excluded hospital in a given semiannual period, their affiliation is considered missing for that period (see Appendix C for additional details of the assignment).

In the end, approximately 73% of observations for BadgerCare Plus HMO adult enrollees are successfully attributed to a predominant provider whose hospital affiliation is linked to a

health system. Thereafter, enrollees are considered attributed to the health systems with which their predominant provider is affiliated.

3.3. Inclusion Criteria

This study conducts analyses at the person-quarter level and applies 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 a predominant provider and the predominant provider was affiliated with a health system, though the predominant provider and health system could vary across quarters; (3) the enrollee were classified into the same group in both quarters to maintain a consistent integration level; and (4) the enrollee visited two or more distinct providers in outpatient settings, requiring care coordination across providers. Applying this inclusion criteria results in a total of 1,489,523 person-quarters of observations (will be 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 through providing better care coordination; (2) requiring two consecutive quarters of enrollment in the same HMO, along with a consistent degree of provider-insurer integrations, ensures that the study design meets the presupposed temporal ordering for mediation analysis—the changes of degrees in provider-insurer integration (treatment) precedes temporally the changes in the care coordination (mediator)[5], which temporally precedes the care use (outcome) (Lugo-Palacios et al., 2023;

[4]This paper includes enrollee did not change Case ID in each quarter. Case ID is likely a unique identifier used to manage a household's benefits. In 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).

Rijnhart et al., 2021). This study assesses care coordination over two consecutive quarters—the current and previous quarters—while assessing outcomes in the second quarter—the current quarter.

As shown in Figure 1, 50%-60% of the included observations are enrollees whose HMO was not offered by an integrated system—non-integrated HMO (Group 0 and Group 1)—throughout the study period. With the exception of Group 4—enrollees who experienced the highest degree of integration—the proportions of the included observations in other groups changed significantly throughout the study period.

The first significant change occurred in 2016, when the proportions of Group 1 and Group 3—enrollees attributed to an integrated health system but enrolled in a plan from a different system—increased, while the proportions of Group 0 and Group 2—enrollees attributed to a non-integrated health system—decreased. This change was mainly driven by the acquisition of Wheaton Franciscan Healthcare, a non-integrated health system, by Ascension Health, an integrated health system that owns a BadgerCare Plus HMO, 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 occurred in 2018, with even larger increases in the proportions of Group 1 and Group 3, accompanied by decreases in the proportions of Group 0 and Group 2. This 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)).

4. Measures

4.1. Outcome Measures

Potentially Avoidable Emergency Department visits

This study identifies potentially avoidable emergency department (ED) visits (hereafter referred to as "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 PQI (AHRQ, 2024). This study follows the AHRQ PQIs released in July 2020 and used SAS QI Software v4.5[6] and v2020 to identify the preventable hospitalizations (AHRQ, 2022) (see Appendix E for PQI composites).

[6] Before Oct 1, 2015, the diagnoses were using the International Classification of Diseases (ICD)-9-Clinical Modification (CM) in the claims data. This study applied specifications of the version released in May 2013 for ICD-9 codes. Although overall composites included four additional PQI in the May 2013 version, this study does not consider hospitalizations represent an ACSC being used to construct these four PQIs potentially preventable.

Contact Days

In this study, the number of contact days is defined as 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. The number of contact days serves as a more patient-centered measure of the frequency of interactions between a patient and the healthcare system. Fewer contact days may, but do not necessarily, indicate better quality of care.

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

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 a quarter, ranging from 90-92 days.

Included observations with the highest degree of provider-insurer integration had the lowest rates of unadjusted avoidable ED visits (153 per 1,000 person-quarters) and the fewest unadjusted contact days (5.1 per person-quarter), as shown in Table 2. The cumulative density function of unadjusted contact days by group also shows that Group 4 first-order stochastically dominates Groups 3 and 1; in turn, these groups first-order stochastically dominate Groups 2 and 0. This ordering corresponds to progressively fewer contact days, moving from Group 0 to Group 2, Group 1, Group 3, and finally Group 4 (Figure 2).

Table 2. 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
SUD (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 System=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: n_miss=[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).
Group classifications and Care Coordination Indicators for the current quarter (t) are generated based on data 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 generated based solely on the current quarter (t).

4.2.Care Coordination

Following the Care Coordination Measures Atlas by AHRQ (McDonald et al., 2014), this study defines care coordination as the deliberate organization of patient care activities between two or more participants (including the patient) involved in a patient's care to facilitate the appropriate delivery of health care services. Care coordination is distinct from direct patient care and is a process that occurs most often during, and in response to, care transitions (McDonald et al., 2014). This study uses outpatient visit concentration and care density to capture various aspects of care coordination.

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

Care Density

Because visit concentration does not capture care coordinating actions among distinct providers, this study also uses care density (Equation 3) to measure care coordination. Care

density 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 visited by patient i, m_i is the total number of possible providers 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 pairs of individual providers for that patient (Pollack et al., 2013). The 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 unadjusted visit concentration of included observations is around 4000 (Table 2). The unadjusted rates of all outcomes of interest decrease as the unadjusted HHI increases up to 5,000. Beyond that point, the unadjusted rates of ED visits and avoidable ED visits remain at a plateau, while the unadjusted rate of hospitalizations and the number of contact days increase as the unadjusted HHI rises further. When the unadjusted HHI exceeds 5,000, the trend in preventable hospitalizations differs slightly across groups (Appendix F).

On average, the unadjusted care density of Groups 0-4 is approximately 3.7-4 (**Table 2**). The unadjusted rates of ED visits, avoidable ED visits, hospitalizations and preventable hospitalizations increase with care density up to 3-4, then decrease thereafter. However, the unadjusted number of contact days continues to rise when care density exceeds 4 (Appendix G). Previous research shows that the probability of providers having a professional relationship becomes approximately 56% or higher when they share 4 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 'Care Density_Binary' analysis).

4.3. Covariates

This study controls for BadgerCare Plus HMO enrollees' demographics and socioeconomics, chronic conditions, and the year and quarter fixed effects of the current quarter

(t) in the regression. Demographic factors include age group, sex[7], race and ethnicity. Socioeconomic factors include income level relative to the Federal Poverty Line (FPL), education level with emphasis on whether one has completed high school, and region of residence in Wisconsin. It is worth mentioning, Group 4 enrollees are more likely to be White and less likely to have an education level below high school. Groups 0 and 1 are more likely to have an income below 50% of the FPL (Table 2).

Geographic Distribution

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). The proportion of enrollees attributed to an integrated health system increased notably in northeastern and southeastern Wisconsin during the study period (see Figure 4**,** Group 1 and Group 3). 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 Group 4 did not change significantly overall (Figure 1), there were offsetting changes across regions: the proportion of Group 4 increased in northern Wisconsin but decreased in the counties bordering western and southern Wisconsin (Figure 4, 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).

[7] 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).

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 BadgerCare Plus 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)).

Chronic 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). A binary indicator is generated to capture whether an individual has been diagnosed with any chronic condition in the past 12 months based on outpatient, inpatient, or emergency department visits. In addition, 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. Notably, because this study focuses on enrollees who visit two or more distinct

providers, more than 90% of the included observations has at least one chronic condition diagnosis in the past 12 months (Table 2).

Health System Characteristics

This study also controls for two health system characteristics—whether a health system operated in multiple states and its admission volume. Information on the former is obtained from AHRQ Compendium, the latter is represented by quartiles of admissions for BadgerCare Plus HMO adult enrollees. The predominant providers of the included observations were affiliated with 67 unique health systems.

Approximately 83% of enrollees whose predominant provider was affiliated with non-integrated health systems (Groups 0 and 2) were attributed to health systems operating in only one state and no more than 80% were attributed to the largest-volume health systems. In contrast, only 12-17% of enrollees whose predominant provider was affiliated with integrated health systems (Groups 1, 3, and 4) were attributed to single-state health systems and more than 90% of them were attributed to the largest-volume health systems. This pattern is consistent with previous research indicating that health systems operating Medicare Advantage health plans tend to be larger (Hedquist et al., 2024)(see Table 2).

5. Mediation Analysis and Results

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 effects of each provider-insurer integration degree on preventable care. See Appendix H 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.

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

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

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

Where I_{jit} $(j = 1,\ 2,\ 3\ ,4)$ represents Group j during quarter $t-1$ and quarter t (6-month), given Group 0 is the reference group. M_{it} represents the mediator, care coordination, during quarter $t-1$ and quarter t (6-month). $\boldsymbol{X}_{it}$ represents the enrollee's covariates in quarter t, including demographics (age, sex, race), socioeconomic factors (income, education), chronic conditions, residence of region, and health system characteristics. $\boldsymbol{T}_t$: the indicators of each year and quarter from 2015-2020 (see Appendix I for the timeframes of the variables).

Hayes and Preacher, 2014 suggests using "relative" effects to emphasize that results may vary depending on the choice of reference group. This study uses Group 0 as reference group because its enrollees didn't experience any provider-insurer integrations. Therefore, the term "relative" is not emphasized below, as this study aims to investigate the impacts of provider-insurer integrations.

As shown in Appendix H, $a_j \times b$ from the OLS results represents the indirect effects (IE), which captures the mediation effects. c_i represents the total effects (TE), while c'_j represents the direct effects (DE). The relationship among these effects is expressed as: $c'_j + a_j \times b = c_j$

Additionally, 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 affected by the treatment (VanderWeele, 2015). Although this study design meets the temporal ordering presupposition, it does not fully

satisfy these strong assumptions. Thus, the results of this study should be interpreted as associations.

5.2. Sensitivity Analyses

Except for the "Care Density_Binary" analysis, this study conducts four additional sensitivity analyses. The first examines the robustness of the results to the length of timeframes used for calculating care coordination measures, as the indirect effects through care coordination may be sensitive to the length of time (Ha et al., 2019). This analysis will be referred to as 'Various Timeframes' analysis. It further restricts observations to those who remained in the same integration status during the current and past three quarters (a total of 12 months) (n=567,050 person-quarters). Then, mediation analysis is repeated with care coordination measures calculated based on three different timeframes: (1) the current and previous quarters (6 months); (2) the current and previous two quarters (9 months); (3) the current and previous three quarters (12 months). Health system characteristics are also adjusted according to these timeframes. However, the outcome measures and values for individual characteristics continue to represent the current quarter.

The second adds individual fixed effects to the regression in the main analysis (n=1,489,523 person-quarters). This will be referred to as "Individual Fixed Effects (FE)" analysis. There are 386,250 unique individuals among included observations. 27% of these individuals experienced different degrees of integration during the study period. On average, these individuals had a 10-quarter longer interval between their first and last quarter of enrollment in the BadgerCare Plus HMO compared to those who remained in the same degree of integration during the study period. They also accumulated 3.5 more enrolled quarters. Changes

in the degree of integration were not associated with geographic mobility, as 98% of individuals stayed in the same region during the study period (see Appendix J).

The third sensitivity analysis adds a control for the HMO's market size at state and region levels, separately. It is referred to as 'HMO Market Size'. HMOs are first classified into quartiles based on their number of BCP HMO adult enrollees in each month.[8] The quarterly quartile of an HMO is then determined by the mode of its monthly quartiles within that quarter. The regression analysis controls for the highest quartile reached by the HMO during the current and previous quarters.

The fourth sensitivity analysis divides the study period into four subperiods: 2015 calendar quarter 2 (2015Q2)–2016Q1, 2016Q2–2018Q1, 2018Q2–2020Q1, and 2020Q2–2020Q4. This design allows the analysis to disentangle the effects of the acquisition of Wheaton Franciscan Healthcare, the merger of Aurora Health Care, and the COVID-19 pandemic. It will be referred to as "Subperiods" analysis.

5.3. Mediation Analyses Results

As Group 0 serves as reference group in the analysis, all results should be interpreted relative to Group 0. The terms "total associations" and "total effects" are used interchangeably below, as are "mediated associations" and "indirect effects."

Total Effects: Total Associations with Care Use

Grey bars—the first bar in each group—in Figure 5 panels (a)–(e) represent the total associations between the care utilization measures of interest and Groups 1–4 relative to Group 0. These correspond to the estimated parameters c_j $(j = 1,\ 2,\ 3\ ,4)$ from Equation A. Notably, in

[8] BadgerCare Plus HMO enrollees who were non-disabled, aged 19-64 living in HMO mandatory counties during study period (21,325,224 person-months).

Figure 5 as well as in in column (1) of Appendix K, enrollees who experienced the highest degree of provider-insurer integration, Group 4, were associated with 23.1 fewer adjusted ED visits and 8.1 fewer adjusted avoidable ED visits per 1,000 person-quarters (PQs). Enrollees attributed to an integrated health system, Groups 1, 3, and 4, were associated with 5.8-7.9 more adjusted hospitalizations per 1,000 PQs. Although these enrollees were also associated with 0.5-0.7 higher adjusted rates of preventable hospitalizations, the association is insignificant for Group 4. Moreover, enrollees who experienced any levels of provider-insurer integrations, (Groups 1-4) had 0.24-1.1 fewer adjusted contact days per person-quarter, with Group 4 had the fewest.

The results of the sensitive analyses (Appendix L) also showed a consistent negative total association between ED visits, avoidable ED visits and Group 4, except in the "Individual FE" analysis, although the association might not always be significant (p-value<0.05). The total associations between hospitalizations and Groups 1 and 3 were positive and significant in the sensitivity analyses, except in the "Subperiods" analysis. Groups 1 and 3 were most affected by the acquisition of Wheaton Franciscan Healthcare and the merger between Aurora Health Care and Advocate Health. The variation in their total associations with hospitalizations across Subperiods could relate to the admission features within these health systems. For Group 4, the positive total association with hospitalizations was consistent across sensitivity analyses, although sometimes statistically insignificant. In the "Individual FE" analysis, the significant difference in the adjusted rate of hospitalizations between Group 4 and Group 0 is notably larger than that in the main analysis (19.1 vs 7.9 more hospitalizations per 1000 person-quarters). Groups 1-4 have fewer contact days than Group 0 in most cases, except for Group 2 during the

first subperiod. It worth pointing out the differences is much smaller and insignificant in the "Individual FE" analysis.

Above results indicate that beneficiaries who experienced the highest degree of integration were associated with 6.4% fewer ED visits and 4.3% fewer avoidable ED visits relative to the average rates of those with no integrations, and beneficiaries at any degrees of integration were associated with 4-19% fewer contact days. However, these associations may be partially due to beneficiaries' characteristics or behavior patterns. In contrast, integrated health systems were associated with an 8-11% higher rate of hospitalizations. Although this total association may be due to health system features, it became larger after accounting for unobserved individual factors.

Associations with Care Coordination

This study uses outpatient visit concentration, measured by HHI, and care density to reflect care coordination. The associations between care coordination and provider-insurer integrations are reflected by estimations of parameters a_j $(j = 1,\ 2,\ 3\ ,4)$ from Equation B. As shown in column (2) of Appendix K, Groups 1, 3, and 4 had a 34-150 lower adjusted HHI compared to Group 0, with Group 4 having the lowest. Group 2 had a 27 higher adjusted HHI. Only the association between adjusted HHI and Group 4 was consistently negative and significant across sensitivity analyses (Appendix M). Given the average HHI across groups is approximately 4,000. The results suggest that enrollees who experienced the highest degree of integration (Group 4) have a slightly lower visit concentration.

Appendix K, column (6) shows that Groups 1-3 exhibited a 0.04-0.08 higher adjusted care density, and Group 4 exhibited a 0.5 higher adjusted care density compared to Group 0. Considering the average unadjusted care density of Group 0 was 3.8, the differences between

Groups 1-3 and Group 0 were minimal, whereas the difference between Group 4 and Group 0 was modest. Additionally, only the difference between Group 4 and Group 0 retained the same sign across sensitivity analyses and was significant except during the first subperiod (Appendix M). The results suggest that providers caring for patients who experienced the highest degree of integration may share more patients and are more likely to have established professional relationships.

These findings show that visit concentration was negatively associated with the highest degree of provider–insurer integrations, whereas care density was positively associated.

