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**PATIENT-PERCEIVED PATIENT-CENTERED MEDICAL HOME
CHARACTERISTICS AND HEALTHCARE UTILIZATION,
EXPENDITURE AND QUALITY**

ALISSA RATANATAWAN

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PATIENT-PERCEIVED PATIENT-CENTERED MEDICAL HOME CHARACTERISTICS
AND HEALTHCARE UTILIZATION, EXPENDITURE AND QUALITY


by

ALISSA RATANATAWAN, MD MPH

APPROVED:


J. MICHAEL SWINT, PHD


ROBERT MORGAN, PHD


WENYAW CHAN, PHD



DEAN, THE UNIVERSITY OF TEXAS
SCHOOL OF PUBLIC HEALTH

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Alissa Ratanatawan, MD MPH PhD
2019

DEDICATION

To My Family

PATIENT-PERCEIVED PATIENT-CENTERED MEDICAL HOME CHARACTERISTICS
AND HEALTHCARE UTILIZATION, EXPENDITURE AND QUALITY

by

ALISSA RATANATAWAN
MD, Thammasat University, 2007
MPH, Harvard University, 2013

Presented to the Faculty of The University of Texas

School of Public Health

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PATIENT-PERCEIVED PATIENT-CENTERED MEDICAL HOME CHARACTERISTICS AND HEALTHCARE UTILIZATION, EXPENDITURE AND QUALITY

Alissa Ratanatawan, MD MPH PhD
The University of Texas
School of Public Health, 2019

Dissertation Chair: J. Michael Swint, PhD

The patient-centered medical home (PCMH) model is a care delivery model which patient treatment is coordinated through their primary care physician to ensure they receive the necessary care when and where they need it, in a manner they can understand with the aims to improve healthcare quality while keeping healthcare cost growth under control. The objective of this study was to analyze health service utilization, expenditure and quality of civilian noninstitutionalized US adult population in healthcare facilities that have 3 domains of PCMH features, which are comprehensive care, patient-centered care, and accessible care, using patient's perspective from the 2016 Medical Expenditure Panel Survey (MEPS) data. The analysis was done using regression analysis with complex survey method. While univariate models show significant associations between the receipt of care from providers that patient considered having characteristics consistent with the 3 domains of PCMH model and number of health service utilizations (ambulatory visits, emergency room visits, and prescription medication refills) and healthcare expenditures (total healthcare expenditures and total emergency department expenditures), no associations were found after controlling for individual demographic and socioeconomic characteristics in all but one measure.

Number of ambulatory visits decreased slightly with the perception of receiving care consistent with the 3 domains of the PCMH model. No significant difference were observed in both adjusted and unadjusted model for number of hospital discharges, total inpatient expenditures, total ambulatory expenditures, total pharmaceutical expenditures, as well as healthcare quality for diabetic patients (HbA1c testing, blood cholesterol testing, dilated eye examination, feet examination, and flu vaccination). However, there were evidences of associations between those outcomes and several social health determinant factors such as age, gender, education, insurance coverage, and self-report health status. Even though there was no evidence of associations between overall patient-perceived PCMH care in terms of comprehensive care, patient-centered care, and accessible care and healthcare utilization, expenditure, and quality, additional research on the effects of specific PCMH attributes on health outcomes in both general population and specific population with chronic illness may provide better understanding of the impact of the PCMH model on achieving quality care at sustainable costs.

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BACKGROUND

Introduction

Rapidly rising healthcare costs are a major problem for the United States. It is reported that the United States healthcare spending reached \$3.5 trillion in 2017, with per capita spending on healthcare of \$10,739 (Centers for Medicare and Medicaid Services, 2018). Moreover, the rate of increase is still growing alarmingly. In 2017, the United States National Health Expenditures (NHE) accounted for 18.3 percent of the gross domestic product (GDP) while it was 13.3 percent in 2000 (U.S. National Health Expenditure As Percent of GDP from 1960 to 2017) and 5 percent in 1960 (Ewing, 2013). Specifically, healthcare spending increased 2 percent faster than GDP growth (Alliance for Healthcare Reform, 2012). This is not sustainable in the long run for all stakeholders involved. The problem is not new but rather a continuing situation. According to a 1932 report from the Committee on Costs, “Many persons do not receive service which is adequate either in quality or quantity, and the costs of service are inequitably distributed. The result is a tremendous amount of preventable physical pain and mental anguish, needless deaths, economic inefficiency, and social waste.” (Ewing, 2013).

Several causes of the increase in healthcare expenditure have been identified, both from provider side and consumer side (Ewing, 2013; America’s Health Insurance Plans, 2012). Prices for medical services and intensity of care both continue to increase. One of the reasons for this is the advancement in medical technologies. Lack of coordination and management as well as fragmented delivery system lead to unnecessary duplication of services and thus increases in unnecessary costs. The fee for service payment system which pays for

volume over value without rewards for coordination provides no incentives for providers to save costs. The practice of defensive medicine and lack of evidence-based medicine further worsen the situation. It has been repeatedly reported that around 20 – 30 percent of healthcare spending is wasteful, harmful, or risky (Sharnk, Rogstad, & Parekh, 2019; Bentley, Effros, Palar, & Keeler, 2008). The increased prevalence of chronic diseases, the growth of the older population and unhealthy lifestyle lead to more demand for healthcare services. Moreover, lack of patient engagement and lack of price transparency results in the unawareness of the increase in healthcare costs. Using more specialty care instead of primary care also increase healthcare expenditures.

In response to these continuing issues, the patient-centered medical home (PCMH) model has been developed and proposed as a promising solution which addresses many sources of this problem. The PCMH is defined as a care delivery model whereby a patient's treatment is coordinated through their primary care physician to ensure they receive the necessary care when and where they need it, in a manner they can understand with the aims to improve healthcare quality while keeping healthcare cost growth under control (Jackson, Powers, & Chatterjee, 2013).

This dissertation analyzed effects of 3 domains of patient-centered medical home characteristics as perceived by patients on three aspects: healthcare utilization, healthcare expenditure, and healthcare quality to determine whether this model is effective in addressing these major issues. The objective of this study is to analyze health service utilization, expenditure and quality of the US adult population in healthcare facilities that have 3

domains of PCMH features, which are comprehensive care, patient-centered care, and accessible care, using patient's perspective from national survey data. Specifically, the questions for this study are 1) What is the effect of these PCMH characteristics on health service utilization? 2) Can these PCMH characteristics help to reduce healthcare expenditure? Finally, 3) Can these PCMH characteristics help to improve the quality of care, in terms of proper disease management, in patients with chronic diseases such as diabetes mellitus?

Literature Review

History and Development of the Patient-Centered Medical Home

The medical home concept was first developed in 1967 by the American Academy of Pediatrics as an ideal model for providing quality care for children with special needs (Scholle, Torda, Peikes, Han, & Genev, 2010). In 2007, four professional organizations, namely, the American College of Physicians (ACP), the American Academy of Family Physicians (AAFP), the American Academy of Pediatrics (AAP) and the American Osteopathic Association (AOA), collaborated to develop the Joint Principles of the Patient-Centered Medical Home to promote demonstrations of new payment models for primary care. As of 2011, the Joint Principles were endorsed by 19 additional physician organizations.

The Joint Principles (AAFP, AAP, ACP, and AOA, 2007) defines the key characteristics of the PCMH as 1) *personal physician*: providing first contact, continuous and

comprehensive care; 2) *physician directed medical practice*: leading a team to take responsibility for patient care; 3) *whole person orientation*: providing care for all stages of life, acute care, chronic care, preventive services, and end of life care; 4) *care is coordinated and/or integrated* across healthcare system and patient's community using health information technology; 5) *quality and safety*: using evidence-based medicine and participating in quality improvement process; 6) *enhanced access*: open scheduling, expanded hours, and new options for communications between patients, physicians, and staff; and 7) *payment*: reflecting the work related to care management, coordinated care, health information technology, enhanced communication access, quality improvement, and cost-saving outcomes.

