

Evaluation of Rhode Island's Health Home Initiative

By

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The long-term goal is to understand how health care integration for the seriously mentally ill can improve quality of care and health outcomes. The overall objective of this study is to examine service use and quality of care before and after the introduction of Rhode Island's Medicaid Health Home. Using longitudinal Medicaid Claims data and quasi-experimental methods we compare integration strategies implemented in community mental health centers that employed diverse care model settings (coordinated, colocated, integrated). The central hypothesis is that health homes alone, and in consort with an integrated care model, can increase access to outpatient services and decrease potentially avoidable service use.

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Introduction

Individuals with serious mental illness die 25 years earlier than those without a mental disorder (1,2,3). It is well known that the fragmented health care system (3-6), preventable comorbid conditions (2,5,7,8) and substandard care (5,6,8-10) contribute to this inequality in life-expectancy. Interventions within Community Mental Health Centers (CMHC) may be the most suitable way to address the disparity as centers are often used by the mentally ill, and may be their only entry point into the healthcare system (2,10). However, CMHCs seldom deliver a full range of medical services (4,5,10), and rarely employ evidence-based approaches to improve such services(10). Consequently, the seriously mentally ill, who are prone to deteriorating states of health(1-10), may go without care (2), seek medical attention in emergency departments (2,5), or be hospitalized when untreated medical conditions worsen (2,5). To address health disparities and inappropriate service use there is a critical need to evaluate approaches that integrate general health services within specialty mental health settings to improve care access and health outcomes.

Numerous studies have shown the benefits of integrated care. However, only limited research demonstrates the best approaches and settings to integrate health services for the seriously mentally ill. To address health disparities, and gaps in knowledge, section 2703 of the Affordable Care Act (ACA) allocated funds for Health Homes, patient-centered care that afford the chronically ill with comprehensive behavioral and primary care services. Twenty-one states have taken advantage of this funding opportunity. This dissertation describes an evaluation of Rhode Island's (RI)

Health Home initiative, which provided coordinated and integrated care to Medicaid beneficiaries who used CMHCs as their medical home.

Our long-term goal is to understand how health care integration for the seriously mentally ill can improve quality of care and health outcomes. Our overall objective of this dissertation is to examine service use and quality of care before and after the introduction of health homes. Using longitudinal administrative data from the RI Medicaid program, we will compare integration strategies implemented in CMHCs that employed diverse care model settings (coordinated, and integrated). Our central hypothesis is that Health Home alone, and in consort with an integrated care model setting, can increase access to outpatient services, decrease potentially avoidable service use, and improve quality of care. Findings from efficacy trials and expert opinion support this hypothesis (2-6,). The rationale for the proposed research is that understanding the outcomes of health homes will inform and guide policymakers as well as states implementing similar initiatives.

We test our central hypothesis by pursuing the following three specific aims:

Aim 1: Establish the degree to which outpatient service use was affected by Health Homes.

Hypothesis 1a: Health Home participant's use of outpatient services, overall and for physical health conditions commonly experienced by individuals with serious mental illness, will increase relative to the comparison group.

Aim 2: Determine the extent to which Health Homes impacted inpatient service use and quality of care.

Hypothesis 2a: Relative to the comparison group, Health Home participants will have fewer hospitalizations and emergency room visits for all-cause, mental health, non-mental health, and ambulatory care sensitive conditions.

Aim 3: Identify the care model setting that affected health service use and quality of care for Health Home participants.

Hypothesis 3a: Health Home participants receiving services from an integrated care model will have more outpatient service use, overall and for physical health conditions commonly experienced by individuals with serious mental illness, than their Health Home counterparts in coordinated care models.

Hypothesis 3b: Health Home participants receiving services from an integrated care model will have fewer hospitalizations and emergency room visits for all-cause, mental health, non-mental health, and ambulatory care sensitive conditions than their Health Home counterparts in coordinated care models.

Regarding outcomes, our work will yield findings that could increase access to outpatient services, improve the quality of care received by the seriously mentally ill as well as identify settings where coordination and integration strategies can be most effective. Such results are expected to advance health policy by further defining best practices for care integration. Equally important, the outcomes are expected to have a positive impact as they may inform the allocation of limited resources, reduce health care costs and enhance health outcomes.

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Chapter I

The Impact of Health Homes on Outpatient Service Use among Medicaid Beneficiaries with Serious Mental Illness

Introduction

Approximately 10 million US adults have a Serious Mental Illness (SMI), such as schizophrenia disorder, bipolar disorder or major depressive disorder (1-3). Individuals with SMI, on average, die 25 years earlier than those without a mental disorder (4-6). Preventable comorbid conditions (5,7,8) are a major contributing factor to this inequality in life expectancy. Some of the most prevalent comorbidities among the SMI population include diabetes, cardiovascular disease, and chronic obstructive pulmonary disease (9). Individual (i.e. sedentary lifestyles, poor diets, and high rates of smoking) and social (i.e. poverty, unemployment, and homelessness) risk factors as well as side-effects from antipsychotic medications (i.e. increased blood pressure, weight gain, and altered glucose levels) (5,9) contribute to the high prevalence of chronic comorbidities.

Timely access to outpatient services can help to prevent and treat many of the conditions experienced by individuals with SMI (10). However, the fragmented healthcare system and symptoms associated with mental illness (i.e. lack of motivation, disorganized thought process, and mistrust of health providers) can serve as barriers to care (5). Moreover, individuals able to access health services may experience lower quality care compared to the non-SMI population (10).

Since publication of the Institute of Medicine's report on (11) mental health care quality, healthcare integration has been highlighted as a means to address health disparities among the mentally ill. The majority of interventions and peer-reviewed literature have focused on the placement of mental health services into a primary care setting,

emphasizing populations with mild to moderate mental illness (1,12). Findings have shown improvements in access to services, quality of care, and health outcomes (1,12). Few studies have concentrated on populations with SMI or settings frequently used by this population, such as Community Mental Health Centers (CMHC) (1,6,12). Integration strategies within CMHCs may be an effective way to address health disparities experienced by individuals with SMI (6-8). CMHCs may serve as the only entry point into the healthcare system for this population (5).

To address health disparities, section 2703 of the Affordable Care Act (1,12) allocated funds for Health Homes, patient-centered care that affords the chronically ill with comprehensive behavioral and primary care services. Twenty-one states have taken advantage of this funding opportunity as of May 2017 (13). This research study evaluates one state's Health Home initiative, which provided coordinated and integrated care to Medicaid beneficiaries with SMI who used CMHCs as their medical home. The purpose of this paper is to examine the extent to which Health Homes impacted access to and use of outpatient services. We hypothesize participants of Health Home will have greater access to and use of outpatient services, relative to the comparison group.

Methods

Intervention

Health Homes was implemented from October 1, 2011 until October 1, 2013 under the auspices of Rhode Island's Department of Behavioral Health Developmental Disabilities and Hospitals (BHDDH). Medicaid beneficiaries receiving BHDDH services with an SMI

diagnosis were automatically enrolled into Health Home. Persons not interested in participating could opt-out and receive services as usual. An SMI diagnosis was ascertained during an individuals' first clinical evaluation at a CMHC. Participants of Health Home met the following eligibility criteria: 1) had a severe and/or persistent mental or emotional disorder but for whom long-term 24-hour care could be averted; and 2) had impaired role functioning; or underwent psychiatric treatment more intensive than outpatient care more than once in a lifetime; or experienced a single episode of continuous, structured supportive residential care other than hospitalization for a duration of at least two months. Enrollees also met at least two of the following criteria, on a continuing or intermittent basis for at least two years: 1) if employed, was employed in a sheltered setting, or had markedly limited skills or a poor work history; 2) required public financial assistance for out-of-hospital maintenance and was unable to procure assistance without help; 3) showed an inability to establish or maintain a social support system; 4) required help in basic living skills; 5) exhibited inappropriate social behavior which resulted in mental health and/or judicial system intervention.

Health Home provided integrated behavioral and primary care through comprehensive case management, care coordination, health promotion services, transitional care, individual and family support services and referrals to community and social support services. Upon enrolling, participants received comprehensive biopsychosocial evaluations and were given personalized treatment plans. Each participant received care from a multidisciplinary team of health professionals. A care manager, the Health

Home team leader, was responsible for coordinating and implementing treatment plans. Nine CMHCs across the state of Rhode Island participated in Health Home.

Study Population

The intervention group consisted of Medicaid beneficiaries who were between 18 to 64 years of age, who were automatically enrolled into Health Homes. Individuals included in our analytic sample were consistently eligible and enrolled in Medicaid (2009-2012).

The comparison group consisted of Medicaid beneficiaries between the ages of 18 to 64 who received mental health services through BHDDH but did not enroll in Health Homes. Individuals were consistently eligible and enrolled in Medicaid (2009-2012).

This comparison group accounts for trends attributed to BHDDH that are not associated with Health Homes and may otherwise confound study effects. Additionally, this group provides the estimates of what would have happen if those enrolled in Health Homes did not participate. We used propensity score weights to ensure the comparison group was similar to those who participated in Health Homes on observable baseline characteristics. A designation of SMI was determined using Medicaid claims data and an International Classification of Diseases, 9th revision (ICD-9) algorithm (14). ICD-9 codes were truncated to the first three digits due to the potential inconsistency in the last two digits. A schizophrenia disorder was defined as having at least one inpatient or two outpatient visits classified with the ICD-9 code 295. A mood disorder was defined as having at least one inpatient or two outpatient visits classified with the ICD-9 code 296.

Data Source

Our study used Medicaid eligibility file and fee-for-service claims for the period 2009 through 2012. The American Community Survey (ACS) and Rhode Island Department of Health (RIDH) Licensee Lists were also used. Claims provided demographic and utilization data on adult Medicaid beneficiaries prior to and following the implementation of Health Home. ACS provided sociodemographic factors at the Zip Code Tabulation Area (ZCTA)-level while RIDH licensee lists supplied the number of health providers. This secondary data analysis was approved by the Brown University Office of Research Integrity.

Outcome Variables

Our primary outcome was outpatient service use. We evaluated the impact of Health Home on having one outpatient visit or more and count of outpatient visits (service use intensity) for individuals with at least one visit. We looked at overall outpatient visits as well as those associated with a physical health condition commonly experienced by individuals with SMI (chronic obstructive pulmonary disease (COPD), cardiovascular disease, diabetes, hypertension, and obesity) (9). We treated all outpatient service use outcomes as dichotomous and count variables.

Independent Variables

The primary factor of interest was an interaction term composed of indicators for Health Home participation (0= no participation; 1=participation) and post-Health Home period (0=pre-period; 1=post-period). To minimize confounding we included both individual and

ZCTA-level variables in our regression models. Individual-level factors included: continuous age, sex indicator, race indicators (White, Black, and Other), number of comorbidities using the Elixhauser comorbidity index, mood disorder indicator, and schizophrenia disorder indicator. ZCTA-level factors included: median household income, percent employed, percent non-Hispanic White, percent non-Hispanic Black, percent Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of psychiatric nurses, number of primary care providers, number of physician assistants, number of CMHCs, and number of federally qualified health centers.

Statistical Methods

We used a difference-in-differences (DD) approach to estimate the extent Health Homes impacted outpatient service use. Employing this analytic method allowed us to estimate the average treatment effect on the treated (15). We compared the impact before and after Health Home began. Our analyses included one pre-intervention period (12-months prior to Health Home implementation) and one post-intervention period (12-months post Health Home onset). In using the DD approach we assume intervention and comparison groups possess parallel trends in the pre-intervention period (15). In other words, if the intervention had never taken place, outpatient service use for intervention and comparison groups would have changed at similar rates. Though this assumption cannot be proven, we checked the validity of parallel trends using Medicaid claims from 2009-2011 (Appendix A. Figures 1-6). DD is the average difference in outpatient service use for Health Home participants minus the average difference in

outpatient service use for the comparison group. Any remaining differences in service use can be associated to the intervention. In a regression framework, an interaction between indicator variables Health Home participation and post-Health Home period yield our DD estimate.

For each count outcome, a multivariable model was estimated with a negative binomial distribution and a log link function with robust standard errors clustered at the individual level. We used a negative binomial distribution as count data was overdispersed. We used generalized estimating equations with an autoregressive correlation structure to account for the clustering of repeated individual observations over time. For each dichotomous outcome we estimated multivariable logistic regression models with a logit link function. Similar to our negative binomial models we used robust standard errors clustered at the individual level and generalized estimating equations. To obtain the desired interpretation of the interaction term in our non-linear models we used the predictive margins method to predict outpatient service use for Health Home and comparison groups in the pre- and post-intervention periods. All regression models were adjusted for individual- and ZCTA-level factors.

Propensity score weights were used in combination with a DD approach to minimize bias and maximize comparability between groups on baseline characteristics.

Propensity score models were generated for each outcome measure. Individual- and ZCTA-level variables as well as pre-period outcomes and pre-period outcome trends were used to specify the propensity score model. A logistic regression model was used

to estimate the propensity score with an indicator for participation in Health Home as the outcome variable. We graphically and empirically assessed balance of the propensity scores. An absolute percent standardized differences in means $\leq 10\%$ was used to determine balance of the propensity scores (16). To estimate the average treatment effect on the treated we weighted by the odds of the propensity score (17, 18). Health Home participants were given a weight of 1 while individuals in the comparison group received a weight of $p_i / (1 - p_i)$ where p_i represents the estimated propensity score for an individual. Using this weighting scheme allows comparisons who are similar to the intervention participants to be weighted higher than those who are dissimilar, which are weighted down (18).

Subgroup analyses were conducted to assess the differential impact of Health Home participation on Black, Hispanic, and individuals with a schizophrenia disorder. Two sensitivity analyses were conducted to evaluate the robustness of our models. One, we reran our analyses with a different comparison group (Appendix C. Table 1-2), composed of Medicaid beneficiaries, aged 18 years and older, who did not participate in Health Home and did not obtain services through BHDDH. Similar to the original analyses, propensity score models were generated for each outcome. We also validated the parallel trends assumption for our DD analysis with the secondary comparison group (See Appendix B. Figures 1-6). Two, we conducted a DD analysis employing an outcome not intended to be impacted by Health Home (Appendix D. Figure 1), access to dental exams.

Results

Before weighting, there were significant differences between Health Home and comparison groups on baseline characteristics (Table 1). One of the larger differences between groups was having a schizophrenia disorder diagnosis. Standardized difference in means ranged from 0.30% to 55.00%. There were no significant differences between Health Home (N=5,272) and comparison (N=1,623) groups after weighting. All variables were balanced with standardized differences in means ranging from 0.00% to 4.10%. The average age among groups was approximately 45 with a larger proportion of females than males, of White race compared to others, had a mood disorder, and experienced an average greater than four comorbidities.

Table 2 presents results from our adjusted and weighted DD analysis for Health Home impact on access to outpatient services. The proportion of Health Home participant's having at least one outpatient visit for COPD increased from 12.98% in the pre-period to 13.30% in the post- period. The concurrent trend for the comparison group was 12.89% to 10.84%, yielding a DD of 2.37 percentage-points (95% CI: 0.89-4.94). There were no differences between groups on having an overall outpatient visit or for a primary diagnosis of cardiovascular disease, diabetes, hypertension, or obesity ($p>0.05$). In our sensitivity analyses, Health Home was associated with a 2.78 percentage-point increase in the proportion having at least one overall outpatient visit (95%CI: 0.32 to 5.25), relative to the secondary comparison group (Appendix C. Table 1). Findings also suggested a significant increase in the proportion of Health Home participants having an outpatient visit for a primary diagnosis of diabetes and hypertension ($p<0.05$).

Among individuals that had ≥ 1 outpatient visit (Table 3), the number of overall outpatient visits increased for Health Home participants, relative to the comparison group, 74.75/100 person-years (95%CI: 31.08 to 118.92). There were no differences in service use intensity between groups for outpatient visits associated with COPD, cardiovascular disease, diabetes, hypertension, or obesity. Sensitivity analyses (Appendix C. Table 2) also showed a significant increase in the number of overall outpatient visits for Health Home participants compared to the secondary comparison group ($p < 0.05$).

Table 4 shows our results from the subgroup analysis on access to outpatient services. Over and above the interaction between Health Home and post-period, Black participants had a significant increase in the proportion obtaining at least one outpatient visit for obesity, 2.34 percentage points (95%CI: 0.38 to 4.30). Black Health Home participants also had an increase in outpatient visit access for cardiovascular disease and diabetes ($p > 0.05$). Lower access ($p > 0.05$) was seen among Black Health Home participants for overall outpatient visits as well as outpatient visits associated with hypertension. Hispanic Health Home participants had non-significant increases in visits associated with COPD, cardiovascular disease, hypertension, and obesity. Individuals with schizophrenia disorder had minor non-significant increases ($p > 0.05$) in all outpatient access outcomes, except visits associated with diabetes.

Discussion

Rhode Island was one of the first states to take advantage of section 2703 of the Affordable Care Act to develop and implement a Health Home. The program took shape as a comprehensive care coordination intervention that targeted individuals with SMI and integrated general health services within a mental health setting. There have been several evaluations of Medicaid Health Homes (19-22). To our knowledge, we are the first to evaluate the impact of the Medicaid Health Homes on access to and use of outpatient services.

An objective of Health Home was to increase access to outpatient services. We hypothesized Health Home participants would have greater access to and use of outpatient services, relative to the comparison group. Results from our analyses suggest the initiative was moderately successful. Relative to the comparison group, Health Home was associated with a significant increase in the proportion of participants having at least one outpatient visit for COPD. Health Home was also associated with a significant increase in the number of overall outpatient visits, between pre- and post-periods. Results from our subgroup analyses suggest Black Health Home participants had an increase in the proportion obtaining at least one outpatient visit associated with obesity. We did not find a difference between comparison groups in many of our outpatient service use outcomes.

Our findings coincide with those of Krupski and colleagues (23) who evaluated the Substance Abuse and Mental Health Services Administration's Primary and Behavioral

Health Care Integration (PBHCI) grant program. PBHCI provided grantees, CMHCs, with funds to integrate primary care services for individuals with SMI. Researcher assessed the impact of PBHCI at two clinics, one had a history of providing integrated services and the other was a standalone CMHC. Researchers found a significant increase in the proportion of PBHCI participants accessing outpatient services at both clinics. PBHCI was also associated with a non-significant increase in the number of outpatient visits, per member per month.

Though limited, our findings are promising as individuals with SMI are a hard to reach population with high rates of morbidity and mortality (5,9). Timely access to outpatient services can help prevent and effectively treat many of the comorbidities experienced by individuals with SMI (10). Increase access to and use of outpatient services among Health Home participants may be attributed to a synergistic effect between preexisting patient-staff relationships and individualized treatment plans.

Patients with strong patient-provider relationships are more likely to adhere to treatment regimens, stay in the healthcare system for longer periods, and have better health outcomes (24). As staffing at CMHCs did not change when Health Home was introduced, participants had established ties with individuals implementing the intervention. These relationships may have resulted in mutual trust, which facilitated the implementation of treatment plans, care coordination, and resulted in outpatient service use. Personalized treatment plans addressed participants' healthcare needs and

treatment goals. Tailored health plans can improve mental health symptoms (25) and increase use of primary care (26).

A key aspect of integrated care is enhanced communication and collaboration. Health professionals involved in Health Homes would regularly meet to discuss patient status and treatment plan progression. Additionally, care managers frequently communicated with area clinics and hospitals to coordinate treatment. Enhanced communication and collaboration via behavioral based integration has been found to increase primary care visits, use of preventive services, and improve clinical outcomes and quality of life (1,12). There is limited research that assesses the impact of inter-team/inter-staff communication on service use or patient outcomes. However, integration framework, conceptualized by the Center for Integrated Health Solutions, cites communication between healthcare providers as a potential means to improve quality of care and health outcomes (27).

Our null results may be attributable to the following three reasons. One, the follow-up period could have been too brief to see an effect. Given the multiple comorbidities and potential barriers to care, a longer follow-up with more exposure to Health Home may be needed. Two, when we evaluated the impact of Health Home on outpatient visits associated with commonly occurring physical health conditions, we did not limit our sample to individuals with diagnosed cases of the conditions. This may have moderated our effect estimates. Three, staff capacity and resources may not have been sufficient.

CMHCs with limited resources may have experienced difficulties prioritizing new and existing demands, which potentially influenced Health Home implementation.

Our evaluation had several limitations. One, our findings may not be generalizable to other SMI populations residing in different states. However, findings may serve as a case study, which provides insight on an integration approach that provided individuals with SMI comprehensive behavioral and primary care services that were patient centered and offered in a mental health setting. Two, Health Home was not a randomized control trial and may be subject to selection bias. To limit this potential bias we employed propensity score weights to maximize comparability between Health Home and comparison groups on baseline characteristics. Three, we were unable to control for factors that occurred at the same time as Health Home that may differentially impact outcomes for our comparison groups.

Our current study also possesses several strengths. We used innovative methods that simulated an experimental design and allowed for causal inferences. By using propensity score weights we addressed potential differences between those who did and did not participate in Health Homes by making them similar on observable baseline factors. Using a DD approach allowed us to account for secular trends that may obscured the true effects of Health Homes. Medicaid data were available for two years prior to Health Home onset, which allowed the validation of the DD parallel trends assumption

Conclusion

Our findings suggest the investment in mental health based integration can improve access to and use of some outpatient services by individuals with SMI. This is promising as people with SMI experience a disproportionate amount of preventable chronic conditions, compared to the general population. Improving access to outpatient services can help reduce preventable service use and improve health outcomes and quality of life (28). Our research contributes to the understanding of approaches that integrate general health services into community mental health settings. Findings can help inform states and organizations implementing similar integration strategies among SMI populations. Future research should elucidate the healthcare integration factors that most prominently influence service use and quality of care for SMI populations so as to establish best practices.

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Table 1.Characteristics of health home participants and a comparison group by variables used in developing propensity score ^a

	Before Weighting			After Weighting ^d		
	HH ^b (N= 5,272)	Comparison (N=1,623)	Standardized Difference in Means ^c	HH (N= 5,272)	Comparison (N=1,623)	Standardized Difference in Means
Individual-Level Factors	Mean	Mean	%	Mean	Mean	%
Age	45.15	43.79	12.30**	45.15	45.36	1.90
Sex (Female)	0.58	0.58	0.50	0.58	0.59	1.60
Race						
White	0.62	0.67	9.60**	0.62	0.62	0.70
Black	0.10	0.07	9.10**	0.10	0.10	0.00
Other ^e	0.14	0.12	8.00**	0.14	0.14	0.10
Mental Illness						
Mood Disorder	0.74	0.75	1.60	0.74	0.74	1.20
Schizophrenia	0.47	0.22	55.00**	0.47	0.48	1.10
Comorbidities	4.63	4.20	15.00**	4.63	4.66	1.10
Area-Level Factors ^f						
Number of Mental Health Counselors	12.78	13.44	5.40	12.78	12.63	1.20
Number of Psychologists	14.57	13.66	5.10	14.57	14.91	1.90
Number of Psychiatrists	7.63	6.63	9.30**	7.63	7.43	1.90
Number of Primary Care Providers	38.94	37.31	4.40	38.94	38.78	0.40
Number of Physician Assistants	13.96	12.93	6.90**	13.96	13.84	0.80
Number of CMHC ^g	0.92	0.86	4.60	0.92	0.87	3.90
Number of FQHC ^h	0.96	0.86	11.30**	0.96	0.98	2.90
Median Household Income	47,560.00	49,522.00	11.20**	47,560.00	47,512.00	0.20
Percent Employed	88.03	88.00	0.30	88.03	87.98	0.40
Percent Non-Hispanic White	65.20	67.51	8.60**	65.20	64.81	1.50
Percent Non-Hispanic Black	7.51	6.94	9.40**	7.51	7.46	0.80
Percent Hispanic/Latino	18.71	17.02	8.60*	18.71	19.19	2.50

^a Propensity score models also included higher order terms and interactions

^b HH, Health Homes

^c Standardized Differences: difference in means of HH and comparison group, divided by the standard deviation of HH

^d Weighting by the Odds: Intervention Group Weight=1; Control Group Weight= propensity score/1-propensity score

^e Other: American Indian or Alaska Native, Asian Pacific Islander Hawaiian Native, Spanish Surname

^f ZCTA: Zip Code Tabulation Areas

^g CMHC: Community Mental Health Center

^h FQHC: Federally Qualified Health Center

* 0.05> p >0.01

** p<0.01

Table 2. Difference-in-differences (DD) analysis of outpatient service use among individuals enrolled in health homes and a comparison group^{a,b,c}

	HH ^d			Comparison			DD	95% CI
	Pre-period ^e	Post-period ^f	Pre-post difference ^g	Pre-period	Post-period	Pre-post difference		
Outpatient Services								
Overall	85.10	86.54	1.45	84.92	87.23	2.31	-0.86	-3.94 to 2.22
Physical Health Conditions^h								
COPD ⁱ	12.98	13.30	0.32	12.89	10.84	-2.05	2.37*	0.89 to 4.94
Cardiovascular Disease	11.40	11.82	0.42	11.30	13.27	1.97	-1.55	-4.07 to 0.96
Diabetes	13.55	14.72	1.17	12.52	14.86	2.34	-1.17	-3.18 to 0.83
Hypertension	15.44	16.78	1.35	15.31	14.63	-0.68	2.03	-0.57 to 4.62
Obesity	2.49	2.41	-0.08	2.56	2.22	-0.34	0.27	-1.02 to 1.56

^a Outcomes are dichotomized, 1=one or more visits; 0=no visits

^b Models weighting by the odds: HH Group Weight=1; Comparison Group Weight= propensity score/1-propensity score

^c Models adjusted for individual and ZCTA-level covariates. Individual-level covariate include: age, sex, race, mood disorders, schizophrenia, comorbidities; ZCTA-level covariates include: median household income, % employed, % non-Hispanic white, % non-Hispanic black, % Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of psychiatric nurses, number of primary care providers, number of physician assistants, number of CMHC number of FQHC

^d HH: Health Home

^e Pre-period: 12-months before Health Home started

^f Post-period: 12-months after Health Home started

^g Pre-Post Difference: Post-period - Pre-period

^h Each physical health condition served as the primary diagnosis for the outpatient encounter

ⁱ COPD: Chronic Obstructive Pulmonary Disorder

* .05> p >0.01

** p<.01

Table 3. Difference-in-differences (DD) analysis of visit counts per 100 person-years for outpatient services among individuals enrolled in health homes and a comparison group^{a,b,c}

		HH ^d			Comparison				
		Pre-period ^e	Post-period ^f	Pre-post difference ^g	Pre-period	Post-period	Pre-post difference	DD	95% CI
Outpatient Services									
Overall		796.26	852.26	55.99	827.09	808.33	-18.76	74.75**	31.08 to 118.42
Physical Health Conditions									
COPD ⁱ		261.36	261.80	0.44	269.57	284.00	14.43	-13.99	-76.15 to 48.17
Cardiovascular Disease		232.51	237.55	5.04	236.93	221.48	-15.45	20.49	-44.33 to 85.32
Diabetes		360.34	365.52	5.18	311.01	354.52	43.52	-38.34	-101.55 to 24.88
Hypertension		239.13	223.95	-15.18	229.50	227.96	-1.54	-13.63	-54.49 to 27.22
Obesity		222.73	187.07	-35.66	194.75	112.72	-82.03	46.36	-38.61 to 131.33

^a Outcomes are count variables and only include cases $\geq$ one visit

^b Models weighting by the odds: HH Group Weight=1; Comparison Group Weight= propensity score/1-propensity score