Indirect Effects: Associations Mediated through Care Coordination

Associations between care utilization and provider-insurer integrations mediated through care coordination—indirect effects—are given by estimating $a_j \times b$ $(j = 1,\ 2,\ 3\ ,4)$ in Equation B and Equation C. Echo to the findings that only Group 4 had modest association with either care coordination measures (estimates of a_j), the magnitude of the indirect effects was modest only in Group 4 and minimal for other groups. The second and third bars in Figure 5 for each group reflect total associations mediated through visit concentration (HHI) (red filled) and care density (red unfilled), respectively.

ED visits, avoidable ED visits, hospitalizations and preventable hospitalizations were negatively associated with either care coordination measures (estimates of parameter b in Equation C, shown in columns (3) and (7) of Appendix K). Therefore, the mediated associations contributed to more of these care uses when care coordination is measured by HHI, while contributed to fewer when care coordination is measured by care density in Group 4 (Figure 5, panels (a)-(d)).

Specifically, for Group 4, when care coordination is measured by HHI, the mediated associations contributed to 6.4 more ED visits and 3.6 more avoidable ED visits per 1000 PQs (Appendix K, column (4)). When care coordination is measured by care density, the mediated associations contributed to 3.6 fewer ED visits and 1.4 fewer avoidable ED visits per 1000PQs (Appendix K, column (8)). Sensitivity analyses showed similar mediated associations. Although the magnitude and significance varied, the direction remained consistent (Appendices N-O).

In Group 4, the mediated associations contributed to 0.56 more hospitalizations and 0.02 more preventable hospitalizations per 1000 PQs, when care coordination is measured by HHI (Appendix K, column (4)), but showed no clear contribution to hospitalizations and 0.04 fewer preventable hospitalizations per 1000 PQs when care coordination is measured by care density (Appendix K, column (8)). The results of sensitivity analyses echoed mediated associations through HHI for hospitalizations, and mediated associations through care density for preventable hospitalizations, although the latter were not always statistically significant (Appendices N-O).

Different from the first four care use outcomes, the number of contact days was negatively associated with visit concentration but positively associated with care density (estimates of parameter b in Appendix K column (3) and (7)). Therefore, in Group 4, associations mediated through both measures of care coordination contributed to more contact days—0.12 more days per person quarter if measured by HHI, 0.27 more days per person quarter if measured by care density as shown in Figure 5, panel(e) (also see Appendix K, columns (4) and (8)). Sensitivity analyses acquire similar results, except for care density during the first subperiod. Noticeably, the magnitude of the mediated associations, whether through HHI or care density, decreased in the “Individual FE” analysis.

The findings suggest that associations between provider-insurer integrations and care use of interest mediated through care coordination are modest only for the highest degree of integration (Group 4), and minimal for others. Additionally, the direction of these mediated associations can vary by care coordination measures and can be opposite to that of total associations. Specifically, among enrollees who experienced the highest degree of integration, mediated associations through visit concentration contributed to approximately 2% higher rates of ED visits and avoidable ED visits, relative to the average rates among those experienced no integrations (Group 0), whereas mediated associations through care density contributed to approximately 1% lower rates of ED visits and avoidable ED visits. The mediated associations through visit concentration contributed to a 0.8% higher rate of hospitalizations, while the mediated associations through care density contributed to a 1.2% lower rate of preventable hospitalizations. Moreover, mediated associations through both care coordination measures contributed to 2.1-5.8% more contact days, but they may be due to individual features.

Discussion

This study examines the extent to which care coordination explains the associations between provider-insurer integrations and preventable care utilization. It found that enrollees who experienced the highest degree of provider-insurer integration had fewer ED visits and fewer avoidable ED visits compared to those who didn't experience any integrations. This may indicate that the alignment of providers and insurers within the same integrated system leads to a reduction in high-cost services. This finding is consistent with previous research showing that enrollees with both integrated health plans and admissions to integrated hospitals had lower utilization of intensive care unit (ICU) (Meyers et al., 2020). However, this finding did not

remain significant or in the same direction when individual fixed effects were added to the regression. This implies that the association might be partially driven by individual-level factors, but it may also be because of the limited number of enrollees who had relevant changes in the degree of integration.

This study also found that integrated health systems were associated with higher rates of hospitalizations. Although this associations may be related to health system features, it enlarged after accounting for individual factors. This suggests that integrated systems may have greater leverage in filling their hospital beds, as ownership of health plans places them in a stronger position when negotiating with other insurers (Ghili, 2022).

The results indicated that enrollees who experienced provider-insurer integration had fewer adjusted contact days. Enrollees who experienced the highest degree of integration had the fewest contact days. The number of contact days serves not only as a measure of care utilization but also as a proxy for the burden of care. Previous research has shown that contact days are significantly associated with care satisfaction with an inverted U-shaped distribution (Daley et al., 2025; Ganguli, 2024; Ganguli et al., 2024). Findings in this study suggest that provider-insurer integrations may enhance the quality of care by reducing the care burden, which is consistent with previous studies showing that integrated health plans are associated with higher star rating quality (Frakt et al., 2013; Johnson et al., 2017; Park et al., 2023). However, similar to the results for ED visits, this difference in the number of contact days may be associated with individual factors.

The mediation analysis showed that only beneficiaries who experienced the highest degree of integration had modest associations with care coordination measures; others' associations with care coordination measures were minimal. On one hand, this suggests that

enrollees with the highest degree of provider-insurer integration experience significantly different care coordination compared to others. On the other hand, it highlights that for enrollees whose predominant provider is affiliated with an integrated health system, if they are enrolled in a health plan not offered by the same integrated system, the integration status of their health plan does not substantially affect their care coordination or the associations mediated by care coordination. These findings are consistent with previous research showing that firm boundaries raise challenges for coordination (Hart & Holmstrom, 2010; Agha et al., 2023).

Additionally, the associations between the highest degree of provider-insurer integration and care coordination varied in direction depending on the measures—negative when care coordination is measured by visit concentration (HHI), positive when measured by care density. Care coordination is a complex and nuanced concept, these two measures are used to capture distinct aspects of it. The two care coordination measures showed low correlation in this study, approximately 0.02 ($p < 0.001$), aligns with previous research (Pollack et al., 2013, 2016). A plausible explanation for the opposite directions in the associations between the highest degree of integration and care coordination measures is that enrollees who are taken care of within the same integrated system from both the provider and insurer sides may have easier access to different providers, who are more likely to have established professional relationships. This may be due to a smoother authorization process for referrals, along with repeat interactions among a group of providers who are affiliated with the same integrated system and included in the same network of a health plan owned by that system (Agha et al., 2022).

The associations between provider-insurer integrations and care utilization of interest, mediated through care coordination, followed a similar pattern to those between provider-insurer integrations and care coordination—they were modest only in the group that experienced the

highest degree of integration and could vary in direction depending on the measure of care coordination. These findings correspond to the weak or mixed evidence in empirical research on the causal chain linking structural and functional integration with care coordination (Burns et al., 2021). Provider-insurer integrations can simultaneously influence different aspects of care coordination, which may have opposing effects on care utilization. Moreover, the influence of provider-insurer integrations mediated through care coordination can in opposite direction to the overall influence. This highlights the importance of considering various dimensions of care coordination and investigating mechanisms of provider-insurer integrations.

The number of contact days is intended to reflect care burden, and thus quality of care to some extent (Burke et al., 2020; Ganguli, 2024). The negative association between visit concentration and the number of contact days found in this study is consistent with previous research indicating that better continuity of care is associated with improved patient satisfaction (Van Walraven et al., 2010; Chen & Cheng, 2023). This study also found a positive association between care density and the number of contact days. Higher care density means that the outpatient providers a patient visited share more patients and are more likely to have professional relationships. These relationships may increase referral frequency, leading to more follow-up visits or specialist appointments, thereby increasing contact days. The high correlation (0.98, $p < 0.001$) between the number of contact days and the number of patient visits, combined with the low correlation (0.20, $p < 0.001$) between the number of contact days and the number of evaluation and management visits, indicates that this is a plausible explanation (Appendix P). This finding aligns with previous research showing that higher physician connectivity is associated with increased utilization (Geissler et al., 2020).

Although all degrees of provider-insurer integration were negatively associated with the number of contact days, the mediated associations through either visit concentration or care density were positive in the group with highest degree of integration. This indicates that care coordination related to provider-insurer integrations may increase healthcare contact and care uses. This also suggests that other mechanisms of provider-insurer integrations may contribute to reducing the number of contact days. There is a possibility that the increased care contact days associated with care coordination substitute other types of healthcare contact and even reduce more of other contact days in integrated systems. However, it is worth pointing out that both the total and mediated associations may be due to individual factors.

5.4.Limitations

This study has several limitations. First, it focuses on the Medicaid population in Wisconsin, which limits the generalizability of the results. However, as mentioned earlier, Wisconsin has a long history of provider-insurer integrations and a high prevalence of enrollees covered by these integrations, which provides an ideal setting for research on provider–insurer integrations. Second, this study focuses on populations who visited at least two distinct providers in the past two quarters to ensure that care coordination measures could be calculated. This restriction limits the study sample to a group of enrollees, 90% of whom have at least one chronic condition. As a result, the findings may not generalize to populations with a low prevalence of chronic conditions. However, because care coordination is particularly important for individuals with chronic conditions, the findings remain informative. Third, although this paper sought to collect comprehensive information to identify the integration status of health plans and health systems, misclassification remains possible. Nevertheless, the results are consistent with previous research and provide valuable insights for future studies.

Conclusions

This study examines the extent to which care coordination mediates the associations between provider-insurer integrations and preventable care utilization, with a focus on the Medicaid population in Wisconsin. The findings suggest that enrollees with the highest degree of provider-insurer integration have the fewest ED visits, avoidable ED visits and healthcare contact days compared to others, although these differences may be partially driven by individual-level factors. Integrated health systems are associated with a higher rate of hospitalizations, while this may relate to health system features.

Care coordination explains a moderate extent of these associations only for enrollees experiencing the highest degree of provider-insurer integration, while the explained portion is minimal for others. This reflects the challenges of care coordination that arise from firm boundaries. This also emphasizes the necessity of distinguishing between integrated health plan enrollees receiving care from the same integrated system and those receiving care from a different integrated system. In practice, the latter group can represent a significant portion of enrollees.

The associations between provider-insurer integrations and care coordination can vary in direction—negative when care coordination is measured by visit concentration (HHI), positive when measured by care density. This leads to similar patterns of mediated associations through these care coordination measures. Specifically, the associations between the highest degree of provider-insurer integration and ED visits, and avoidable ED visits through visit concentration are positive, while mediated through care density are negative. Noticeably, mediated associations and total associations can run in opposite directions. These findings highlight the importance of

considering various aspects of care coordination and studying the mechanisms of provider-insurer integrations. Future research can investigate this pathway using other care coordination measures and take a closer look at differences in care teams between the group that experienced the highest degree of integration and other groups.

Moreover, the associations mediated through either visit concentration or care density contribute to an increase in contact days, because the number of contact days is negatively associated with visit concentration but positively related to care density. Additionally, the meditated associations with contact days through care coordination contrast in direction with the total associations. It would be valuable to explore whether the increased contact days associated with care coordination substitute for or even reduce contact days in other care services in the integrated systems.

Given the trend of provider–insurer integration under payment reform, the findings of this study provide valuable insights for antitrust agencies, healthcare policymakers and healthcare industry leaders. For example, changes in the size of the population experiencing the highest degree of integration as a result of a merger case could significantly influence the consequences of the case. Additionally, the results suggest that healthcare workers could promote campaigns or provide guidance to encourage enrollees with an integrated health plan to seek care from predominant providers affiliated with the same integrated system. Moreover, leaders of healthcare organizations and insurance companies might consider implementing programs that foster professional relationships among providers to help reduce preventable care utilization.

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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).

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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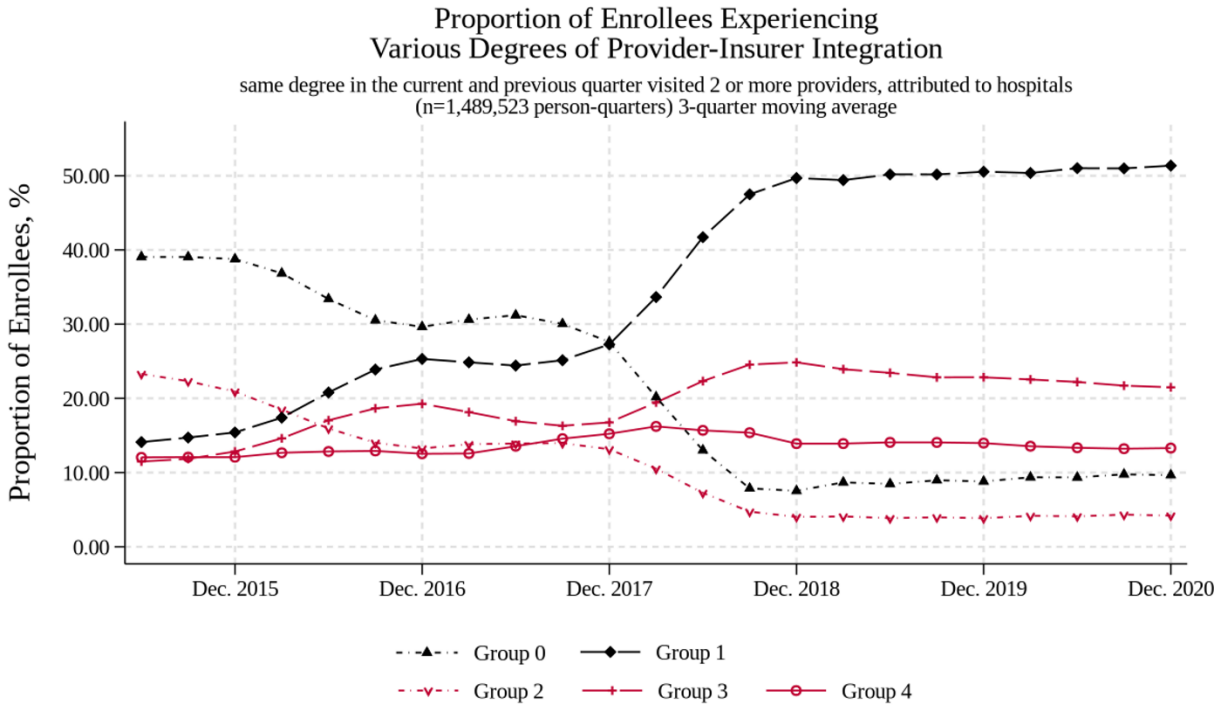
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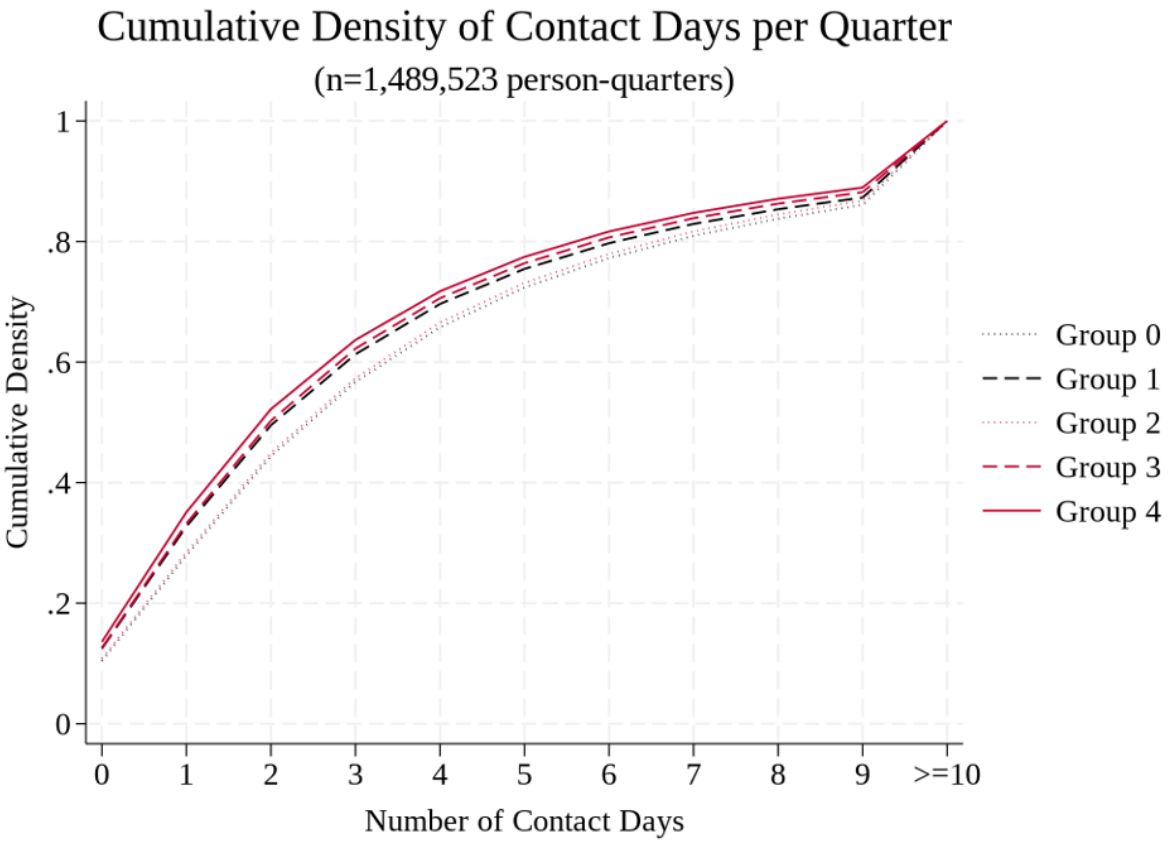
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Figure 1. Proportion of Enrollees Experiencing Various Degrees of Provider-Insurer Integration (n=1,489,523 person-quarters)