The PCMH model is built on three foundation supports and has five key domains (American College of Physicians; Agency for Healthcare Research and Quality). The three foundation supports include health information technology (IT), workforce and finance. Health IT is used to collect, store, and manage personal health information, as well as aggregated data that can be used to improve process and outcome. Workforce includes all healthcare personnel. Payment reform to compensate for care coordination and enhance access is required. The five key domains of the PCMH model are comprehensive care, patient-centered care, coordinated care, accessible care, and quality and safety. To provide comprehensive care, which includes both physical and mental needs of patients in terms of prevention and wellness, acute care, and chronic care, a team of care providers is necessary. Patient-centeredness emphasizes the whole person approach. Patients and their families have

to be fully informed and participate in any decision-making regarding the care received. Care has to be coordinated across the healthcare system, especially if the patient receives care from multiple settings. The service has to be accessible when needed. Quality and safety are also important and providers should use evidence-based medicine and clinical decision-support tools to guide shared decision making with patients and families.

The PCMH model has been widely supported since it is perceived as a way to enhance primary care and deliver better care to patients with chronic conditions. It has stimulated the attention of payers, Medicaid policy makers, physicians, and patient advocates, as it has the potential to address several of the shortcomings of the current healthcare system. In the private sector, the purchaser-led Patient-Centered Primary Care Collaborative (PCPCC), most national insurers and some regional insurers have expressed interest in this concept with the hope of attracting and retaining primary care physicians and supporting their ability to coordinate care for patients (The National Committee for Quality Assurance, 2008). With respect to the public sector, legislation requires the Centers for Medicare and Medicaid Service (CMS) to implement and evaluate a Medicare PCMH demonstration. Many states also adopted the PCMH model in their Medicaid program.

The PCMH model also aligns well with the six major aims for a quality health care system as reported by the Institute of Medicine (IOM) in 2001. The IOM states that, “Healthcare should be safe, effective, patient-centered, timely, efficient, and equitable.” (Institute of Medicine, 2001) Furthermore, another report from the IOM in 2005 states that

investments in information and communications technologies can help make healthcare more safe, efficient and effective (Institute of Medicine, 2005).

With respect to the consumer perspective, several papers report that patients value well-organized and coordinated physicians. The most important physician characteristics to consumers are the physician's ability to communicate and to show a caring attitude (Robinson & Brodie , 2007). Consumer needs in healthcare services in addition to the care itself include access and coordination of care, appropriate education, communication, information, support and alleviation of fear and anxiety, as well as assistance with any additional tests and follow-up appointments (Edgman-Levitan & Cleary, 1996).

Effects of the Patient-Centered Medical Home

The main outcomes of interest of the PCMH model are whether the healthcare expenditures can be reduced, whether it will change the pattern of healthcare utilization toward primary care, and whether it can help improve quality of care. The PCMH model is designed to address healthcare cost with the combination of waste reduction, expansion of health information technology/electronic medical record used, increased role of primary care, better patient engagement, and increased coordination. All of these aspects lead to better management of health services, especially for patients with chronic diseases. With more emphasis on primary care and preventive care, patient should receive better quality care with a resulting reduction in unnecessary healthcare utilizations such as hospitalization and use of

emergency department. Therefore, lower healthcare expenditure can be expected. However, in current literature the effects of the PCMH as present are still mixed.

Effects of Patient-Centered Medical Home on Healthcare Utilization

Existing literature on effects of PCMH on healthcare utilization mainly focus on number of emergency department visits, number of hospitalizations, and type of providers visited. Most of them evaluate the effects of PCMH facility in either a specific state or specific population. The results are mixed. Some papers support the hypothesis that PCMH model decreases number of emergency department visits and hospitalizations, while others reports no significant difference in healthcare utilization between PCMH and non-PCMH facilities (Pines, van Hasselt, & McCall, 2015; Van Haselt, McCall, Keyes, Wensky, & Smith, 2014; Harbrecht & Latts, 2012; Raskas, 2012; Rosenthal, et al., 2015). The same controversy is reported for type of provider visited (Fontaine, Flottemesch, Solberg, & Asche, 2011; Kaushal, Edwards, & Kern, 2015).

A recent study reports the emergency department utilization of Medicare population comparing between 146,410 beneficiaries in 308 NCQA's PCMH recognized practice and 446,273 beneficiaries in 1,906 control practices without the PCMH model (Pines, van Hasselt, & McCall, 2015). The results show that the rate of growth in all-cause emergency department visits per 100 beneficiaries were 13 and 12 visits fewer for PCMH in 2009 and 2010 respectively. The ambulatory-care- sensitive emergency department visits per 100 beneficiaries were also fewer for PCMH in the same period (8 and 7 visits fewer

respectively). However, there was no hospitalization effect from the PCMH model. The number of admissions from all-causes and ambulatory-care-sensitive hospitalization were not statistically different between those in PCMHs and non-PCMHs. Another study for Medicare fee-for-service beneficiaries using the same database also shows that the PCMH groups had fewer emergency department visits of 55 and 13 per 1,000 beneficiaries for all causes and ambulatory care sensitive conditions respectively (Van Haselt, McCall, Keyes, Wensky, & Smith, 2014). However, no significant difference was found for hospitalization and type of providers visited (primary care, medical specialist, and surgical specialist).

Another study analyzed Colorado's multi-payer PCMH pilots operating in 2009 to 2012 (Harbrecht & Latts, 2012). This pilot was one of the first voluntary multi-payer PCMH pilot projects in the country. It involved six health plans, the state's high risk pool carrier, sixteen primary care practice and roughly 100,000 patients. The preliminary result shows that the PCMH pilot significantly reduce emergency department visits and hospital admissions, especially for patients with multiple chronic conditions. Another study from this pilot reported that the admission rate per 1,000 decreased by 18 percent in PCMH pilots while the rate increased by 18 percent in the control group (Raskas, 2012). Specialist visits for the PCMH group remained the same but it increased by 10 percent in the control group.

A study by Rosenthal et al in 2015 involves approximately 98,000 patients in 15 small and medium-sized multi-payer PCMH pilots and 66 comparison practices in Colorado. Using difference-in-difference analyses this study provided evidence of positive results (Rosenthal, et al., 2015). Two years after the PCMH's implementation, there was reduction

in emergency department use by 7.9 percent or 1.4 visits per 1,000 member months compared to baseline level. The additional decline was observed after 3 years of implementation with a 9.3 percent or 1.6 visits per 1,000 member months reduction in emergency department visits. After three years primary care visits in the pilot practices also decreased by 1.5 percent. In general, there was no significant difference for ambulatory care sensitive admission. However, for patients who had more than one comorbidity, there was a significant reduction in ambulatory care sensitive admission by 10.3 percent.

A Minnesota study compared utilization among privately insured enrollees who attended a PCMH practice with those with fragmented care and concluded that the PCMH practice attendees made significantly fewer primary care and specialist visits than groups who received less consistent primary care (Fontaine, Flottemesch, Solberg, & Asche, 2011).

A prospective cohort study using 275 primary care physicians with small practices and 230,593 patients was undertaken in New York state during 2008 to 2010 (Kaushal, Edwards, & Kern, 2015). The purposes of the study were to determine association between the PCMH model and healthcare utilization and to isolate that effect from the use of electronic health records (EHR). Three groups of physicians were studied (physicians in level 3 NCQA's PCMH recognition practices and using EMR; physicians using paper record; and physicians using EHR without the PCMH). The results showed that after one year of implementation, for patients with physicians in the PCMH model, there were 21 fewer specialist visits per 100 patients compared to those with paper records physicians and 22 fewer specialist visits per 100 patients compared to those with physicians who used EHR

without the PCMH model. However, no significant difference was found in the number of primary care visits, radiology tests, laboratory tests, emergency department visits, admissions, or readmissions.

A study in 2014 evaluated the effectiveness of the medical home in reducing ER visits (Fandre, McKenna, Beauvais, Kim, & Mangelsdorff, 2014). The study was done with the PCMH care delivery model in Kentucky, which was part of a campaign to implement the PCMH model throughout the Army Medical Command. Comparing to standard primary care clinic enrollees, those enrolled in the PCMH model were 67 percent less likely to visit the emergency room when controlled for age, gender, race, beneficiary category, marital status, and outpatient visits.

Another study from Rhode Island reports reduction in healthcare utilization 2 years after implementation of the PCMH model in five independent primary care practices and three private insurers in Chronic Care Sustainability Initiative (Rosenthal, Friedberg, Singer, Eastman, Li, & Schneider, 2013). The pilot practices received financial support, care managers, and technical assistance for quality improvement and practice transformation. After two years, the PCMH pilots had significantly fewer ambulatory care sensitive emergency department visits of approximately 0.8 per 1000 member months or 11.6 percent compare to the baseline rate of 6.9 visits per 1000 member months. Although not achieving significance, there were downward trends in emergency department visits and inpatient admissions.