^c Models adjusted for individual and ZCTA-level covariates. Individual-level covariate include: age, sex, race, mood disorders, schizophrenia, comorbidities; ZCTA-level covariates include: median household income, % employed, % non-Hispanic white, % non-Hispanic black, % Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of psychiatric nurses, number of primary care providers, number of physician assistants, number of CMCH number of FQHC

^d HH: Health Home

^e Pre-period: 12-months before Health Home started

^f Post-period: 12-months after Health Home started

^g Pre-Post Difference: Post-period - Pre-period

^h Each physical health condition served as the primary diagnosis for the outpatient encounter

ⁱ COPD: Chronic Obstructive Pulmonary Disorder

* .05 > p > 0.01

** p < .01

Table 4. Difference-in-difference-in-differences (DDD) sub-group analysis of outpatient service use^{a,b,c}

	Dependent variables									
	Overall		COPD ^d		Cardiovascular Disease		Diabetes		Hypertension	
	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI
HH ^e X Post-period ^f X Black	-8.24	-15.10 to -1.38	-6.51	-21.91 to 8.90	5.76	-1.00 to 12.52	5.10	-5.74 to 15.94	-8.24	-18.36 to 1.88
HH X Post-period X Hispanic	-1.21	-7.21 to 4.79	7.19	0.20 to 14.18	3.76	-3.57 to 11.08	-2.32	-8.58 to 3.95	4.97	-3.30 to 13.23
HH X Post-period X Schizophrenia	0.20	-5.82 to 6.21	2.09	-2.42 to 6.59	0.25	-4.83 to 4.33	-4.52	-8.03 to 1.00	0.33	-4.17 to 4.83
									0.30	-2.26 to 2.87

^a Outcomes are dichotomized, 1=one or more visits; 0=no visits

^b Models weighting by the odds: HH Group Weight=1; Comparison Group Weight=propensity score/1-propensity score

^c Models adjusted for individual and ZCTA-level covariates. Individual-level covariates include: age, sex, mood disorders, comorbidities; ZCTA-level covariates include: median household income, % employed, % non-Hispanic white, % non-Hispanic black, % Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of primary care providers, number of physician assistants, number of CMHC number of FQHC

^d COPD: Chronic Obstructive Pulmonary Disorder

^e HH: Health Home

^f Post-period: 12-months after Health Home started

* .05> p >.01

** p<.01

Chapter 1

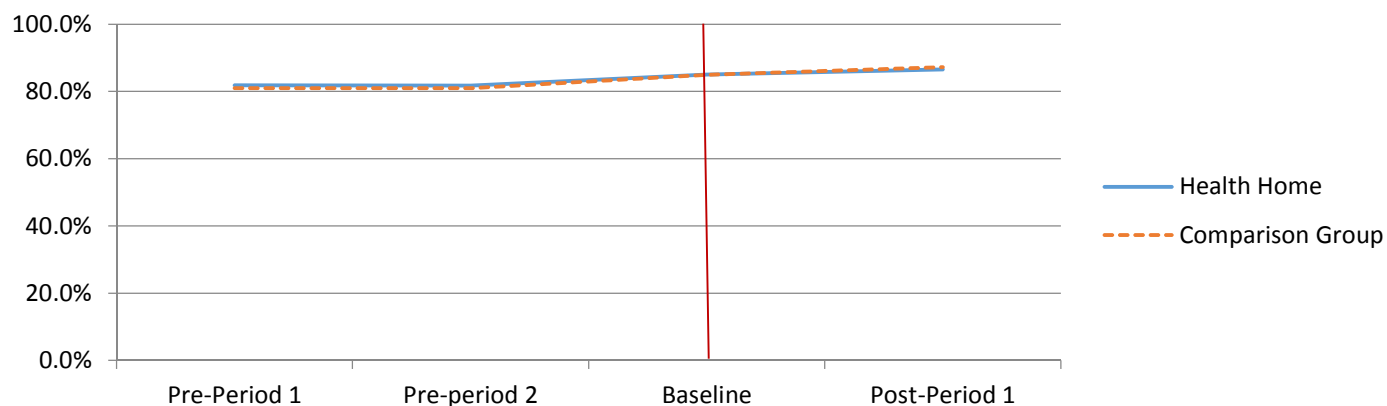
The Impact of Health Homes on Outpatient Service Use among Medicaid Beneficiaries with Serious Mental Illness

Appendix

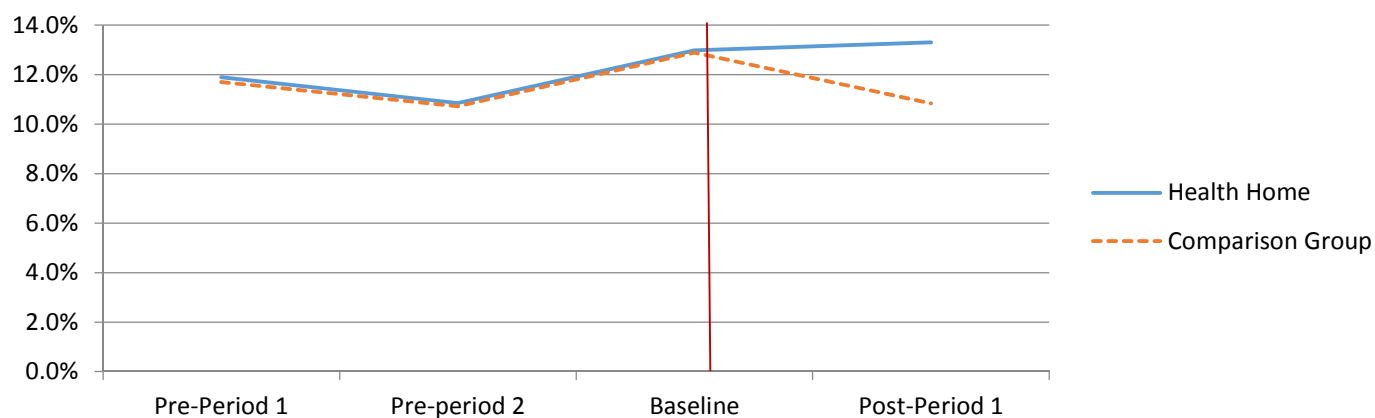
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B. Validation of parallel trends assumption for Health Home and secondary comparison group.....	31
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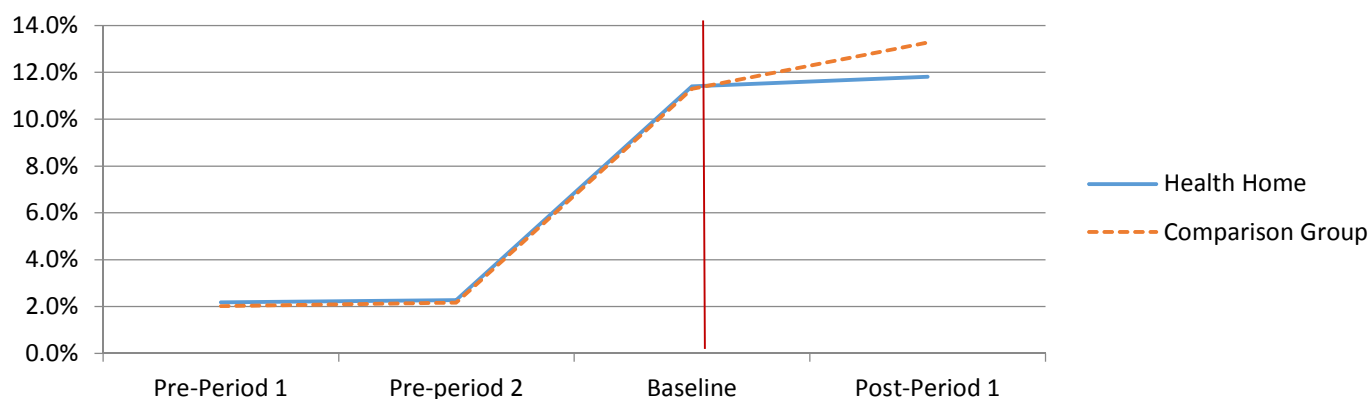
Appendix A. Figure 1
Percent Outpatient Service Use: Overall
Health Home and Comparison Groups



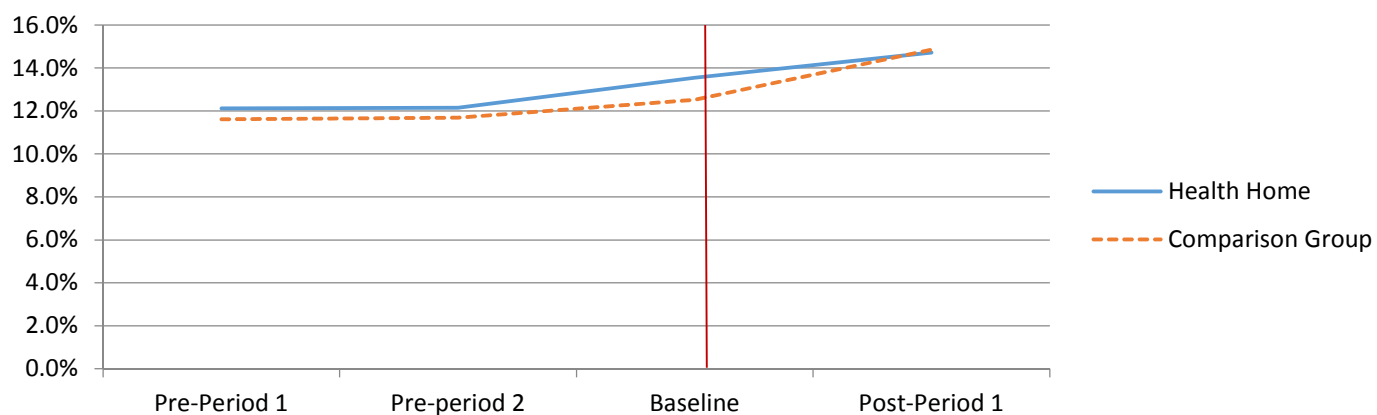
Appendix A. Figure 2
Percent Outpatient Service Use: COPD
Health Home and Comparison Groups



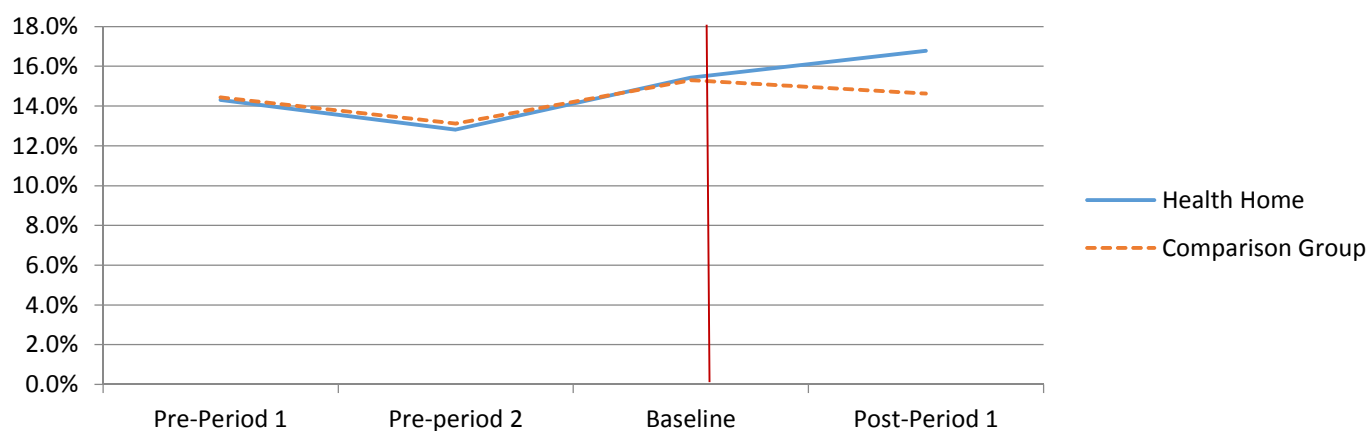
Appendix A. Figure 3
Percent Outpatient Service Use: CVD
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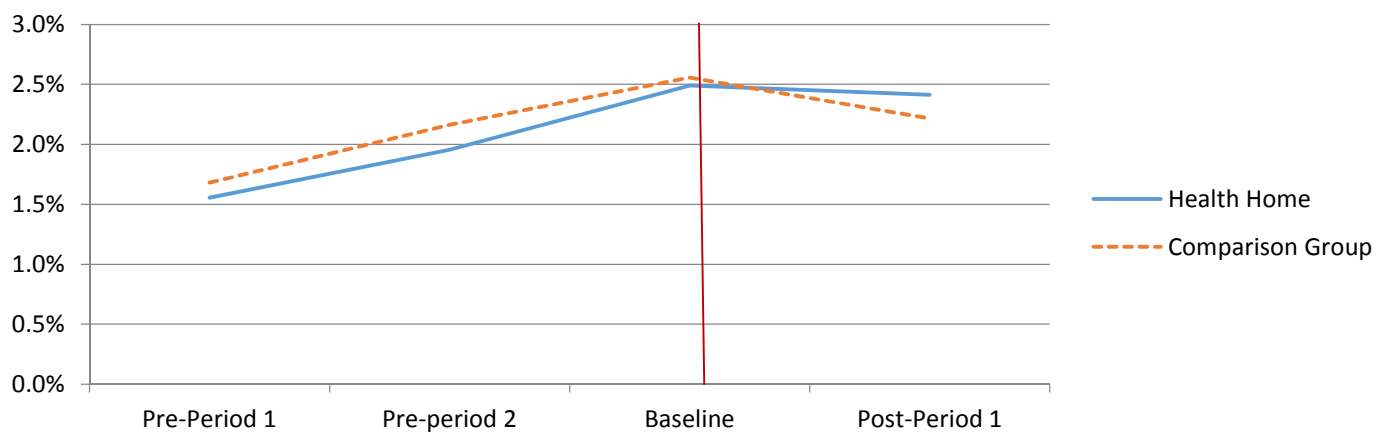
Appendix A. Figure 4
Percent Outpatient Service Use: Diabetes
Health Home and Comparison Groups



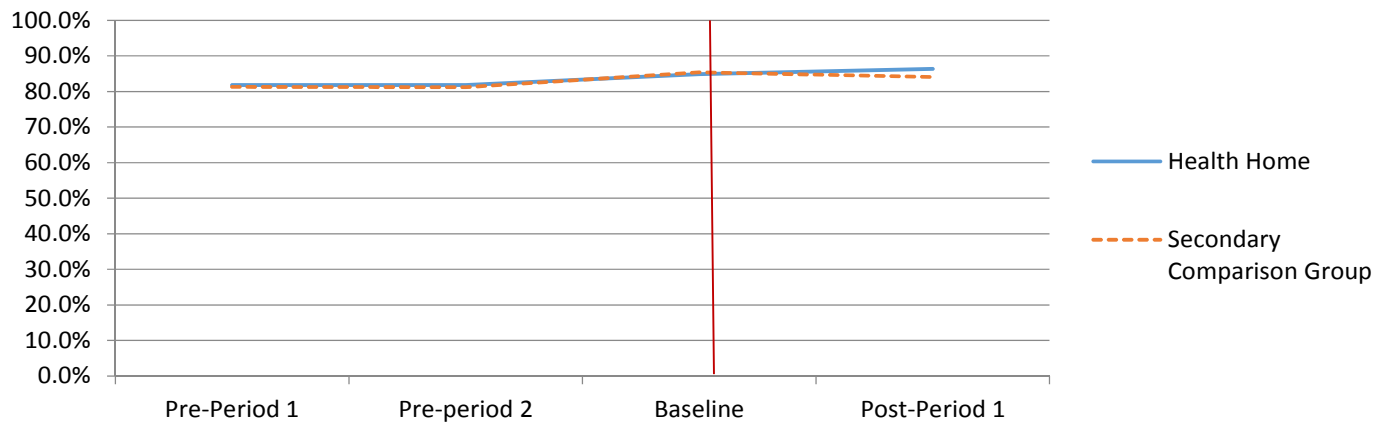
Appendix A. Figure 5
Percent Outpatient Service Use: Hypertension
Health Home and Comparison groups



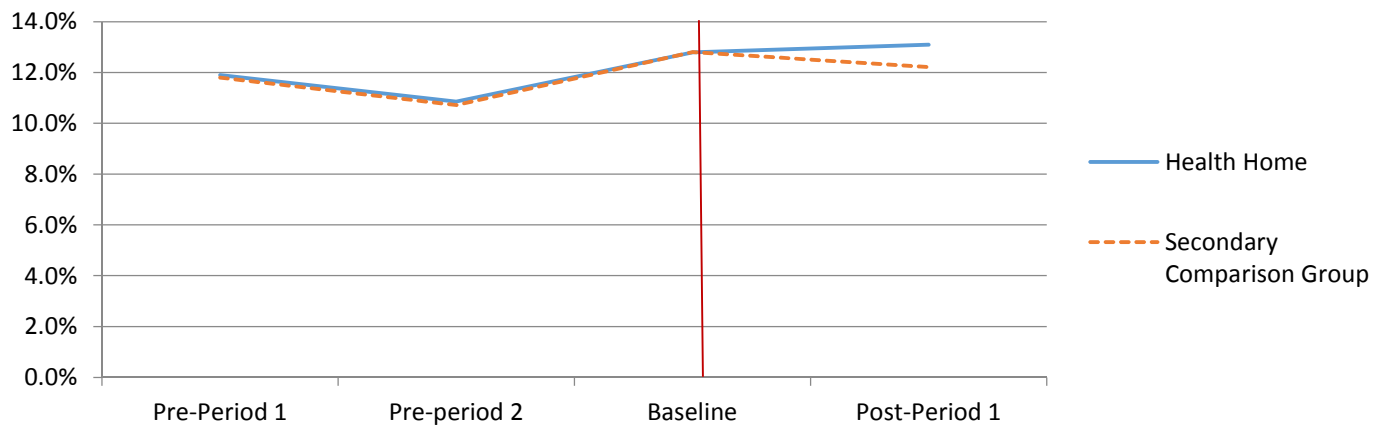
Appendix A. Figure 6
Percent Outpatient Service Use: Obesity
Health Home and Comparison Groups



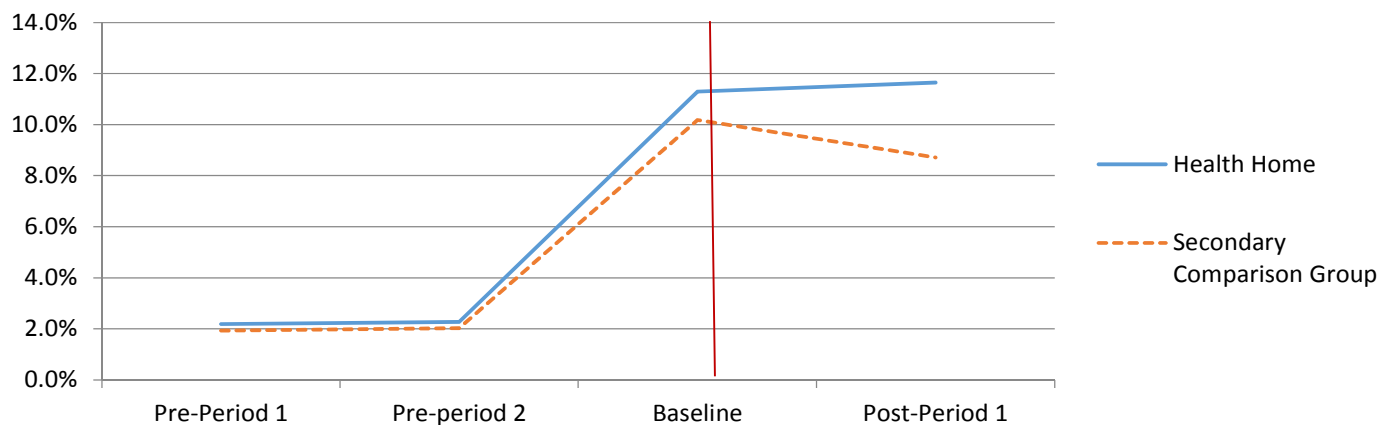
Appendix B. Figure 1
Percent Outpatient Service Use: Overall
Health Home and Secondary Comparison Groups



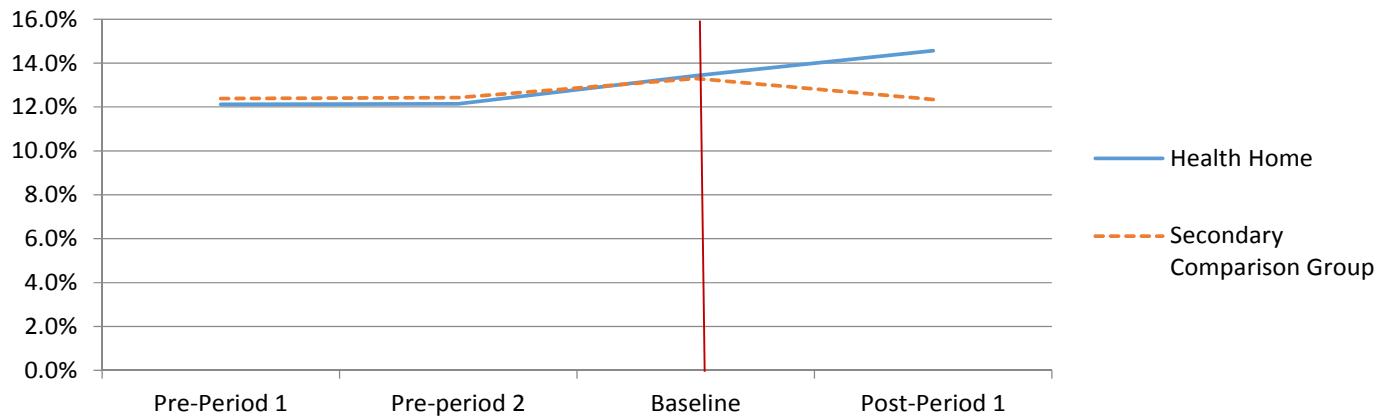
Appendix B. Figure 2
Percent Outpatient Service Use: COPD
Health Home and Secondary Comparison Groups



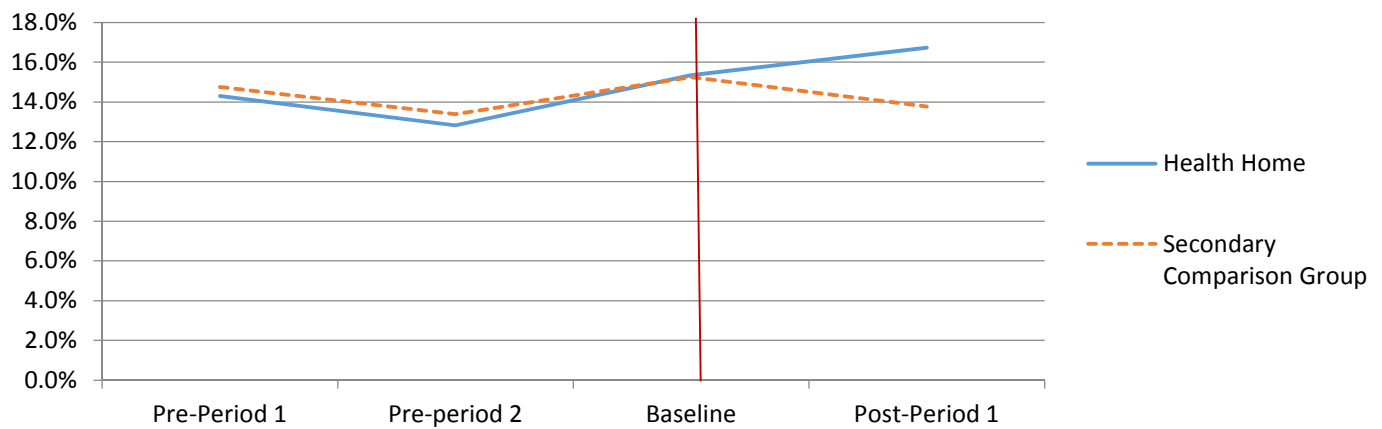
Appendix B. Figure 3
Percent Outpatient Service Use: CVD
Health Home and Secondary Comparison Groups



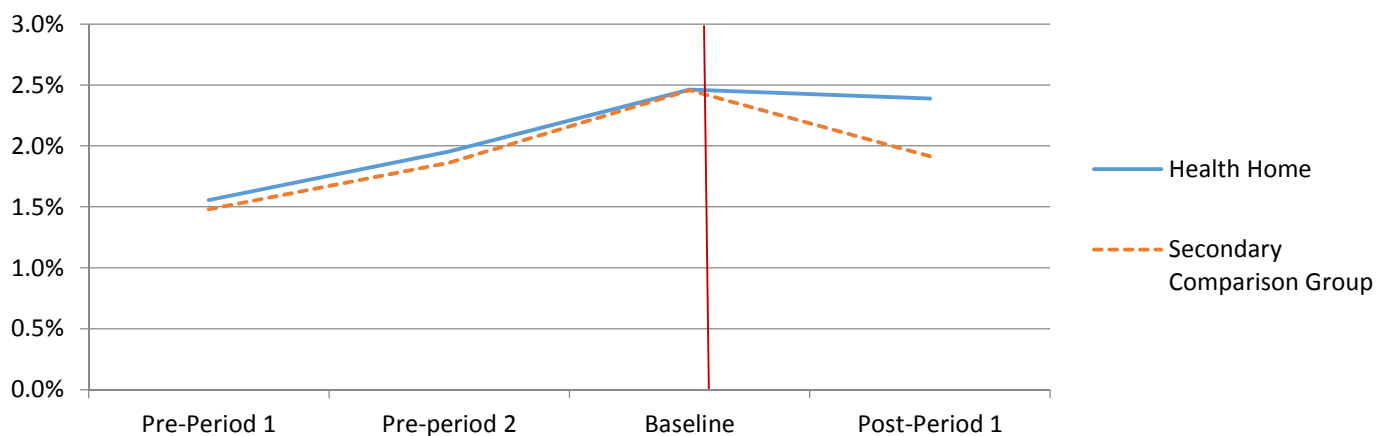
Appendix B. Figure 4
Percent Outpatient Service Use: Diabetes
Health Home and Secondary Comparison Groups



Appendix B. Figure 5
Percent Outpatient Service Use: Hypertension
Health Home and Secondary Comparison Groups



Appendix B. Figure 6
Percent Outpatient Service Use: Obesity
Health Home and Secondary Comparison Groups



C. First sensitivity test: Secondary comparison group

Table 1. Difference-in-differences (DD) analysis of outpatient service use among individuals enrolled in health homes and a secondary comparison group^{a,b,c}

		HH ^d			Comparison			DD	95% CI
		Pre-period ^e	Post-period ^f	Pre-post difference ^g	Pre-period	Post-period	Pre-post difference		
Outpatient Services									
	Overall	84.91	86.35	1.44	85.40	84.05	-1.34	2.78*	0.32 to 5.25
Physical Health Conditions									
	Chronic Obstructive Pulmonary Disorder	12.79	13.09	0.30	12.81	12.21	-0.60	0.89	-1.14 to 2.93
	Cardiovascular Disease	11.29	11.65	0.35	10.18	8.71	-1.47	1.82	-0.26 to 3.90
	Diabetes	13.42	14.56	1.14	13.30	12.35	-0.95	2.09*	0.02 to 4.17
	Hypertension	15.35	16.72	1.37	15.25	13.76	-1.49	2.85*	0.84 to 4.86
	Obesity	2.46	2.39	-0.07	2.46	1.91	-0.54	0.47	-0.43 to 1.37

^a Outcomes are dichotomized, 1=one or more visits; 0=no visits

^b Models weighting by the odds: HH Group Weight=1; Comparison Group Weight= propensity score/1-propensity score