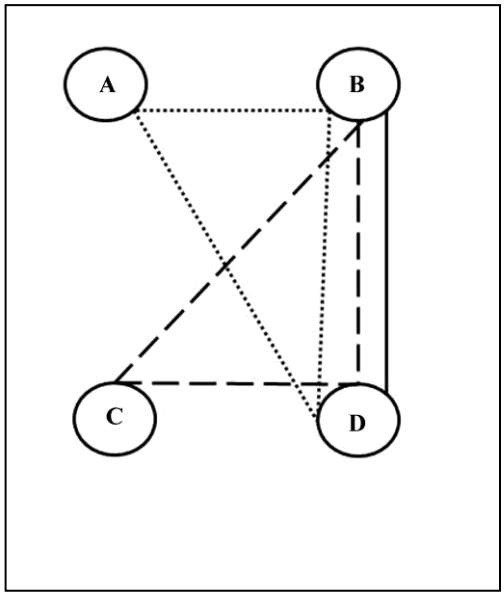
Note: Figure 1 shows the 3-quarter moving average of the proportions. **Group 0** ("No, No, No" responses) includes enrollees who enrolled in a non-integrated health plan and were attributed to a non-integrated health system. **Group 1** ("No, Yes, No" responses) represents enrollees who enrolled in a non-integrated health plan but were attributed to an integrated health system. **Group 2** ("Yes, No, No" responses) represents enrollees who enrolled in an integrated health plan but were attributed to a non-integrated health system. **Group 3** ("Yes, Yes, No" responses) includes enrollees who enrolled in an integrated health plan but were attributed to a different integrated system. **Group 4** ("Yes, Yes, Yes" responses) includes enrollees who enrolled in an integrated health plan and were attributed to the same integrated system.

Figure 2. Cumulative Density for Number of Contact Days by Group



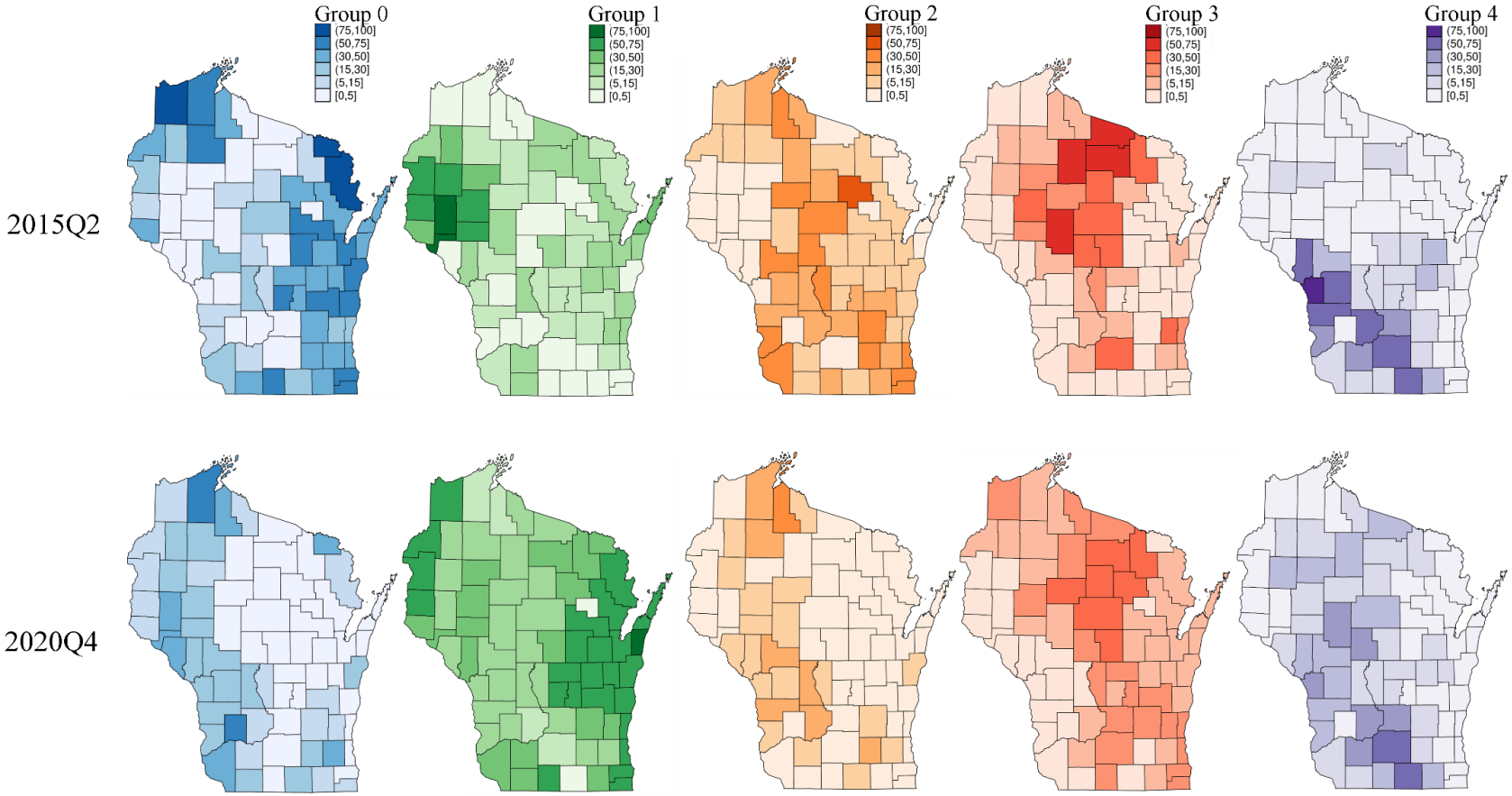
Note: **Group 0** ("No, No, No" responses) includes enrollees who enrolled in a non-integrated health plan and were attributed to a non-integrated health system. **Group 1** ("No, Yes, No" responses) represents enrollees who enrolled in a non-integrated health plan but were attributed to an integrated health system. **Group 2** ("Yes, No, No" responses) represents enrollees who enrolled in an integrated health plan but were attributed to a non-integrated health system. **Group 3** ("Yes, Yes, No" responses) includes enrollees who enrolled in an integrated health plan but were attributed to a different integrated system. **Group 4** ("Yes, Yes, Yes" responses) includes enrollees who enrolled in an integrated health plan and were attributed to the same integrated system.

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



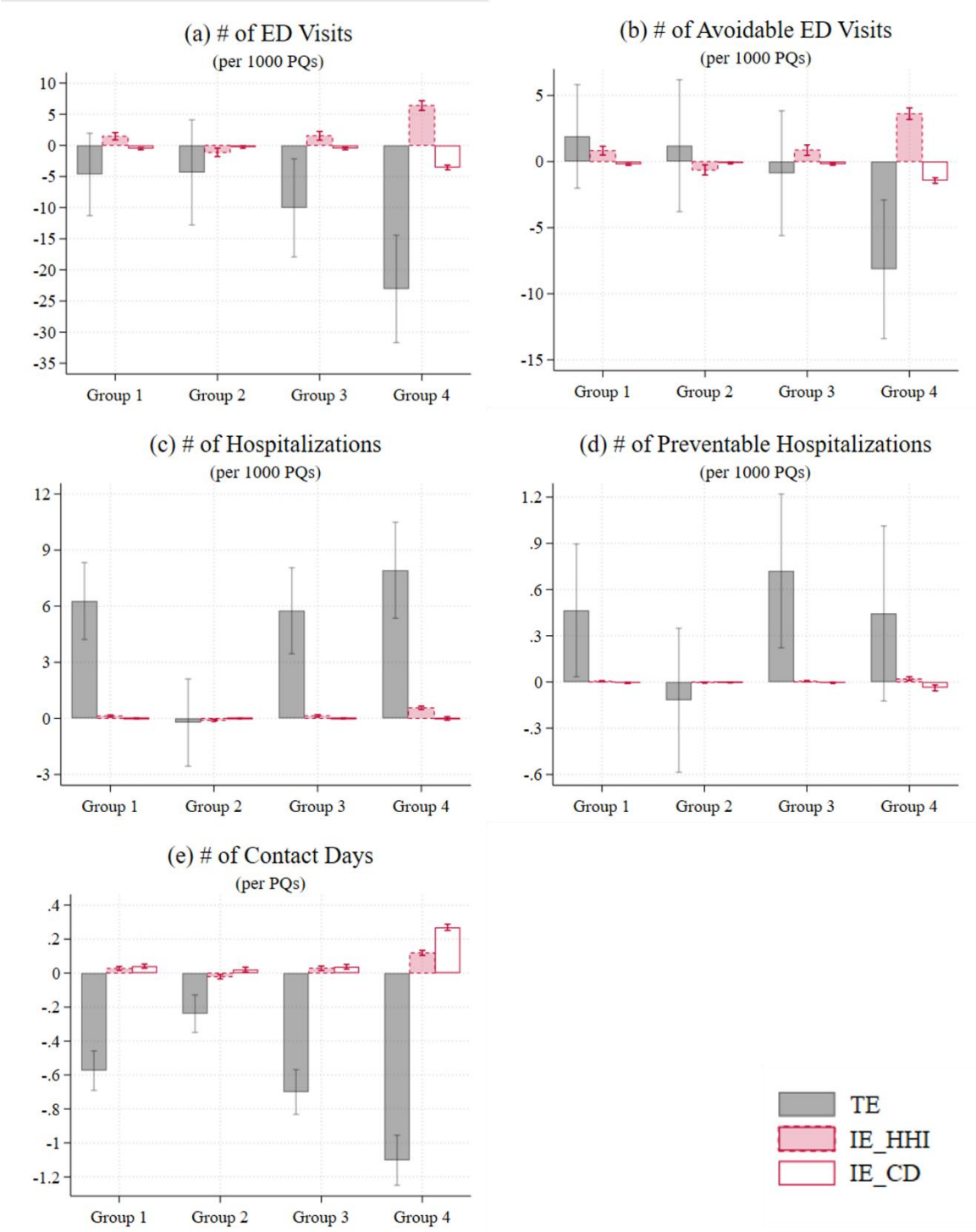
Note: Four providers are represented by circles A through D, and three patients are represented by different line styles: solid, long-dashed, and short-dashed. The patient represented by the long-dashed line sees providers B, C, and D. Provider pair B and C share one patient, B and D share three, and 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. Proportion of Enrollees Experiencing Various Degrees of Provider-Insurer Integration by County (n=1,384,851person-quarters)



Note: 104,672 person-quarters out of 1,489,523 person-quarters do not have information on residency. However, this missingness would not change the shape of the trend in Figure 1. Map lines delineate study areas and do not necessarily depict accepted national boundaries. **Group 0** ("No, No, No" responses) includes enrollees who enrolled in a non-integrated health plan and were attributed to a non-integrated health system. **Group 1** ("No, Yes, No" responses) represents enrollees who enrolled in a non-integrated health plan but were attributed to an integrated health system. **Group 2** ("Yes, No, No" responses) represents enrollees who enrolled in an integrated health plan but were attributed to a non-integrated health system. **Group 3** ("Yes, Yes, No" responses) includes enrollees who enrolled in an integrated health plan but were attributed to a different integrated system. **Group 4** ("Yes, Yes, Yes" responses) includes enrollees who enrolled in an integrated health plan and were attributed to the same integrated system.

Figure 5. Total Effects (TE) of Provider–Insurer Integrations and Corresponding Indirect Effects (IE) Through Care Coordination



Note: HHI—Herfindahl–Hirschman Index, CD—Care Density. **Group 0** ("No, No, No" responses) includes enrollees who enrolled in a non-integrated health plan and were attributed to a non-integrated health system. **Group 1** ("No, Yes, No" responses) represents enrollees who enrolled in a non-integrated health plan but were attributed to an integrated health system. **Group 2** ("Yes, No, No" responses) represents enrollees who enrolled in an integrated

health plan but were attributed to a non-integrated health system. **Group 3** (“Yes, Yes, No” responses) includes enrollees who enrolled in an integrated health plan but were attributed to a different integrated system. **Group 4** (“Yes, Yes, Yes” responses) includes enrollees who enrolled in an integrated health plan and were attributed to the same integrated system.

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, 2024b; Wisconsin Department of Health Services, 2022).

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., MD, RN, NP, 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.

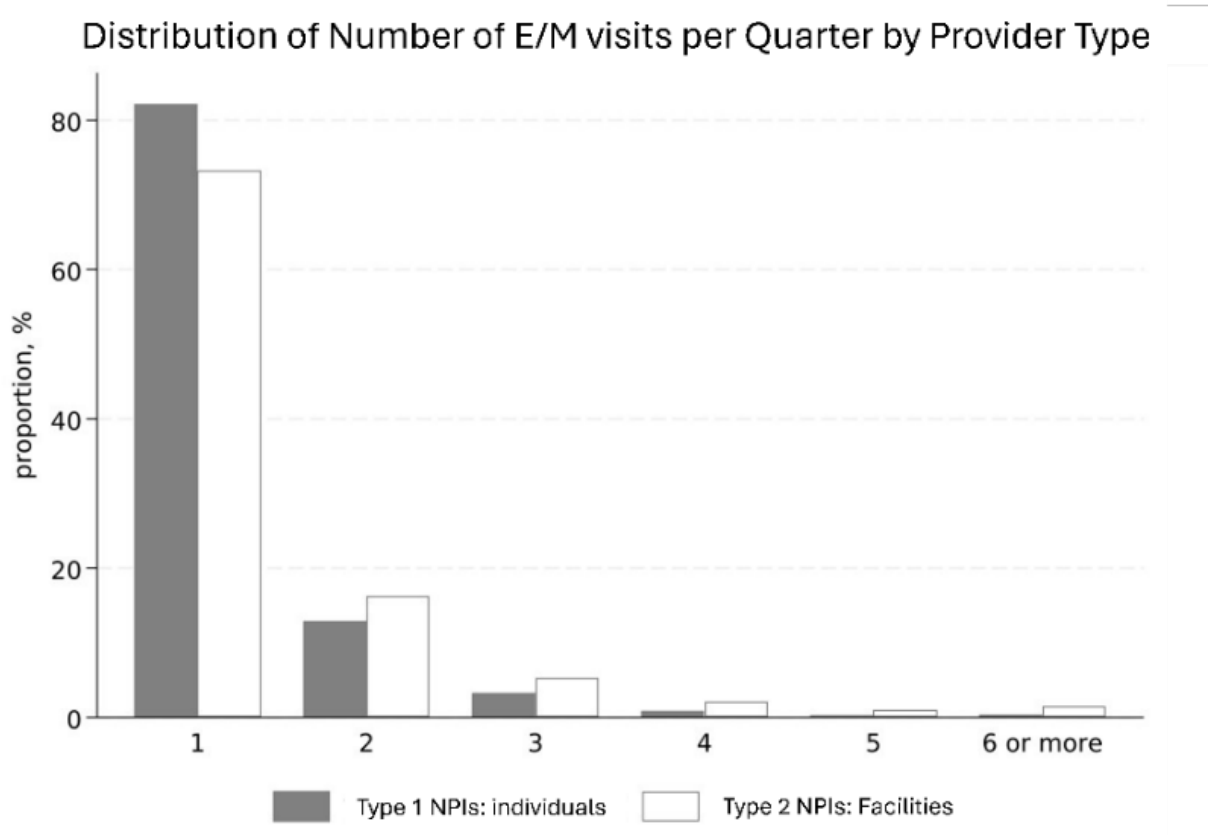
B.2. Treating Individual and Facility Providers as Equivalent in Attribution

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 HMO 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 imputed, but reverse to missing	0	234,803	3,385	7,589	0	245,777	1.15
entitytype=2, had been assigned/imputed, reverse to missing	0	0	12,837	0	0	12,837	0.06
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.