The Veterans Health Administration (VHA) implemented the PCMH model in their primary care clinics in 2010 with the aims to improve health outcomes through team-based care, improved access, and care management (Nelson, et al., 2014). The analyses using data for more than 5.6 million veterans who received care at 913 VHA hospital-based and community-based primary care clinics found that the veterans 65 years or older receiving care from practices with PCMH characteristics had significantly lower hospitalization rates for ambulatory care-sensitive conditions (4.42 vs 3.68 quarterly admissions per 1000 patients). Emergency department uses were also significantly lower for the PCMH group (188 vs 245 visits per 1,000 patients).

Effects of Patient-Centered Medical Home on Healthcare Expenditure

Existing literature of effects of PCMH on healthcare expenditure also provide mixed results. The categories of expenditures analyzed in this research are total expenditure, emergency department expenditure and inpatient expenditure in either a specific state with PCMH pilot programs or a specific population. While most papers show that PCMH model is associated with lower healthcare expenditure, a few studies found that it has no significant effect, or even an increase expenditure in some domains.

A study in 2012 shows that patients treated in NCQA's PCMH practices had lower total healthcare expenditure (DeVries, Chia-Hsuan, Sridhar, Hummel, Breidbart, & Baron, 2012). The study used data from 31,032 PCMH patients and 350,015 non-PCMH patients with Empire Blue Cross Blue Shield, New York City. The total costs were \$409 per member

per month for patients in the PCMH model compared to \$484 per member per month for non-PCMH patients.

Another study reported a lower rate of growth in emergency department payment per beneficiary for Medicare population the PCMH model (Pines, van Hasselt, & McCall, 2015). According to the report, the PCMHs reduced the growth in outpatient emergency department visits by 11 percent over non-PCMHs. Compared to non-PCMH enrollees, the rate of growth was \$54 and \$48 less for those in the PCMH model in 2009 and 2010 respectively. However, there was no hospitalization effect from the PCMH model. The study found no difference in payment for all cause and ambulatory-care-sensitive condition admission between the two groups. Another study by Hasselt et al for Medicare fee-for-service beneficiaries using the same database showed that average annual total Medicare spending per beneficiary was \$265 or 4.9 percent lower for those in PCMHs. They also had lower acute care hospital spending of \$164 (62 percent). However, there was no significant difference in outpatient department payments, home health payments, hospice payments, federally qualified health center payments or physician payments.

A study using national survey data reports lower healthcare expenditures among Medicare beneficiaries who received care from practices that had PCMH features (Stockbridge, Philpot, & Pagán, 2014). Lower inpatient and total expenditure was associated with having little to no difficulty contacting the regular source of care by telephone during business hours, by \$2,867 and \$3,736, respectively. Having extended office hours at night or on weekends was also associated with significantly less expenditure by \$535, \$103, and \$328

for outpatient, emergency department, and other expenditure respectively. However, having a usual source of care that paid attention to medication and treatments that were prescribed from other providers was associated with significantly higher pharmacy expenditures by \$362.

The Colorado PCMH pilot study reports significantly lower emergency department costs compared to non-PCMH practices by 13.9 percent after two years and 11.8 percent after three years (Kaushal, Edwards, & Kern, 2015). The patterns are the same for patients with comorbidities. Another Colorado's multi-payer PCMH pilot preliminary report states that the PCMH model gave a return on investment of 250 to 400 percent during the period of study (Rosenthal, et al., 2015).

In addition, a study shows that patients in PCMH practices incurred significantly fewer professional fees than those in non-PCMH practices (Fontaine, Flottemesch, Solberg, & Asche, 2011). Those with fragmented care incurred \$715 per person per year compared to \$526 per person per year for those in the PCMH model.

Effects of Patient-Centered Medical Home on Healthcare Quality

The existing literature on the effects of PCMH on healthcare quality mostly evaluates a few common quality measures such as cancer screening, health screening and management of chronic diseases (Rosenthal, et al., 2015; Rosenthal, Friedberg, Singer, Eastman, Li, & Schneider, 2013; DeVries, Chia-Hsuan, Sridhar, Hummel, Breidbart, & Baron, 2012). The population evaluated is also limited to a specific state and population group. The analyses

yield mixed results that the PCMH model has either positive effects, negative effects or no significant effects on healthcare quality compared to facilities without the PCMH model.

The Colorado PCMH pilot study shows mixed results for quality of care (Rosenthal, et al., 2015). The PCMH pilots had significantly more cervical cancer screening after two and three years (12.5 percent and 9 percent increase respectively). However, the pilot practices had lower rate of HbA1c testing in diabetic patients by 0.7 percent after three years and lower rate of colon cancer screening by 21.1 percent and 18.1 percent after two and three years respectively.

Another study shows no significant improvements in any of the quality measures investigated in the studies (Rosenthal, Friedberg, Singer, Eastman, Li, & Schneider, 2013). The six process measures of quality of care analyzed in this study include 3 for diabetes mellitus and 3 for colon, breast, and cervical cancer screening.

A study in 2012 shows that patients treated in NCQA's PCMH practices had equal or better care management (DeVries, Chia-Hsuan, Sridhar, Hummel, Breidbart, & Baron, 2012). For patients with diabetes and cardiovascular disease, the PCMH population had higher rate of HbA1c testing (82.11 percent vs 77.7 percent), higher rate of LDL screening (75.9 percent vs 73.5 percent), and better LDL control of less than 100 mg/dl (64.7 percent vs 57.3 percent). The PCMH model was also associated with fewer inappropriate prescriptions of antibiotics as antibiotic use was lower in PCMH children (27.5 percent vs 35.4 percent). Another study from the Pennsylvania multi-payer advanced primary care practice demonstration also evaluated care for cardiovascular disease and diabetes (Gabby, Bailit,

Mauger, Wagner, & Siminerio, 2011). The PCMH model shows 8.5 percent increase in the percentage of patients with LDL cholesterol < 130 mg/dl, 4 percent increase in the percentage of patients with BP < 140/90 mmHg, and 2.5 percent decrease in the percentage of patients with HbA1c > 9.

A study published in 2010 found that the medical home may provide an opportunity to improve the delivery services for children (Romaine & Bell, 2010). National survey data were used to analyze the associations between practices with PCMH characteristics (accessible, family-centered, comprehensive, and compassionate care) and receipt of specific health screenings and anticipatory guidance appropriated for children aged 0 to 17 years. The results suggest that the medical home is associated with increased odds of children receiving three health screenings (weight, height, and blood pressure) and guidance including dental checkups, diet, exercise, car and bike safety by 26 to 54 percent.

The Veterans Health Administration's PCMH model also shows supportive evidence for quality improvement (Stockbridge, Philpot, & Pagán, 2014). The practices with the PCMH characteristics received significantly higher patient satisfaction scores of 9.33 comparing to the non-PCMH practices score of 7.53. The PCMH practices also had higher performance on 41 of 48 measures of clinical quality. In addition, staff in the PCMH practices reported lower burnout compared to staff in other practices (Maslach Burnout Inventory emotional exhaustion subscale, 2.29 vs 2.80).

Challenges for Patient-Centered Medical Home Implementation and Maintenance

In order to fully implement the PCMH model, practices are required to invest significantly in infrastructure. For example, a secured health information technology system is essential since it is one of the fundamental supports of the PCMH model. This is a huge financial burden to a small practice in addition to the need to increase number of staff members for the multidisciplinary team. Therefore, more evidence is needed to ascertain whether these investments are worthwhile and can address the healthcare problems that the United States is confronting.

Public Health Significance

Evidence of the effects of the PCMH model on healthcare utilization, healthcare expenditure, and healthcare quality is still needed. Even though the medical home idea is not new, the NCQA recognition of the PCMH model has just been recently introduced and implemented (National Committee for Quality Assurance, 2019). For example, an initiation of PCMH pilot in Colorado was launched in 2009 (Rosenthal, Aldina, Friedberg, Singer, Eastman, & Schneider, 2016) while a pilot of the PCMH model in Maine was launched in 2010 (Coburn, Gray, McGuire, Thayer, & Ziller, 2016). At present, we can see only its short-term effects. Moreover, studies examining the effects of the PCMH model show mixed results. Among the first publications, the focus was on comparing PCMH pilot practices with non-PCMH in a state. The nation-wide analyses of the NCQA's PCMH recognition practices are limited to some specific populations such as the Medicare population and veterans. Most

of the studies report that the PCMH model has some positive effects, especially for patients with chronic diseases who need continuous care. In addition, most reports are analyzed from provider perspective. There are only few studies using patient perspective to evaluate some specific features of the PCMH. Therefore, this study provides additional evidence regarding effects of PCMH characteristics on healthcare utilization, healthcare expenditure, and healthcare quality from the patient perspective on a national scale.