^c Models adjusted for individual and ZCTA-level covariates. Individual-level covariate include: age, sex, race, mood disorders, schizophrenia, comorbidities; ZCTA-level covariates include: median household income, % employed, % non-Hispanic white, % non-Hispanic black, % Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of psychiatric nurses, number of primary care providers, number of physician assistants, number of CMHC number of FQHC

^d HH: Health Home

^e Pre-period: 12-months before Health Home started

^f Post-period: 12-months after Health Home started

^g Pre-Post Difference: Post-period - Pre-period

^h Each physical health condition served as the primary diagnosis for the outpatient encounter

ⁱ COPD: Chronic Obstructive Pulmonary Disorder

* .05> p >0.01

** p<.01

C. First sensitivity test: Secondary comparison group

Table 2. Difference-in-differences (DD) analysis of visit counts per 100 person-years for outpatient services among individuals enrolled in health homes and a secondary comparison group^{a,b,c}

		HH ^d			Comparison			DD	95% CI
		Pre-period ^e	Post-period ^f	Pre-post difference ^g	Pre-period	Post-period	Pre-post difference		
Outpatient Services									
	Overall	788.13	843.09	54.96	857.71	849.92	-7.79	62.74*	24.03 to 101.44
Physical Health Conditions									
	Chronic Obstructive Pulmonary Disorder	259.85	261.51	1.66	264.29	274.41	10.11	-8.45	-54.65 to 37.76
	Cardiovascular Disease	232.88	233.67	0.79	251.83	290.29	38.46	-37.67	-98.01 to 22.68
	Diabetes	353.76	362.00	8.24	358.69	382.48	23.79	-15.56	-65.83 to 34.72
	Hypertension	237.74	219.87	-17.86	213.05	228.30	15.25	-33.11	-70.27 to 4.04
	Obesity	221.18	182.11	-39.07	132.49	143.11	10.62	-49.68	-108.61 to 9.25

^a Outcomes are count variables and only include cases $\geq$ one visit

^b Models weighting by the odds: HH Group Weight=1; Comparison Group Weight= propensity score/1-propensity score

^c Models adjusted for individual and ZCTA-level covariates. Individual-level covariate include: age, sex, race, mood disorders, schizophrenia, comorbidities; ZCTA-level covariates include: median household income, % employed, % non-Hispanic white, % non-Hispanic black, % Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of psychiatric nurses, number of primary care providers, number of physician assistants, number of CMCH number of FQHC

^d HH: Health Home

^e Pre-period: 12-months before Health Home started

^f Post-period: 12-months after Health Home started

^g Pre-Post Difference: Post-period - Pre-period

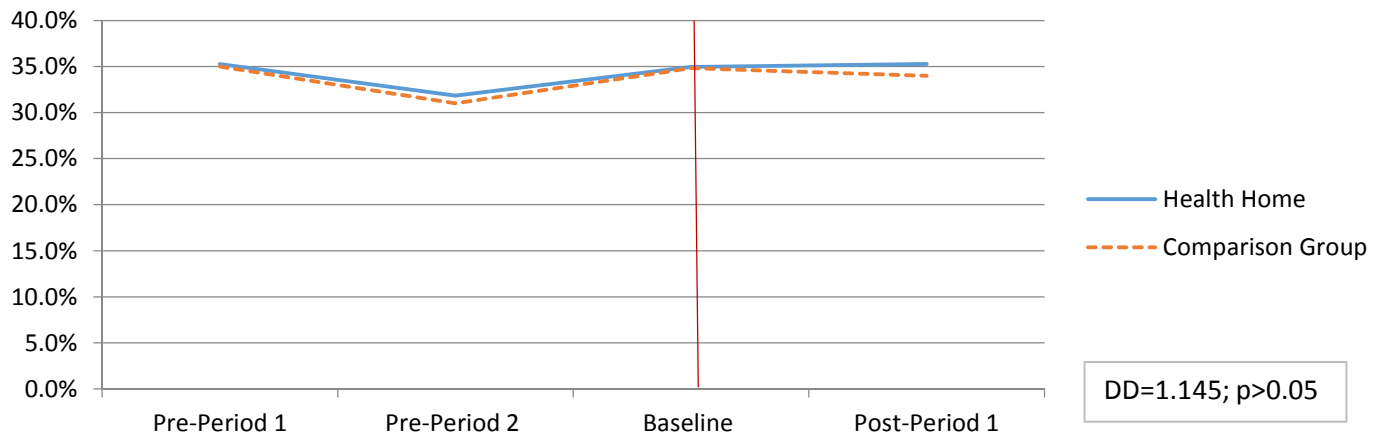
^h Each physical health condition served as the primary diagnosis for the outpatient encounter

ⁱ COPD: Chronic Obstructive Pulmonary Disorder

* .05 > p > 0.01

** p < .01

Appendix D. Second Sensitivity Test: Alternative Outcome
Percent Dental Exams
Health Home and Comparison Groups



Chapter II

The Impact of Health Home on Emergency Department and Hospital Use among Medicaid Beneficiaries with Serious Mental Illness

Introduction

Individuals with Serious Mental Illness (SMI) are predisposed to higher rates of morbidity and mortality than the general population (1,2,3,4). Preventable chronic comorbidities such as cardiovascular disease, diabetes and respiratory illness account for a large proportion of the health disparity (1,2,3,4). Despite the elevated incidence and prevalence of chronic conditions, individuals with SMI are less likely to utilize preventative and general health services (3). Not employing timely care can exacerbate health conditions and result in preventable hospitalizations or emergency department (ED) use (5,6,7).

Individuals with SMI use ED and inpatient services at higher rates than individuals without a mental illness (1,4). Mental disorders, either as a primary or secondary diagnosis, accounted for 21.2% of all hospitalizations in the United States (8). Mood and schizophrenia disorders are the most common primary diagnoses among adults 18 years and older who are hospitalized with a mental illness (8). ED visits associated with a mental illness accounted for 8.0% of all visits to the ED (9). Of these visits, mood disorders are the most commonly encountered conditions (9).

Given the health disparities experienced by individuals with SMI, obtaining adequate healthcare may help to prevent or alleviate costly service use. However, there is evidence that suggests people with SMI are less likely to receive quality care, such as guideline concordant services for cardiovascular disease and diabetes (5). Primary care providers have also been found to misperceive the physical symptoms of SMI patients

as psychosomatic, which may delay appropriate treatment (5). Poor quality care in conjunction with a fragmented healthcare system place individuals with SMI at risk of inferior health and premature death (10). Integrated healthcare has been shown to improve quality of care, health outcomes, and reduce hospitalizations and ED use (11). However, limited research extends to populations with SMI. Even fewer consider mental health settings as the primary coordinating site (10,11).

Section 2703 of the Affordable Care Act provides funds for the development of Health Home programs, which aim to provide coordinated and integrated healthcare services to populations with chronic health conditions, such as SMI (2,10,11). Rhode Island was an early adopter of Health Home, which developed a comprehensive care coordination program that integrated general health services within community mental health center's (CMHC) for populations with SMI. The purpose of this article is to determine the extent to which Health Home impacted ED and hospital use among individuals with SMI. We hypothesize individuals enrolled in Health Home will have fewer hospitalizations and ED visits than the comparison group not enrolled in Health Home.

Methods

Intervention

Health Home took place from October 1, 2011 until October 1, 2013 under the supervision of Rhode Island's Department of Behavioral Health Developmental Disabilities and Hospitals (BHDDH). Medicaid beneficiaries with SMI who received BHDDH services were automatically enrolled into Health Home. Persons not interested

in participating could opt-out and receive services as usual. During an individual's first CMHC encounter, a clinical evaluation was conducted to determine if they possessed a SMI diagnosis. Participants of Health Home met the following eligibility criteria: 1) had a severe and/or persistent mental or emotional disorder but for whom long-term 24-hour care could be averted; and 2) had impaired role functioning; or underwent psychiatric treatment more intensive than outpatient care more than once in a lifetime; or experienced a single episode of continuous, structured supportive residential care other than hospitalization for a duration of at least two months. Enrollees also met at least two of the following criteria, on a continuing or intermittent basis for at least two years: 1) if employed, was employed in a sheltered setting, or had markedly limited skills or a poor work history; 2) required public financial assistance for out-of-hospital maintenance and was unable to procure assistance without help; 3) showed an inability to establish or maintain a social support system; 4) required help in basic living skills; 5) exhibited inappropriate social behavior which resulted in mental health and/or judicial system intervention.

Upon enrollment, each Health Home participant received a comprehensive biopsychosocial evaluation that resulted in an individualized treatment plan. A care manager, designated as the Health Home team leader, was responsible for coordinating and implementing the treatment plans. Each participant received care from a multidisciplinary team of health professionals. Health Home provided integrated behavioral and primary care through comprehensive case management, care coordination, health promotion services, transitional care, individual and family support

services and referrals to community and social support services. Nine CMHCs across the state of Rhode Island participated in the Health Home program.

Study Population

The intervention group consisted of Medicaid beneficiaries who were between 18 to 64 years of age, who were automatically enrolled into Health Home. Individuals included in our analytic sample were consistently eligible and enrolled in Medicaid throughout the evaluation period (2009-2012).

The comparison group consisted of Medicaid beneficiaries between the ages of 18 to 64 who did not enroll in Health Home but received services through BHDDH. Individuals were consistently eligible and enrolled in Medicaid throughout the evaluation period (2009-2012). This comparison group accounts for secular trends not associated with Health Home that may otherwise confound study effects. Additionally, this group provides the estimates of what would have happen if those enrolled in Health Home did not participate. We used propensity score weights to ensure the comparison group was similar to those who participated in Health Homes on observable baseline characteristics. A designation of SMI was determined using Medicaid claims data and an International Classification of Diseases, 9th revision (ICD-9) algorithm (18). ICD-9 codes were truncated to the first three digits due to the potential inconsistency in the last two digits. A schizophrenia disorder diagnosis was defined as having at least one inpatient or two outpatient visits classified with the ICD-9 code 295. A mood disorder

diagnosis was defined as having at least one inpatient or two outpatient visits classified with the ICD-9 code 296.

Data Source

The study used Medicaid eligibility files and fee-for-service claims for the period 2009 through 2012. The American Community Survey (ACS) and the Rhode Island Department of Health (RIDH) Licensee Lists were also used. Claims provided demographic and utilization data on adult Medicaid beneficiaries prior to and following the implementation of Health Home. ACS was used to obtain Zip Code Tabulation Area (ZCTA)-level factors while the RIDH licensee lists supplied the number of health providers. This study was approved by the Brown University Office of Research Integrity.

Outcome Variables

Our primary outcomes consisted of hospital and ED use. We evaluated the impact of Health Home on having a visit and number of visits (service use intensity) for individuals with at least one visit. Hospital use was divided into four categories: all-cause, visits associated with a primary mental illness (MI) diagnosis (ICD-9 codes: 295-302, 306-314), visits not associated with a MI diagnosis (non-MI), and preventable. Preventable hospitalizations were those associated with an Ambulatory Care Sensitive Condition (ACSC). We used an algorithm developed by the Agency for Healthcare Research and Quality to identify ACSC events in administrative data (12). Composite measures were

used to assess acute, chronic, and overall ACSC hospitalizations. Acute conditions consisted of dehydration, bacterial pneumonia and urinary tract infection. Chronic conditions included diabetes (uncontrolled; short and long term complications), chronic obstructive pulmonary disease, asthma, hypertension, congestive heart failure, angina without procedure, and lower extremity amputation among patients with diabetes. Overall ACSC hospitalization reflected having an acute or chronic condition. All-cause, MI, and non-MI hospitalizations were treated as dichotomous and count variables. Preventable hospitalization outcomes were treated as dichotomous variables.

Similar to hospital use, ED visits were divided into four categories consisting of all-cause, primary MI diagnosis, non-MI, and preventable. We used the same ICD-9 codes to identify a primary diagnosis of MI and the same ACSC algorithms as those for our preventable hospitalization outcomes. All-cause, MI, and non-MI ED use were treated as dichotomous and count variables. Preventable ED use outcomes were treated as dichotomous variables.

Independent Variables

The primary factor of interest was an interaction term composed of indicators for Health Home participation and post-Health Home period. To minimize confounding we included both individual and ZCTA-level variables in our regression models. Individual-level factors included: age, sex, race (White, Black, Other), number of comorbidities using the Elixhauser comorbidity index, mood disorder, and schizophrenia disorder. ZCTA-level

factors included: median household income, percent employed, percent non-Hispanic White, percent non-Hispanic Black, percent Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of psychiatric nurses, number of primary care providers, number of physician assistants, number of CMHCs, and number of federally qualified health centers.

Statistical Analysis

We used a difference-in-differences (DD) approach to estimate the extent to which Health Home impacted hospital and ED use. Our analyses included one pre-period (12-months prior to Health Home onset) and one post-period (12-months post Health Home onset). To obtain valid results from the DD approach, intervention and comparison groups must possess parallel trends in the pre-period (13). That is to say, in the absence of Health Home, hospital and ED use would have changed at similar rates for both Health Home and comparison groups. Though this cannot be directly proven, we checked the validity of the parallel trends assumption using Medicaid claims from 2009-2010 (Appendix A. Figures 1-12). DD is the average difference in health service use for Health Home participants minus the average difference in health service use for the comparison group. Any remaining differences in health service use can be attributed to the intervention. In a regression framework, the interaction between indicator variables, Health Home participation and post-Health Home period, yield our DD estimate.

For each dichotomous outcome, we estimated a multivariable logistic regression model with a logit link function with robust standard errors clustered at the individual level. For

each count outcome, a multivariable model was estimated with a negative binomial distribution and a log link function with robust standard errors clustered at the individual level. We used generalized estimating equations with an autoregressive correlation structure to account for the clustering of repeated individual observations over time. To obtain the desired interpretation of the interaction term in our non-linear models we used the predictive margins method to predict health service use for treatment and control groups in the pre- and post-Health Home periods. All regression models were adjusted for individual- and ZCTA-level factors.

Propensity score weights were used in combination with a DD approach to minimize bias and maximize comparability between groups on baseline characteristics. A logistic regression model, with Health Home participation as the outcome, was used to estimate the propensity score. Models were specified with individual- and ZCTA-level variables as well as pre-period outcomes and pre-period outcome trends. We assessed balance empirically and graphically. Balance was achieved once the absolute percent standardized differences in means were $\leq 10\%$ (22). To estimate the average treatment effect on the treated we weighted by the odds of the propensity score (23, 24). Health Home participants were given a weight of 1 while individuals in the comparison group received a weight of $p_i / (1 - p_i)$ where p_i represents the estimated propensity score for an individual. Using this weighting scheme allows comparisons who are similar to the intervention participants to be weighted higher than those who are dissimilar, which are weighted down (24).

Subgroup analyses were conducted to assess the association of Health Home on hospital and ED use for Blacks, Hispanics, and those with a schizophrenia disorder. To evaluate the robustness of our findings we conducted two sensitivity analyses. First, we reran our analyses (Appendix C. Table 1-3) with an alternate comparison group consisting of Medicaid beneficiaries between the ages of 18 to 64 with SMI who did not receive BHDDH services or participated in Health Home. Similar to our main analyses, we constructed propensity score weights for all outcomes and validated the DD parallel trends assumption (Appendix B. Figures 1-12). Second, we conducted a DD analyses on an outcome not intended to be affected by Health Home, eye exams (Appendix D. Figure 1).

Results

Before weighting, there were significant differences between Health Home and comparison groups on baseline factors (Table 1). Percent standardized difference in means ranged from 0.30% to 55.00%. Notable differences between groups were age, having a schizophrenia disorder, number of FQHC's, and median household income. After weighting, there were no significant differences between groups. All baseline characteristics were below the 10% criteria for balance. Percent standardized difference in means ranged between 0.00% and 2.90%. The average age among groups was approximately 45, a larger proportion were female than male, of White race, had a mood disorder, and experienced an average greater than four comorbidities.

Table 2 shows our adjusted and weighted DD results for our evaluation of Health Home impact on hospitalization and ED use. Relative to the comparison group, there was a significant increase the proportion of Health Home participants having at least one hospitalization for a primary MI diagnosis, 4.56 percentage-points (95% CI: 1.64 to 7.48). Our findings suggest no differences existed between groups on having an all-cause or non-MI hospitalization. There were non-significant difference in the proportion of Health Home participants obtaining at least one ED visit for all-cause, non-MI, and MI. Similar to our main analyses results, sensitivity analyses (Appendix C. Table 1) findings suggest, relative to the alternate comparison group, Health Home was associated with a significant increase in the proportion having at least one hospitalization for a primary MI diagnosis ($p < 0.05$).

Among individuals having ≥ 1 ED visits, service use intensity increased for some of our outcomes (Table 3). The number of all-cause ED visits for Health Home participants increased from 420.74/100 person-years in the pre-period to 465.74/100 person-years in the post-period. Among the comparison group, during the same time-period, the number of all-cause ED visits decreased from 378.66/100 person-years to 370.13/100 person-years, yielding an adjusted and weighted DD of 53.55 visits per 100 person-years (95% CI: 3.39 to 103.65). Similarly, Health Home was associated with an increase in non-MI ED visits ($p < 0.05$), from pre- to post-periods, relative to the comparison. Participants of Health Home also experienced a non-significant decrease in ED visits associated with a primary MI diagnosis. There were no differences between Health

Home and comparison groups on number of visits for all-cause, non-MI, and MI hospitalizations.

Table 4 shows results from our analysis of Health Home's impact on ACSC hospitalizations and ED use. Our findings suggest, relative to the comparison group, Health Home participation was associated with a decrease in the proportion having at least one acute ACSC hospitalization, -1.69 percentage-points (95%CI: -2.81 to -0.57). There were no differences between groups on having at least one overall or chronic ACSC hospitalization. Similarly, there were no differences between Health Home and comparison groups on having an overall, acute, or chronic ACSC ED visit.

In our subgroup analyses (Table 5) we found over and above the interaction between Health Home and post-period, Black participants had a significant decrease in the proportion obtaining at least one non-MI hospitalization, -11.04 percentage-points (95% CI: -20.60 to -1.38). Though all non-significant, participation in Health Home among Black enrollees was associated with a decrease in 10 out of 11 outcomes (Table 5). Findings from our subgroup analyses also suggest, over and above the interaction between Health Home and post-period, participants with a schizophrenia disorder had a decrease in the proportion having at least one non-MI ED visit, -7.33 percentage-points (95% CI: -13.74 to -0.93). Health Home participation among individual with a schizophrenia diagnosis was associated with a decrease in 6 out of 11 outcomes ($p>0.05$).

Discussion

An objective of Health Home was to reduce hospitalizations and ED use. We hypothesized Health Home participation would reduce ED and hospital use. Our evaluation yielded mixed results. Findings suggest Health Home was associated with a decrease in the proportion having an acute ACSC hospitalization. Among Black participants, Health Home was associated with a decrease in having a non-MI hospitalization. While Health Home participants with a schizophrenia diagnosis experienced a decrease in having a non-MI ED visit. Our findings also suggest Health Home was associated with an increase in the proportion having at least one hospitalization for a primary MI diagnosis. When looking at service use intensity, Health Home was associated with an increase in the number of all-cause and non-MI ED visits.

A function of Health Home was to develop and implement individualized treatment plans. This emphasis may have contributed to the decreases in hospitalizations and ED use for Black and schizophrenic Health Home participants, respectively. Individual treatment plans were patient-centered, focused on a person's holistic needs, and incorporated their treatment goals, and unique life circumstances. Among individuals with a schizophrenia disorder, individualized care that is patient-centered has been shown to positively influence their engagement in health and social services (14). This engagement can lead to reductions in ED use and hospitalizations (15,16). Findings from Berg and colleagues (15) showed a dose response among Medicaid beneficiaries with major depressive and schizophrenia disorders. Individuals were exposed to a disease management intervention that was patient-centered and included an

individualized treatment plan. Researchers evaluated the extent to which treatment plan related contacts impacted health service use. Engaging in a higher number of contacts was associated with a significant reduction in all-cause hospitalizations and ED use (15). The reduction in service use occurred sooner for individuals with major depressive disorder who engaged in fewer contacts. Among individuals with schizophrenia disorder, a larger number of contacts were needed to see a significant decrease in service use. This was especially true for ED use, where the odds of use were higher at lower contact levels. Findings from Berg and colleagues suggest greater engagement in patient-centered individualized treatment can decrease hospitalizations and ED use. It also alludes to the differences in service need between those with major depressive and schizophrenia disorders.

Our results also suggested Health Home was associated with a decrease in acute ACSC hospitalizations. This finding may be attributed to Health Home expanding access to physical health services and health promotion services. ACSC are ailments that can be addressed with timely outpatient care (7). Individuals with SMI may be at increased risk of ACSC hospitalizations due to inadequate access to and use of physical health services (7). Findings from Rosano and colleagues (17) suggest access to primary care, among vulnerable populations, can lead to lower rates of ACSC hospitalization. Major drivers of this reduction are provider supply and continuity of care (18).

Our finding concerning ED service use intensity may be indicative of barriers to outpatient services. Reasons for accessing ED services oppose to a primary care setting include long wait-times, crowded waiting rooms, and limited hours of operation (19). These barriers may prove more difficult for populations with MI as they experience cognitive impairment, disorganized thinking, and lack motivation (1). Consequently, the ED may be perceived as a logical alternative to outpatient services. Work by Cheung and colleagues (20) show a positive relationship between the number of barriers experienced in accessing primary care and the likelihood of using the ED. Many of the conditions being treated within the ED could be adequately addressed or prevented by timely use of outpatient services (21). Even if individuals with SMI are able to access outpatient services there is evidence that suggests informative materials for populations with MI may be written at levels that far exceed their literacy capabilities (22, 23), which may influence treatment non-adherence (24), lead to further health impairment (25) and result in ED use (26).

Low health literacy may also contribute to our findings of increase service use intensity for all-cause and non-MI ED. Health literacy is defined as the ability to obtain and understand health-related information to make a health decision (27). There is an inverse relationship between health literacy and ED use. In a study conducted within an urban academic ED setting, researcher evaluated the impact of health literacy on ED utilization (26). Using the Short Test of Functional Health Literacy (scores rang 0 to 36) to distinguish between inadequate (scores 0-16), marginal (scores 17-22) and adequate (scores >22) health literacy levels, Griffey and colleagues (26) found inadequate health

literacy had higher ED utilization, relative to those with adequate health literacy. The low literacy population was also more likely to return to the ED within seven days (26).

Individuals with MI have been found to have low literacy levels (22,28). In a nationally representative sample of individual with self-reported MI, researchers found a strong relationship between lower literacy levels and MI, even after adjusting for factors associated with low literacy (i.e. education, poverty, and race/ethnicity) (29). Despite Health Home participant's receiving individualized treatment plans, enhanced care coordination and increased access to general health services, they may experience difficulties understanding and applying newly acquired information.

Our finding of Health Home participants having at least one hospitalization for a primary MI diagnosis may be attributed to health provider's referral patterns. Some general health providers may have experience working with SMI populations and able to recognize the symptoms associated with a psychotic crisis and correctly hospitalize patients. Other general health providers may have consulted with a mental health clinician and admitted patients based on the information exchange. Conversely, an inexperienced health provider may be risk-adverse and hospitalize patient's when they exhibit symptoms not typically encountered (30). There is evidence that suggests primary care providers may attribute symptoms of physical illness to mental health when evaluating patients with MI (31).

We did not find a differential effect between Health Home and comparison group on a majority of the utilization outcomes. Given the medical complexity of Health Home

participants and the nature of the outcomes under examination, it may take a longer follow-up period to see changes between groups. Another potential reason for our null findings is that Health Home was predominately focused on increasing access to general health services. This emphasis may have distracted from other activities intended to improve hospitalizations and ED use.

Our evaluation had several limitations. One, Health Home was not a randomized control trial and may be subject to selection bias. To address this potential bias we used propensity score weights to balance Health Home and comparison groups on observable baseline factors. In addition, we satisfied the parallel trend assumption, which allows our comparison group to serve as the counterfactual. Two, we were unable to account for factors that may have occurred concurrently as Health Home and differentially affected outcomes for Health Home and comparison groups. Three, our findings may not be generalizable to other SMI populations residing in different states. Nonetheless, it can provide insight on a behavioral health based integration strategy that targeted individuals with SMI and was implemented in a real world setting.

Our study also possesses several strengths. We used methods that simulated an experimental design and allowed for causal inferences. By using propensity score weights we addressed selection bias and made those who did and did not participate in Health Home similar on observable baseline factors. Regression models were adjusted for all variables used to specify the propensity scores. Employing this approach allows us to address residual covariate imbalance between health Home and comparison

groups. In using a DD approach we can account for confounding secular trends that may have otherwise obscured the true effects of Health Home. Medicaid data were available for two years prior to Health Home onset, which allowed the validation of the DD parallel trends assumption.

Conclusion

Our findings suggest Health Home can decrease ED and hospital use for specific groups. Results can inform the development of interventions that target sub-groups that possess SMI. Our work contributes to the growing body of literature on behavioral based integration for populations with SMI. Better understand of these strategies can lead to the development of best practices and wide spread implementation.