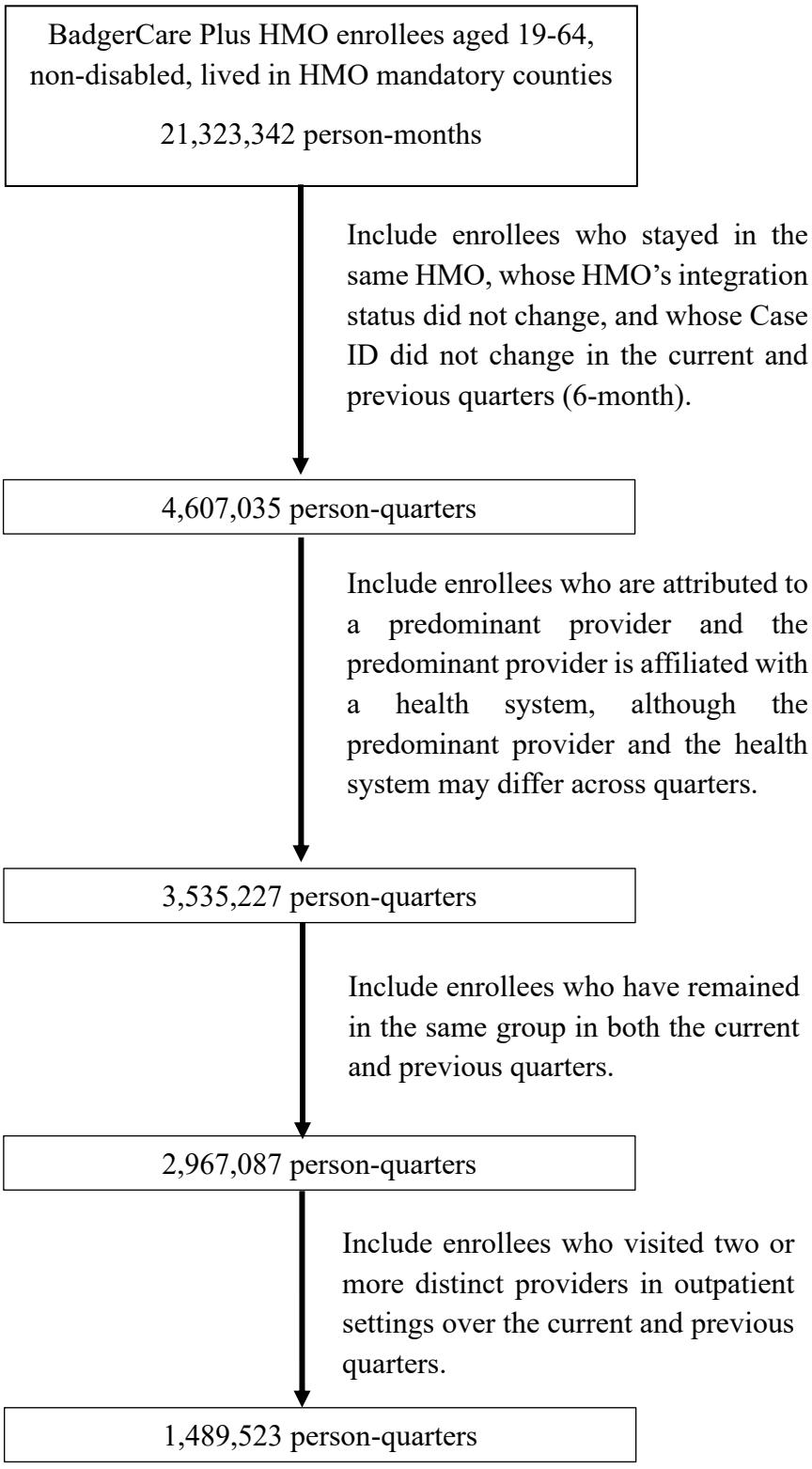
Table C.2.1

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

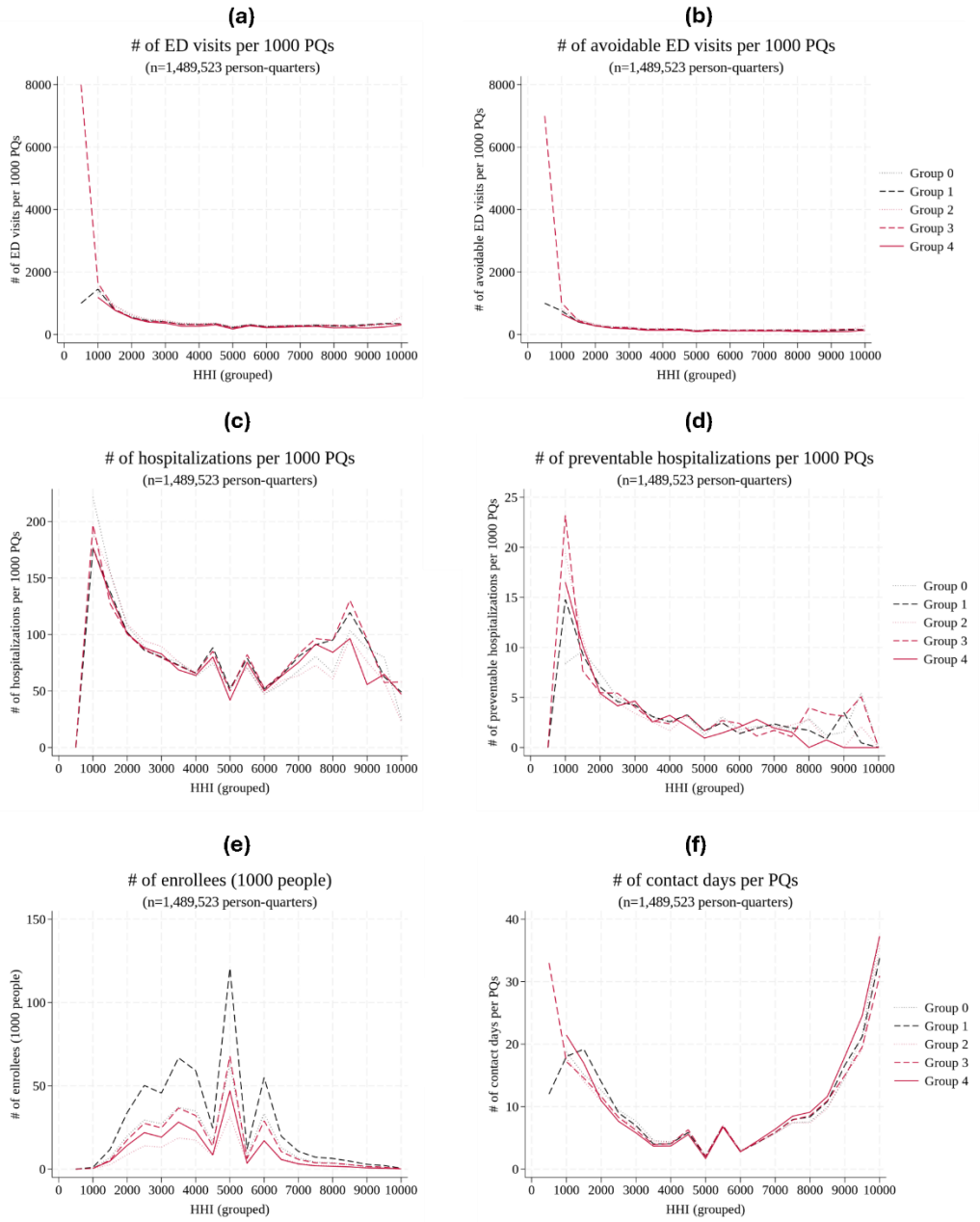
PQI 1 Diabetes Short-Term Complications Admission Rate
PQI 3 Diabetes Long-Term Complications Admission Rate
PQI 5 Chronic Obstructive Pulmonary Disease (COPD) or Asthma in Older Adults Admission Rate
PQI 7 Hypertension Admission Rate
PQI 8 Heart Failure Admission Rate
PQI 14 Uncontrolled Diabetes Admission 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

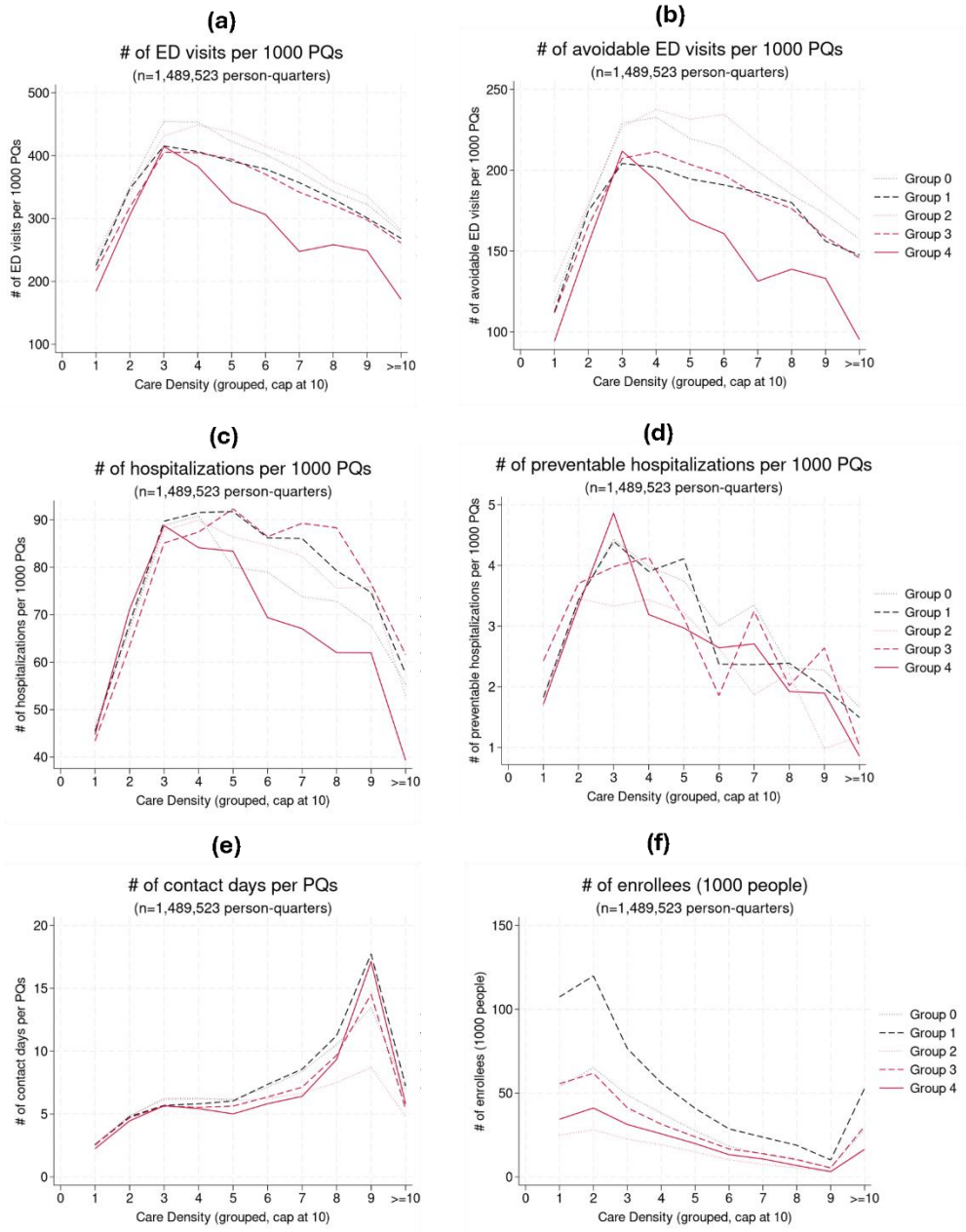
*None of the PQI composite measures are endorsed by the National Quality Forum.
*From Quality Indicator User Guide: Prevention Quality Indicators (PQI) Composite Measures version 2020, https://qualityindicators.ahrq.gov/Downloads/Modules/PQI/v2020/PQI_Composite_Development.pdf

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



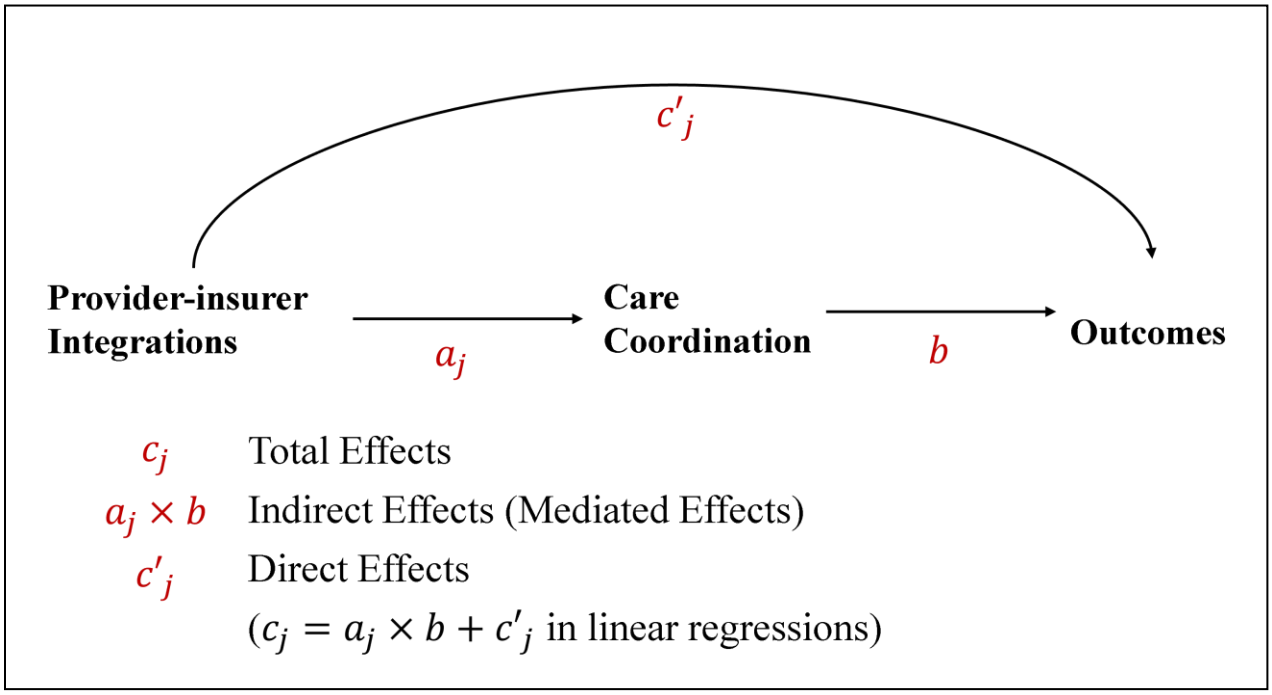
Note: PQs--person-quarters. Observations (person-quarters) are grouped into categories based on HHI values. For example, enrollees with a HHI greater than 1000 but less than or equal to 1500 are classified into the "HHI 1500" category (x-axis). **Group 0** ("No, No, No" responses): non-integrated health plan and non-integrated health system. **Group 1** ("No, Yes, No" responses): non-integrated health plan and integrated health system. **Group 2** ("Yes, No, No" responses): integrated health plan and non-integrated health system. **Group 3** ("Yes, Yes, No" responses): integrated health plan and integrated health system from a different integrated system. **Group 4** ("Yes, Yes, Yes" responses): integrated health plan and integrated health system from the same integrated system.