Problem Statement

The patient-centered medical home model was proposed as a solution to the problem of rising healthcare expenditures as well as a way to improve quality of care in the United States. It remains to be shown whether it can be effective in changing the pattern of healthcare utilization toward primary care, reducing healthcare expenditure, and assisting in healthcare quality improvement.

Conceptual Framework

The conceptual framework for evaluating effects of the PCMH model is shown in Figure 1. The PCMH model is a combination of five key domains as defined by the Agency for Healthcare Research and Quality. The five domains are comprehensive care, patient-centered, coordinated care, accessible care, and quality and safety. While providers use these domains as guidelines to provide low cost and high-quality care, it also depends on patients to recognize the effort. Patient characteristics are also essential factors that determine

outcomes of the PCMH model. The three outcomes of interest in this study are whether the PCMH model can change the pattern of healthcare utilization toward primary care, whether the healthcare expenditures can be reduced with the PCMH model and whether the PCMH model can help improve quality of care.

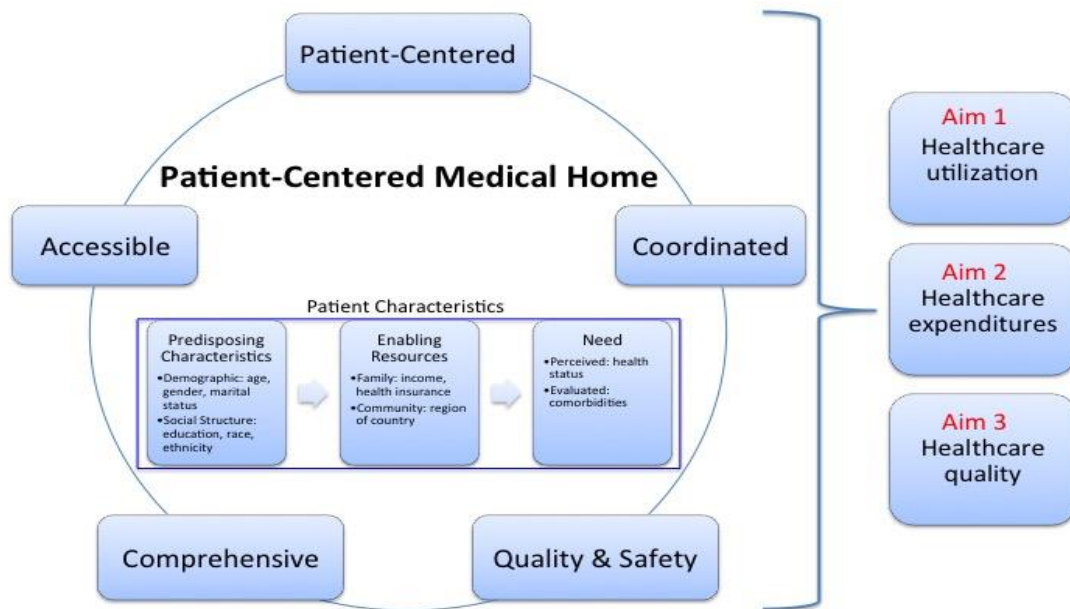


Figure 1: Conceptual framework for the evaluation of the patient-centered medical home.

Adapted from The Medical Home Model (Zutshi) and The Behavioral and Health Service Utilization Model (Aday & Andersen, 1974).

Study Objectives

The objectives of this study are to use national survey data to analyze healthcare utilization, expenditure and quality from the patient's perspective for the US adult population

in healthcare facilities that have 3 domains of PCMH features: comprehensive care, patient-centered care, and accessible care.

Aim 1: Healthcare utilization

The first aim of this study is to determine the association between the receipt of care consistent with the 3 domains of PCMH model (comprehensive care, patient-centered care, and accessible care) and the amount of health service utilization, specifically, emergency department visits, hospital admissions, ambulatory care visits, and prescriptions filled, adjusting for patient characteristics.

Specific objectives and hypothesis

- 1) To examine the association of the receipt of care consistent with the 3 domains of PCMH and the number of emergency department visits. Patients who received care from PCMH should have fewer ED visits.
- 2) To examine the association of the receipt of care consistent with the 3 domains of PCMH and the number of hospitalizations. Patients who received care from PCMH should have fewer hospitalizations.
- 3) To examine the association of the receipt of care consistent with the 3 domains of PCMH and number of ambulatory care visits. Patients who received care from PCMH should have more ambulatory care visits.
- 4) To examine the association of the receipt of care consistent with the 3 domains of PCMH and number of prescription filled. Patients who received care from PCMH should have more prescription filled.

Aim 2: Healthcare expenditure

The second aim of this study is to determine the association between the receipt of care consistent with the 3 domains of PCMH model (comprehensive care, patient-centered care, and accessible care) and healthcare expenditure in terms of total expenditure, emergency department expenditure, inpatient expenditure, ambulatory care expenditure, and pharmaceutical expenditure, adjusting for patient characteristics.

Specific objectives and hypothesis

- 1) To examine the association of the receipt of care consistent with the 3 domains of PCMH and total expenditure. Patients who received care from PCMH should have less total expenditure.
- 2) To examine the association of the receipt of care consistent with the 3 domains of PCMH and emergency department expenditure. Patients who received care from PCMH should have less ED expenditure.
- 3) To examine the association of the receipt of care consistent with the 3 domains of PCMH and inpatient expenditure. Patients who received care from PCMH should have less inpatient expenditure.
- 4) To examine the association of the receipt of care consistent with the 3 domains of PCMH and ambulatory care expenditure. Patients who received care from PCMH should have more ambulatory care expenditure.

5) To examine the association of the receipt of care consistent with the 3 domains of PCMH and pharmaceutical expenditure. Patients who received care from PCMH should have more pharmaceutical expenditure.

Aim 3: Healthcare quality for diabetic patients

The third aim of this study is to determine the association between the receipt of care consistent with the 3 domains of PCMH model (comprehensive care, patient-centered care, and accessible care) and healthcare quality for diabetic patients in terms of proper disease management, adjusting for patient characteristics. The services to be analyzed in this aim are HbA1c test, blood cholesterol test, dilated eye examination, feet examination, and flu vaccination.

Specific objectives and hypothesis

- 1) To examine the association of the receipt of care consistent with the 3 domains of PCMH and whether diabetic patients were tested for HbA1c. Patients who received care from PCMH should be more likely to have HbA1c test.
- 2) To examine the association of the receipt of care consistent with the 3 domains of PCMH and whether diabetic patients were tested for blood cholesterol. Patients who received care from PCMH should be more likely to have blood cholesterol test.
- 3) To examine the association of the receipt of care consistent with the 3 domains of PCMH and whether diabetic patients received dilated eye examination. Patients who received care from PCMH should be more likely to have dilated eye examination.

4) To examine the association of the receipt of care consistent with the 3 domains of PCMH and whether diabetic patients received foot examination. Patients who received care from PCMH should be more likely to have foot examination.

5) To examine the association of the receipt of care consistent with the 3 domains of PCMH and whether diabetic patients received flu vaccination. Patients who received care from PCMH should be more likely to receive flu vaccination.

METHODS

Study Design

This study is a retrospective cross sectional analysis which compares outcomes of interest between individuals who received care consistent with 3 domains of PCMH model and those who received care not consistent with the 3 domains of PCMH model, based on these individuals' experience with their providers. The analysis was done using regression analysis with complex survey method.