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Table 1.Characteristics of health home participants and a comparison group by variables used in developing propensity score ^a

	Before Weighting			After Weighting ^d		
	HH ^b (N= 5,272)	Comparison (N=1,623)	Standardized Difference in Means ^c	HH (N= 5,272)	Comparison (N=1,623)	Standardized Difference in Means
Individual-Level Factors	Mean	Mean	%	Mean	Mean	%
Age	45.15	43.79	12.30**	45.15	45.36	1.90
Sex (Female)	0.58	0.58	0.50	0.58	0.59	1.60
Race						
White	0.62	0.67	9.60**	0.62	0.62	0.70
Black	0.10	0.07	9.10**	0.10	0.10	0.00
Other ^e	0.14	0.12	8.00**	0.14	0.14	0.10
Mental Illness						
Mood Disorder	0.74	0.75	1.60	0.74	0.74	1.20
Schizophrenia	0.47	0.22	55.00**	0.47	0.48	1.10
Comorbidities	4.63	4.20	15.00**	4.63	4.66	1.10
Area-Level Factors ^f						
Number of Mental Health Counselors	12.78	13.44	5.40	12.78	12.63	1.20
Number of Psychologists	14.57	13.66	5.10	14.57	14.91	1.90
Number of Psychiatrists	7.63	6.63	9.30**	7.63	7.43	1.90
Number of Primary Care Providers	38.94	37.31	4.40	38.94	38.78	0.40
Number of Physician Assistants	13.96	12.93	6.90**	13.96	13.84	0.80
Number of CMHC ^g	0.92	0.86	4.60	0.92	0.87	3.90
Number of FQHC ^h	0.96	0.86	11.30**	0.96	0.98	2.90
Median Household Income	47,560.00	49,522.00	11.20**	47,560.00	47,512.00	0.20
Percent Employed	88.03	88.00	0.30	88.03	87.98	0.40
Percent Non-Hispanic White	65.20	67.51	8.60**	65.20	64.81	1.50
Percent Non-Hispanic Black	7.51	6.94	9.40**	7.51	7.46	0.80
Percent Hispanic/Latino	18.71	17.02	8.60*	18.71	19.19	2.50

^a Propensity score models also included higher order terms and interactions

^b HH, Health Homes

^c Standardized Differences: difference in means of HH and comparison group, divided by the standard deviation of HH

^d Weighting by the Odds: Intervention Group Weight=1; Control Group Weight= propensity score/1-propensity score

^e Other: American Indian or Alaska Native, Asian Pacific Islander Hawaiian Native, Spanish Surname

^f ZCTA: Zip Code Tabulation Areas

^g CMHC: Community Mental Health Center

^h FQHC: Federally Qualified Health Center

* 0.05> p >0.01

** p<0.01

Table 2. Difference-in-differences (DD) analysis of emergency department and hospital use among individuals enrolled in health homes and a comparison group^{a,b,c}

		HH ^d			Comparison			DD	95% CI
		Pre-period ^e	Post-period ^f	Pre-post difference ^g	Pre-period	Post-period	Pre-post difference		
At least one Hospital									
	All-Cause	21.86	23.48	1.63	20.82	21.31	0.49	1.14	-2.18 to 4.45
	Non-MI ^h	14.39	15.79	1.40	14.04	15.97	1.93	-0.52	-3.24 to 2.19
	MI ⁱ	12.12	13.74	1.61	13.04	10.08	-2.95	4.56*	1.64 to 7.48
Emergency Department									
	All-Cause	35.86	37.79	1.93	36.01	40.57	4.56	-2.64	-6.34 to 1.06
	Non-MI	32.25	34.86	2.61	33.06	38.73	5.67	-3.06	-6.59 to 0.47
	MI	10.17	9.64	-0.53	9.88	8.15	-1.73	1.20	-1.53 to 3.93

^a Outcomes are dichotomized, 1=one or more visits; 0=no visits

^b Models weighting by the odds: HH Group Weight=1; Comparison Group Weight= propensity score/1-propensity score

^c Models adjusted for individual and ZCTA-level covariates. Individual-level covariate include: age, sex, race, mood disorders, schizophrenia, comorbidities; ZCTA-level covariates include: median household income, % employed, % non-Hispanic white, % non-Hispanic black, % Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of psychiatric nurses, number of primary care providers, number of physician assistants, number of CMHC number of FQHC

^d HH: Health Home

^e Pre-period: 12-months before Health Home started

^f Post-period: 12-months after Health Home started

^g Pre-Post Difference: Post-period - Pre-period

^h Non-MI: Visits not associated with primary mental illness diagnosis

ⁱ MI: Visits associated with a primary mental illness diagnosis

* .05> p >0.01

** p<.01

Table 3. Difference-in-differences (DD) analysis of visit counts per 100 person-years for emergency department and hospital use among individuals enrolled in health homes and a comparison group^{a,b,c}

		HH ^d			Comparison				
		Pre-period ^e	Post-period ^f	Pre-post difference ^g	Pre-period	Post-period	Pre-post difference	DD	95% CI
Number of visits									
Hospital									
	All-Cause	332.84	379.32	46.47	327.11	331.46	4.35	42.12	-37.24 to 121.49
	Non-MI ^h	263.94	286.63	22.69	322.63	278.51	-44.11	66.80	-22.44 to 156.05
	MI ⁱ	281.58	339.98	58.40	211.76	292.38	80.62	-22.22	-143.22 to 98.77
Emergency Department									
	All-Cause	420.74	465.74	45.00	378.66	370.13	-8.53	53.52*	3.39 to 103.65
	Non-MI	396.53	453.45	56.91	365.64	355.26	-10.37	67.28*	13.88 to 120.69
	MI	229.07	251.76	22.69	176.88	224.31	47.43	-24.73	-99.62 to 50.15

^a Outcomes are count variables and only include cases $\geq$ one visit

^b Models weighting by the odds: HH Group Weight=1; Comparison Group Weight= propensity score/1-propensity score

^c Models adjusted for individual and ZCTA-level covariates. Individual-level covariate include: age, sex, race, mood disorders, schizophrenia, comorbidities; ZCTA-level covariates include: median household income, % employed, % non-Hispanic white, % non-Hispanic black, % Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of psychiatric nurses, number of primary care providers, number of physician assistants, number of CMCH number of FQHC

^d HH: Health Home

^e Pre-period: 12-months before Health Home started

^f Post-period: 12-months after Health Home started

^g Pre-Post Difference: Post-period - Pre-period

^h Non-MI: Visits not associated with primary mental illness diagnosis

ⁱ MI: Visits associated with a primary mental illness diagnosis

* .05 > p > 0.01

** p < .01

Table 4. Difference-in-differences (DD) analysis of ACSC emergency and hospital use among individuals enrolled in health homes and a comparison group^{a,b,c,d}

Comparison group		HH ^e			Comparison			DD	95% CI
		Pre-period ^f	Post-period ^g	Pre-post difference ^h	Pre-period	Post-period	Pre-post difference		
At least one									
Hospital									
	Overall ⁱ	3.78	3.61	-0.17	3.83	4.30	0.47	-0.64	-3.20 to 1.92
	Acute ^j	1.48	1.31	-0.17	1.02	2.54	1.52	-1.69*	-2.81 to -0.57
	Chronic ^k	2.55	2.55	0.00	2.73	2.18	-0.55	0.55	-1.05 to 2.15
Emergency Department									
	Overall	3.71	4.26	0.55	3.97	4.51	0.54	0.02	-1.76 to 1.79
	Acute	1.52	2.17	0.65	1.70	1.87	0.16	0.48	-0.57 to 1.53
	Chronic	2.41	2.39	-0.02	2.43	3.33	0.90	-0.92	-2.24 to 0.40

^a Outcomes are dichotomized, 1=one or more visits; 0=no visits

^b Models weighting by the odds: HH Group Weight=1; Comparison Group Weight= propensity score/1-propensity score

^c Models adjusted for individual and ZCTA-level covariates. Individual-level covariate include: age, sex, race, mood disorders, schizophrenia, comorbidities; ZCTA-level covariates include: median household income, % employed, % non-Hispanic white, % non-Hispanic black, % Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of psychiatric nurses, number of primary care providers, number of physician assistants, number of CMHC number of FQHC

^d ACSC: Ambulatory Care Sensitive Conditions

^e HH: Health Home

^f Pre-period: 12-months before Health Home started

^g Post-period: 12-months after Health Home started

^h Pre-Post Difference: Post-period - Pre-period

ⁱ Overall: having an acute or chronic ACSC

^j Acute: Dehydration, bacterial pneumonia and urinary tract infection

^k Chronic: Diabetes (uncontrolled; short and long term complications), chronic obstructive pulmonary disease, asthma, hypertension, congestive heart failure, angina without procedure, and lower extremity amputation among patients with diabetes

* .05 > p > 0.01

** p < .01

Table 5. Difference-in-difference-in-differences (DDD) sub-group analysis of emergency department and hospital use ^{a,b,c}													
	Dependent variables												
	Hospital						Emergency Department						
	All-Cause			Non-MI ^d			All-Cause			Non-MI			MI
	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD
HH ^f X Post-period ^g X Black	-7.88	-17.42 to 1.66	-11.04*	-20.60 to -1.38	-2.23	-11.19 to 6.73	-8.51	-21.17 to 4.15	-11.43	-24.41 to 1.55	-4.82	-15.82 to 6.18	
HH X Post-period X Hispanic	0.98	-7.42 to 9.39	-3.13	-10.61 to 4.35	1.33	-6.09 to 8.75	0.78	-8.98 to 10.53	-2.13	-11.43 to 7.16	5.62	-1.68 to 12.92	
HH X Post-period X Schizophrenia	-1.31	-7.304.67	-2.41	-7.15 to 2.32	3.73	-1.76 to 9.21	-6.28	-13.01 to 0.45	-7.33*	-13.74 to -0.93	1.66	-3.55 to 6.82	
	ACSC Emergency Department												
	ACSC Hospital						ACSC Emergency Department						
	Overall ^h			Acute ⁱ			Overall			Acute			Chronic
	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD
HH X Post-period X Black	-1.39	-7.27 to 4.50	1.13	-0.70 to 2.95	-3.64	-10.00 to 2.72	-2.51	-10.54 to 5.53	-1.23	-3.87 to 1.40	-0.85	-7.74 to 6.03	
HH X Post-period X Hispanic	-1.12	-5.80 to 3.56	-1.31	-5.71 to 3.09	-1.61	-5.40 to 2.18	0.46	-2.94 to 3.86	0.25	-2.15 to 2.65	0.46	-1.47 to 2.39	
HH X Post-period X Schizophrenia	-1.24	-5.77 to 3.28	-2.38	-4.11 to 0.64	0.65	-2.07 to 3.37	0.62	-2.55 to 3.78	0.86	-0.93 to 2.66	-1.73	-4.16 to 0.70	

^a Outcomes are dichotomized. 1=one or more visits; 0=no visits

^b Models weighting by the odds: HH Group Weight=1; Comparison Group Weight= propensity score/1-propensity score

^c Models adjusted for individual and ZCTA-level covariates. Individual-level covariate include: age, sex, mood disorders. comorbidities: ZCTA-level covariates include: median household income, % employed, % non-Hispanic white, % non-Hispanic black, % Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of psychiatric nurses, number of primary care providers, number of physician assistants, number of CMHC number of FQHC

^d Non-MI: Visits not associated with primary mental illness diagnosis

^e MI: Visits associated with a primary mental illness diagnosis

^f HH: Health Home

^g Post-period: 12-months after Health Home started

^h Overall: Having an acute or chronic ACSC

ⁱ Acute: Dehydration, bacterial pneumonia and urinary tract infection

^j Chronic: Diabetes (uncontrolled; short and long term complications), chronic obstructive pulmonary disease, asthma, hypertension, congestive heart failure,

angina without procedure, and lower extremity amputation among patients with diabetes

* .05> p >0.01

** p<.01

Chapter II

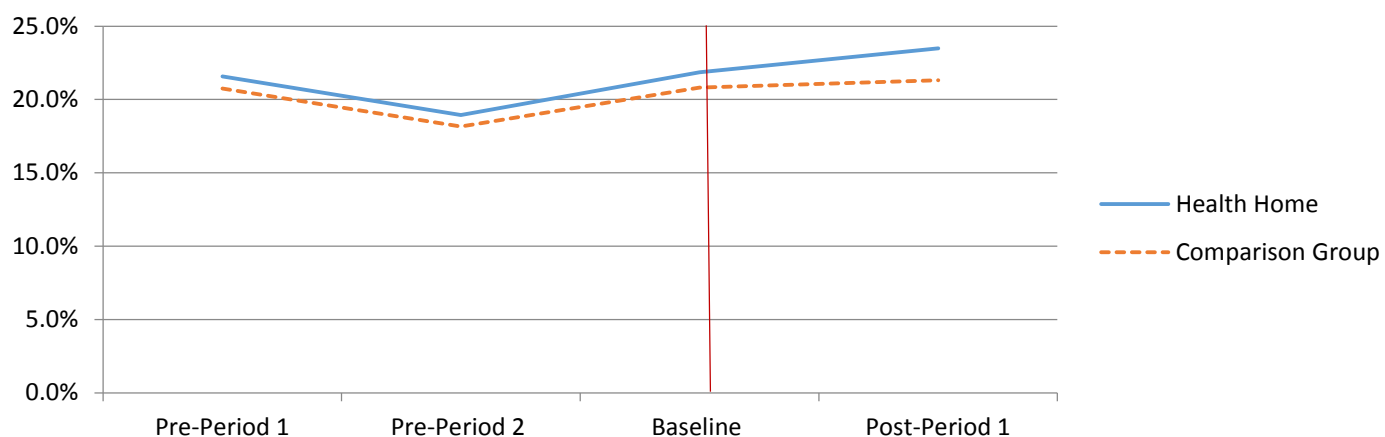
The Impact of Health Home on Emergency Department and Hospital Use among Medicaid Beneficiaries with Serious Mental Illness

Appendix

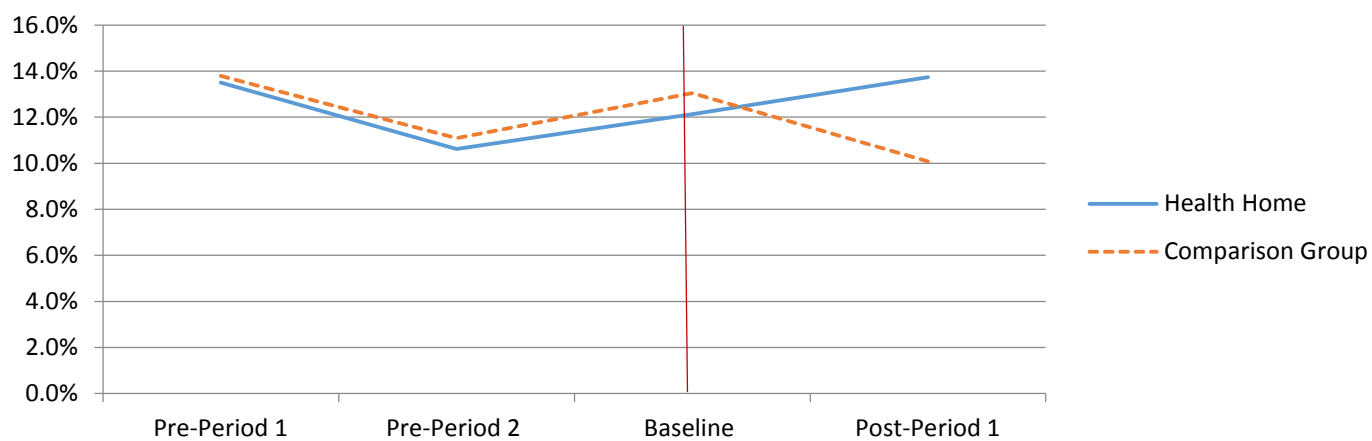
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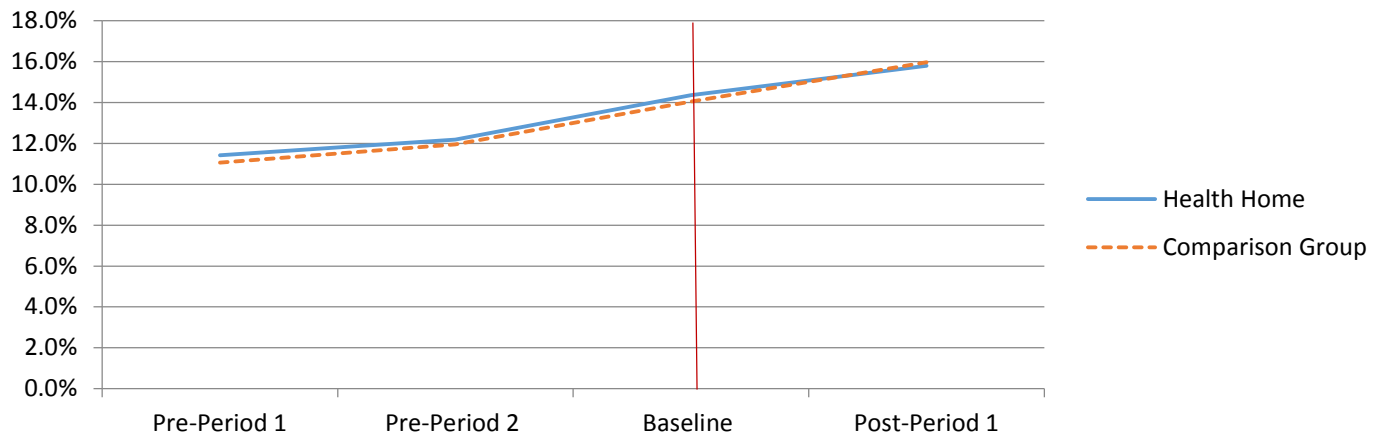
Appendix A. Figure 1
Percent Hospital Use:All-cause
Health Home and Comparison Groups



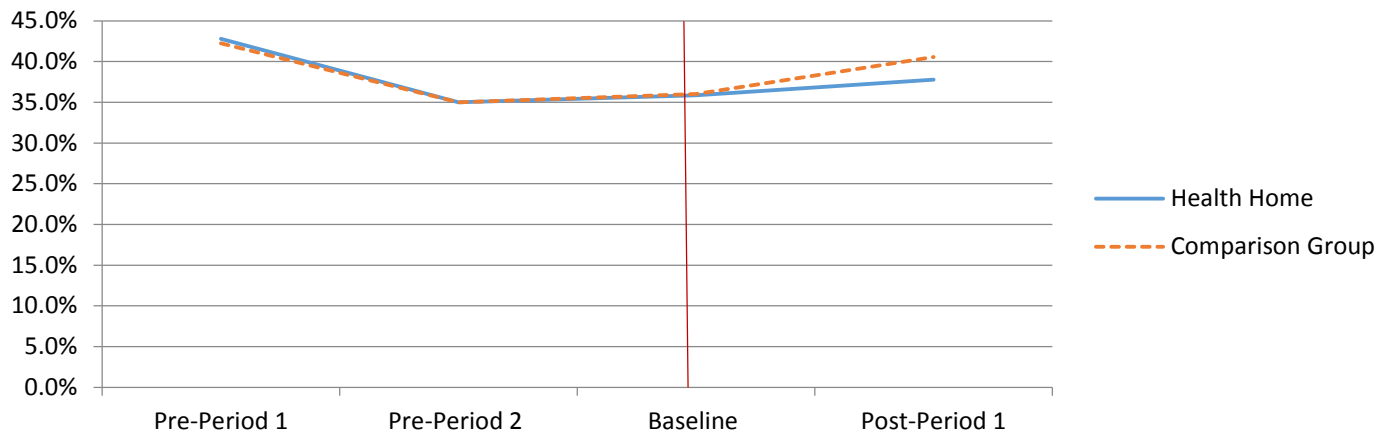
Appendix A. Figure 2
Percent Hospital Use:MI
Health Home and Comparison Groups



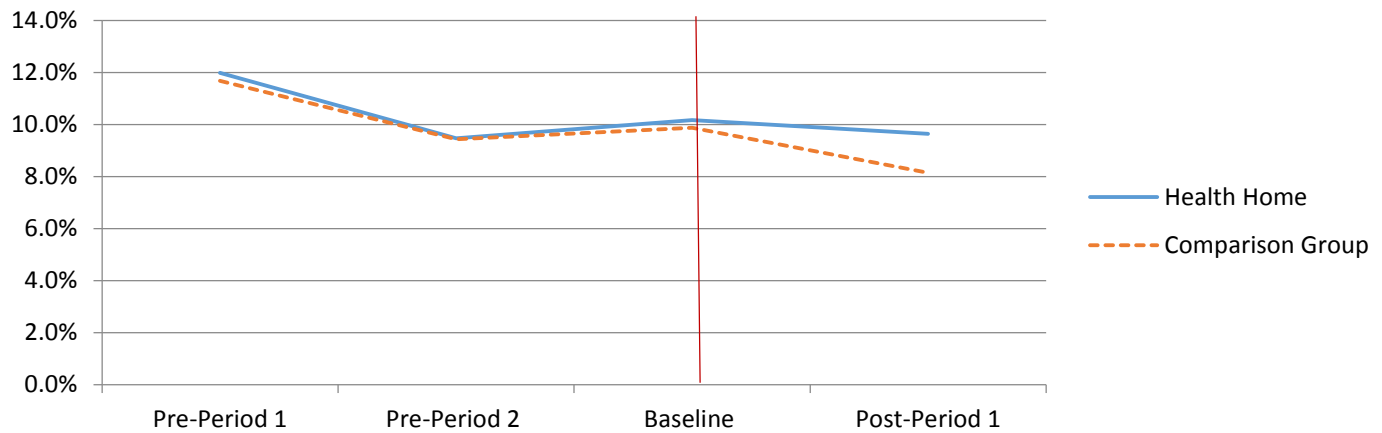
Appendix A. Figure 3
Percent Hospital Use:Non-MI
Health Home and Comparison Groups



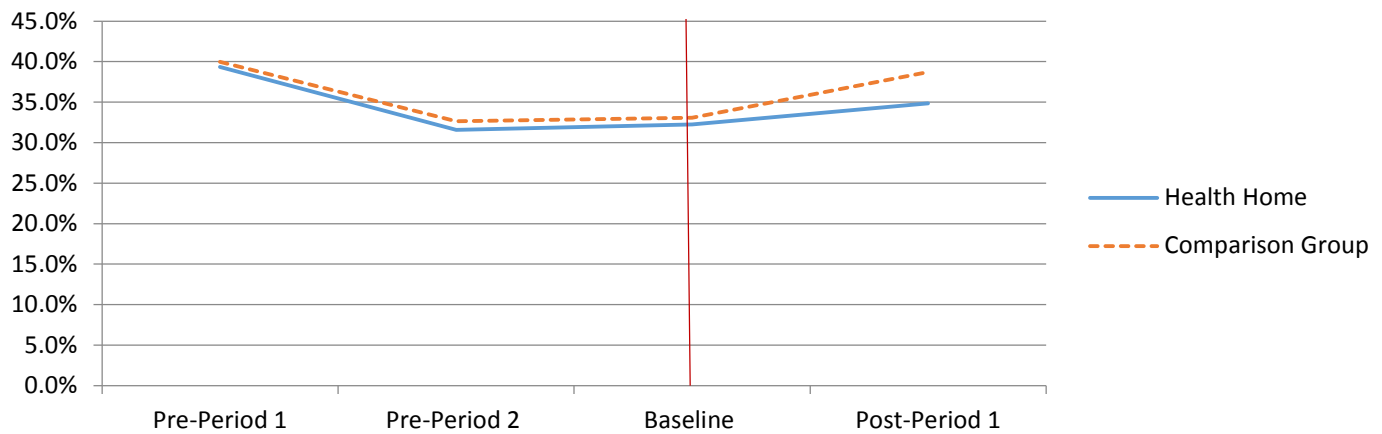
Appendix A. Figure 4
Percent ED Use:All-cause
Health Home and Comparison Groups



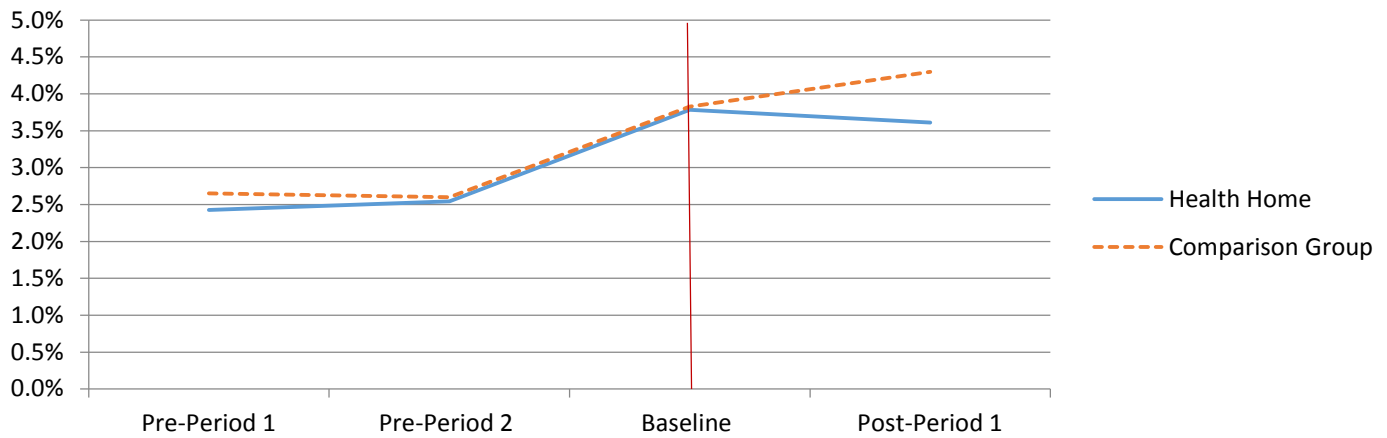
Appendix A. Figure 5
Percent ED Use:MI
Health Home and Comparison Groups



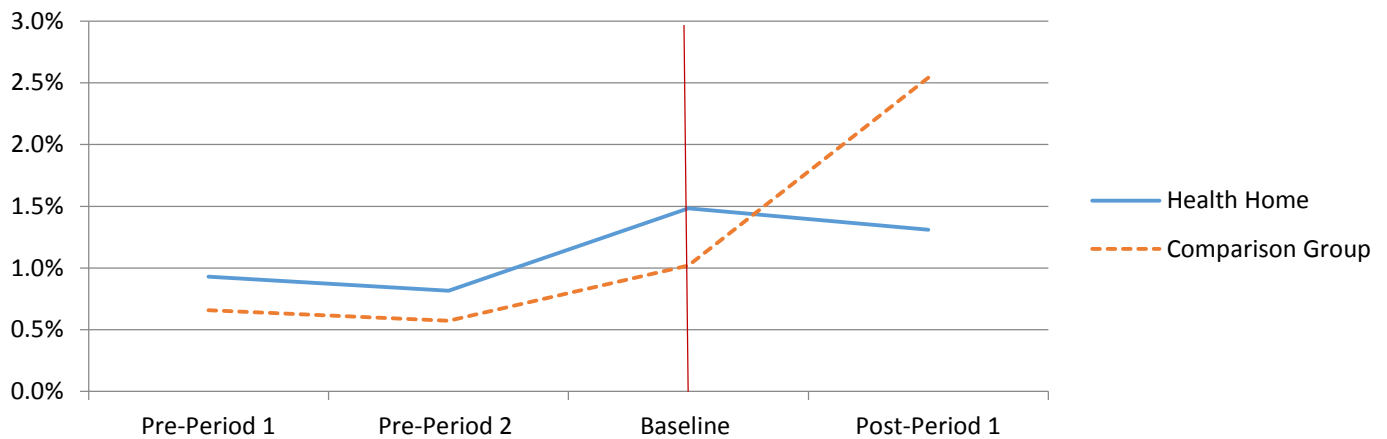
Appendix A. Figure 6
Percent ED Use:Non-MI
Health Home and Comparison Groups



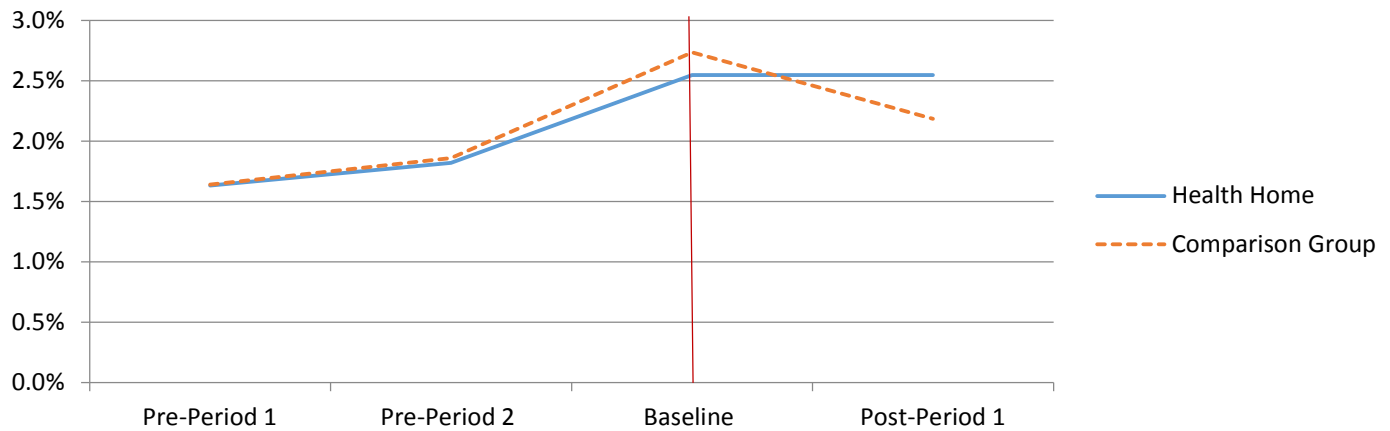
Appendix A. Figure 7
Percent ACSC Hospital Use: Overall
Health Home and Comparison Groups