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



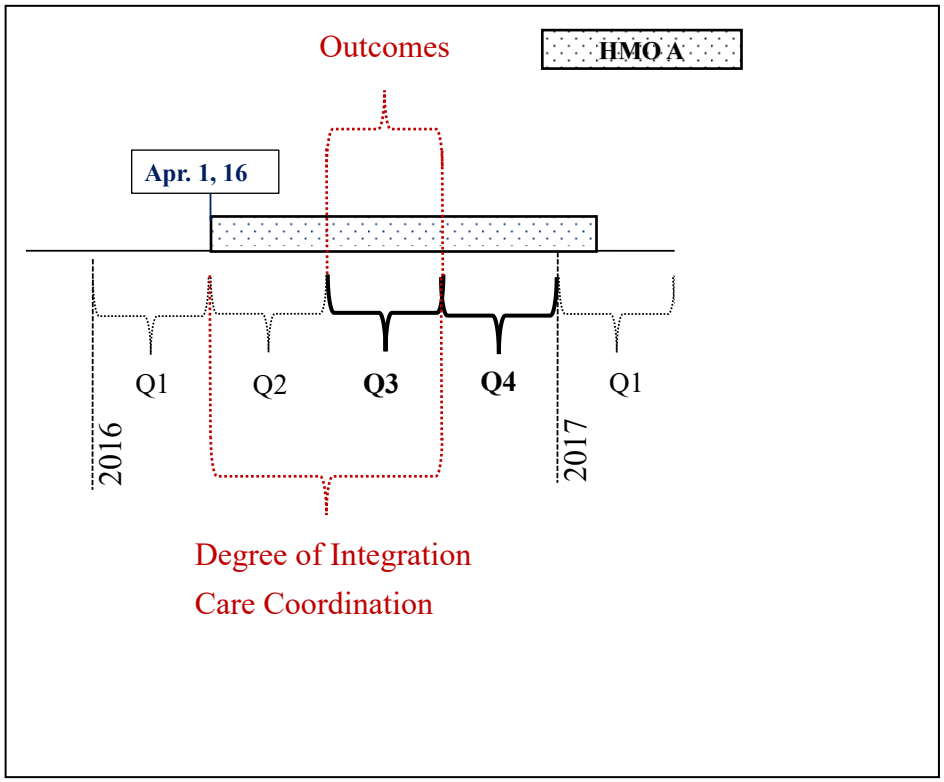
Note: PQs—person-quarters. Observations (person-quarters) are grouped into categories based on care density values. For example, enrollees with a care density greater than 2 but less than or equal to 3 are classified into the 'Care Density 3' category (x-axis). **Group 0** ("No, No, No" responses): non-integrated health plan and non-integrated health system. **Group 1** ("No, Yes, No" responses): non-integrated health plan and integrated health system. **Group 2** ("Yes, No, No" responses): integrated health plan and non-integrated health system. **Group 3** ("Yes, Yes, No" responses): integrated health plan and integrated health system from a different integrated system. **Group 4** ("Yes, Yes, Yes" responses): integrated health plan and integrated health system from the same integrated system.

Appendix H. Conceptual Model of Mediation Analysis



Note: $\boldsymbol{j} = \mathbf{1}, \mathbf{2}, \mathbf{3}, \mathbf{4}$: 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 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 I. Timeframes of the Variables



Appendix J. Statistics at the Enrollee Level

	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:*n_miss=14,140. This table reflects enrollee-level statistics. FPL = federal poverty line.

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)
	TE (c_j)		HHI/10000 (a_j)	DE (b or c'_j)	IE (a_j*b)	[Bootstrap BC 95% CI]		Care Density (a_j)	DE (b or c'_j)	IE (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, TE—total effects, DE—direct effects, IE—indirect effects. 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. **Group 0** ("No, No, No" responses): non-integrated health plan and non-integrated health system. **Group 1** ("No, Yes, No" responses): non-integrated health plan and integrated health system. **Group 2** ("Yes, No, No" responses): integrated health plan and non-integrated health system. **Group 3** ("Yes, Yes, No" responses): integrated health plan and integrated health system from a different integrated system. **Group 4** ("Yes, Yes, Yes" responses): integrated health plan and integrated health system from the same integrated system.

Appendix L. Total Effects (TE)--Sensitivity Analyses

	Main	VT_6mon	VT_9mon	VT_12mon	Individual_FE	HMO_MS_State	HMO_MS_Region	15Q2_16Q1	16Q2_18Q1	18Q2_20Q1	20Q2_20Q4
	TE (c_j)	TE (c_j)	TE (c_j)	TE (c_j)	TE (c_j)	TE (c_j)	TE (c_j)	TE (c_j)	TE (c_j)	TE (c_j)	TE (c_j)
person-quarters	1,381,628	508,073	508,077	508,077	1,381,628	1,381,628	1,381,628	236,069	459,987	472,415	213,157
# of beneficiaries					371,684						
# of ED visits per 1000 person-quarters											
Group 1	-4.659	-23.065***	-17.671**	-16.745**	-6.643	-5.52	-5.022	-12.007	-11.276	5.419	13.546
Group 2	-4.349	3.649	3.098	2.8	4.13	-7.186	-4.312	0.427	-4.167	-13.589	-3.74
Group 3	-10.039*	-22.776***	-17.235*	-16.047*	0.975	-12.492**	-8.856*	-30.309***	-22.054**	7.268	9.765
Group 4	-23.056***	-33.924***	-28.742***	-27.442***	4.473	-29.583***	-22.663***	-6.566	-24.547**	-20.213**	-20.539*
R-square	0.065	0.062	0.062	0.062	0.011	0.065	0.065	0.07	0.068	0.066	0.055
# of avoidable ED per 1000 person-quarters											
Group 1	1.904	-7.539*	-5.649	-5.656	-3.396	1.654	1.903	-9.367	4.534	6.332	5.139
Group 2	1.202	7.055	6.796	6.585	-0.076	0.516	0.662	2.081	4.059	-7.649	-3.434
Group 3	-0.886	-7.294	-5.349	-5.25	-5.526	-1.575	-0.97	-20.588***	-3.027	8.393	4.214
Group 4	-8.142**	-13.909**	-12.362**	-11.777**	-0.124	-9.147**	-8.152**	-6.018	-4.38	-7.835	-12.22*
R-square	0.045	0.044	0.044	0.044	0.006	0.045	0.045	0.049	0.047	0.044	0.034
# of hospitalizations per 1000 person-quarters											
Group 1	6.272***	4.054*	3.319*	3.715*	11.921***	6.147***	6.177***	5.754*	8.414***	-3.798	1.812
Group 2	-0.223	1.706	1.822	1.836	0.125	-0.545	-0.006	0.994	-1.954	-2.09	0.459
Group 3	5.759***	8.054***	7.287***	7.671***	13.997***	5.393***	6.107***	7.529*	9.522***	-4.421	-1.248
Group 4	7.923***	6.179**	5.535**	5.825**	19.105***	6.417***	8.038***	2.312	9.127***	0.747	3.502
R-square	0.037	0.038	0.038	0.038	0.016	0.037	0.037	0.042	0.038	0.036	0.034
# of preventable hospitalizations per 1000 person-quarters											
Group 1	0.465*	0.19	0.059	0.134	0.051	0.442*	0.455*	-0.767	1.263**	0.26	0.946*
Group 2	-0.118	-0.049	-0.035	-0.04	0.94	-0.204	-0.096	-0.503	-0.193	0.044	1.627*
Group 3	0.721**	0.741	0.6	0.683	1.04	0.653*	0.761**	0.441	0.891	0.963*	0.749
Group 4	0.445	-0.139	-0.251	-0.189	0.657	0.22	0.464	-0.547	1.043	0.592	0.136
R-square	0.015	0.015	0.015	0.015	0.003	0.015	0.015	0.018	0.014	0.016	0.015
# of contact days per person-quarter											
Group 1	-0.574***	-0.447***	-0.451***	-0.436***	-0.011	-0.562***	-0.573***	-0.377***	-1.034***	-0.759***	-0.122
Group 2	-0.239***	-0.378**	-0.377**	-0.374**	-0.069	-0.194***	-0.232***	0.01	-0.505***	-0.536**	-0.083
Group 3	-0.701***	-0.604***	-0.608***	-0.595***	-0.103	-0.666***	-0.701***	-0.358***	-1.016***	-0.939***	-0.164
Group 4	-1.102***	-1.288***	-1.278***	-1.283***	-0.07	-1.048***	-1.1***	-0.457***	-1.406***	-1.351***	-0.775***
R-square	0.076	0.082	0.082	0.082	0.012	0.076	0.076	0.089	0.081	0.087	0.075

Note: HMO—Health Maintenance Organization. TE—total effects. 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. 15Q2_16Q1—the start of the 2nd quarter of 2015 to the end of the 1st quarter of 2016. References: *** p<0.001, ** p<0.01, * p<0.05. **Group 0** ("No, No, No" responses): non-integrated health plan and non-integrated health system. **Group 1** ("No, Yes, No" responses): non-integrated health plan and integrated health system. **Group 2** ("Yes, No, No" responses): integrated health plan and non-integrated health system. **Group 3** ("Yes, Yes, No" responses): integrated health plan and integrated health system from a different integrated system. **Group 4** ("Yes, Yes, Yes" responses): integrated health plan and integrated health system from the same integrated system.

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

	HHI/10000										
	Main	VT_6mon	VT_9mon	VT_12mon	Individual_FE	HMO_MS_State	HMO_MS_Region	15Q2_16Q1	16Q2_18Q1	18Q2_20Q1	20Q2_20Q4
	(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	1,381,628	1,381,628	1,381,628	236,069	459,987	472,415	213,157
# of beneficiaries					371,684						
Group 1	-0.0034***	-0.0015	-0.0037**	-0.0024	-0.0013	-0.0038***	-0.0036***	0.0007	-0.0077***	-0.0033*	0.0072***
Group 2	0.0027***	0.0042**	0.0035*	0.0039*	-0.0004	0.0017*	0.003***	0.0027*	0.0048***	0.0007	0.004
Group 3	-0.0036***	-0.001	-0.0034*	-0.0021	0	-0.0046***	-0.0031***	-0.0022	-0.0111***	-0.0029*	0.0101***
Group 4	-0.0150***	-0.0131***	-0.0162***	-0.0142***	-0.0074***	-0.0166***	-0.0149***	-0.0097***	-0.0159***	-0.0178***	-0.0076***
R-square	0.054	0.057	0.060	0.061	0.011	0.055	0.055	0.064	0.055	0.054	0.046

	Care Density											
	Main	VT_6mon	VT_9mon	VT_12mon	Individual_FE	HMO_MS_State	HMO_MS_Region	15Q2_16Q1	16Q2_18Q1	18Q2_20Q1	20Q2_20Q4	CD_Binary
	(aj)	(aj)	(aj)	(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	1,381,628	1,381,628	1,381,628	236,069	459,987	472,415	213,157	1,381,628
# of beneficiaries					371,684							
Group 1	0.079***	0.169***	-0.038	-0.12***	-0.002	0.085***	0.071***	-0.413***	0.276***	0.381***	0.057	0.014***
Group 2	0.042**	-0.131***	-0.12***	-0.129***	-0.058*	0.04**	0.06***	-0.032	-0.059**	0.348***	0.269***	0.009***
Group 3	0.073***	0.14***	-0.069**	-0.154***	-0.066*	0.086***	0.105***	-0.264***	0.348***	0.338***	-0.012	0.016***
Group 4	0.532***	0.75***	0.455***	0.327***	0.372***	0.494***	0.54***	0.047	0.383***	1.026***	0.654***	0.099***
R-square	0.099	0.103	0.107	0.111	0.010	0.100	0.101	0.117	0.116	0.100	0.096	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. 15Q2_16Q1—the start of the 2nd quarter of 2015 to the end of the 1st quarter of 2016. CD_Binary—Care Density_Binary. References: *** p<0.001, ** p<0.01, * p<0.05. **Group 0** ("No, No, No" responses): non-integrated health plan and non-integrated health system. **Group 1** ("No, Yes, No" responses): non-integrated health plan and integrated health system. **Group 2** ("Yes, No, No" responses): integrated health plan and non-integrated health system. **Group 3** ("Yes, Yes, No" responses): integrated health plan and integrated health system from a different integrated system. **Group 4** ("Yes, Yes, Yes" responses): integrated health plan and integrated health system from the same integrated system.

Appendix N. Indirect Effects (IE) through Visit Concentration—Sensitivity Analyses

	HHI/10000										
	Main	VT_6mon	VT_9mon	VT_12mon	Individual_FE	HMO_MS_State	HMO_MS_Region	15Q2_16Q1	16Q2_18Q1	18Q2_20Q1	20Q2_20Q4
	(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	1,381,628	1,381,628	1,381,628	236,069	459,987	472,415	213,157
# of beneficiaries					371,684						
# of ED visits per 1000 person-quarters											
Group 1	1.47	0.564	1.152	0.69	0.396	1.622	1.536	-0.379	3.607	1.186	-2.535
Group 2	-1.153	-1.597	-1.113	-1.099	0.132	-0.705	-1.276	-1.53	-2.234	-0.263	-1.387
Group 3	1.553	0.391	1.078	0.599	0	1.972	1.333	1.218	5.179	1.048	-3.52
Group 4	6.412	5.005	5.123	4.025	2.321	7.084	6.358	5.435	7.405	6.466	2.642
# of avoidable ED per 1000 person-quarters											
Group 1	0.828	0.324	0.678	0.418	0.181	0.914	0.865	-0.219	1.963	0.682	-1.391
Group 2	-0.65	-0.916	-0.655	-0.665	0.06	-0.397	-0.719	-0.883	-1.216	-0.151	-0.761
Group 3	0.875	0.224	0.634	0.362	0	1.111	0.751	0.703	2.819	0.603	-1.932
Group 4	3.613	2.87	3.014	2.437	1.064	3.991	3.581	3.136	4.031	3.72	1.45
# of hospitalizations per 1000 person-quarters											
Group 1	0.129	0.051	0.058	0.029	0.091	0.142	0.135	-0.032	0.33	0.09	-0.284
Group 2	-0.101	-0.144	-0.056	-0.047	0.03	-0.062	-0.112	-0.129	-0.204	-0.02	-0.156
Group 3	0.136	0.035	0.054	0.026	0	0.173	0.117	0.103	0.473	0.079	-0.395
Group 4	0.563	0.451	0.257	0.172	0.534	0.62	0.559	0.457	0.676	0.49	0.296
# of preventable hospitalizations per 1000 person-quarters											
Group 1	0.005	0.0028	0.0008	-0.0015	0.0018	0.0052	0.0049	0	0.0149	0.003	-0.0164
Group 2	-0.004	-0.0079	-0.0008	0.0024	0.0006	-0.0023	-0.0041	0	-0.0092	-0.0007	-0.009
Group 3	0.005	0.0019	0.0007	-0.0013	0	0.0063	0.0043	0	0.0213	0.0027	-0.0227
Group 4	0.020	0.0246	0.0036	-0.0089	0.0103	0.0227	0.0204	0	0.0305	0.0164	0.0171
# of contact days per person-quarter											
Group 1	0.027	0.014	0.026	0.015	0.003	0.03	0.028	-0.002	0.066	0.033	-0.044
Group 2	-0.021	-0.04	-0.026	-0.023	0.001	-0.013	-0.024	-0.008	-0.041	-0.007	-0.024
Group 3	0.029	0.01	0.025	0.013	0	0.036	0.025	0.006	0.095	0.029	-0.061
Group 4	0.119	0.127	0.117	0.086	0.02	0.131	0.118	0.028	0.135	0.182	0.046

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. 15Q2_16Q1—the start of the 2nd quarter of 2015 to the end of the 1st quarter of 2016. CD_Binary—Care Density_Binary. The borders of a cell indicate that the IE's bias-corrected bootstrap 95% confidence interval contains 0. Thus, it is unclear whether these IEs are significantly different from 0. **Group 0** ("No, No, No" responses): non-integrated health plan and non-integrated health system. **Group 1** ("No, Yes, No" responses): non-integrated health plan and integrated health system. **Group 2** ("Yes, No, No" responses): integrated health plan and non-integrated health system. **Group 3** ("Yes, Yes, No" responses): integrated health plan and integrated health system from a different integrated system. **Group 4** ("Yes, Yes, Yes" responses): integrated health plan and integrated health system from the same integrated system.