Data Source

The data source of this study is the Medical Expenditure Panel Survey (MEPS) 2016 full year consolidation data file (HC-192). MEPS is a publicly available large-scale survey conducted annually under the supervision of Agency for Health Care Research and Quality (AHRQ). The survey includes variables regarding survey administration, demographics, income, person-level conditions, health status, disability days, quality of care, employment, health insurance, and person-level medical care use and expenditures for the civilian

noninstitutionalized US population of all ages. MEPS consists of three components: the household component (HC), the medical provider component (MPC) and the insurance component (IC). For household component, a new panel of approximately 15,000 households is randomly selected each year from the national subsample of households that participated in the National Health Interview Survey (NHIS) conducted by the NCHS of the earlier year. The NHIS sampling frame provides a nationally representative sample of the U.S. civilian noninstitutionalized population using stratification and cluster in multi-stage sample design. First, approximately 20 percent of the geographically defined primary sampling units (PSUs) is selected. Each PSUs could be either counties, a small group of contiguous counties or metropolitan statistical areas. The largest PSUs are sampled with certainty and the rest were stratified geographically. Within most of the strata, at least two PSUs are chosen with a probability proportional to population size. Within each subsample group, low-income population, Asians, Blacks and Hispanics are oversampled. These samples are then surveyed for the household component. The response rate for household component usually ranges from 65-71 percent. Then the corresponding medical provider component and the insurance component were acquired from providers with permission of the household respondents to obtain information that household respondents could not accurately provide such as healthcare expenditures. The expenditures in the MEPS data represent the total of out-of-pocket paid by patients and the amount paid by insurers. For 2016 data, the total sample size for MEPS is 33,259 persons in 13,491 families.

Study Population

The population for this study was the civilian noninstitutionalized US population age at least 18 years old in MEPS 2016 data who identified themselves as having either a person or facility as their usual source of care. Individuals who reported having emergency department as their usual source of care were excluded from the study. Since the sample size of MEPS is large, any observation with missing values was excluded from the study. Prior studies reported approximately 2 percent of the missing PCMH values in MEPS data (Bowdoin, Rodriguez-Monguio, Puleo, Keller, & Roche, 2016).

Data Analysis

Independent variable

The principal independent variable in this study was whether or not an individual has a usual source of care from providers with 3 domains of patient-centered medical home characteristics. Individual's responses to the selected survey items were aggregated into a binary indicator of having a PCMH based on a previously published approach using a total of 14 questions in MEPS (Bowdoin, Rodriguez-Monguio, Puleo, Keller, & Roche, 2016). These questions were included based on face validity of the requirement of the PCMH, specifically that it provided all aspects of care for the patients including new health problems, preventive healthcare, referrals, and ongoing healthcare (Beal, Hernandez , & Doty, 2009; Jones, Cochran, Leibowitz, Wells, Kominski, & Mays, 2015). Each survey question was assigned to one of the domains of the PCMH: comprehensive care, patient-centered, or accessible services. However, no question from the survey aligned with the coordinated care domain as

well as quality and safety domain. Thus, these two domains could not be measured in the study (Romaine & Bell, 2010; Bowdoin, Rodriguez-Monguio, Puleo, Keller, & Roche, 2016; Hoilette, Blumkin, Boldwin, Fiscella, & Szilagyi, 2013; Beal, Hernandez , & Doty, 2009). Prior studies showed that approximately 23 percent of the population received care that was consistent with the PCMH model (Bowdoin, Rodriguez-Monguio, Puleo, Keller, & Roche, 2016). Details of MEPS questions used to determine whether not an individual had a usual source of care with PCMH setting are shown in Appendix A.

An individual was determined to have a valid usual source of care if they reported: 1) having a usual source of care; 2) having provider type of either person or facility; and 3) not having emergency room as usual source of care.

Comprehensive care was determined based on five criteria: 1) the provider usually asks about prescription medications and treatments other doctors may give; 2) the provider cares for new health problems; 3) the provider cares for preventive health care; 4) the provider cares for referrals to other health professionals; and 5) the provider cares for ongoing health problems. An individual was considered receiving comprehensive care if he/she reported yes to all five criteria.

Patient-centered care was determined based on three criteria: 1) the provider presents and explains all options; 2) the provider asks about and shows respect for medical, traditional, and alternative treatments that the person is happy with; and 3) the provider ask the person to help make decisions between a choice of treatments. An individual was

considered receiving patient-centered care if he/she reported yes, usually, or always to all three criteria.

Accessible care was determined based on three criteria: 1) difficulty to contact the provider by phone during office hours; 2) whether the provider has office hours at night or on the weekend; and 3) whether the provider speak the person's language or provided translator services. An individual was considered receiving accessible care if he/she reported yes, not too difficult, or not at all difficult to all three criteria.

To be qualified as receiving care consistent with the overall 3 domains of PCMH model in this study, an individual must have had a valid usual source of care and perceived that their usual source of care provided comprehensive care, patient-centered, and accessible care.

Dependent variables

Outcome variables for this study were categorized into three domains according to the three aims of the study: healthcare utilization, healthcare expenditure, and healthcare quality in diabetic patients. (Appendix B)

For Aim 1, dependent variables for healthcare utilization domains consisted of the number of ambulatory care visits (which is a combination of office visits and hospital outpatient department visits), the number of emergency department visits, and the number of prescriptions filled. These measures reflected the number of health services used during one year as reported by respondents.

For Aim 2, dependent variables for healthcare expenditure domains were categorized in the same way as the healthcare utilization domain, with the addition of total healthcare expenditure. Other outcome variables in this domain were total ambulatory care expenditure (which was a combination of total office visits expenditure and total hospital outpatient department visits expenditure), total emergency department expenditure, total inpatient expenditure, and total pharmaceutical expenditure. The total expenditures included facility and professional expenditures which were paid out-of-pocket and the amount paid by insurer (if the individual was insured). To improve accuracy these data were collected from providers with permission of the respondents.

For Aim 3, dependent variables for healthcare quality for diabetic patients domain addressed recommended care for diabetic patients. According to the American Diabetic Association (ADA) diabetic guidelines, diabetic patients should have their feet checked and receive dilated eye examination. They should be tested for HbA1c and cholesterol. Moreover, CDC recommends that they receive flu vaccination every year.

A few studies have investigated the validity and reliability of healthcare expenditures and utilization reported in the MEPS data. The Medical Provider Component from participants' providers is used to supplement and/or replace medical event information that was reported by survey respondents. Comparing health service utilization in MEPS data with Medicare claims data, reports of inpatient data, numbers of prescriptions filled and total expenditures in MEPS data are reasonably accurate (96-97 percent agreement rate) while MEPS data tend to underreport emergency department visits by one-third and office-based

visits by 19 percent (Zuvekas & Olin, 2009; Hill, Zuvekas, & Zodet, 2011). However, analyses of the determinant of utilization and expenditures were largely unaffected because the underreporting occurred in all sociodemographic groups. Marginal effects from healthcare utilization and expenditures regressions showed the same sign and usually similar magnitudes. MEPS tried to minimize the underreporting problem by using a relatively short recall period (5 months on average) relative to the 12 months periods that is common in many large-scale surveys. MEPS also asked responders to keep diaries, medical bills, explanations of benefit forms, and other document related to all healthcare use as references when answering the survey.

Covariates

Additional covariates for the regressions are listed in Appendix C. These variables represent characteristics that can affect perception of PCMH characteristics, healthcare utilization, healthcare expenditure, and whether they receive recommended care for diabetic patients. These covariates have been included in regression analysis in prior studies (Jones, Cochran, Leibowitz, Wells, Kominski, & Mays, 2015) (Stockbridge, Philpot, & Pagán, 2014; Jerant, Fenton, & Franks, 2012; Beal, Hernandez, & Doty, 2009). The demographic and socio-economic status variables included age, sex, race and ethnicity, geographic location, marital status, level of education, categorized income level based on percentage of poverty line, and insurance status. Individual health status is defined using self-perceived health status. Whether an individual had any comorbidities was also considered since they tend to

behave differently from healthy individuals. For the diabetic population in Aim 3, having comorbidities was defined as having at least one comorbidity in addition to diabetes while it was defined as having any comorbidity for Aim 1 and 2.

Other variables

Other variables from the MEPS data that were needed for complex survey analysis are shown in Appendix D. These variables were weight for each individual as well as variances based on stratum and primary sampling unit of the MEPS survey.

Data Analysis

The analysis for this study was done using the complex survey method for individual level regression analysis to study the association between the perceived characteristics of PCMH and 1) healthcare utilization; 2) healthcare expenditure; and 3) quality of care for diabetic patients, controlling for patient characteristics. The Adjusted Wald test and Pearson Chi Squared Test were used to test the difference between those who received care from practices with PCMH characteristics and those who did not.