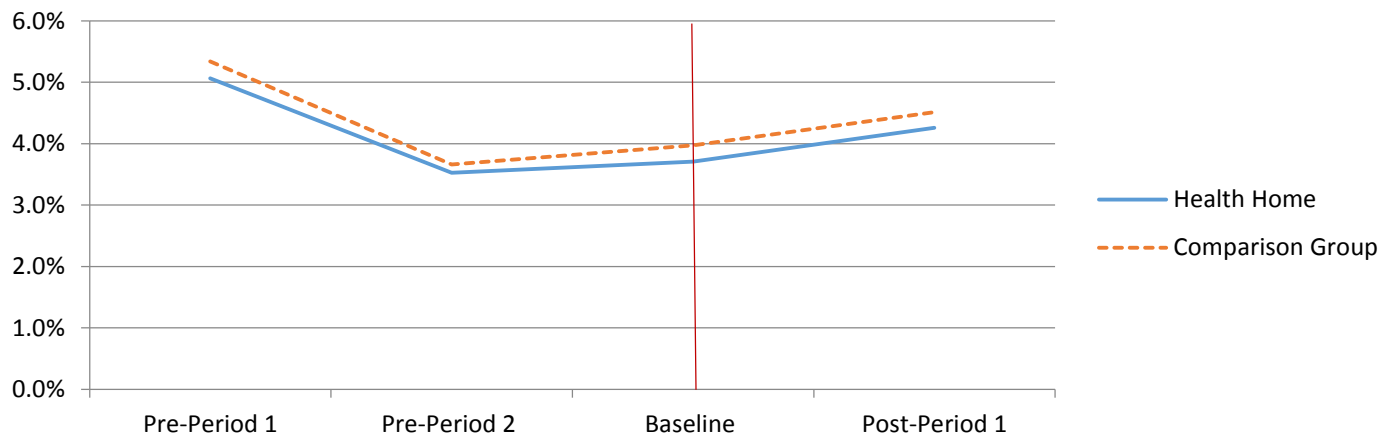
Appendix A. Figure 8
Percent ACSC Hospital Use: Acute
Health Home and Comparison Groups



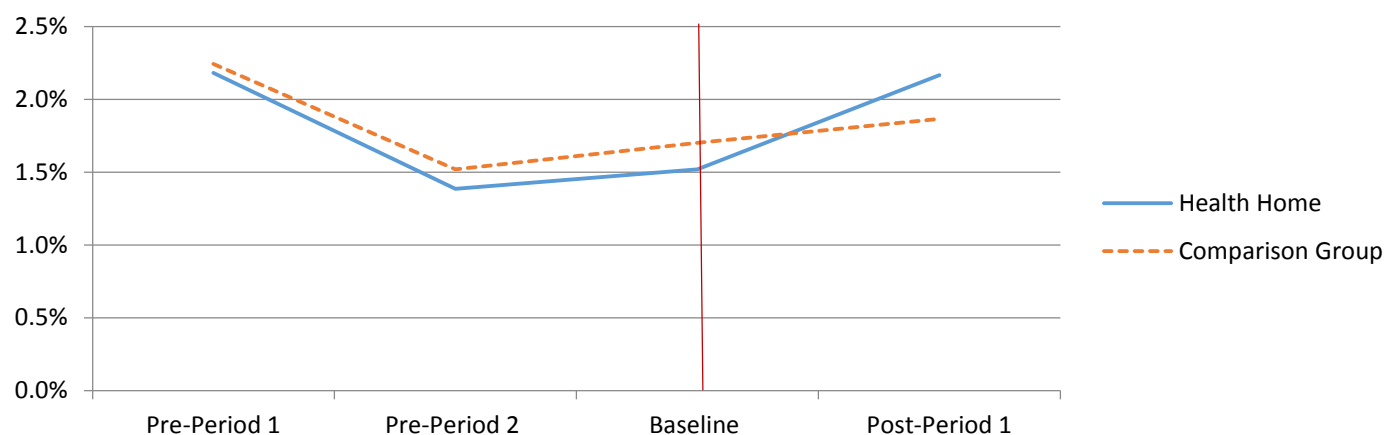
Appendix A. Figure 9
Percent ACSC Hospital Use: Chronic
Health Home and Comparison Groups



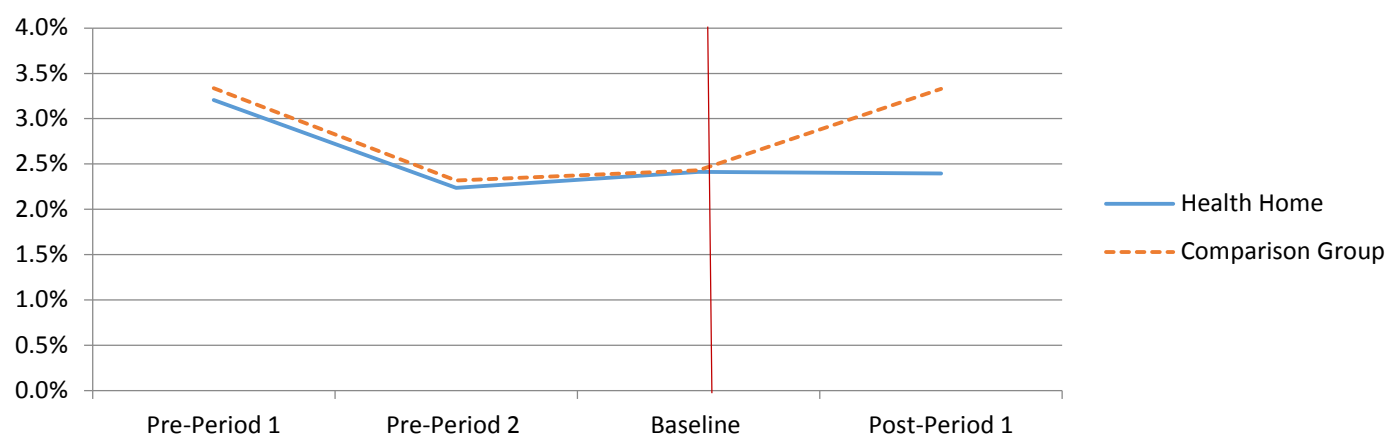
Appendix A. Figure 10
Percent ACSC ED Use: Overall
Health Home and Comparison Groups



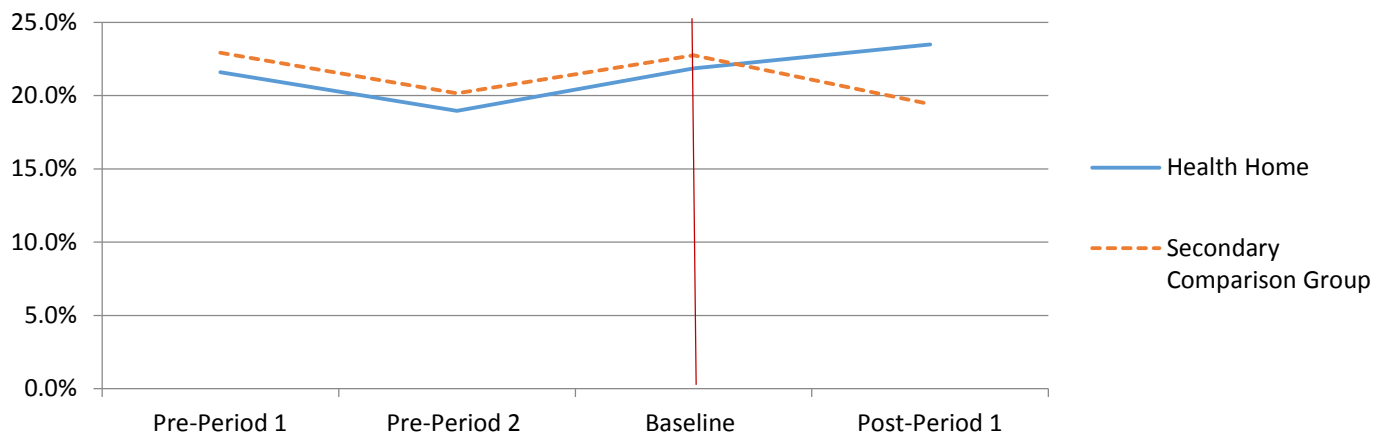
Appendix A. Figure 11
Percent ACSC ED Use: Acute
Health Home and Comparison Groups



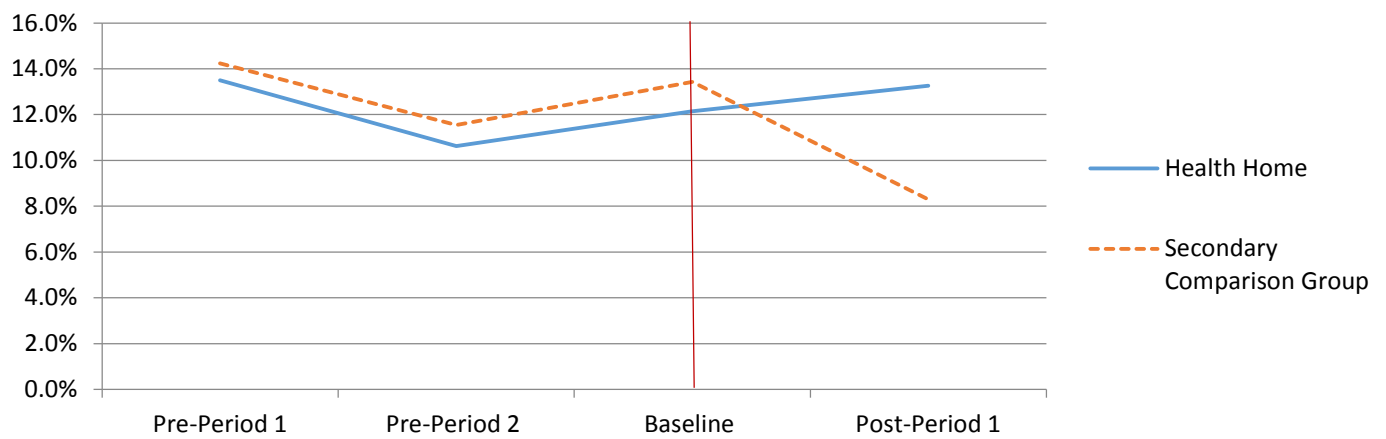
Appendix A. Figure 12
Percent ACSC ED Use: Chronic
Health Home and Comparison Groups



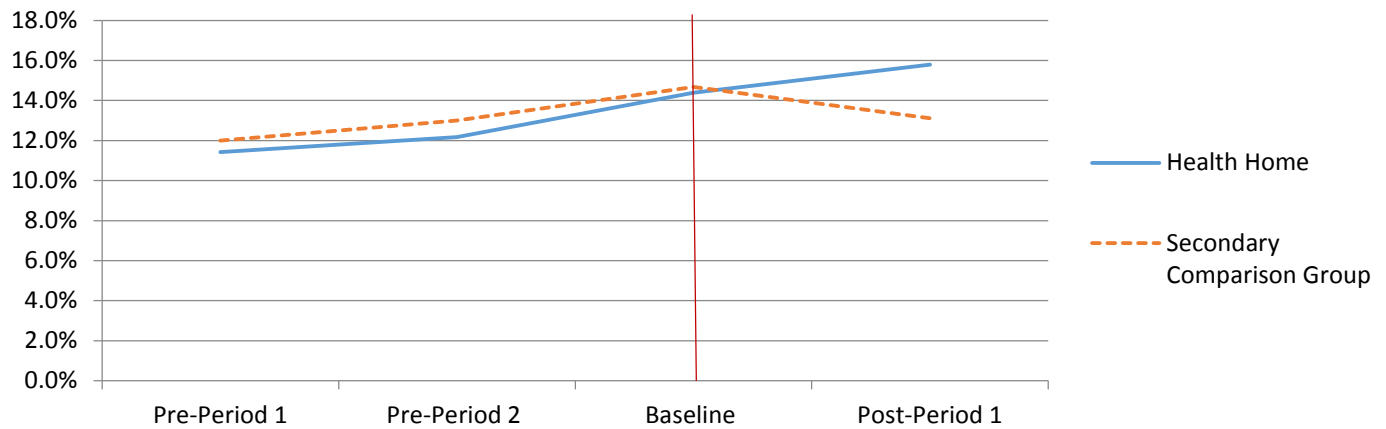
Appendix B. Figure 1
Percent Hospital Use:All-cause
Health Home and Secondary Comparison Groups



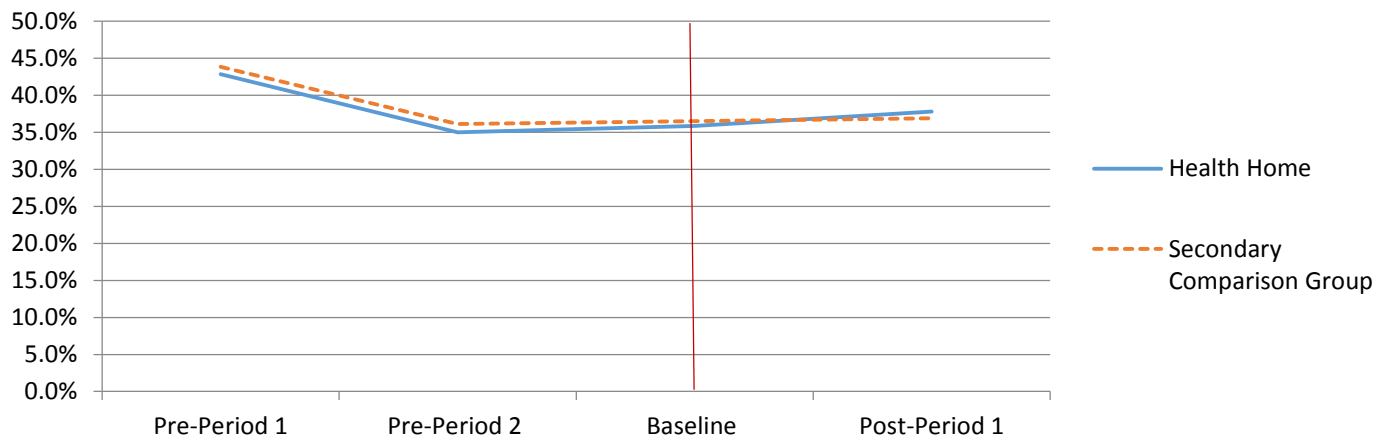
Appendix B. Figure 2
Percent Hospital Use:MI
Health Home and Secondary Comparison Groups



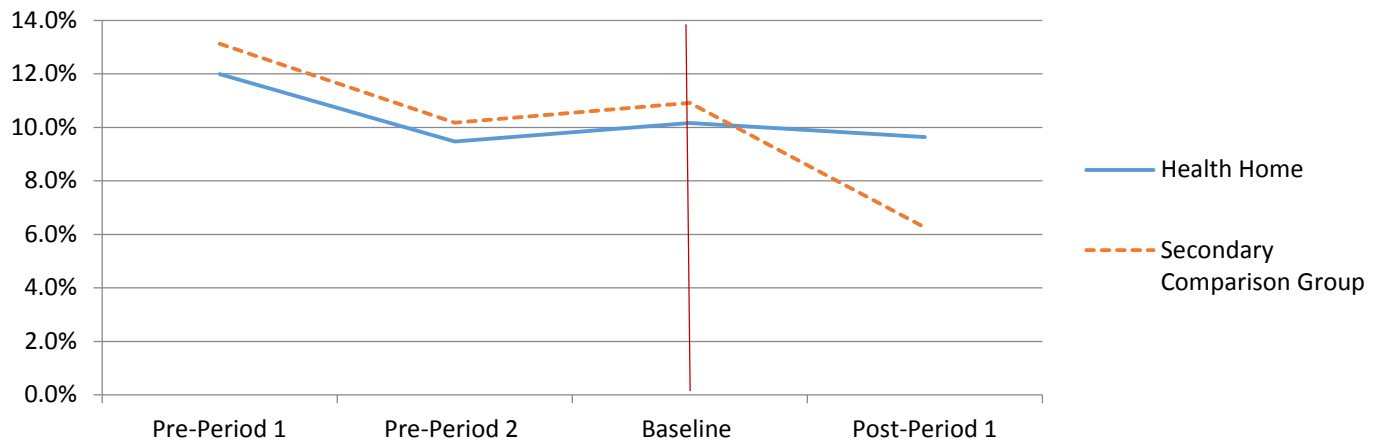
Appendix B. Figure 3
Percent Hospital Use: Non-MI
Health Home and Secondary Comparison Groups



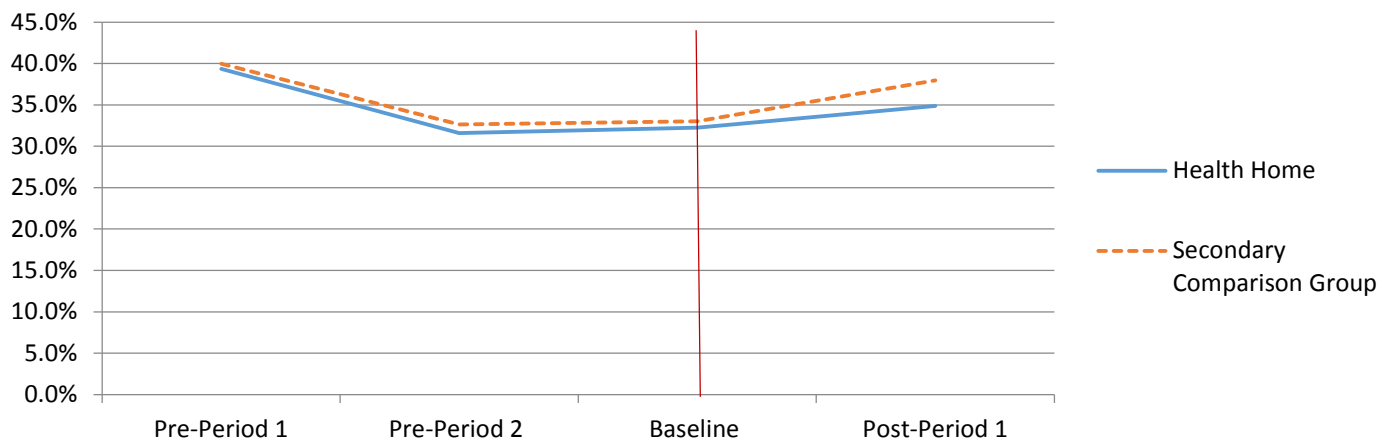
Appendix B. Figure 4
Percent ED Use: All-cause
Health Home and Secondary Comparison Groups



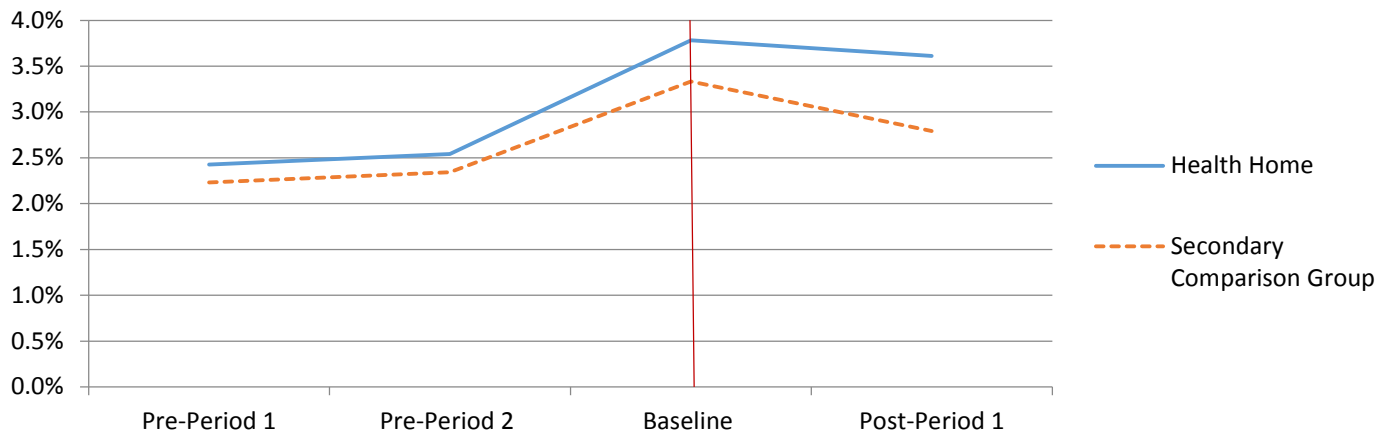
Appendix B. Figure 5
Percent ED Use: MI
Health Home and Secondary Comparison Groups



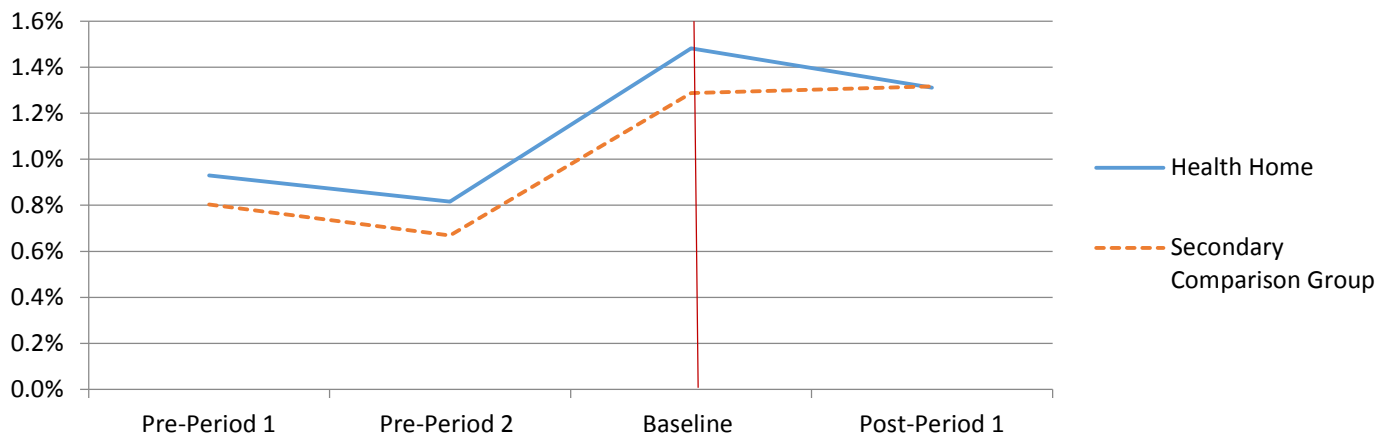
Appendix B. Figure 6
Percent ED Use: Non-MI
Health Home and Secondary Comparison Groups



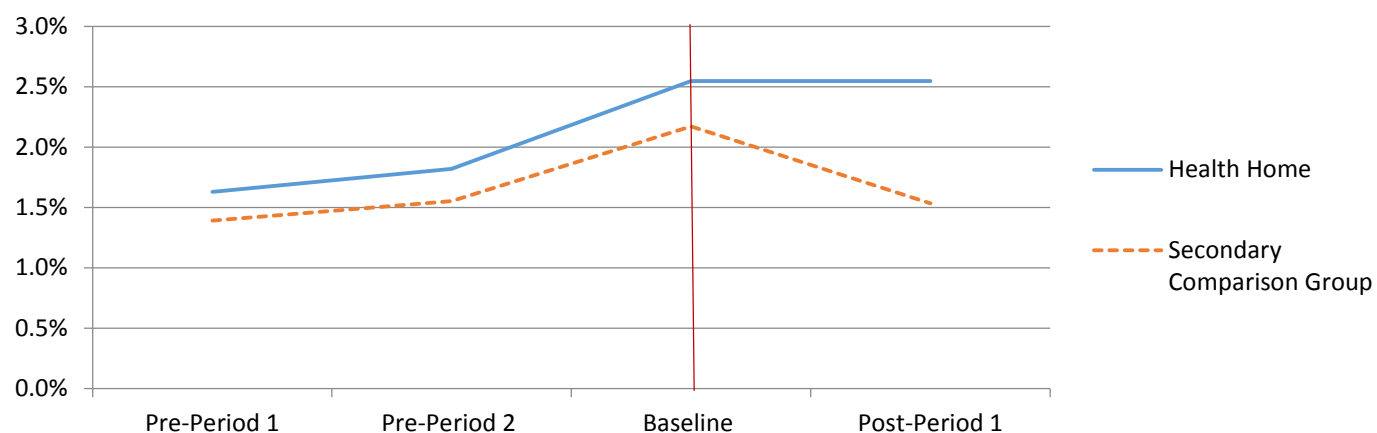
Appendix B. Figure 7
Percent ACSC Hospital Use: Overall
Health Home and Secondary Comparison Groups



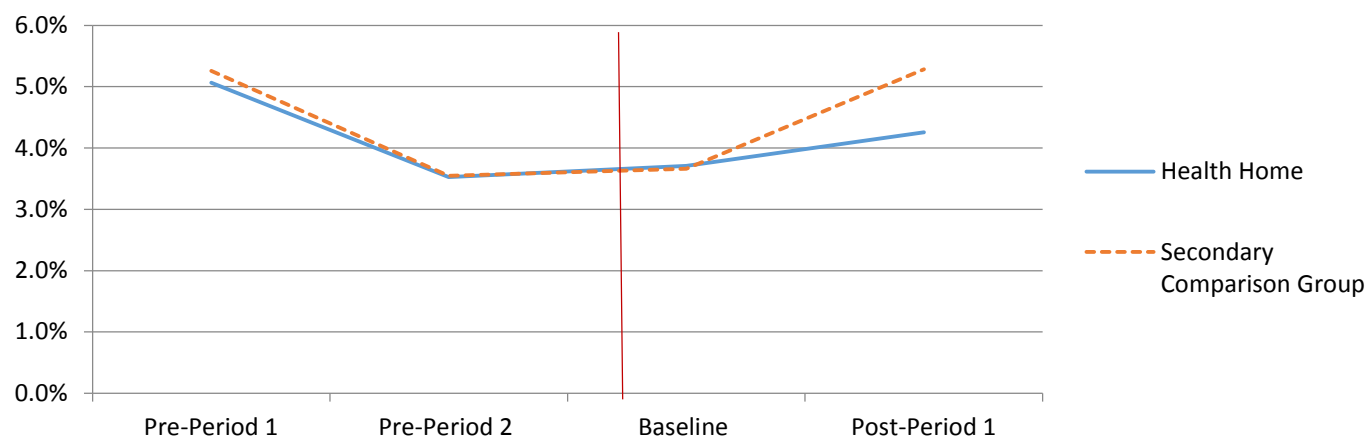
Appendix B. Figure 8
Percent ACSC Hospital Use: Acute
Health Home and Secondary Comparison Groups



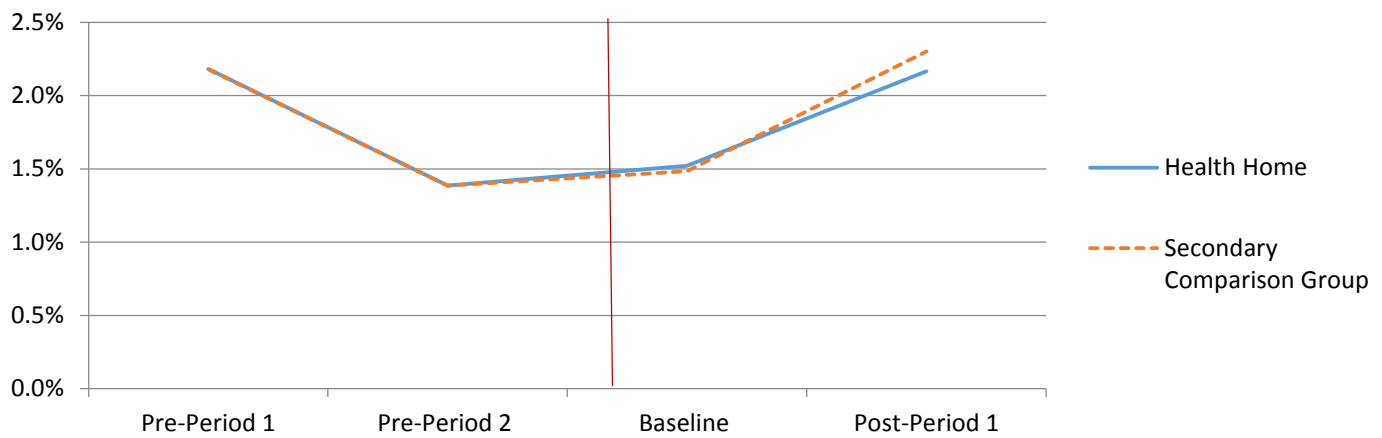
Appendix B. Figure 9
Percent ACSC Hospital Use: Chronic
Health Home and Secondary Comparison Groups