Appendix O. Indirect Effects (IE) through Care Density—Sensitivity Analyses

	Care Density											
	Main	VT_6mon	VT_9mon	VT_12mon	Individual_FE	HMO_MS_State	HMO_MS_Region	15Q2_16Q1	16Q2_18Q1	18Q2_20Q1	20Q2_20Q4	CD_Binary
	(a_j*b)	(aj*b)	(aj*b)	(aj*b)	(aj*b)	(aj*b)	(aj*b)	(aj*b)	(aj*b)	(aj*b)	(aj*b)	(aj*b)
person-quarters	1,381,628	508,073	508,077	508,077	1,381,628	1,381,628	1,381,628	236,069	459,987	472,415	213,157	1,381,628
# of beneficiaries					371,684							
# of ED visits per 1000 person-quarters												
Group 1	-0.534	-1.084	0.212	0.683	0.014	-0.569	-0.482	2.985	-1.894	-2.529	-0.306	-0.538
Group 2	-0.282	0.838	0.673	0.736	0.47	-0.268	-0.41	0.232	0.403	-2.309	-1.449	-0.33
Group 3	-0.491	-0.897	0.388	0.881	0.538	-0.574	-0.714	1.907	-2.391	-2.242	0.063	-0.592
Group 4	-3.556	-4.814	-2.561	-1.863	-3.031	-3.303	-3.684	-0.341	-2.635	-6.803	-3.519	-3.715
# of avoidable ED per 1000 person-quarters												
Group 1	-0.216	-0.403	0.074	0.245	0.006	-0.23	-0.195	1.05	-0.802	-1.079	-0.119	-0.226
Group 2	-0.114	0.312	0.237	0.264	0.207	-0.108	-0.166	0.081	0.171	-0.985	-0.565	-0.139
Group 3	-0.199	-0.334	0.137	0.315	0.237	-0.232	-0.29	0.671	-1.013	-0.957	0.024	-0.248
Group 4	-1.441	-1.792	-0.901	-0.667	-1.333	-1.335	-1.493	-0.12	-1.116	-2.903	-1.372	-1.56
# of hospitalizations per 1000 person-quarters												
Group 1	-0.002	-0.129	0.028	0.127	0.001	-0.003	-0.003	0.079	-0.16	0.157	0.012	0.016
Group 2	-0.001	0.1	0.089	0.137	0.028	-0.001	-0.002	0.006	0.034	0.143	0.058	0.01
Group 3	-0.002	-0.107	0.051	0.163	0.032	-0.003	-0.004	0.05	-0.202	0.139	-0.003	0.018
Group 4	-0.012	-0.573	-0.34	-0.345	-0.181	-0.017	-0.021	-0.009	-0.222	0.422	0.141	0.11
# of preventable hospitalizations per 1000 person-quarters												
Group 1	-0.006	-0.0157	0.0029	0.0108	0.0001	-0.0059	-0.005	0.0198	-0.0267	-0.0313	-0.0015	-0.0064
Group 2	-0.003	0.0121	0.0091	0.0116	0.0029	-0.0028	-0.0043	0.0015	0.0057	-0.0286	-0.0073	-0.0039
Group 3	-0.005	-0.013	0.0052	0.0139	0.0033	-0.0059	-0.0074	0.0127	-0.0337	-0.0277	0.0003	-0.007
Group 4	-0.037	-0.0698	-0.0345	-0.0294	-0.0186	-0.0341	-0.0383	-0.0023	-0.0372	-0.0841	-0.0177	-0.0439
# of contact days per person-quarter												
Group 1	0.04	0.106	-0.021	-0.061	-0.0001	0.0429	0.0358	0.0603	0.1222	0.2816	0.0461	0.0402
Group 2	0.021	-0.082	-0.067	-0.066	-0.004	0.02	0.03	0.005	-0.026	0.257	0.218	0.025
Group 3	0.037	0.088	-0.039	-0.079	-0.005	0.043	0.053	0.039	0.154	0.25	-0.009	0.044
Group 4	0.269	0.471	0.256	0.167	0.028	0.249	0.274	-0.007	0.17	0.757	0.53	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. 15Q2_16Q1—the start of the 2nd quarter of 2015 to the end of the 1st quarter of 2016. CD_Binary—Care Density_Binary. The borders of a cell indicate that the IE's bias-corrected bootstrap 95% confidence interval contains 0. Thus, it is unclear whether these IEs are significantly different from 0. **Group 0** ("No, No, No" responses): non-integrated health plan and non-integrated health system. **Group 1** ("No, Yes, No" responses): non-integrated health plan and integrated health system. **Group 2** ("Yes, No, No" responses): integrated health plan and non-integrated health system. **Group 3** ("Yes, Yes, No" responses): integrated health plan and integrated health system from a different integrated system. **Group 4** ("Yes, Yes, Yes" responses): integrated health plan and integrated health system from the same integrated system.

Appendix P. Correlation Between the Number of Contact Days and the Number of Outpatient Visits or Evaluation and Management (E/M) Visits

Correlation				
n=1,489,523 person-quarters	**# of contact days per person-quarter**	**# of outpatient contact days per person-quarter**	**# of outpatient visits per person-quarter**	**# of E/M visits per person-quarter**
# of contact days per person-quarter	1			
# of outpatient contact days per person-quarter	0.9821***	1		
# of outpatient visits per person-quarter	0.9801***	0.9967***	1	
# of E/M visits per person-quarter	0.1981***	0.1759***	0.2008***	1
References: *** p<0.001, ** p<0.01, * p<0.05				

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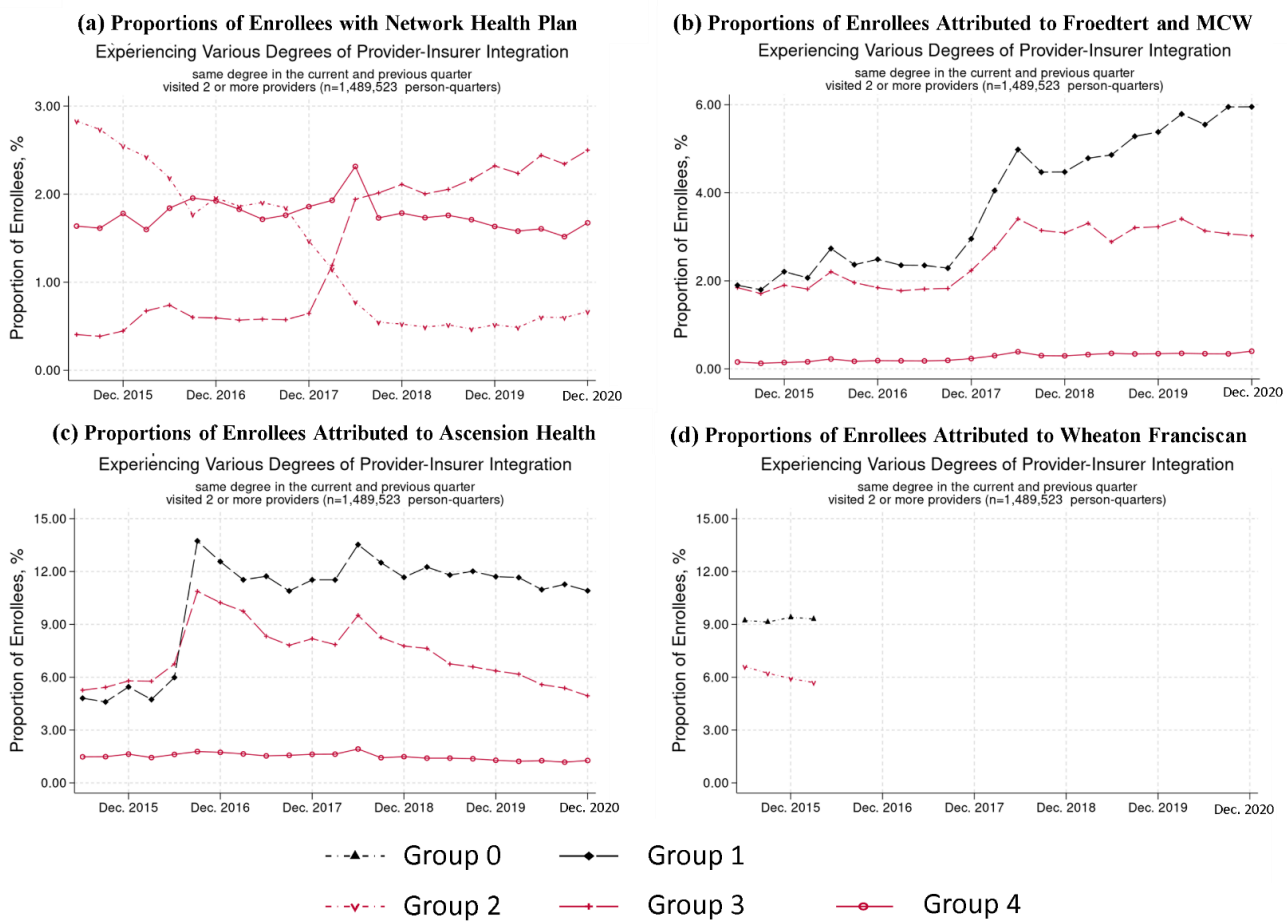
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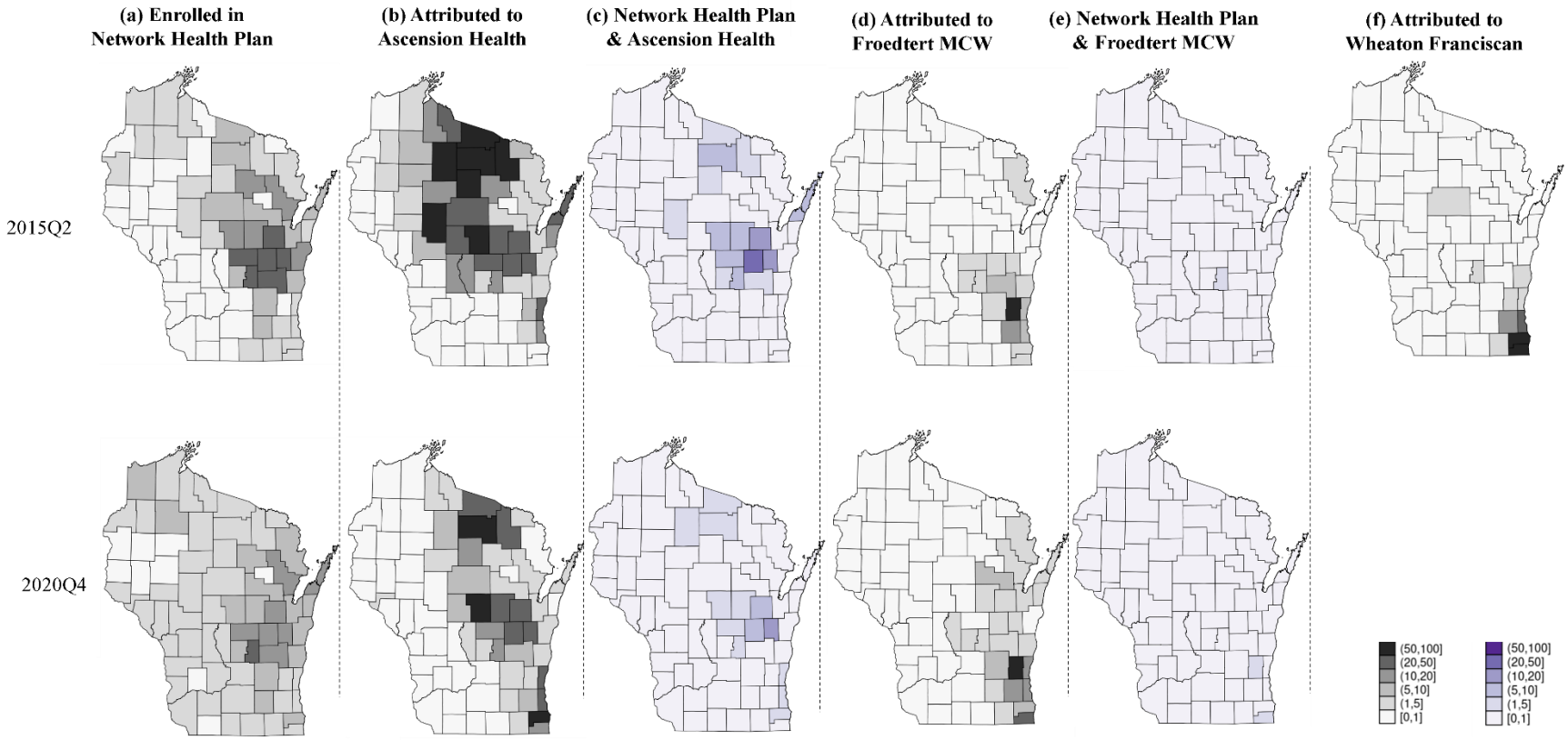
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Supplementary 1.1. Network Health Plan—Proportion of Enrollment



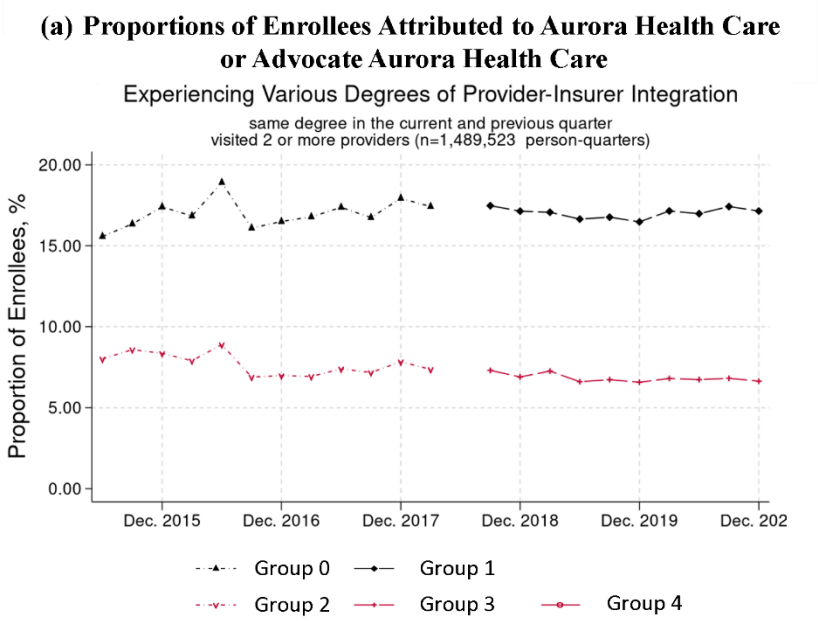
Note: Network Health Plan, a BadgerCare Plus Health Maintenance Organization (HMO), was equally owned by Froedtert and the Medical College of Wisconsin (Froedtert and MCW) and Ascension Health from January 2015 to December 2020 (Ascension Health, 2022; Network Health, 2022; Wisconsin Office of the Commissioner of Insurance, 2021c). In March 2016, Ascension Health purchased Wheaton Franciscan Healthcare (PR Newswire, 2016). **Group 0** ("No, No, No" responses): non-integrated health plan and non-integrated health system. **Group 1** ("No, Yes, No" responses): non-integrated health plan and integrated health system. **Group 2** ("Yes, No, No" responses): integrated health plan and non-integrated health system. **Group 3** ("Yes, Yes, No" responses) integrated health plan and integrated health system from a different integrated system. **Group 4** ("Yes, Yes, Yes" responses) integrated health plan and integrated health system from the same integrated system.