The multivariate regression model that was used in this analysis is:

$$\text{Link}(E(Y)) = \beta_0 + \beta_1 \text{PCMH} + \beta_x \text{Covariates}.$$

Y is the outcome of interest in each aim as shown in Table 1. For Aim 1, the outcome variables were count variables; therefore, Poisson regression was used. For Aim 2, since expenditures are likely to be right-skewed, generalized linear model (GLM) analysis with a

gamma distribution and log-link function was used. For Aim 3, all variables were binary variable representing yes/no and logistic regression was used. PCMH was the key independent variable indicating whether or not the individual had received healthcare services with PCMH characteristics. Covariates for this model were patient characteristics

Table 1: List of outcome variables of interest

Aims	Domains	Outcome of interest (Y)
1	Utilization	# ED visits
		# Hospitalizations
		# Ambulatory visits
		# Prescription filled
2	Expenditure	Total expenditure
		ED expenditure
		Inpatient expenditure
		Ambulatory expenditure
		Pharmaceutical expenditure
3	Quality of care for diabetic patients	HbA1c
		Cholesterol
		Dilated eye exam
		Feet examination
		Flu vaccination

variables. Covariates used to in the multivariate models included age, gender, race & ethnicity, marital status, education, income, insurance coverage, location, health status, and comorbidities. They were selected based on evidence from literature reviews. Each regression-coefficients (β) denote the effect of each covariate on the outcome. All analysis was conducted using STATA 14.0 (StataCorp. 2015. *Stata Statistical Software: Release 14*. College Station, TX: StataCorp LP).

Human Subjects Considerations

This dissertation was determined to qualify for exempt status according to 45 CFR 46.101(b) by Committee for the Protection of Human Subject, University of Texas Health Science Center at Houston (HSC-SPH-19-0271) since the data used in this study was existing data which was de-identified and publicly available.

RESULTS

Study Sample and Characteristics

The demographic and socioeconomic characteristics of the sample used in this analysis are shown in table 2. The final study sample was comprised of 17,649 individuals who were at least 18 years old and had usual source of care, represented 186 million US non-institutionalized individuals in the weighted population. Among them, there were 3,029 individuals who reported that they received care from a usual provider with 3 domains of PCMH characteristics as defined in the criteria for this study, and 14,620 individuals who reported that they received care from usual providers that were not consistent with all 3 domains of the PCMH model. The average weighted ages of study sample for those groups were 47.11 and 51.17 years respectively. In both groups, the study sample had the highest proportion in the following categories: female (55.24%, 54.63%), non-Hispanic White (64.70%, 67.65%), living in the South (35.18%, 35.78%), married (58.86%, 56.46%), with at least high school education (88.97%, 87.65%), high income (45.79%, 46.46%), any private insurance (76.23%, 71.47%), very good health status (34.32%, 34.52%), and had comorbidities (62.31%, 68.92%). The proportions of demographic and socioeconomic characteristics for the groups were significantly different in terms of age, health insurance status, self-reported health status and comorbidities. Those reported receiving care consistent with 3 domains of the PCMH model are younger, more likely to have private health insurance, better health status and less comorbidities.

Table 2: Characteristics of study population by provider type

	Receive Care in 3 PCMH Domains						P-Value
	Yes			No			
	Mean or N	Weighted Mean or Percentage	(Weighted SE)	Mean or N	Weighted Mean or Percentage	(Weighted SE)	
Age (year)	46.03	47.11	(0.58)	50.38	51.17	(0.30)	< 0.001
Gender							0.554
Female	1,772	55.24%	(1.01)	8,234	54.63%	(0.40)	
Male	1,257	44.76%	(1.01)	6,284	45.37%	(0.40)	
Race/Ethnicity							0.106
Non-Hispanic White	1,331	64.70%	(1.78)	6,847	67.65%	(1.08)	
Non-Hispanic Black	604	12.76%	(1.12)	2,462	10.40%	(0.60)	
Hispanic	763	13.41%	(1.19)	3,696	13.42%	(0.78)	
Others/Multiple Races	331	9.13%	(1.26)	1,513	8.53%	(0.54)	
Census region							0.012
Northeast	588	21.73%	(1.98)	2,478	18.05%	(0.84)	
Midwest	696	24.24%	(0.96)	2,909	21.33%	(1.04)	
South	1,022	35.18%	(2.45)	5,127	35.78%	(1.17)	
West	723	18.85%	(1.48)	4,004	24.83%	(0.93)	
Marital status							0.084
Married	1,584	58.86%	(1.28)	7,462	56.46%	(0.68)	
Single	1,445	41.14%	(1.28)	7,056	43.54%	(0.68)	
Education							0.100
Less than high school	519	11.03%	(0.70)	2,849	12.35%	(0.47)	
High school or above	2,495	88.97%	(0.70)	11,555	87.65%	(0.47)	

	Receive Care in 3 PCMH Domains						P-Value
	Yes			No			
	Mean or N	Weighted Mean or Percentage	(Weighted SE)	Mean or N	Weighted Mean or Percentage	(Weighted SE)	
Family income							0.615
Poor/Near poor (<125% FPL)	626	13.04%	(0.98)	3,168	13.54%	(0.54)	
Low income (125-200% FPL)	460	10.99%	(0.85)	2,189	11.65%	(0.39)	
Middle income (200-400% FPL)	915	30.17%	(1.32)	4,108	28.35%	(0.70)	
High income (>400% FPL)	1,028	45.79%	(1.63)	5,053	46.46%	(0.94)	
Health insurance status							< 0.001
Any private	2,007	76.23%	(1.31)	8,901	71.47%	(0.80)	
Public	796	18.33%	(1.03)	4,566	23.85%	(0.76)	
Uninsured	226	5.45%	(0.70)	1,051	4.68%	(0.30)	
Health status							0.004
Excellent	709	25.34%	(1.35)	2,918	21.53%	(0.57)	
Very good	975	34.32%	(1.25)	4,474	34.52%	(0.61)	
Good	906	28.54%	(1.48)	4,501	29.31%	(0.56)	
Fair	337	9.61%	(0.79)	2,061	11.41%	(0.37)	
Poor	120	2.20%	(0.27)	558	3.24%	(0.23)	
Comorbidities							< 0.001
Yes	1,849	62.31%	(1.26)	9,808	68.92%	(0.59)	
No	1,180	37.69%	(1.26)	4,710	31.08%	(0.59)	

Details of individuals who reported having the various PCMH characteristics are presented in Table 3. The entire study sample who reported having usual source of care (n = 17,649) stated that their provider was either a facility or person (n = 17,649; 100%). Among them, 123 (0.37%) reported that their usual source of care was the emergency room. Therefore, there were 17,526 individuals (99.63%) had a valid usual source of care. Combining with criteria from 3 PCMH domains, a total of 3,029 individuals (17.24%) reported that they received care from a usual source of care that had characteristics consistent with PCMH model.

There were 12,824 individuals (74.00%) who received all 5 features of care consistent with PCMH comprehensive care domain. More than 95% of them reported that they went to a usual source of care for new health problems, ongoing health problems, preventive health care, and referrals. However, approximately 80% reported that their provider asked about other treatments that they might receive from other providers.

There were 11,694 individuals (67.71%) who received all 3 features of care consistent with PCMH patient-centered care domain. More than 90% of them stated that provider presented and explained all options to them. Approximately 80% reported that provider showed respect for alternative treatments with which they were happy and asked them to help make decisions between choices of treatment.

Only 5,196 individuals (29.20%) received all 3 features of care consistent with PCMH accessible care domain. Almost all of them had access to a provider who spoke their language. Approximately 80% of them reported that it was not difficult to contact their

Table 3: Study population with perceived care in each PCMH domains

Domain	PCMH Characteristics	N	Weighted Percentage
Usual Provider	Have usual source of care (USC)	17,649	100.00%
	Provider is either facility or person	17,649	100.00%
	USC was not emergency room	17,526	99.63%
	Have a valid USC	17,526	99.63%
Comprehensive Care	Provider asks about other treatments	13,529	78.30%
	Go to USC for new health problems	17,255	97.94%
	Go to USC for preventive health care	17,167	97.15%
	Go to USC for referrals	17,139	97.15%
	Go to USC for ongoing health problems	17,081	96.46%
	Received comprehensive care	12,824	74.00%
Patient-Centered Care	Provider explains options to you	16,238	92.43%
	Provider shows respect for treatments other doctors may give	14,338	81.32%
	Provider asks you to help make decisions	13,405	77.95%
	Received patient-centered care	11,694	67.61%
Accessible Care	Not difficult to contact USC by phone	14,089	80.57%
	USC has office hours at nights or on the weekends	6,246	34.83%
	Provider speaks person's language	17,543	99.67%
	Received accessible care	5,196	29.20%
PCMH Care	Received care from USC providers with PCMH characteristics	3,029	17.24%

provider by phone during office hours. However, only about 35% of their usual providers had office hours at night or on the weekend.