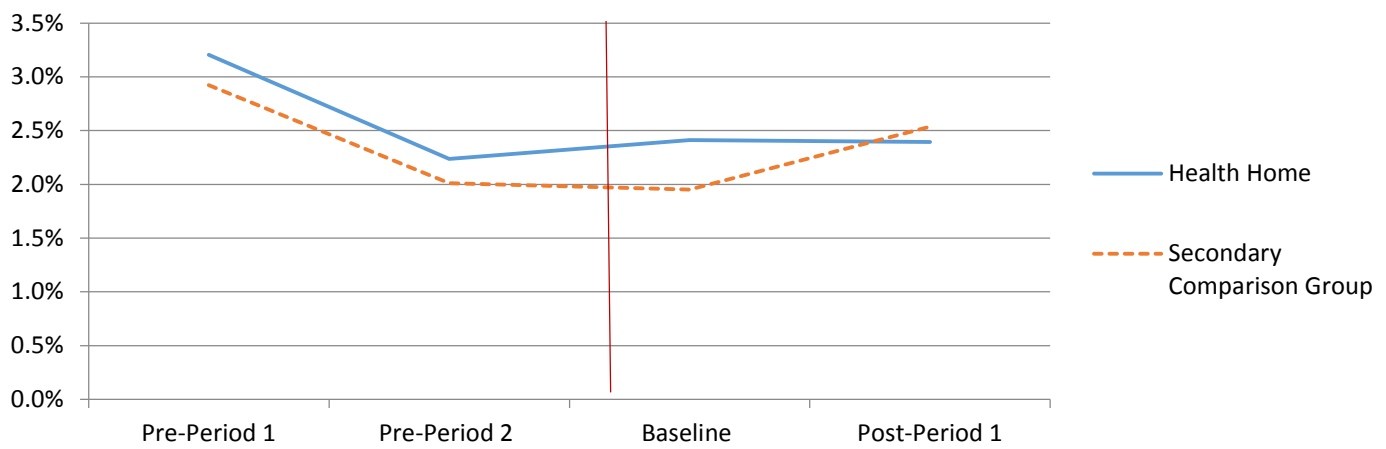
Appendix B. Figure 10
Percent ACSC ED Use: Overall
Health Home and Secondary Comparison Groups



Appendix B. Figure 11
Percent ACSC ED Use: Acute
Health Home and Secondary Comparison Groups



Appendix B. Figure 12
Percent ACSC ED Use: Chronic
Health Home and Secondary Comparison Groups



Appendix C. First sensitivity test: Secondary comparison population

Table 1. Difference-in-differences (DD) analysis of emergency department and hospital use among individuals enrolled in health homes and a secondary comparison group^{a,b,c}

		HH ^d			Comparison				
		Pre-period ^e	Post-period ^f	Pre-post difference ^g	Pre-period	Post-period	Pre-post difference	DD	95% CI
At least one									
Hospital									
	All-Cause	21.85	23.49	1.63	22.76	19.41	-3.35	4.98*	2.17 to 7.79
	Non-MI ^h	14.39	15.79	1.40	14.68	13.12	-1.56	2.96	-0.025 to 5.34
	MI ⁱ	12.14	13.26	1.12	13.43	8.30	-5.12	6.24**	3.50 to 8.97
Emergency Department									
	All-Cause	35.86	37.79	1.94	36.48	36.89	0.41	1.52	-1.63 to 4.68
	Non-MI	32.25	34.86	2.61	33.04	37.98	4.94	-2.33	-4.32 to 1.47
	MI	10.17	9.64	-0.53	10.92	6.26	-4.66	4.12**	1.18 to 7.07

^a Outcomes are dichotomized, 1=one or more visits; 0=no visits

^b Models weighting by the odds: HH Group Weight=1; Comparison Group Weight= propensity score/1-propensity score

^c Models adjusted for individual and ZCTA-level covariates. Individual-level covariate include: age, sex, race, mood disorders, schizophrenia, comorbidities; ZCTA-level covariates include: median household income, % employed, % non-Hispanic white, % non-Hispanic black, % Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of psychiatric nurses, number of primary care providers, number of physician assistants, number of CMHC number of FQHC

^d HH: Health Home

^e Pre-period: 12-months before Health Home started

^f Post-period: 12-months after Health Home started

^g Pre-Post Difference: Post-period - Pre-period

^h Non-MI: Visits not associated with primary mental illness diagnosis

ⁱ MI: Visits associated with a primary mental illness diagnosis

* .05> p >0.01

** p<.01

Appendix C. First sensitivity test: Secondary comparison population

Table 2. Difference-in-differences (DD) analysis of emergency department and hospital use among individuals enrolled in health homes and a secondary comparison group^{a,b,c}

		HH ^d			Comparison			DD	95% CI
		Pre-period ^e	Post-period ^f	Pre-post difference ^g	Pre-period	Post-period	Pre-post difference		
Number of visits									
Hospitalizations									
	All-Cause	334.95	379.84	44.89	333.50	368.42	34.92	9.96	-57.18 to 77.10
	Non-Psychiatric	263.94	286.63	22.69	285.37	235.47	-49.90	72.59	-17.23 to 161.38
	Psychiatric	294.01	345.82	51.81	310.65	332.62	21.97	29.84	-68.99 to 128.66
ED Visits									
	All-Cause	417.70	462.63	44.93	378.42	434.27	55.85	-10.92	-67.14 to 45.31
	Non-Psychiatric	396.53	453.45	56.91	343.78	409.87	66.09	-9.18	-62.12 to 80.3
	Psychiatric	226.82	251.30	24.48	132.05	164.45	32.40	-7.92	-95.07 to 79.23

^a Outcomes are dichotomized, 1=one or more visits; 0=no visits

^b Models weighting by the odds: HH Group Weight=1; Comparison Group Weight= propensity score/1-propensity score

^c Models adjusted for individual and ZCTA-level covariates. Individual-level covariate include: age, sex, race, mood disorders, schizophrenia, comorbidities; ZCTA-level covariates include: median household income, % employed, % non-Hispanic white, % non-Hispanic black, % Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of psychiatric nurses, number of primary care providers, number of physician assistants, number of CMHC number of FQHC

^d HH: Health Home

^e Pre-period: 12-months before Health Home started

^f Post-period: 12-months after Health Home started

^g Pre-Post Difference: Post-period - Pre-period

^h Non-MI: Visits not associated with primary mental illness diagnosis

ⁱ MI: Visits associated with a primary mental illness diagnosis

* .05> p >0.01

** p<.01

Appendix C. First sensitivity test: Secondary comparison population

Table 3. Difference-in-differences (DD) analysis of ACSC emergency and hospital use among individuals enrolled in health homes and a secondary comparison group^{a,b,c,d}

		HH ^e			Comparison			DD	95% CI
		Pre-period ^f	Post-period ^g	Pre-post difference ^h	Pre-period	Post-period	Pre-post difference		
At least one Hospital									
	Overall ⁱ	3.78	3.61	-0.17	3.33	2.79	-0.54	0.37	-0.89 to 1.63
	Acute ^j	1.48	1.31	-0.17	1.29	1.32	0.03	-0.20	-1.05 to 0.65
	Chronic ^k	2.55	2.55	0.00	2.17	1.53	-0.64	0.64	-0.28 to 1.56
Emergency Department									
	Overall	3.71	4.26	0.55	3.66	5.28	1.62	-1.07	-2.85 to 0.71
	Acute	1.52	2.17	0.65	1.48	2.30	0.82	-0.17	-1.25 to 0.90
	Chronic	2.41	2.39	-0.02	1.95	2.54	0.58	-0.60	-1.70 to 0.50

^aOutcomes are dichotomized, 1=one or more visits; 0=no visits

^bModels weighting by the odds: HH Group Weight=1; Comparison Group Weight= propensity score/1-propensity score

^cModels adjusted for individual and ZCTA-level covariates. Individual-level covariate include: age, sex, race, mood disorders, schizophrenia, comorbidities; ZCTA-level covariates include: median household income, % employed, % non-Hispanic white, % non-Hispanic black, % Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of psychiatric nurses, number of primary care providers, number of physician assistants, number of CMHC number of FQHC

^dACSC: Ambulatory Care Sensitive Conditions

^eHH: Health Home

^fPre-period: 12-months before Health Home started

^gPost-period: 12-months after Health Home started

^hPre-Post Difference: Post-period - Pre-period

ⁱOverall: having an acute or chronic ACSC

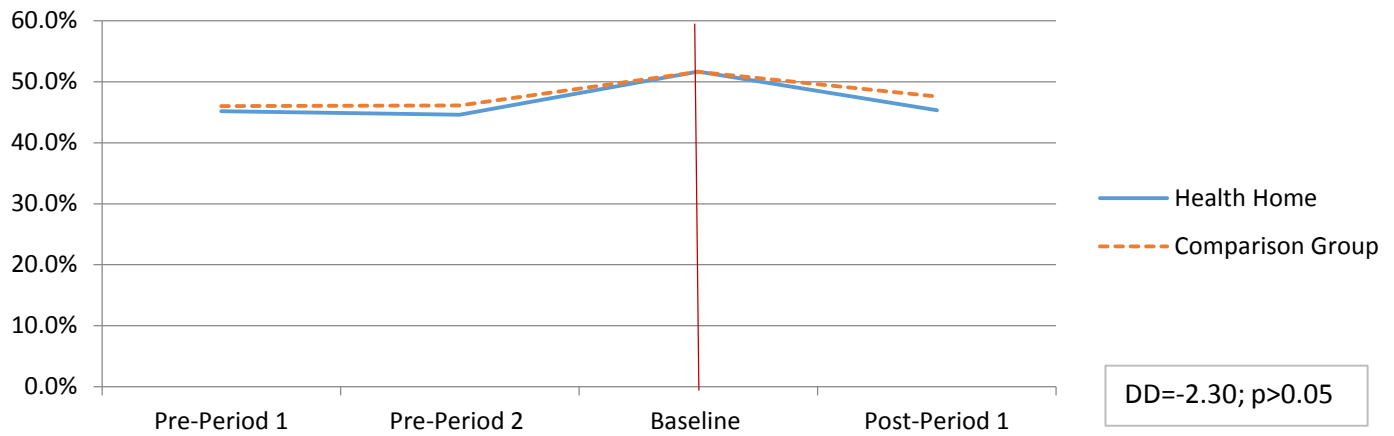
^jAcute: Dehydration, bacterial pneumonia and urinary tract infection

^kChronic: Diabetes (uncontrolled; short and long term complications), chronic obstructive pulmonary disease, asthma, hypertension, congestive heart failure, angina without procedure, and lower extremity amputation among patients with diabetes

* .05> p >0.01

** p<.01

Appendix D. Second Sensitivity Test: Alternative Outcome
Percent Eye Exams
Health Home and Comparison Groups



Chapter III

Assessing the joint effects of Health Home and Integrated Care Setting on Health Service Use among Medicaid Beneficiaries with Serious Mental Illness

Introduction

It is well documented that combining behavioral health and primary care services can yield high-quality, low-cost care (1). Most studies emphasize the placement of mental health services into primary care settings (2-4). Individuals with Serious Mental Illness (SMI) are not likely to participate in this form of service integration (5). Different strategies are needed to engage this population and address their high rates of morbidity and mortality (2,6-8). Little research addresses how to best integrate health services for individuals with SMI (3,4). Evidence suggests the introduction of general medical care into community mental health centers (CMHC), where individuals with SMI primarily seek care, can improve care quality and health outcomes (2-4,7,8).

Most research assessing behavioral health based integration originates from the Veteran Affairs Medical Centers (VAMC) (3,4). In a randomized controlled trial (RCT) targeting individuals with bipolar disorder and cardiovascular risk factors, Kilbourne and colleagues (9) introduced a care manager intervention within a referral-based care model setting. Researchers found the intervention was associated with decreased systolic and diastolic blood pressure as well as reduced manic symptoms (9). In another RCT, VAMC researchers colocated primary care and case management services within a CMHC for veterans with SMI. Relative to the control group, individuals in the intervention were more likely to have made a primary care visit, obtain a greater number of primary care visits, and received guideline concordant preventative care (10). Though findings from these RCTs have been positive, they may not generalize to other health systems and populations.

Beyond research conducted at the VAMC, few empirical studies on behavioral health based integration exist in the peer-reviewed literature (3,4). Studies have employed different means of integrating health services into CMHC's, such as introducing a general health clinician or developing referral arrangements with primary care clinics (11). Integration strategies such as Health Homes, which enhance care coordination, access to general health services, and wellness promotion, have been implemented within diverse practice structures (referral-based, colocated, and integrated care settings). To date, results from behavioral health based integration have been mixed (12-15).

A conceptual framework developed by the Center for Integrated Health Solutions (16), which builds on work from Doherty (17) and Blount (18), places integration on a continuum from no integration to full integration (Figure 1). Progression towards the right of the arrow indicates a higher-level of service integration, collaboration, and communication. A higher-level of integration will theoretically produce better health outcomes (16). Consequently, introducing an integration strategy within an existing integrated care setting, oppose to a referral-based setting, should yield superior results. However, there are no comparative effective studies to determine the best practice structure for the introduction of an integration strategy. The purpose of this study is to evaluate the extent to which an integrated care setting, implementing Health Home, impacts health service use among Medicaid beneficiaries with SMI. We hypothesize an integrated care setting that implements Health Home will increase use of outpatient

services, decrease hospitalizations and emergency department use, relative to the comparison group, a referral-based setting implementing Health Home.

Methods

Intervention

Health Homes was implemented from October 1, 2011 until October 1, 2013 under the auspices of Rhode Island's Department of Behavioral Health Developmental Disabilities and Hospitals (BHDDH). Individuals obtaining BHDDH services who were Medicaid beneficiaries with an SMI diagnosis (bipolar disorders, major depressive disorders, and schizophrenic disorders) were automatically enrolled into Health Home. Those not interesting in participating could opt-out and receive services as usual. SMI diagnoses were ascertained during a clinical evaluation at an individuals' first CMHC encounter. Participants of Health Home met the following eligibility criteria: 1) had a severe and/or persistent mental or emotional disorder but for whom long-term 24-hour care could be averted; and 2) had impaired role functioning; or, underwent psychiatric treatment more intensive than outpatient care more than once in a lifetime; or, experienced a single episode of continuous, structured supportive residential care other than hospitalization for a duration of at least two months. Enrollees also met at least two of the following criteria, on a continuing or intermittent basis for at least two years: 1) if employed, was employed in a sheltered setting, or had markedly limited skills or a poor work history; 2) required public financial assistance for out-of-hospital maintenance and was unable to procure assistance without help; 3) showed an inability to establish or maintain a social

support system; 4) required help in basic living skills; 5) exhibited inappropriate social behavior which resulted in mental health and/or judicial system intervention.

Upon enrollment, each Health Home participant received a comprehensive biopsychosocial evaluation, which resulted in an individualized treatment plan. A care manager, designated as the Health Home team leader, was responsible for coordinating and implementing the treatment plans. Each participant received care from a multidisciplinary team of health professionals. Health Home provided integrated behavioral and primary care services through comprehensive case management, care coordination, health promotion services, transitional care, individual and family support services and referrals to community and social support services. Nine CMHCs across the state of Rhode Island participated in the Health Home program.

Study Population

The intervention group consisted of Medicaid beneficiaries who were between 18 to 64 years of age, who were enrolled in Health Home and obtained services from an Integrated Care Setting (ICS). ICS were CMHCs that provided both mental and general health services at the same site prior to the implementation of Health Home. Health Home encounter data was used to discern ICS. For the purpose of this study, we designated individuals to an ICS based on having greater than 50% of their Health Home services from that care setting. Individuals included in our analytic sample were eligible and consistently enrolled in Medicaid through the study period (2009-2012).

The comparison group consisted of Health Home participants between the ages of 18 to 64 who received services from a referral-based care model setting. CMHC's that provided services on a referral basis partnered with clinics in their catchment area to provide preventive and general health services. Centers did not provide these services within their setting. We classified individuals to a referral-based care setting if they received greater than 50% of their Health Home services from that care setting. This comparison group accounts for trends not associated with ICS that may otherwise confound study effects. We used propensity score weights to ensure the comparison group was similar to those who received services from ICS on observable baseline characteristics. Our comparison group was also consistently enrolled in Medicaid throughout the study period.

Data Source

We used Medicaid eligibility and fee-for-service claims for the period 2009 through 2012. In addition, we accessed the American Community Survey (ACS), Rhode Island Department of Health (RIDH) Licensee Lists, and BHDDH Health Home encounter data. Claims provided demographic and utilization data on adult Medicaid beneficiaries prior to and following the implementation of Health Home. ACS data provided Zip Code Tabulation Area (ZCTA)-level factors, RIDH licensee lists provided the number of health providers, and Health Home encounter data supplied the care model settings most used during Health Home implementation.

Independent Variables

The primary factor of interest was an interaction term composed of indicators for ICS participation and post-Health Home period. To minimize confounding, we applied the same individual and ZCTA-level variables used to specify our propensity scores to all regression models. Individual-level factors included: age, sex, race (White, Black, and Other), number of comorbidities using the Elixhauser comorbidity index, mood disorder diagnosis, and schizophrenia diagnosis. ZCTA-level factors included: median household income, percent employed, percent non-Hispanic White, percent non-Hispanic Black, percent Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of psychiatric nurses, number of primary care providers, number of physician assistants, number of CMHCs, and number of federally qualified health centers.

Outcome Variables

Our primary outcomes consisted of outpatient service use, hospitalizations, and ED use. We assessed the combined impact of Health Home and ICS on having any visits (dichotomous) and service use intensity (count of visits) among those with at least one visit. The outpatient service use outcome consisted of overall visits and those associated with physical health conditions commonly experienced by individuals with SMI (chronic obstructive pulmonary disease (COPD), cardiovascular disease, diabetes, hypertension, and obesity) (19). All outpatient visit outcomes were treated as dichotomous and count variables.

Our hospital use outcome was divided into four categories, all-cause, visits associated with a primary mental illness (MI) diagnosis (ICD-9 codes: 295-302, 306-314)(20), visits not associated with an MI diagnosis (non-MI) and, preventable. Preventable hospitalizations were those associated with an Ambulatory Care Sensitive Condition (ACSC). We used an algorithm developed by the Agency for Healthcare Research and Quality to identify ACSC events in administrative data (21). Composite measures assessed acute, chronic, and overall ACSC hospitalizations. Acute conditions consisted of dehydration, bacterial pneumonia and urinary tract infection. Chronic conditions included diabetes (uncontrolled; short and long term complications), chronic obstructive pulmonary disease, asthma, hypertension, congestive heart failure, angina without procedure, and lower extremity amputation among patients with diabetes. Overall ACSC hospitalization reflected having an acute or chronic condition. All-cause, MI, and non-MI hospitalizations were treated as dichotomous and count variables. ACSC hospitalization outcomes were treated as dichotomous variables.

Similarly to our hospital outcomes, ED use was categorized as all-cause, MI, non-MI, and preventable. We used the same ACSC algorithms and ICD-9 codes to identify preventable ED use and an MI diagnosis, respectively. All-cause, MI, and non-MI ED use outcomes were treated as dichotomous and count variables. Preventable ED use outcomes were treated as dichotomous variables.

Statistical Methods

We used a quasi-experimental difference-in-differences (DD) approach to estimate the impact of ICS with health service use. In a DD analysis we subtract the average change in health service use, between the pre- and post-periods, in the ICS group, to the average change in health service use in the comparison group, during the same periods (22). This approach allows us to control for secular trends that are not associated with ICS (22). The pre-period was 12-months prior to Health Home implementation while the post-period was 12-months after Health Home started. In a regression framework the interaction between our indicators for post-Health Home period and ICS participation yield our DD estimate. In order for the DD analysis to provide valid estimates, we assume ICS and comparison groups possess similar trends in the pre-intervention period (22). Though we are unable to prove this assumption, we checked the validity by using Medicaid claims from the pre-intervention period, 2009-2010 (Appendix A. Figures 1-18).

For our count outcomes, we estimated multivariable negative binomial models with log link functions and robust standard errors clustered at the individual level. Dichotomous outcomes were evaluated using multivariable binomial models with a logit link function and robust standard errors clustered at the individual level. For all count and dichotomous outcomes we used generalized estimating equations with an autoregressive correlation structure to account for clustering of repeated individual observations. To obtain the desired interpretation of the interaction term in our non-

linear models we used the predictive margins methods to predict health service use in the pre- and post-periods for ICS and comparison groups.

We paired our DD analysis with propensity score weights. A logistic regression model, with ICS participation as the outcome variable, was used to estimate our propensity scores. A separate propensity score was estimated for each outcome variable. We specified our models with individual- and ZCTA-level factors as well as pre-period outcomes and pre-period outcome trends. Balance was assessed graphically and empirical using standardized difference in means (23). Balance was achieved once the absolute percent standardized difference in means was $\leq 10\%$ (24,25). To estimate the average treatment effect on the treated we constructed weights based on the odds of the propensity score. ICS participants were given a weight of 1 while individuals in the comparison group received a weight of $p_i / (1 - p_i)$ where p_i represents the estimated propensity score for an individual (24,25). Using this weighting scheme allows comparisons who are similar to the intervention participants to be weighted higher than those who are dissimilar, which are weighted down.

Subgroup analyses were also conducted to evaluate the association of ICS on health service use for Blacks, Hispanics, and those with a schizophrenia disorder. This secondary data analysis was approved by the Brown University Office of Research Integrity.

Results

Table 1 illustrates the ICS and comparison groups before and after weighting. Prior to weighting, there were significant differences between groups on race and many of the ZCTA-level factors. After weighting, groups were balanced on baseline characteristics. There were no differences between groups and standardized differences in means were below 10%. The average age among groups was approximately 45, with a larger proportion being female than male, were of White race, had a mood disorder, and experienced an average greater than four comorbidities.

Table 2 presents our findings from the adjusted and weighted DD analysis of outpatient service use. Among ICS participants, the proportion having an outpatient visit increased from 83.85% in the pre-period to 88.18% in the post-period. During the same period, the comparison group increased from 83.93% to 85.10%, which is yielded a non-significant DD of 3.16 percentage-points. ICS was also associated with minor non-significant increases in having an outpatient visit for cardiovascular disease, hypertension, and obesity. Looking at the association of ICS and outpatient service use intensity, there was a moderate increase ($p>0.05$) in the number of visits for overall, cardiovascular disease, diabetes, and hypertension.

Relative to the comparison group, the proportion of ICS participants having a hospital visit (Table 3) decreased ($p>0.05$) for all-cause, non-MI, and MI. When looking at ED use, ICS was associated with a non-significant decrease in the proportion having a visit associated with MI; while, a non-significant increase in having a visit for all-cause and

non-MI ($p>0.05$), relative to the comparison group. Service use also decreased ($p>0.05$) for those in ICS, relative to the comparison group (Table 3). The number of hospital visits for all cause, non-mental illness, and MI decreased, from pre- to post-periods, for ICS participants. ICS was also associated with non-significant decreases in the number of ED visits for all-cause and MI.

Table 4 shows our adjusted and weighted DD results for preventable hospital and ED use. Our results suggest there were no significant differences between ICS and comparison groups in obtaining a hospital visit for overall, acute or chronic ACSC. Similarly, our findings suggest there were no differences among groups in the proportion having an ED visit for all-cause, acute, or chronic ACSC.

In our sub-group analyses (Table 5) we did not see a significant change in the proportion obtaining an outpatient visit, overall or for any physical health condition, among any of our sub-groups. Concerning hospitalizations, (Table 5) findings suggest, over and above the interaction between ICS and post-Health Home period, the proportion obtaining a hospitalization for non-MI significantly decreased for Hispanics in ICS, -14.95 percentage-points (95%CI: -26.93 to -2.97). Among individuals in ICS with a schizophrenia diagnosis, there was a significant decrease in the proportion obtaining an all-cause Hospitalization, -7.69 percentage-points (95% CI: -15.09 to -0.29). There were no differences in hospitalizations or ED use for Blacks in ICS.

Discussion

To our knowledge, there is no research that has evaluated the best setting for the placement of an integration strategy for individuals with SMI. This study is an important contribution that can help to further define best practices for SMI populations and inform the allocation of limited resources. There is evidence that the placement of general health services within a CMHC may be the best way to address health disparities among the SMI population (2-4). However, there is little guidance on the best practice structure (referral-based, colocated, and integrated care settings) to implement care integration strategies. Rhode Island's Health Home provided a unique opportunity that allows us evaluate the extent to which Health Home in consort with an integrated care setting impacted health service use.

Contrary to our hypotheses, there were no differences between ICS and the comparison group in outpatient service use or ED use. Findings from our subgroup analysis suggest the implementation of Health Home within an ICS may decrease all-cause hospitalization for individuals with schizophrenia. Our results also suggest that ICS in consort with Health Home may decrease non-MI hospitalizations for Hispanics. Our positive findings may be attributed to the synergistic effects between ICS and Health Home, which may have enhanced communication and collaboration among clinical staff (16). Systematic reviews have shown their positive effect on mental and physical health outcomes for populations with SMI (3,4,26,27)

Our evaluation and findings most closely coincide with those of Krupski and colleagues (12) who assessed the Primary and Behavioral Health Care Integration (PBHCI) program. A large- scale grant initiative funded by the Substance Abuse and Mental Health Services Administration. Under this program CMHCs were provided funds to incorporate primary care and preventive services. Grantees were required to institute four mandatory elements (screening/referrals to general medical care, tracking system for general medical care outcomes, care management, and wellness services) and had the option of collocating primary care providers into their setting. Researchers evaluated the impact of PBHCI on utilization and costs of healthcare at two CMHCs. Clinic 1 had functioned as a fully integrated health care facility for over ten-years prior to PBHCI implementation. Clinic 2 had functioned as a stand-alone CMHC and began providing integrated services once the grant started. Findings suggested PBHCI participants at Clinic 1 had a significantly lower proportion being hospitalized, relative to the comparison group. There were no differences between groups on ED use. At Clinic 2 there were no differences between groups on hospitalizations or ED use. These findings suggest that experience operating as an ICS and introducing an integration strategy can lead to reductions in hospital use.

Our finding of decrease hospital use by individuals with schizophrenia is encouraging as the disorder is associated with substantial economic burden. Approximately 40% of total direct medical costs (\$37.7 billion) for schizophrenia are associated with hospitalizations (28). Drivers of hospital use include treatment nonadherence (29), symptoms of MI (19), recent schizophrenia diagnosis (30), individual and social risk factors (19) and lack of

access to outpatient services (6,19). Participation in an ICS that implemented Health Home may have helped to moderate some of these driving factors.