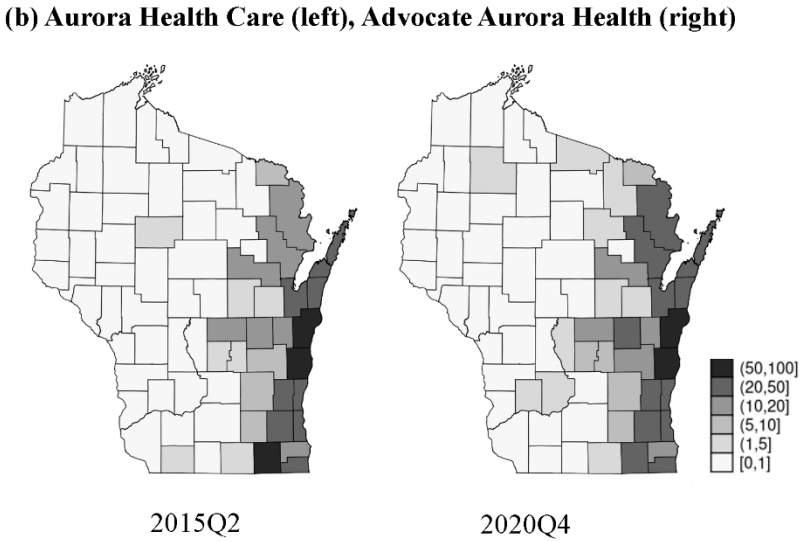
Supplementary 1.2. Network Health Plan—Geographic Distribution



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.

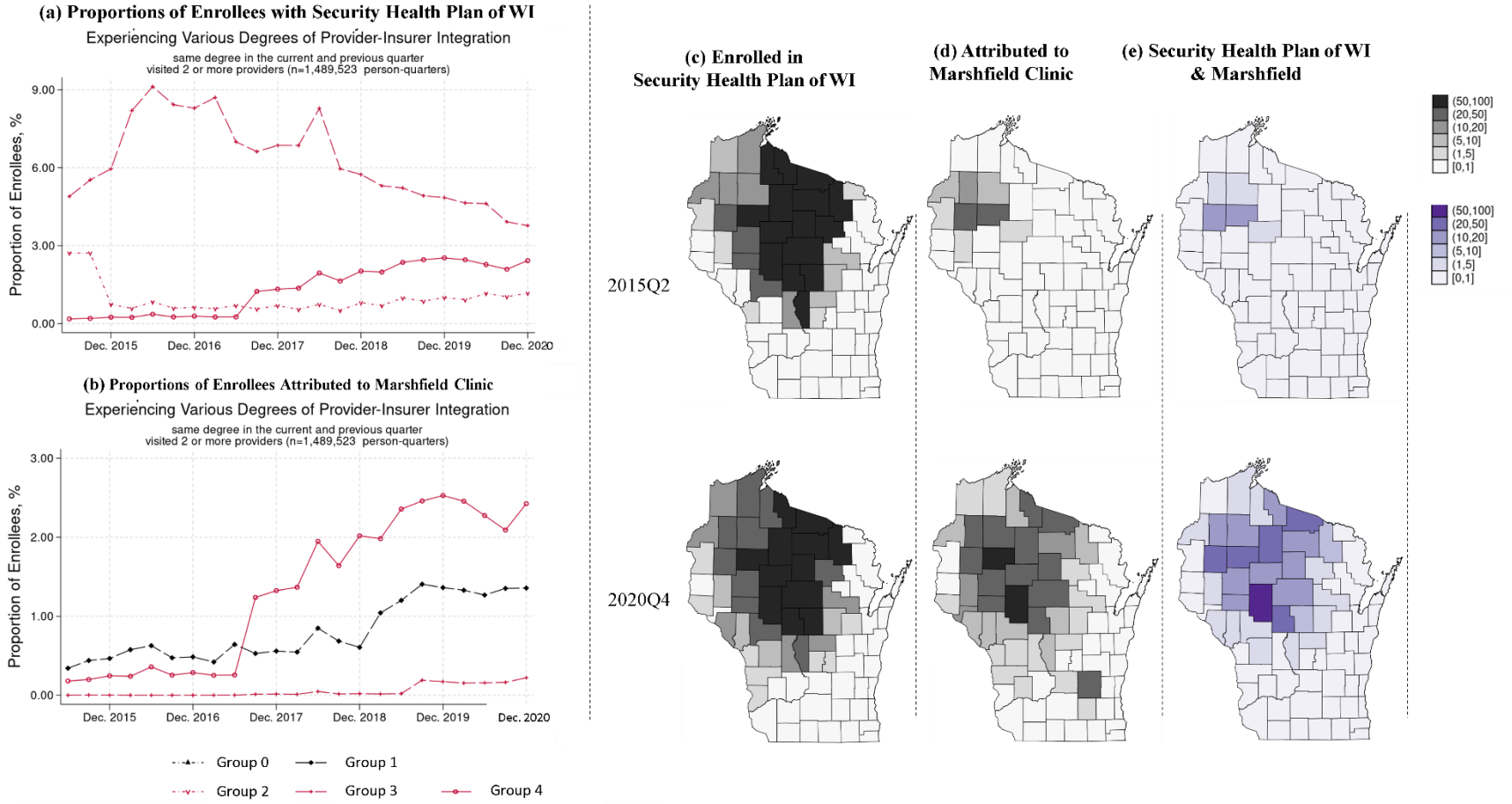
Supplementary 2. Advocate Aurora Health





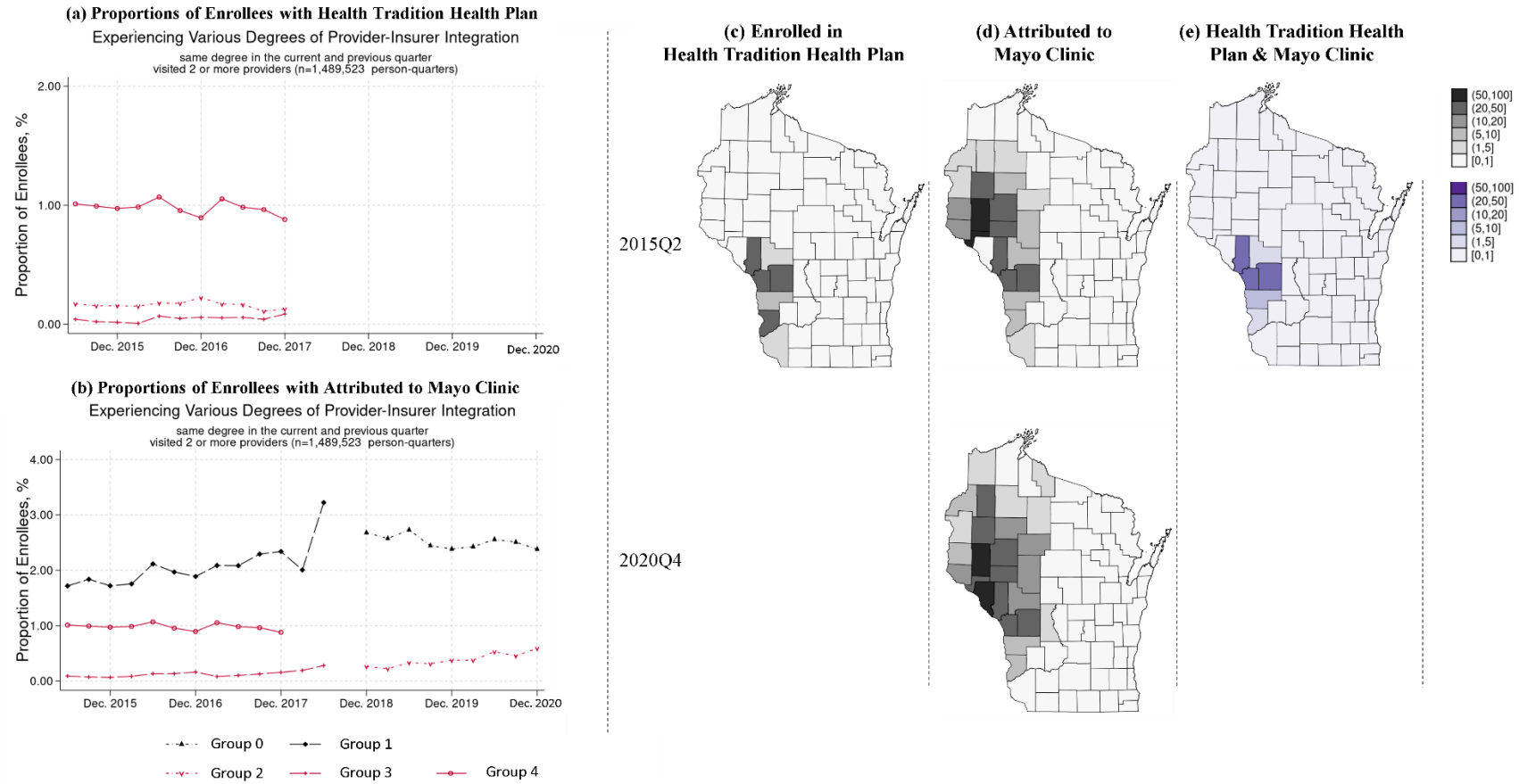
Note: Observations with missing residency information are excluded from these maps. Of the included observations (1,489,523 person-quarters), 104,672 person-quarters lack residency information. Excluding those without residency information does not affect the shape of the curves in panel (a). Map lines 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.

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.

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.

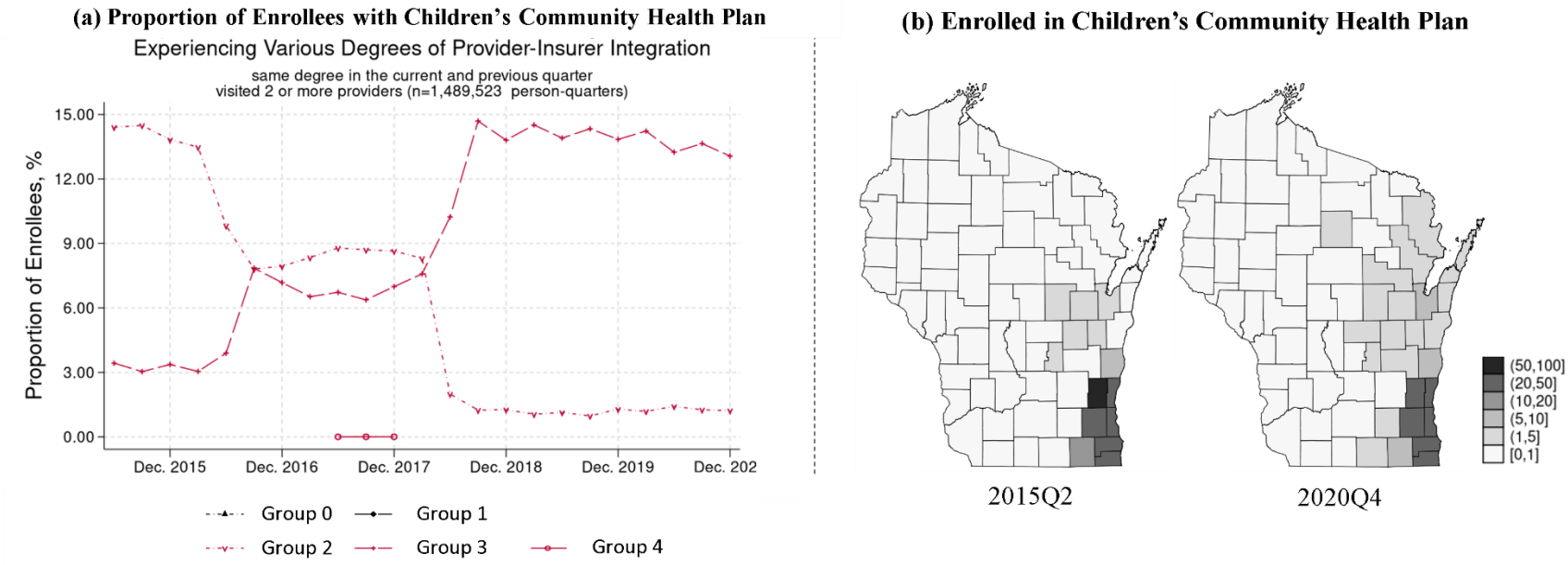
Supplementary 5. BadgerCare Plus HMOs from 2015-2020

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)
Anthem	0	n/a
Children's Community Health Plan	1	1
Compcare	0	n/a
Dean Health Plan	1	1
Group Health Cooperative of Eau Claire	0	n/a
Group Health Cooperative of South Central Wisconsin	1	0
Gundersen Health Plan	1	1
Health Tradition Health Plan	1	1
Independent Care Health Plan	0	n/a
Mercy Care Insurance Company	1	1
MHS of Wisconsin	0	n/a
Molina Healthcare of Wisconsin	0	n/a
Network Health Plan	1	1
Physicians Plus Insurance Corporation	1	1
Quartz	1	1
Security Health Plan of Wisconsin	1	1
Trilogy Health Insurance	1	0
UnitedHealthcare Community Health Plan	0	n/a
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.

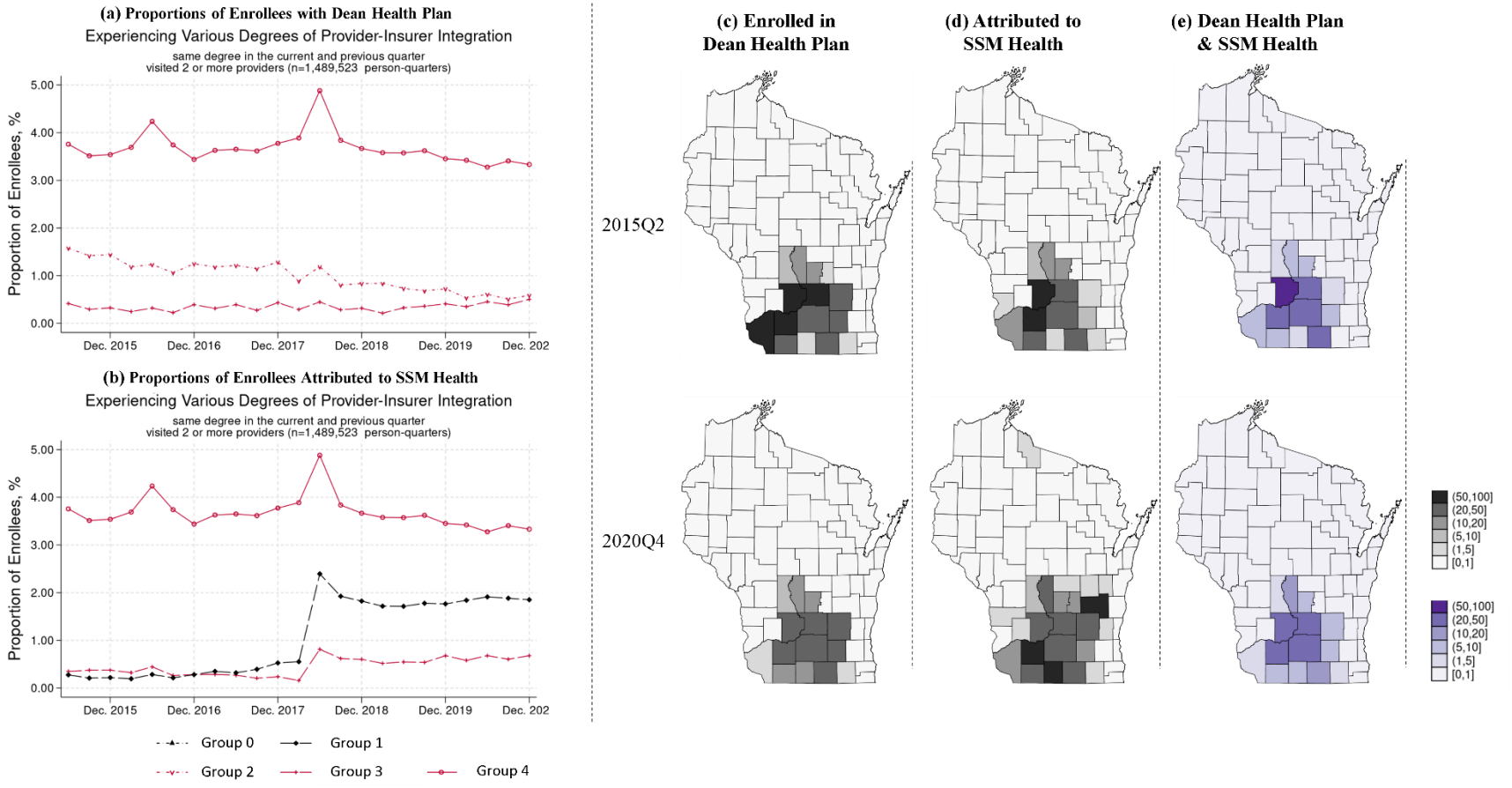
This study observes a large overlap between the residence of enrollees in a given integrated HMO and the residence of those attributed to the health system owned by the same integrated system for six of the eleven integrated HMOs: Network Health Plan, partially owned by Ascension Health (Supplementary 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.