Healthcare Utilization

The results of regression analysis to determine the association between the receipt of care consistent with 3 domains of the PCMH model as perceived by patients and the number of health service utilization are presented in Table 4. The full model results can be found in Appendix E. The univariate regression showed that compared to those who did not receive care consistent with 3 domains of the PCMH model, those who received care consistent with 3 domains of the PCMH model tended to have significantly fewer ambulatory visits, fewer emergency room visits, and fewer prescription medication refills. Individuals who received care consistent with 3 domains of the PCMH model were estimated to have 16.19% (coeff. -0.177; 95%CI -0.263,-0.090) fewer ambulatory visits than those who did not. Individuals who received care consistent with 3 domains of the PCMH model were estimated to have 14.06% (coeff. -0.152; 95%CI -0.299,-0.004) fewer emergency room visits than those who did not. Individuals who received care consistent with 3 domains of the PCMH model were estimated to have 15.22% (coeff. -0.165; 95%CI -0.256,-0.074) fewer prescription medication refills than those who did not. The number of inpatient admissions was not significantly different between the two groups.

However, after controlling for age, sex, race, location, marital status, education, income, health insurance, self-reported health, and comorbidities, those who received care consistent with 3 domains of the PCMH model had lower health service utilization than those who did not in only one type of service, ambulatory visits (7.14% at the 90% significance level). While those who received care consistent with 3 domains of the PCMH were

estimated to have fewer emergency room visits, inpatient admissions, and prescription medication refills, these results were not statistically significant different between the two groups.

Table 4: Unadjusted and adjusted differences in healthcare utilizations by provider type (PCMH compared with non-PCMH)

Characteristics	Unadjusted Coefficient (95% CI)	Adjusted Coefficient ^a (95% CI)
Ambulatory visits	-0.177 *** (-0.263, -0.090)	-0.074 * (-0.154, 0.006)
Emergency room visits	-0.152 ** (-0.299, -0.004)	-0.060 (-0.203, 0.087)
Hospital discharges	-0.092 (-0.285, 0.101)	0.061 (-0.126, 0.248)
Prescription medication refills	-0.165 *** (-0.256, -0.074)	0.007 (-0.058, 0.072)

^a adjusted for age, sex, race, location, marital status, education, income, health insurance, self-reported health, and comorbidities

* p-value < 0.10; ** p-value < 0.05; *** p-value < 0.001

In addition, the multivariate analysis showed that there are other factors that were associated with the level of health service utilization in this study (Appendix E). Being female was significantly associated with the increased number of all four categories of health service utilization. The number of ambulatory visits was estimated increased by 28.62% for women. Emergency department visits was estimated increased by 27.13% for women.

Inpatient admissions was estimated increased by 42.23% and the number of prescription medication refills was estimated increased by 13.63% for women.

Self-perceived health status was also significantly associated with number of health service utilization in all categories. There were statistically significant association between individuals who perceived their health as poorer and higher health service utilizations. For example, compared to individuals who reported having excellent health status, those who identified themselves as having poor health status had more ambulatory visits, emergency department visits, inpatient admissions, and prescription medication refills by 307.71%, 541.10%, 911.07% and 420.35% respectively. When comparing individuals who reported having excellent health status with those who reported having very good health status, the latter group had higher utilizations than the former by 26.63%, 25.73%, 39.53%, and 50.90%, respectively.

Moreover, having no insurance was significantly associated with a decrease in number of ambulatory visits by 36.13% and the decrease in number of prescription medication refills by 19.73%, compared to those with private insurance. However, having public insurance was significantly associated with an increase in the number of emergency department visits by 36.13%, in the number of inpatient admissions by 30.78%, and in the number of prescription medication refills by 25.72%, compared to those with private insurance.

Being older, non-Hispanic White, having at least high school education, and having comorbidities were associated with an increase in health service utilization across all

categories. Having more family income was associated with a higher number of ambulatory visits, but with fewer number of emergency department visits and prescription medications refilled.

Healthcare Expenditures

The results of regression analysis to determine the association between the receipt of care consistent with 3 domains of the PCMH model as perceived by patients and healthcare expenditures are presented in Table 5. The full model results can be found in Appendix F. The univariate regression showed that compared to those who did not receive care consistent

Table 5: Unadjusted and adjusted differences in healthcare expenditures by provider type (PCMH compared with non-PCMH)

Characteristics	Unadjusted Coefficient (95% CI)	Adjusted Coefficient ^a (95% CI)
Total healthcare expenditures	-0.140 * (-0.271,-0.010)	-0.013 (-0.127,0.100)
Total ED expenditure	-0.310 ** (-0.539,-0.079)	-0.187 (-0.424,0.051)
Total inpatient expenditure	-0.079 (-0.338,0.181)	0.068 (-0.221,0.358)
Total ambulatory expenditure	-0.097 (-0.275,0.082)	0.019 (-0.131,0.169)
Total pharmaceutical expenditure	-0.095 (-0.285,0.096)	0.056 (-0.167,0.278)

^a adjusted for age, sex, race, location, marital status, education, income, health insurance, self-reported health, and comorbidities

* p-value < 0.05; ** p-value < 0.01

with 3 domains of the PCMH model, those who received care consistent with 3 domains of the PCMH model were estimated to have fewer total healthcare expenditures by 13.10% (coeff. -0.140; 95%CI -0.271,-0.010), and less total emergency department expenditures by 9.21% (coeff. -0.310; 95%CI -0.539,-0.079) while total inpatient expenditures, total ambulatory expenditures, and total pharmaceutical expenditures were not significantly different between the two groups.

After adjusting for age, sex, race, location, marital status, education, income, health insurance, self-reported health, and comorbidities, there were no significant difference in healthcare expenditures for any of the 5 categories.

However, the multivariate analysis showed that there are other factors that were associated with the number of healthcare expenditure (Appendix F). Being female was significantly associated with the increased in total healthcare expenditure, total inpatient expenditure, and total ambulatory expenditure by 27.60%, 68.26%, and 38.89%, respectively.

Self-perceived status was also significantly associated with all categories of healthcare expenditure. There was a statistically significant association between individuals who perceived their health as poorer and higher healthcare expenditures. For example, compared to individuals who reported having excellent health status, those who identified themselves as having poor health status had more total expenditures, total emergency department expenditures, total inpatient expenditures, total ambulatory expenditures, and total pharmaceutical expenditures by 619.97%, 613.15%, 1276.29%, 528.38%, and 654.01%, respectively. When compared individuals who reported having excellent health status with

those who reported having very good health status, the latter group had more expenditures than the former by 40.39%, 25.65%, 54.43%, 41.83%, and 82.95%, respectively.

Moreover, having no insurance was significantly associated with decreases in total healthcare expenditures by 46.56%, total ambulatory expenditure by 48.33%, and total pharmaceutical expenditures by 52.30%, respectively, compared to those with private insurance. However, having public insurance was significantly associated with an increase in the number of emergency department visits by 36.13% and by an increase in total inpatient expenditure by 25.11%, compared to those with private insurance. Also, those who identified themselves as having high income tended to have higher total ambulatory care expenditure.

Being older and having comorbidities were associated with an increase in healthcare expenditure across all categories. Being non-Hispanic White was associated with an increase in total expenditure, total ambulatory expenditure, and total pharmaceutical expenditure. Having at least a high school education was associated with the increased in healthcare expenditure in all categories except total inpatient expenditure.

Quality of Care

The results of regression analysis to determine the association between the receipt of care consistent with 3 domains of the PCMH model and quality of care for diabetic patients are presented in Table 6. The full model results can be found in Appendix G. The univariate regression showed that compared to those who did not receive care consistent with 3 domains of the PCMH model, those who received care consistent with 3 domains of the PCMH model

did not have significantly different odds in receiving HbA1c test, blood cholesterol test, dilated eye examination, feet examination, and flu vaccination in that year. In addition, after adjusting for age, sex, race, location, marital status, education, income, health insurance, self-reported health, and comorbidities, the odds that a diabetic patient would receive these five services were not significantly different between the two groups.