Participation in ICS was also associated with a decrease in non-mi hospital use among Hispanics. Although Hispanics may experience a lower prevalence of MI than their non-Hispanic White counterparts (31), they are less likely to have a usual source of care (32), access primary care services (32), access specialty mental health services, and stay in treatment (33). Consequently, Hispanics with SMI may be at increased risk of hospitalizations. It is important to note the heterogeneity within Hispanic sub-groups. According to figures from the Pew Research Center (34), 65.5% of Hispanics aged 18 years and older residing in Rhode Island were of Puerto Rican (35.8%) or Dominican (29.7%) descent. Puerto Ricans have been found to have the highest overall prevalence of psychiatric disorders among all Hispanic sub-groups (33). Consequently, our findings may be most relevant for this demographic and may not be generalizable to other Hispanic subgroups.

We did not see a difference between groups in many of our outcomes. However, several of our primary findings were in the hypothesized direction. This included an increase in overall outpatient visits (at least one visit and number of visits) and a decrease in all hospitalization outcomes. Our null findings may be attributed to the nature of our outcomes and the medical complexity of our sample population. A longer follow-up period may be needed to see a difference between groups in ED and hospital use. Our null findings concerning outpatient service use for commonly occurring

physical health conditions may be attributed to us not limiting the analysis to diagnosed cases of the conditions.

Our evaluation had several limitations. One, participants were not randomized into an ICS and may be subject to selection bias. The inclination of Health Home participants to prioritize one care setting over another may not be fully captured in our propensity score models. We were able to balance groups on baseline characteristics, which included individual- and area-level sociodemographics factors. However, there may be unmeasurable factors that we are not able to incorporate. Two, we were unable to account for factors that may have occurred concurrently as Health Home and differentially affected outcomes for our comparison groups. Three, our findings may not be generalizable to other SMI populations residing in different states. In addition, the Hispanic sub-groups in our sample population are not reflective of the larger Hispanic demographic. Nonetheless, our findings provide insight on an integration strategy that took place in the real world and may have a positive impact on a Hispanic sub-group with high rates of mental illness.

Our study also possesses several strengths. We used methods that simulated an experimental design and allowed for causal inferences. By using propensity score weights we addressed selection bias and made those who did and did not received care from an ICS similar on observable baseline factors. Regression models were adjusted for all variables used to specify the propensity scores. Employing this approach allows us to address any residual covariate imbalance. In using a DD approach we can

account for confounding secular trends that may have otherwise obscured the true effects of an ICS. Medicaid data were available for two years prior to Health Home onset, which allowed the validation of the DD parallel trends assumption.

Conclusion

Our findings suggest Health Home in consort with an ICS can decrease hospital use among specific populations. Our research contributes to the understanding of approaches that integrate primary care into community mental health settings. Moreover, provides insight on care settings for the introduction of Health Home. As behavioral-health based integration gains traction, it is crucial to understand how diverse populations respond to Health Home so as to inform the development of strategies that can better serve the SMI population. Future research should disentangle the different aspects of health integration such as provider, organizational, and environmental factors, both individually and synergistically, to elucidate their influence on performance. Employing an implementation science framework with a mixed-methods approach can help yield practical evidence that can be used to inform policy and improve the care quality and health outcomes of individuals with SMI.

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Figure 1. Care Integration Continuum

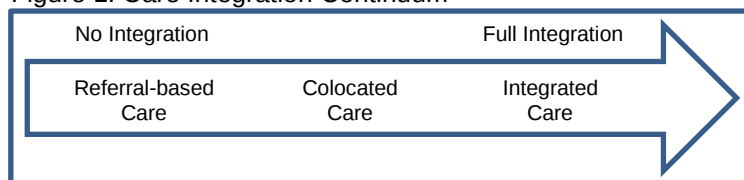


Table 1. Characteristics of individuals who received care within an integrated care setting and a comparison group, by variables used in developing the propensity score ^a

		Before Weighting			After Weighting ^d		
		ICS ^b (N= 2,177)	Comparison (N=3,095)	Standardized Difference in Means ^c	ICS (N= 2,177)	Comparison (N=3,095)	Standardized Difference in Means
Individual-Level Factors		Mean	Mean	%	Mean	Mean	%
Age		45.47	44.92	4.90	45.47	45.09	3.60
Sex (Female)		0.58	0.59	0.70	0.58	0.58	0.50
Race							
	White	0.48	0.72	50.20**	0.48	0.49	0.50
	Black	0.14	0.07	24.50**	0.14	0.15	0.70
	Other ^e	0.25	0.07	51.80**	0.25	0.25	1.20
Mental Illness							
	Mood Disorder	0.74	0.75	1.10	0.74	0.75	2.40
	Schizophrenia	0.45	0.48	6.50	0.45	0.47	2.80
Comorbidities		4.60	4.64	1.70	4.60	4.74	5.00
Area-Level Factors ^f							
Number of Mental Health Counselors		13.14	12.55	4.90	13.14	12.70	3.70
Number of Psychologists		21.13	9.99	56.00**	21.13	21.42	1.50
Number of Psychiatrists		10.30	5.78	36.30**	10.30	10.14	1.30
Number of Primary Care Providers		45.01	34.72	26.50**	45.01	44.60	1.10
Number of Physician Assistants		16.12	12.45	23.70**	16.12	15.58	3.50
Number of CMHC ^g		0.43	1.27	71.80**	0.43	0.42	0.40
Number of FQHC ^h		1.10	0.86	29.70	1.10	1.11	1.50
Median Household Income		43,258.00	50,565.00	44.10**	43,258.00	43,236.00	0.10
Percent Employed		86.42	89.14	23.30**	86.42	86.25	1.50
Percent Non-Hispanic White		54.40	72.73	71.20**	54.40	54.46	0.20
Percent Non-Hispanic Black		9.30	6.26	52.60**	9.30	9.43	2.30
Percent Hispanic/Latino		27.23	12.75	75.10**	27.23	26.82	2.10

^a Propensity score models also included higher order terms and interactions

^b ICS: Integrated Care Setting

^c Standardized Differences: difference in means of HH and comparison group, divided by the standard deviation of HH

^d Weighting by the Odds: Int Group Weight=1; Control Group Weight= propensity score/1-propensity score

^e Other: American Indian or Alaska Native, Asian Pacific Islander Hawaiian Native, Spanish Surname

^f ZCTA: Zip code tabulation areas

^g CMHC:Community Mental Health Center

^h FQHC:Federally Qualified Health Center

* .05> p >0.01 ; ** p<.01

Table 2. Difference-in-differences (DD) analysis of outpatient service use among individuals who received care within an integrated care setting and a comparison group ^{a,b}

		ICS ^c			Comparison				
		Pre-period ^d	Post-period ^e	Pre-post difference ^f	Pre-period	Post-period	Pre-post difference	DD	95%CI
At least one visit ^g									
Primary Care									
	Overall	83.85	88.18	4.33	83.93	85.10	1.17	3.16	-3.39 to 9.70
Physical Health Conditions ^h									
	COPD ⁱ	11.39	11.71	0.32	11.40	12.61	1.20	-0.88	-3.48 to 1.71
	Cardiovascular Disease	10.27	10.73	0.46	9.92	10.33	0.40	0.06	-3.60 to 3.72
	Diabetes	14.16	15.71	1.55	13.98	15.82	1.84	-0.28	-4.43 to 3.87
	Hypertension	17.42	20.01	2.58	17.12	18.17	1.05	1.54	-4.75 to 7.82
	Obesity	2.62	3.27	0.65	2.52	2.58	0.06	0.59	-1.37 to 2.83
Number of visits ^{jk}									
Primary Care									
	Overall	775.97	832.30	56.32	813.22	820.16	6.95	49.38	-70.84 to 169.59
Physical Health Conditions									
	COPD	286.63	298.39	11.76	234.45	273.41	38.96	-27.20	-195.46 to 141.06
	Cardiovascular Disease	227.58	244.47	16.90	191.75	202.39	10.64	6.26	-57.45 to 69.97
	Diabetes	371.74	371.12	-0.62	382.15	355.91	-26.24	25.62	-93.22 to 144.46
	Hypertension	240.49	230.29	-10.21	512.06	367.33	-144.73	134.52	-63.49 to 332.54
	Obesity	238.56	170.83	-67.73	103.34	103.64	0.31	-68.04	-136.37 to 0.295

^a Models weighting by the odds: Int Group Weight=1; Comparison Group Weight= propensity score/1-propensity score

^b Models adjusted for individual and ZCTA-level covariates. Individual-level covariate include: age, sex, race, mood disorders, schizophrenia, comorbidities; ZCTA-level covariates include: median household income, % employed, % non-Hispanic white, % non-Hispanic black, % Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of psychiatric nurses, number of primary care providers, number of physician assistants, number of CMHC number of FQHC

^c ICS: Integrated Care Setting

^d Pre-period: 12-months before Health Home started

^e Post-period: 12-months after Health Home started

^f Pre-post difference: post-period - pre-period

^g Outcomes are dichotomized, 1=one or more visits; 0=no visits

^h Each physical health condition was a primary diagnosis for a primary care visit

ⁱ COPD: Chronic Obstructive Pulmonary Disorder

^j Outcomes are count variables and only include cases $\geq$ one visit; per 100 person-years

^k Interpretation of count values: per 100 person-years

* .05> p >0.01 ; ** p<.01

Table 3. Difference-in-differences (DID) analysis of hospitalizations and emergency department use among individuals who received care within an integrated care setting and a comparison group^{a,b}

Within an integrated care setting and a comparison group									
		Int ^c			Comparison				
		Pre-period ^d	Post-period ^e	Pre-post Difference ^f	Pre-period	Post-period	Pre-post Difference	DID	95% CI
At least one visit ^g									
Hospital									
	All-Cause	20.77	22.03	1.26	22.04	26.24	4.19	-2.94	-7.92 to 2.05
	Non-MI ^h	13.91	15.12	1.21	13.98	17.31	3.33	-2.12	-6.08 to 1.84
	MI ⁱ	11.62	11.90	0.28	11.89	13.13	1.24	-0.96	-4.87 to 2.95
Emergency Department									
	All-Cause	35.19	38.16	2.98	36.29	35.06	-1.23	4.20	-1.95 to 10.36
	Non-MI	32.02	35.49	3.48	32.22	32.87	0.65	2.82	-2.64 to 8.29
	MI	9.47	8.45	-1.02	9.74	10.33	0.59	-1.61	-7.21 to 3.98
Number of visits ^{jk}									
Hospital									
	All-Cause	360.09	352.64	-7.45	287.93	329.00	41.07	-48.52	-124.01 to 26.96
	Non-MI	276.40	263.87	-12.53	242.20	254.11	11.91	-24.45	-86.92 to 38.03
	MI	292.41	331.10	38.69	285.38	372.24	86.86	-48.17	-144.68 to 48.34
Emergency Department									
	All-Cause	414.16	461.62	47.46	362.67	412.50	49.83	-2.37	-74.08 to 69.35
	Non-MI	384.81	456.47	71.66	332.67	396.66	63.99	7.67	-60.79 to 76.13
	MI	258.79	252.27	-6.52	216.83	264.39	47.56	-54.08	-147.39 to 39.23

^a Models weighting by the odds of the propensity score: Int Group Weight=1; Comparison Group Weight= propensity score/1-propensity score

^b Models adjusted for individual and ZCTA-level covariates. Individual-level covariate include: age, sex, race, mood disorders, schizophrenia, comorbidities; ZCTA-level covariates include: median household income, % employed, % non-Hispanic white, % non-Hispanic black, % Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of psychiatric nurses, number of primary care providers, number of physician assistants, number of CMHC number of FQHC

^c Int: Integrated Care Setting

^d Pre-period: 12-months before Health Home started

^e Post-period: 12-months after Health Home started

^f Pre-post difference: post-period - pre-period

^g Outcomes are dichotomized, 1=one or more visits; 0=no visits

^h Non-MI: Visits not associated with primary mental illness diagnosis

ⁱ MI: Visits associated with a primary mental illness diagnosis

^j Outcomes are count variables and only include cases ≥ one visit; per 100 person-years

^k Interpretation of count values: per 100 person-years

* .05> p>0.01 ; ** p<.01

Table 4. Difference-in-differences (DD) analysis of ACSC emergency and hospital use among individuals who received care within an integrated care setting and a comparison group^{a,b,c,d}

		ICS ^e			Comparison			DD	95% CI
		Pre-period ^f	Post-period ^g	Pre-post difference ^h	Pre-period	Post-period	Pre-post difference		
At least one									
Hospital									
	Overall ⁱ	4.15	3.55	-0.61	4.05	2.62	-1.43	0.83	-1.68 to 3.34
	Acute ^j	1.40	1.31	-0.09	1.32	0.79	-0.53	0.43	-0.93 to 1.80
	Chronic ^k	2.94	2.66	-0.28	2.94	2.03	-0.91	0.63	-1.70 to 2.96
Emergency Department				0.00			0.00		
	Overall	3.41	3.92	0.51	3.17	3.59	0.42	0.09	-1.80 to 1.97
	Acute	1.21	1.82	0.61	1.20	1.99	0.79	-0.19	-1.58 to 1.21
	Chronic	2.33	2.38	0.05	2.32	1.80	-0.51	0.56	-1.08 to 2.20

^a Outcomes are dichotomized, 1=one or more visits; 0=no visits

^b Models weighting by the odds: HH Group Weight=1; Comparison Group Weight= propensity score/1-propensity score

^c Models adjusted for individual and ZCTA-level covariates. Individual-level covariate include: age, sex, race, mood disorders, schizophrenia, comorbidities; ZCTA-level covariates include: median household income, % employed, % non-Hispanic white, % non-Hispanic black, % Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of psychiatric nurses, number of primary care providers, number of physician assistants, number of CMHC number of FQHC

^d ACSC: Ambulatory Care Sensitive Conditions

^e Int: Integrated Care Setting

^f Pre-period: 12-months before Health Home started

^g Post-period: 12-months after Health Home started

^h Pre-Post Difference: Post-period - Pre-period

ⁱ Overall: having an acute or chronic ACSC

^j Acute: Dehydration, bacterial pneumonia and urinary tract infection

^k Chronic: Diabetes (uncontrolled; short and long term complications), chronic obstructive pulmonary disease, asthma, hypertension, congestive heart failure, angina without procedure, and lower extremity amputation among patients with diabetes

* .05> p >0.01

** p<.01

Table 6. Difference-in-difference-in-differences (DDD) sub-group analysis of outpatient, emergency department, and hospital service use^{a,b,c}

	Dependent variables																								
	Outpatient Service Use																								
	Overall		COPD ^d		Cardiovascular Disease		Diabetes		Hypertension		Obesity														
	DDD (%)	95% CI	DDD (%)	95% CI	DDD (%)	95% CI	DDD (%)	95% CI	DDD (%)	95% CI	DDD (%)	95% CI													
ICS ^e X Post ^f X Black	2.94	-14.52 to 20.41	-4.96	-11.21 to 1.29	-9.54	-20.16 to 1.09	5.60	-1.99 to 13.19	11.49	-3.25 to 26.22	0.91	-1.41 to 3.24													
ICS X Post X Hispanic ^g	-10.37	-29.84 to 9.11	-3.31	-8.55 to 1.93	-3.55	-8.79 to 1.69	-10.43	-24.18 to 3.31	-4.30	-15.67 to 7.08	1.85	-1.00 to 4.69													
ICS X Post X Schizophrenia	4.17	-3.26 to 11.61	-1.86	-5.97 to 2.25	-1.90	-6.33 to 2.53	-1.00	-6.07 to 4.07	3.93	-4.55 to 12.41	1.51	-1.38 to 4.39													
	Hospital												Emergency Department												
	All-Cause				Non-MI ^h				MI ⁱ				All-Cause				Non-MI				MI				
	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI							
	ICS X Post X Black	3.64	-14.93 to 22.21	-2.01	-17.10 to 13.08	3.13	-7.79 to 14.05	-1.45	-21.91 to 19.01	-4.92	-22.26 to 12.42	3.35	-1.91 to 8.60												
	ICS X Post X Hispanic	-9.70	-22.01 to 2.62	-14.95*	-26.93 to -2.97	-0.35	-12.51 to 11.80	13.39	-2.14 to 28.92	7.77	-6.46 to 22.00	0.91	-21.40 to 23.22												
	ICS X Post X Schizophrenia	-7.69*	-15.09 to -0.29	-2.70	-8.56 to 3.16	-3.49	-10.10 to 3.13	-6.08	-16.41 to 4.26	-1.93	-10.92 to 7.07	-6.18	-14.36 to 2.00												
		ACSC ^j Hospital												ACSC Emergency Department											
		Overall ^k				Acute ^l				Chronic ^m				Overall				Acute				Chronic			
		DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI	DDD	95% CI						
		ICS X Post X Black	-0.60	-5.22 to 4.01	-0.55	-3.68 to 2.57	-1.26	-4.43 to 1.90	0.89	-3.73 to 5.50	-0.15	-2.38 to 2.09	0.14	-3.89 to 4.17											
ICS X Post X Hispanic	2.55	-3.81 to 8.91	-0.09	-2.23 to 2.06	0.38	-7.04 to 7.81	0.79	-2.36 to 3.94	-0.37	-2.82 to 2.09	1.05	-0.93 to 3.03													
ICS X Post X Schizophrenia	1.28	-2.46 to 5.03	0.70	-1.74 to 3.15	1.05	-2.81 to 4.92	-0.65	-3.90 to 2.61	-0.84	-3.72 to 2.05	0.63	-1.73 to 2.99													

^a Outcomes are dichotomized, 1=one or more visits; 0=no visits

^b Models weighting by the odds: HH Group Weight=1; Comparison Group Weight= propensity score/1-propensity score

^c Models adjusted for individual and ZCTA-level covariates. Individual-level covariate include: age, sex, mood disorders, comorbidities; ZCTA-level covariates include: median household income, % employed, % non-Hispanic white, % non-Hispanic black, % Hispanic, number of psychiatrist, number of psychologist, number of clinical social workers, number of mental health counselors, number of physician assistants, number of CMHC number of FQHC

^d COPD: Chronic Obstructive Pulmonary Disorder

^e ICS: Integrated Care Setting

^f Post-period: 12-months after Health Home started

^g Hispanic: Spanish surname was used as a proxy for hispanic ethnicity

^h Non-MI: Visits not associated with primary mental illness diagnosis

ⁱ MI: Visits associated with a primary mental illness diagnosis

^j ACSC: Ambulatory Care Sensitive Condition

^k Overall: Having an acute or chronic ACSC

^l Acute: Dehydration, bacterial pneumonia and urinary tract infection

^m Chronic: Diabetes (uncontrolled; short and long term complications), chronic obstructive pulmonary disease, asthma, hypertension, congestive heart failure, angina without procedure, and lower extremity amputation among patients with diabetes

* .05> p>0.01

** p<.01

Chapter III

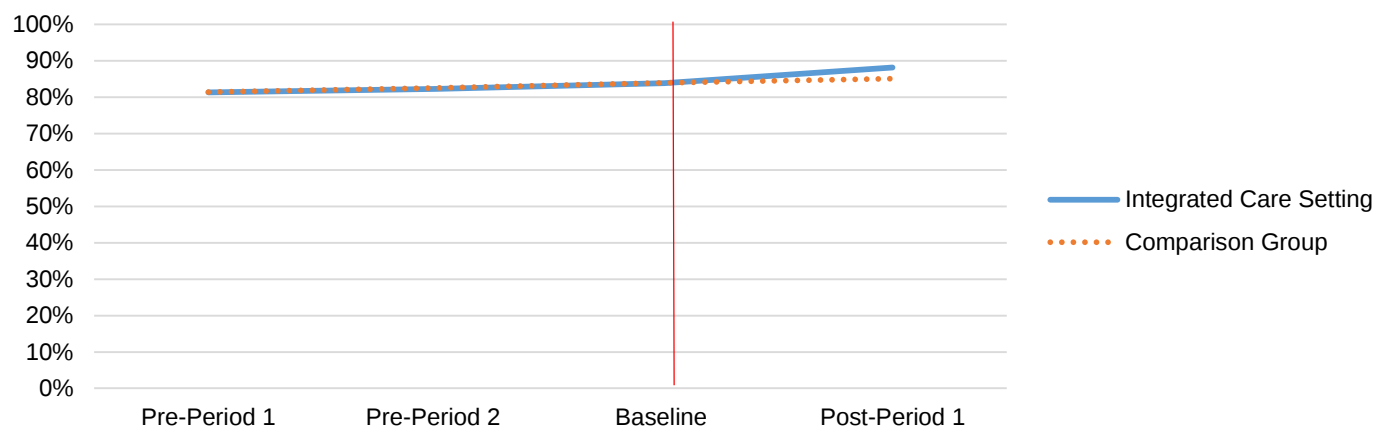
Assessing the joint effects of Health Home and Integrated Care Setting on Health Service Use among Medicaid Beneficiaries with Serious Mental Illness

Appendix

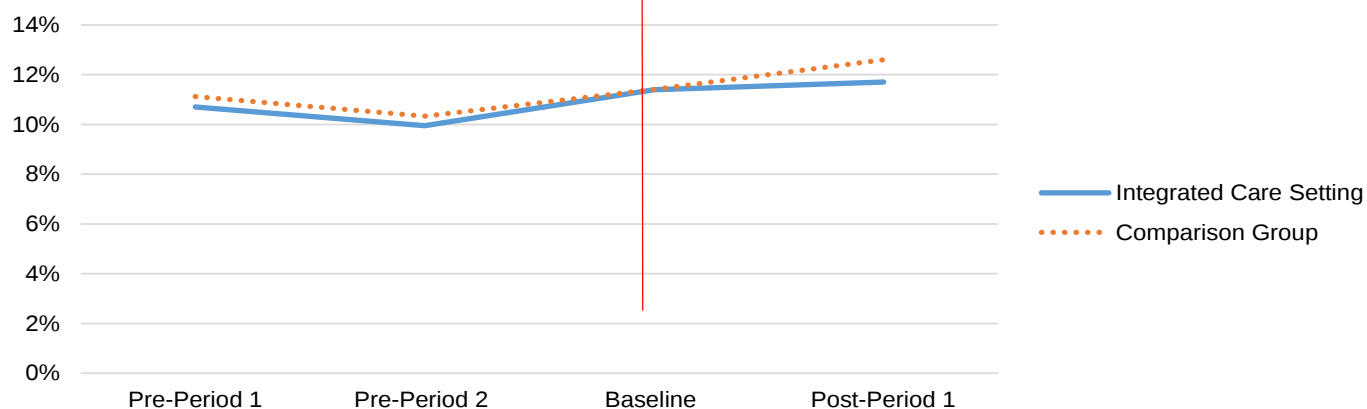
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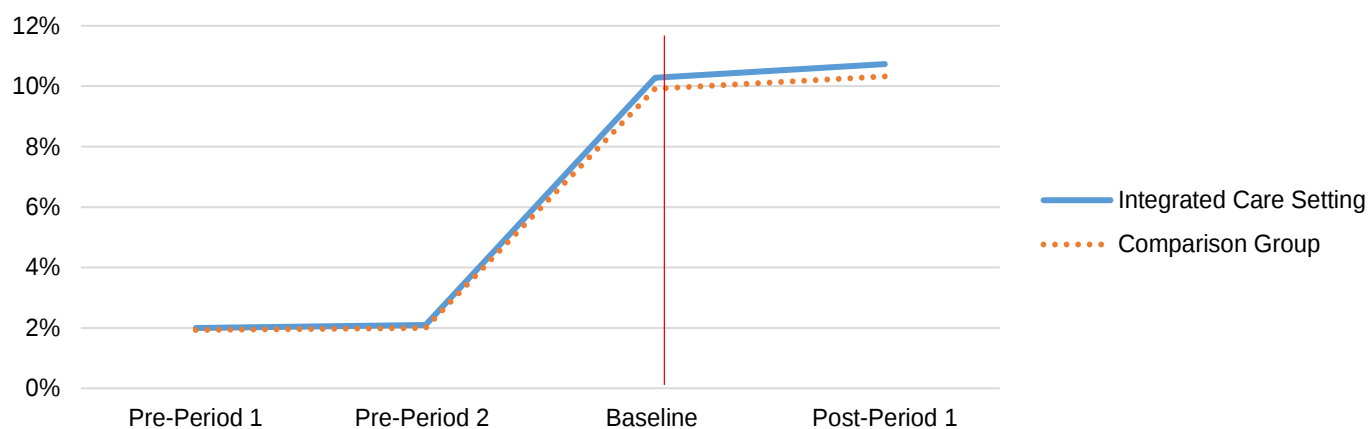
Appendix A. Figure 1
Percent Outpatient Service Use: Overall
Integrated Care Setting and Comparison Groups



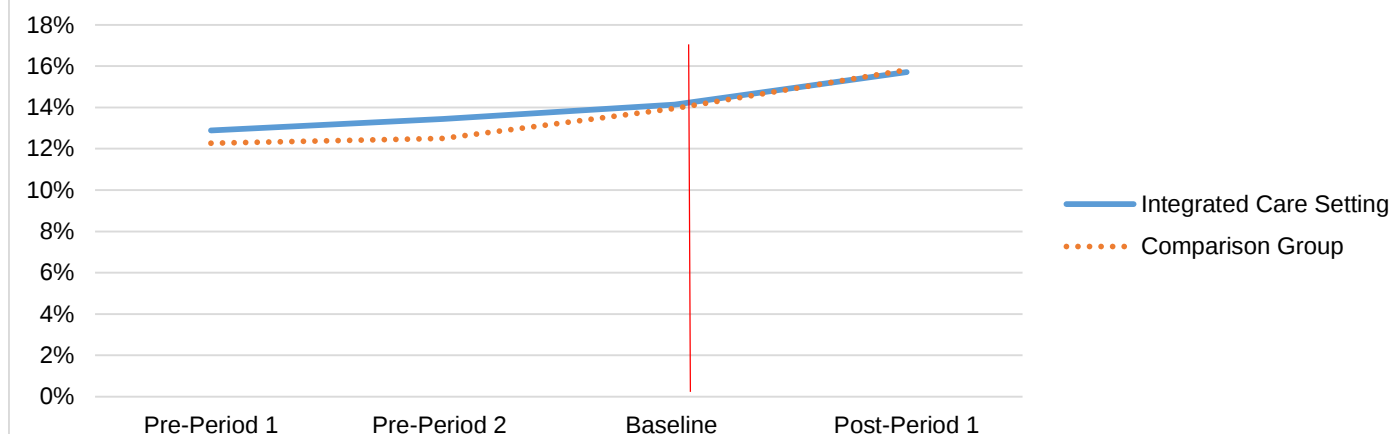
Appendix A. Figure 2
Percent Outpatient Service Use: COPD
Integrated Care Setting and Comparison Groups



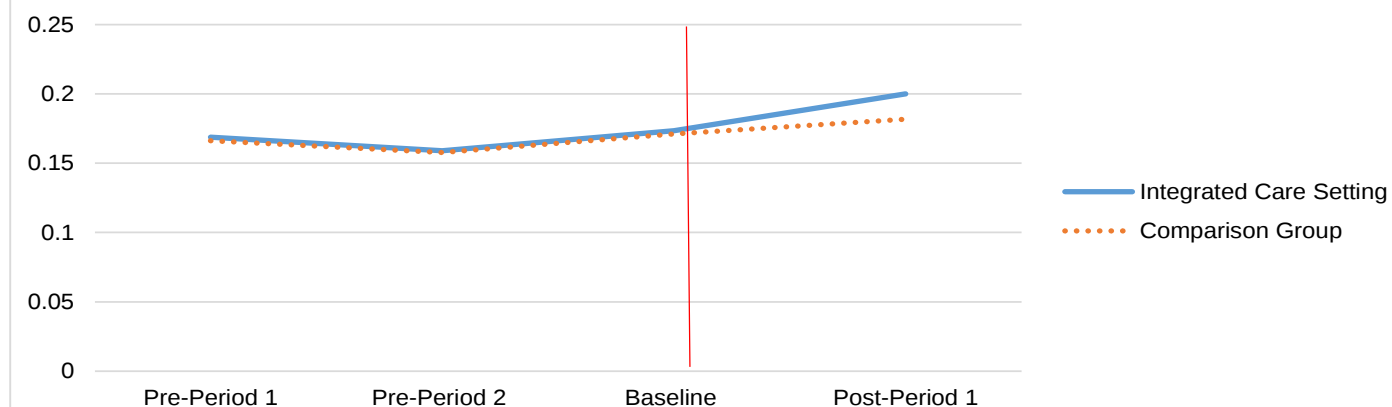
Appendix A. Figure 3
Percent Outpatient Service Use: CVD
Integrated Care Setting and Comparison Groups