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.

Supplementary 8. Quartz

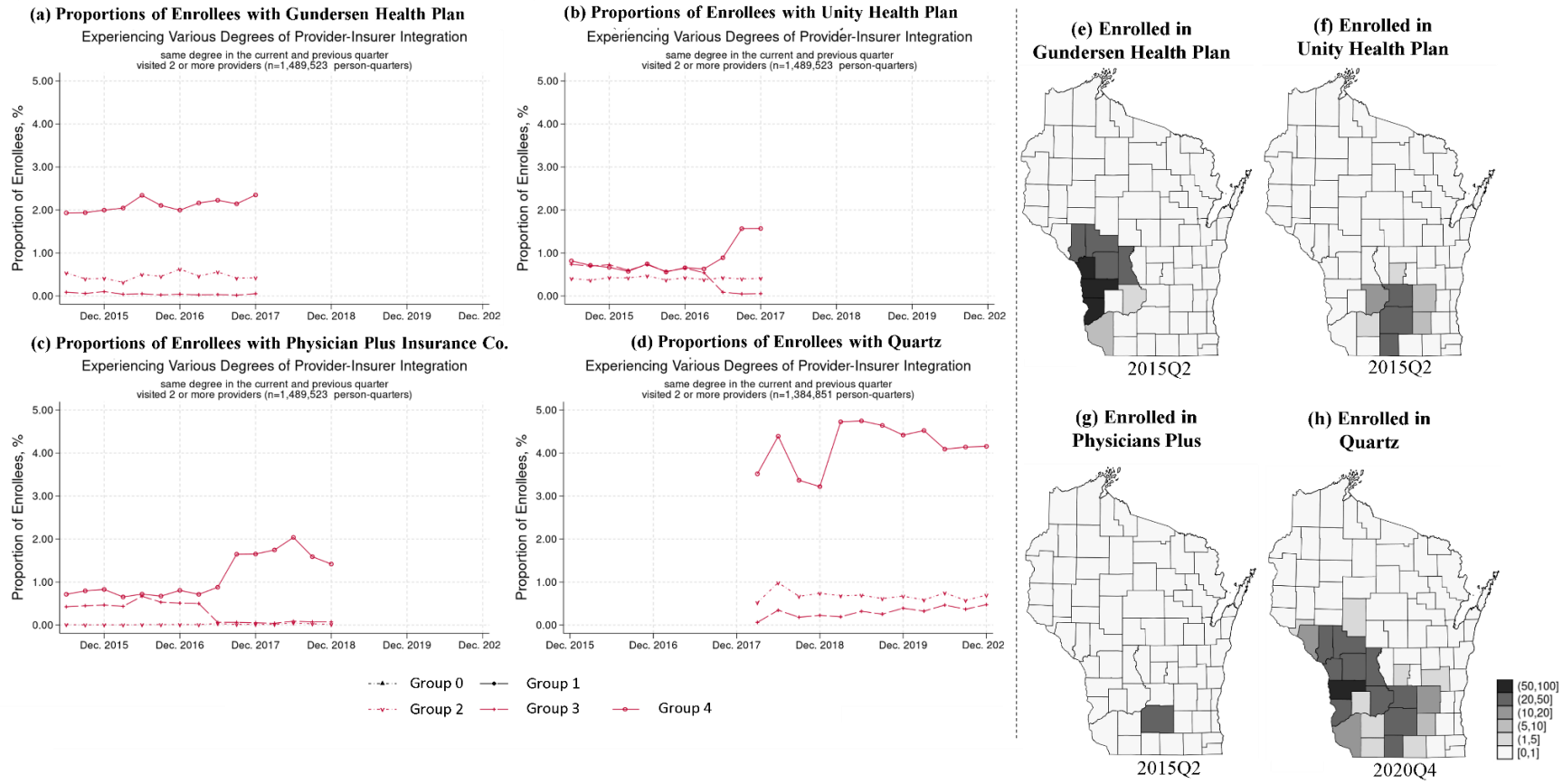
Gundersen Health Plan (GHP) was incorporated in Wisconsin on March 13, 1995, by Gundersen Clinic, Ltd. (the Clinic) and Gundersen Lutheran Medical Center, Inc. (the Hospital). On January 1, 2000, Gundersen Lutheran, Inc., an affiliation created by the Clinic and the Hospital in 1996, became the new parent 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).

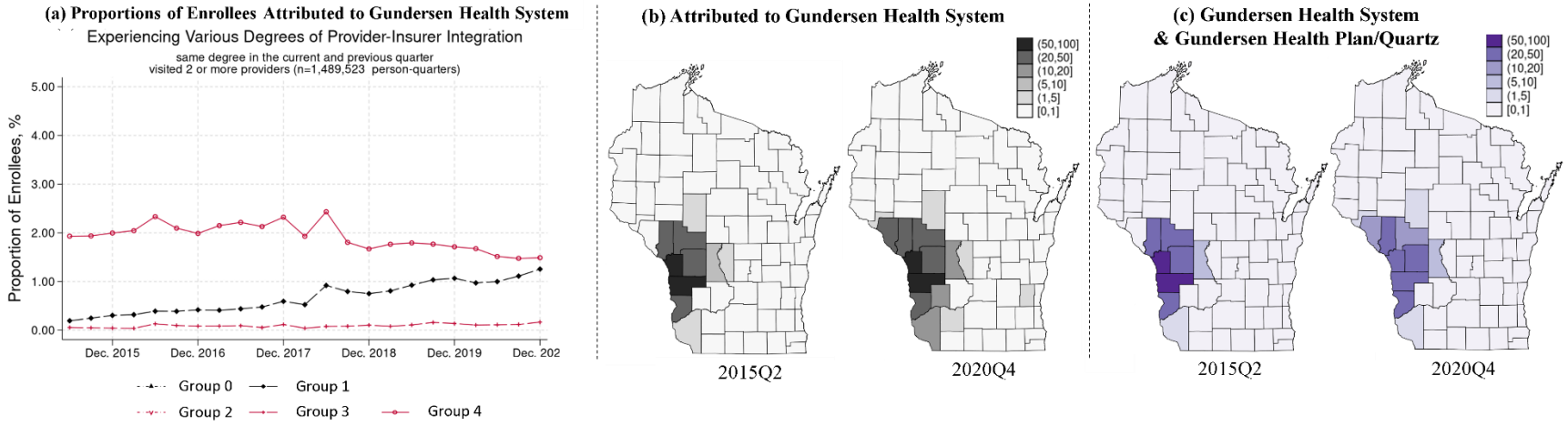
On April 21, 2016, acquisitions of Gundersen Health Plan by University Health Care (a subsidiary of UW Health) and Unity Health Plans by Gundersen Lutheran got approved (Quartz 2016 transaction). As a result, each of Gundersen Health Plan and Unity Health Plans became co-owned by Gundersen Health System 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



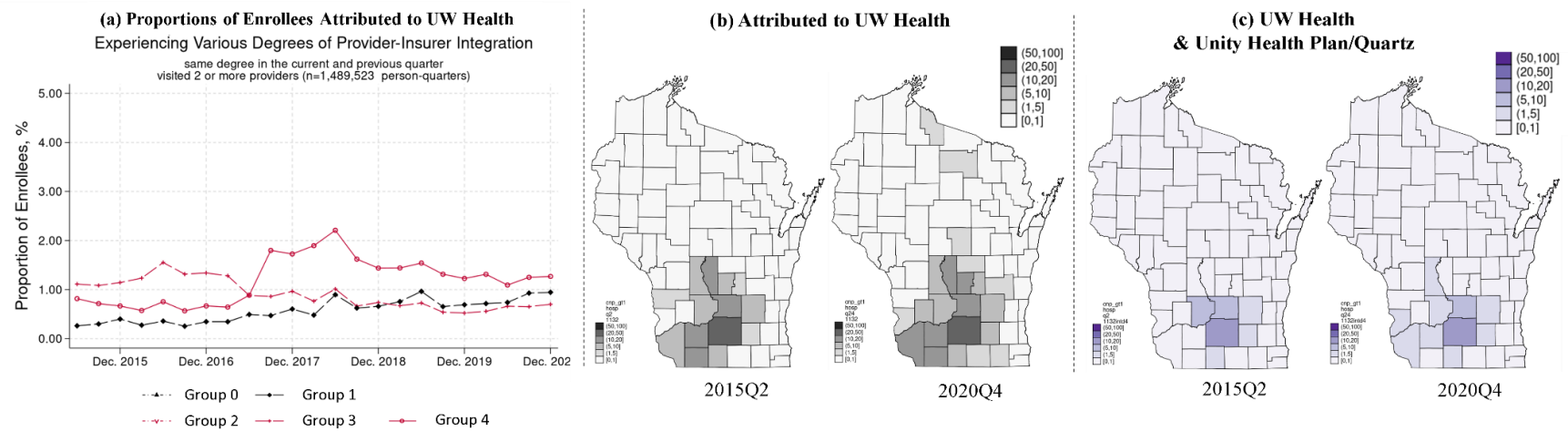
Note: Observations with missing residency information are excluded from the maps. Of the included observations (1,489,523 person-quarters), 104,672 person-quarters lack residency information. Excluding those without residency information does not affect the shape of the curves in panels (a)-(d). Map 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.

Supplementary 8.2. Gundersen Health System



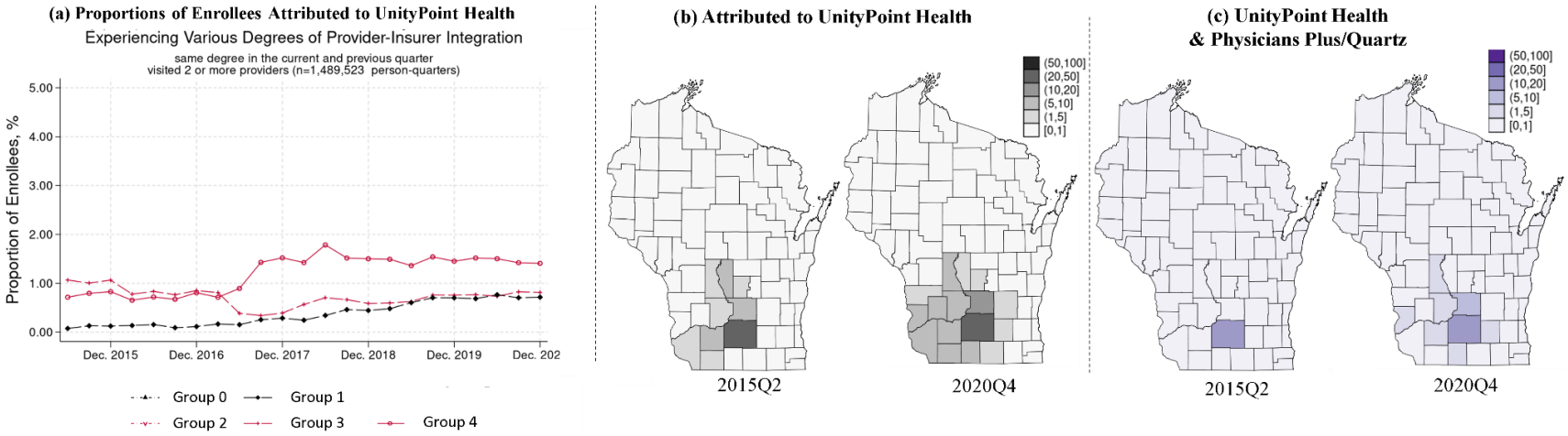
Note: Observations with missing residency information are excluded from the maps. Of the included observations (1,489,523 person-quarters), 104,672 person-quarters lack residency information. Excluding those without residency information does not affect the shape of the curves in panel (a). Map lines 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.

Supplementary 8.3. UW Health



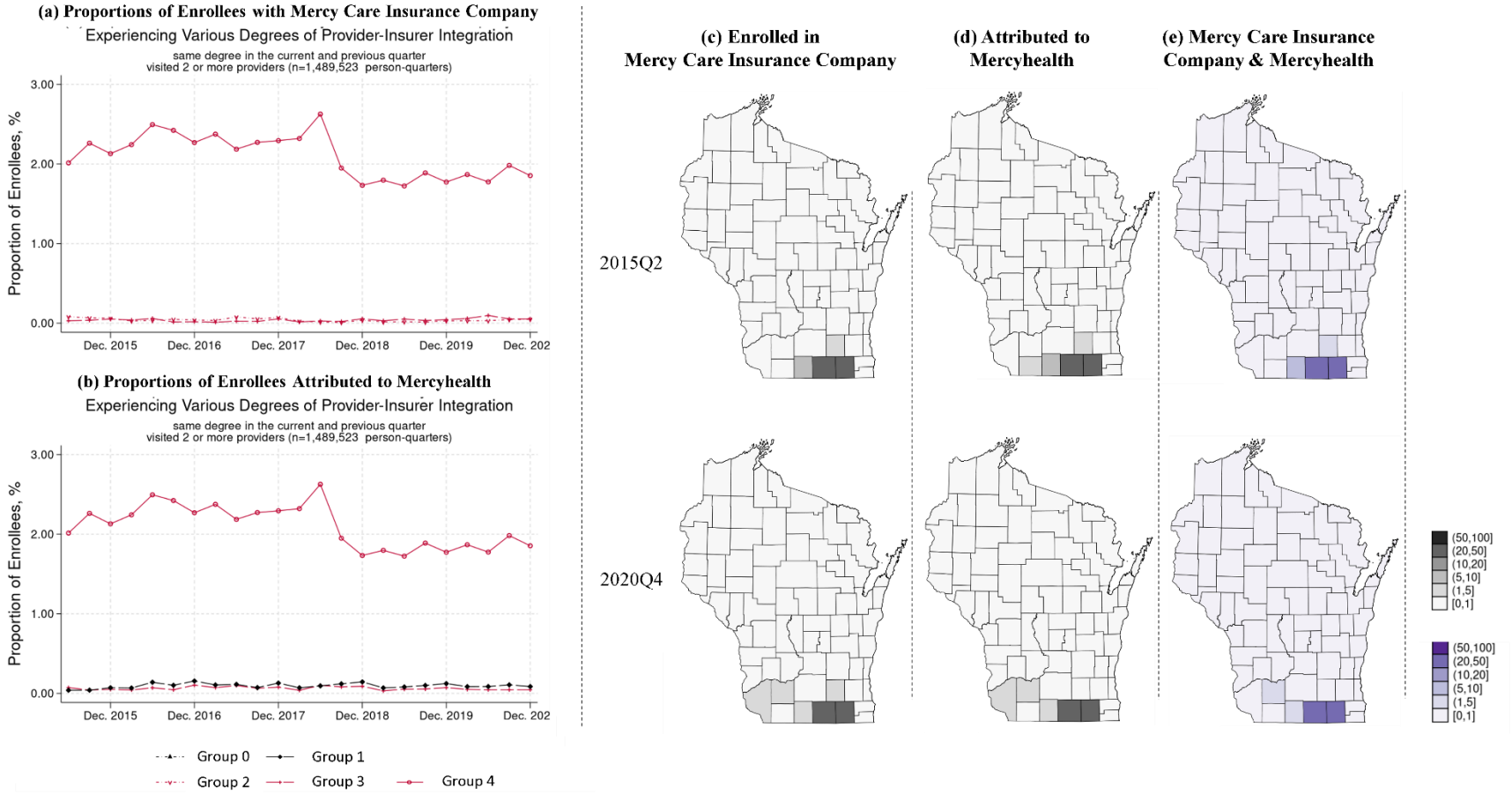
Note: Observations with missing residency information are excluded from the maps. Of the included observations (1,489,523 person-quarters), 104,672 person-quarters lack residency information. Excluding those without residency information does not affect the shape of the curves in panel (a). Map lines 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.

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.

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.

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