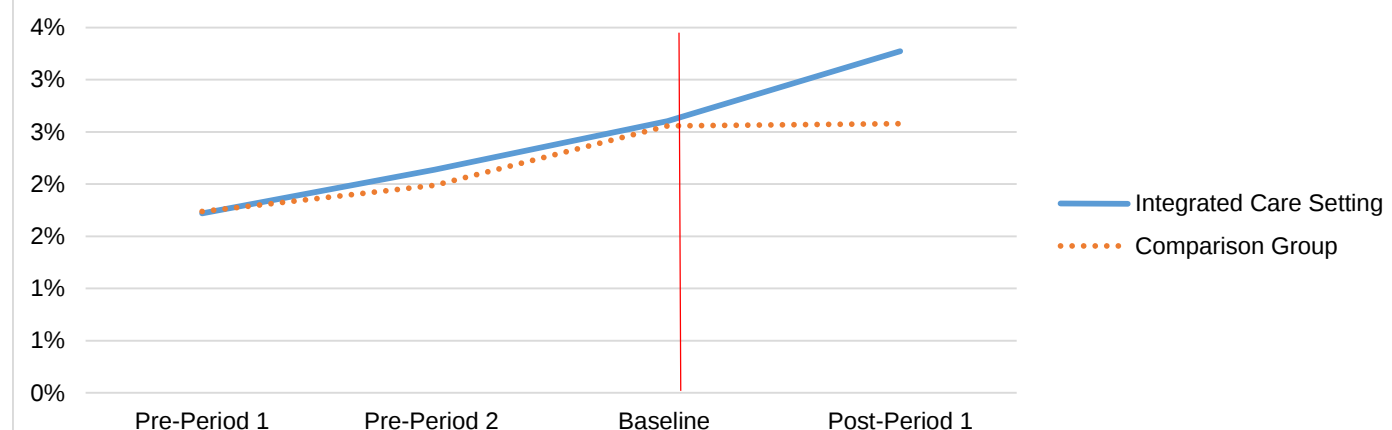
Appendix A. Figure 4
Percent Outpatient Service Use: Diabetes
Integrated Care Setting and Comparison Groups



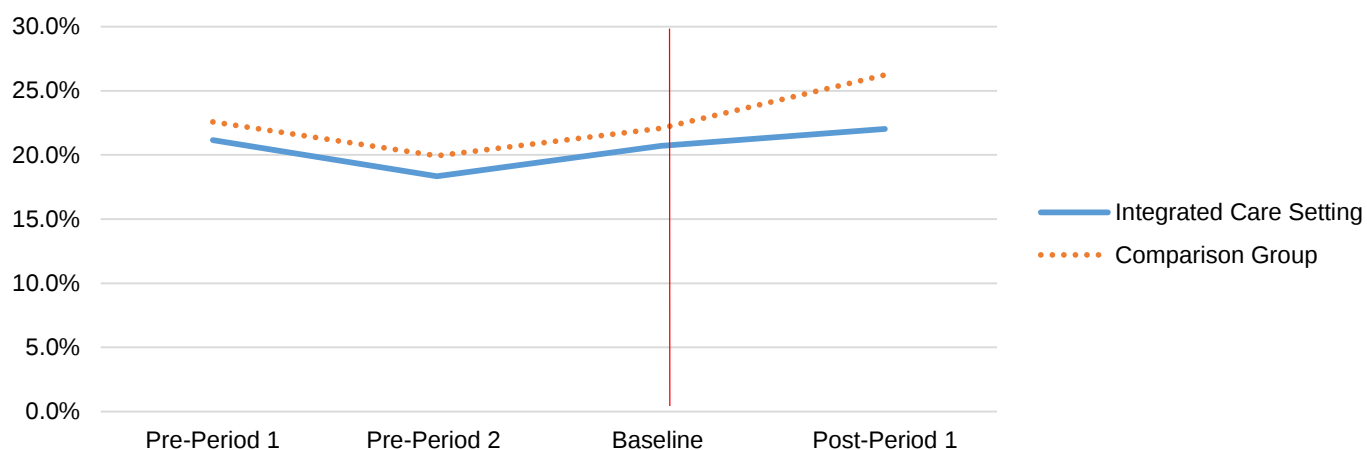
Appendix A. Figure 5
Percent Outpatient Service Use: Hypertension
Integrated Care Setting and Comparison Groups



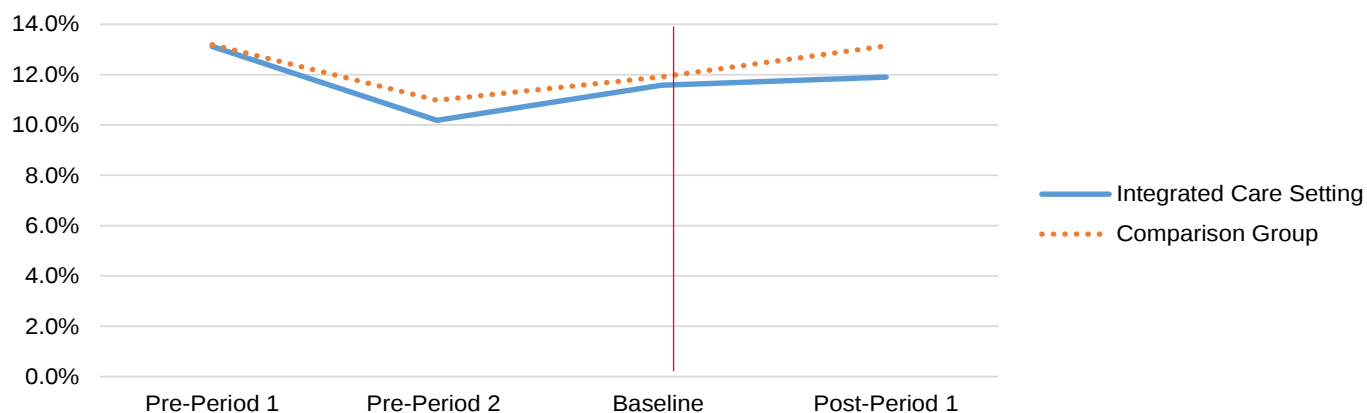
Appendix A. Figure 6
Percent Outpatient Service Use: Obesity
Integrated Care Setting and Comparison Groups



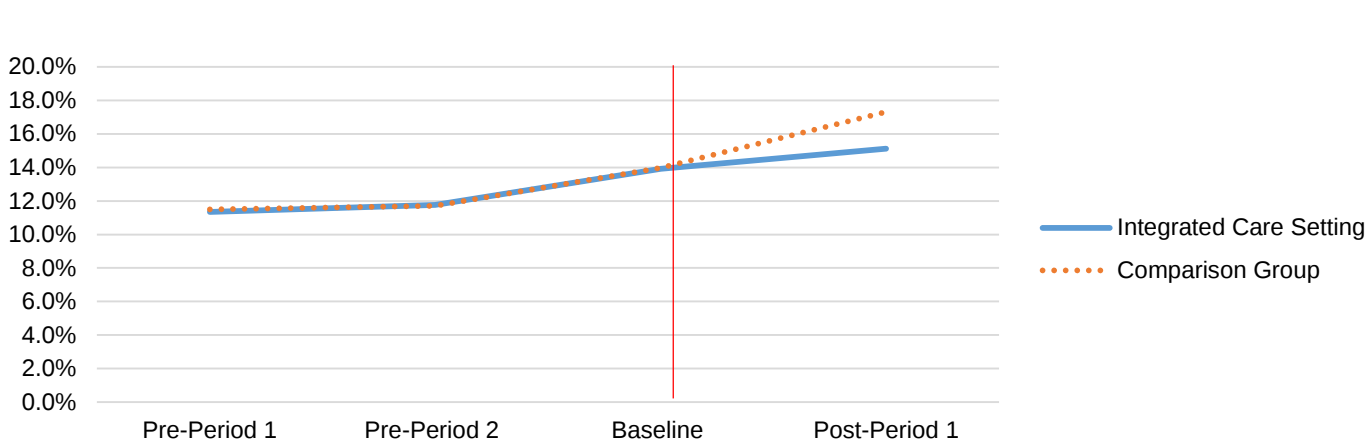
Appendix A. Figure 7
Percent Hospital Use: All-cause
Integrated Care Setting and Comparison Groups



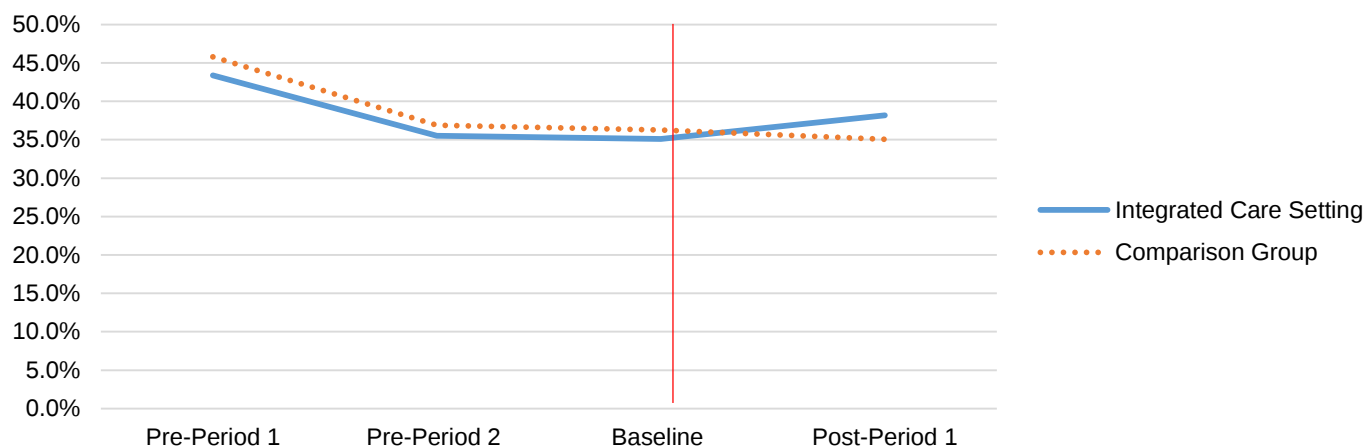
Appendix A. Figure 8
Percent Hospital Use: MI
Integrated Care Setting and Comparison Groups



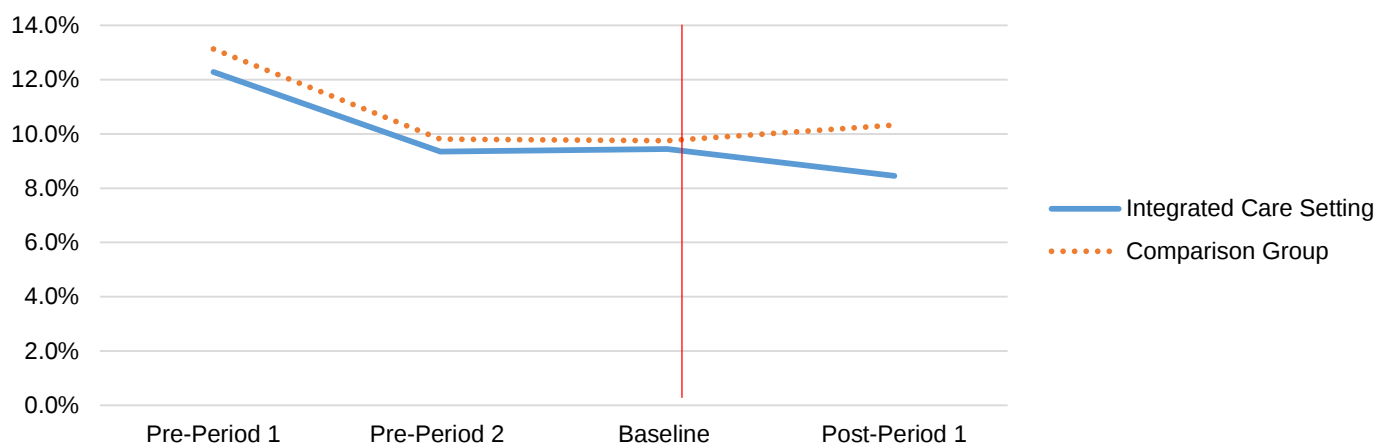
Appendix A. Figure 9
Percent Hospital Use: Non-MI
Integrated Care Setting and Comparison Groups



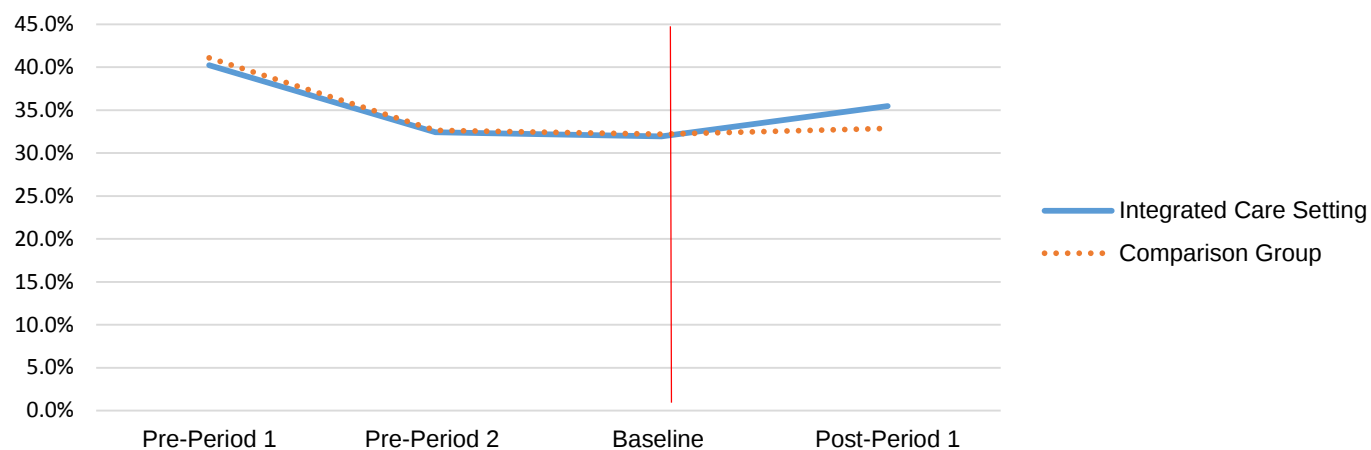
Appendix A. Figure 10
Percent ED Use: All-cause
Integrated Care Setting and Comparison Groups



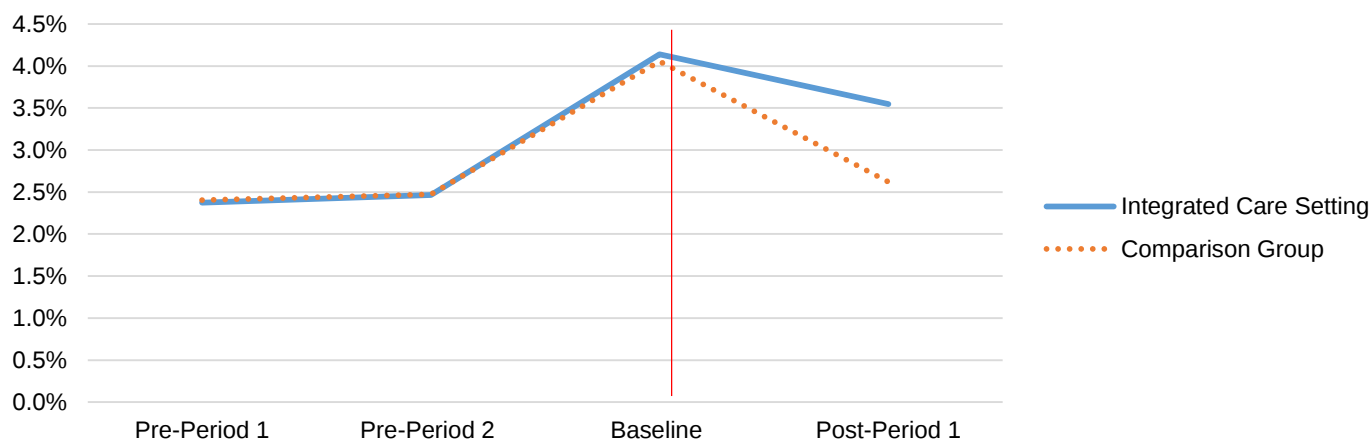
Appendix A. Figure 11
Percent ED Use: MI
Integrated Care Setting and Comparison Groups



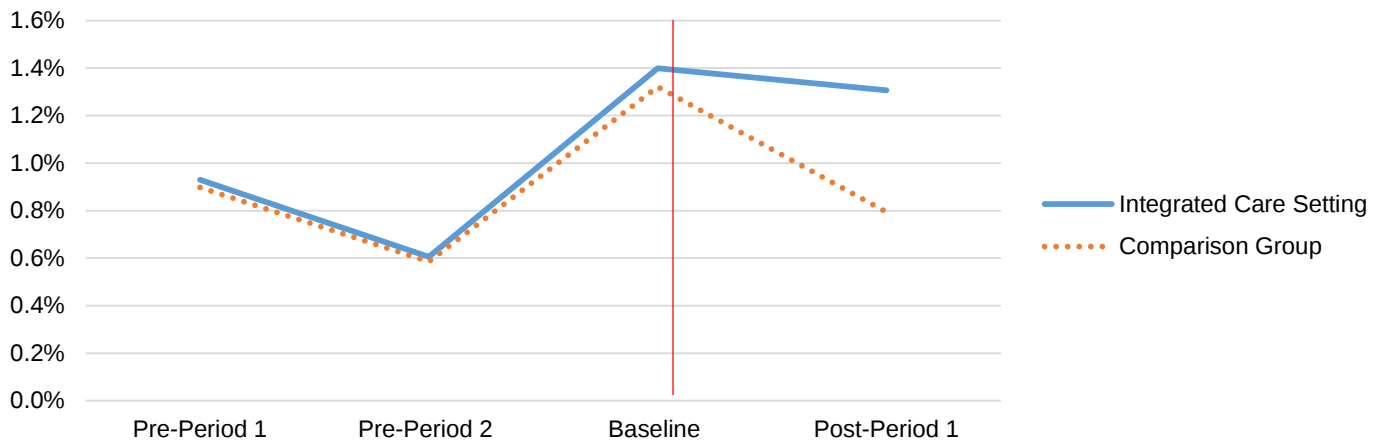
Appendix A. Figure 12
Percent ED Use: Non-MI
Integrated Care Setting and Comparison Groups



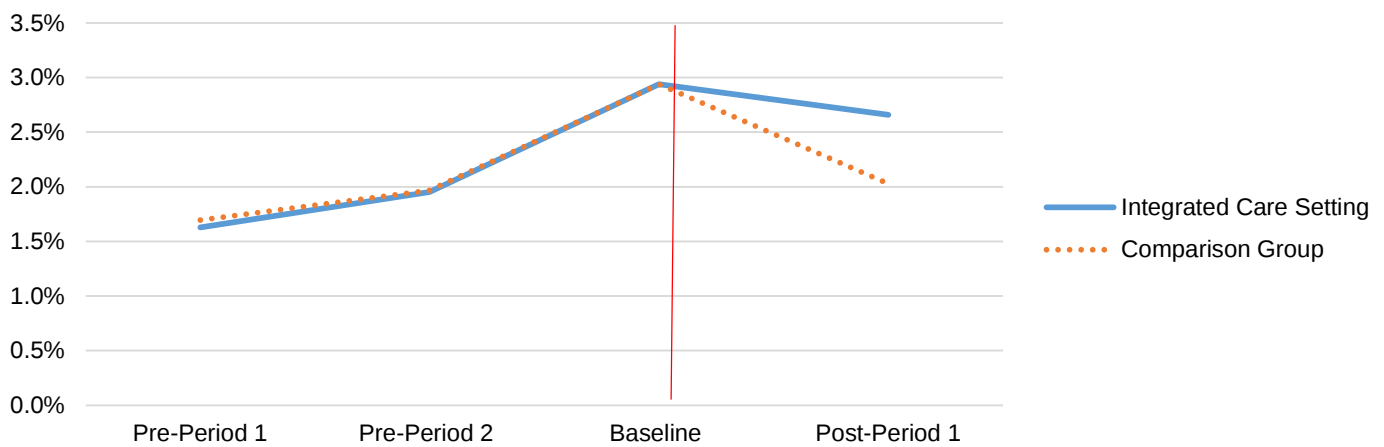
Appendix A. Figure 13
Percent ACSC Hospital Use: Overall
Integrated Care Setting and Comparison Groups



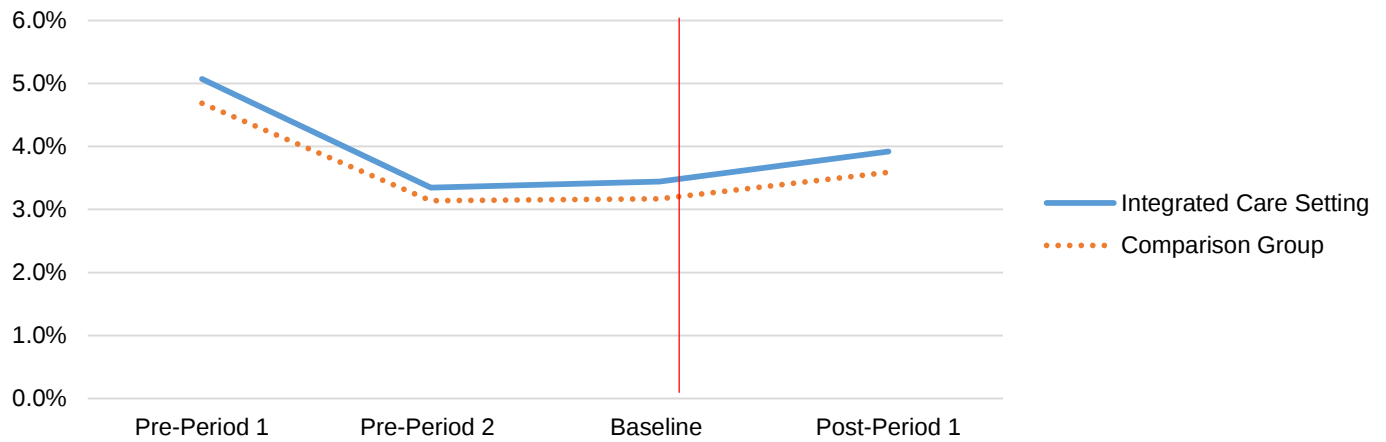
Appendix A. Figure 14
Percent ACSC Hospital Use: Acute
Integrated Care Setting and Comparison Groups



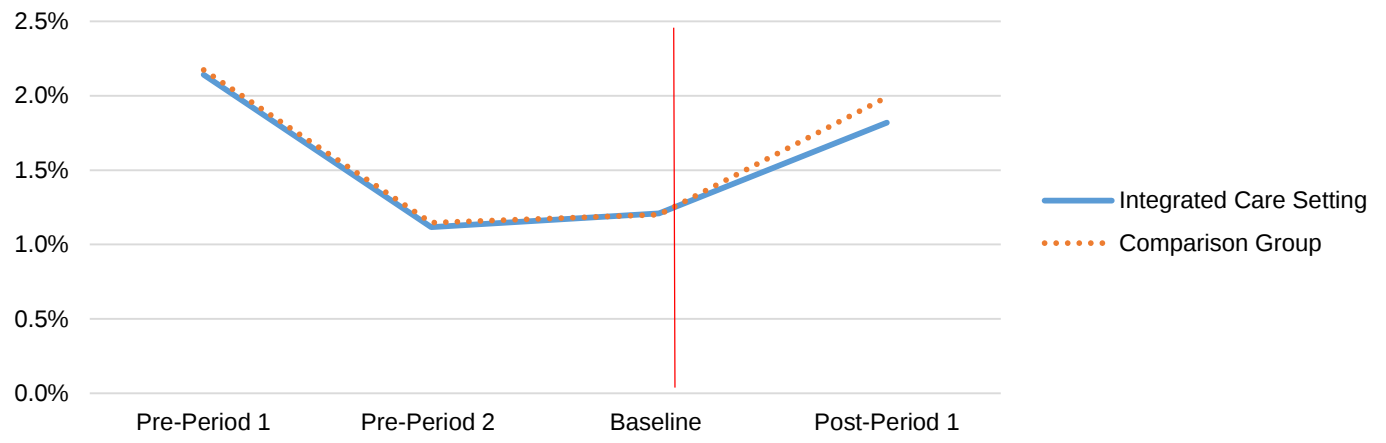
Appendix A. Figure 15
Percent ACSC Hospital Use: Chronic
Integrated Care Setting and Comparison Groups



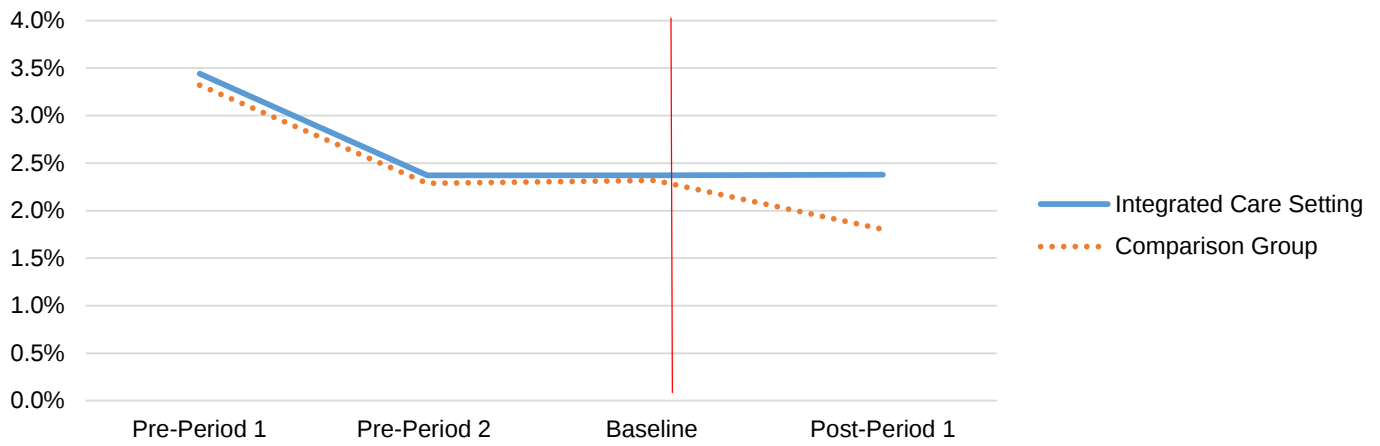
Appendix A. Figure 16
Percent ACSC ED Use: Overall
Integrated Care Setting and Comparison Groups



Appendix A. Figure 17
Percent ACSC ED Use: Acute
Integrated Care Setting and Comparison Groups



Appendix A. Figure 18
Percent ACSC ED Use: Chronic
Integrated Care Setting and Comparison Groups



Bibliography

Chapter I

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