Table 6: Unadjusted and adjusted differences in quality of care for diabetic patients by provider type (PCMH compared with non-PCMH)

Characteristics	Unadjusted Odds Ratio (95% CI)	Adjusted Odds Ratio ^a (95% CI)
HbA1c	0.738 (0.396,1.372)	0.753 (0.393,1.442)
Cholesterol	0.793 (0.501,1.254)	0.793 (0.506,1.242)
Dilated eye exam	0.916 (0.674,1.244)	0.963 (0.702,1.322)
Feet examination	1.199 (0.842,1.706)	1.275 (0.885,1.839)
Flu vaccination	0.992 (0.702,1.400)	1.060 (0.735,1.529)

^a adjusted for age, sex, race, location, marital status, education, income, health insurance, self-reported health, and comorbidities

However, the multivariate analysis showed that there are other factors that were associated with quality of care for diabetic patients (Appendix G). Older age was significantly associated with the increased the odds of receiving care in all 5 categories.

Being female, married, and having at least high school education were associated with increased odds of having dilated eye examination by 49.06% 32.43%, 30.54% respectively. Having at least high school education was also significantly associated with receiving influenza vaccination as those individuals had 37.10% increased odds of receiving the vaccine than those who had less education.

The odds of having HbA1c test were not significantly different between any demographic and socioeconomic groups. Those with private insurance tended to have higher odds of having blood cholesterol test and dilated eye examination. Those who had private insurance had lower odds of receiving these two tests by 47.95% and 30.44% while the uninsured had lower odds of receiving these two tests by 46.15% and 49.72% respectively. Self-perceived status and other comorbidities were not significantly associated with any categories of quality of care for diabetic patients.

DISCUSSION

This study is one of the first studies to analyze health service utilization, expenditure and quality of US adult population in healthcare facilities with PCMH features using patient's perspective from national survey data. Among the study's sample patients, all of whom had a usual source of care, fewer than one-fifth perceived that they received care from facilities or providers in consistent with 3 domains of the PCMH model. This was approximately the same as the 17.8% - 22.3 % rates found in 2010 – 2015 (Almki, et al., 2018).

Among the 3 domains of the PCMH evaluated in this study, the major cause of why individuals did not meet the PCMH characteristics criterion was the score in PCMH accessible care domain. Less than 30% met the criteria for meeting the accessible care PCMH domain in this study. Approximately one-third of the study sample stated that their usual source of care had office hours at nights or on the weekend. The extended office hours were one of the major characteristics of PCMH aimed to promote accessible care for the patient population (AAFP, AAP, ACP, and AOA, 2007). It is understandable that smaller healthcare facilities and clinics may not be able to open twenty-four hours seven days a week. However, it is still practical to have extended office hours for some evening and parts of the weekend for those who also have to work or go to school and cannot visit in the usual hours. Since different communities have different needs and availabilities, the added office hours may varies accordingly. Having additional office hours costs more for providers in

terms of expenses for staff, utilities and supplies, but it may also increase patient revenues (EisnerAmper, 2017).

Patient-centered care domain of PCMH received better score as about two-thirds of the individuals in the study passed the criteria for the domain. The components of this domain were specifically related to provider behavior. They seemed to be good at explaining treatment options to their patients, but not very good at asking patients to help make decisions. Shared-decision making is a relatively new concept for physicians. Before 1980s, physicians assumed the dominant role of all health services provided to their patients because of their professional authority (Charles, Gafni, & Whelan, 1999). The shared decision making concept has evolved afterward. It should be emphasized that decision-related competencies should be essential to the medical education outcomes that medical students have to learn, for both the physicians' own decision skills and the ability to guide patients in shared decision (Schwartz, 2011).

PCMH comprehensive care domains received the best score among the three domains. Almost all of the usual care providers in this study offered a wide variety of health services to their patients that can be considered comprehensive care. One component that lowered the score of this domain is providers' behavior. That is, less than 80% of them asked about other treatment that the patient might have. This issue should be promoted among physicians.

Healthcare Utilization

This study provided evidence that the receipt of care consistent with 3 domains of the PCMH model as perceived by patients was associated with health service utilization in terms of emergency department visits, hospital admissions, ambulatory care visits, and prescriptions filled in the univariate model. Patients who received care consistent with the 3 domains of PCMH model tend to use fewer health services in all four categories. The same trends were found in Medicare population for emergency department visits and ambulatory care visits (Pines, van Hasselt, & McCall, 2015; Van Haselt, McCall, Keyes, Wensky, & Smith, 2014). A study of the Veterans Health Administration (VHA) PCMH project showed the same results for patients in the PCMH model as they had fewer emergency department visits and inpatient admissions (Nelson, et al., 2014; Chaiyachati, et al., 2014). It was the same trend that was found in an early PCMH pilot in Colorado which reported that the PCMH group had a lower hospital admission rate (Raskas, 2012) and lower primary care visits (Rosenthal, et al., 2015).

However, after controlling for biological and socioeconomic characteristics, only the number of ambulatory visits of those who perceived that they received care consistent with 3 domains of the PCMH group remained lower than those who did not at the 90% significance level. Numbers of emergency room visits, inpatient admissions, and prescription medication refills were not significantly different between the two groups. A national study examining PCMH model characteristics and healthcare utilization using 2007-2010 data also found that the empirical evidence did not indicate whether PCMH model reduced healthcare utilization

in terms of emergency department visits and admissions (Xin H. , Kilgore, Menachemi, & Sen, 2014). The multivariate results from this study are different from the result from many PCMH pilot studies. PCMH pilots in several states showed significantly reduce ambulatory care visits, emergency department visits and hospital admissions (Harbrecht & Latts, 2012; Fontaine, Flottemesch, Solberg, & Asche, 2011; Fandre, McKenna, Beauvais, Kim, & Mangelsdorff, 2014; Rosenthal, Friedberg, Singer, Eastman, Li, & Schneider, 2013). The difference became even more prominent in a population with chronic illness (Christensen, et al., 2013; Wong, Rosland, Fihn, & Nelson, 2016). However, there was also a study from PCMH pilot in New Hampshire that reported no statistically significant finding for utilization between PCMH and non-PCMH group (Flieger, 2017).

The changes in the significance level of the results after controlling for covariates are reasonable since those patient characteristics greatly affect the need for health service utilization (Aday & Andersen, 1974). One possibility for the increase service utilization for female is pregnancy-related conditions. Older age also comes with more health problems which result in more services needed. Being White and having higher education is also associated with more health service utilization (Flores, Bauchner, Feinstein, & Nguyen, 1999). An individual with at least one chronic disease or comorbidity normally needs more healthcare services than a healthy person. One study found no significant association between PCMH status and emergency room visits among patients with no chronic illness while adopting the PCMH model was significantly associated with lower emergency department utilization for chronically ill patients (David, Gunnarsson, Saynisch, Chawla, &

Nigam, 2015). The same idea applies to those with poorer self-perceived health status (O'Hara & Caswell, 2013). Having higher family incomes implies that a person has more resources to spend taking care of himself in a timely manner so that he uses more ambulatory care and less emergency care. Health insurance status is also an important factor. Those without any health insurance, they were less likely to receive non-emergency health services. Therefore, after controlling for some social determinants of health, the effect of whether an individual received care consistent with PCMH model might not be as significant.

Healthcare Expenditures

This study provided evidence that the receipt of care consistent with 3 domains of the PCMH model as perceived by patients was associated with some categories of healthcare expenditures. Receiving care consistent with 3 domains of PCMH model was associated with lower total healthcare expenditures and total emergency department expenditures while there was no evidence of association for total inpatient expenditures, total ambulatory expenditures, or total pharmaceutical expenditures. The same trend for total healthcare expenditures was found in a 2012 study in which patients treated in NCQA's PCMH in New York practices had lower total healthcare expenditure than those who were not treated in NCQA's PCMH (DeVries, Chia-Hsuan, Sridhar, Hummel, Breidbart, & Baron, 2012). A national survey of the Medicare population showed the similar results (Stockbridge, Philpot, & Pagán, 2014). Lower emergency department expenditures among PCMH patients were also observed among Medicare population. In addition, there were also no significant

difference in inpatient expenditures and ambulatory expenditures between the two groups (Pines, van Hasselt, & McCall, 2015).

However, after controlling for biological and socioeconomic characteristics, there was no evidence of association of whether a person received care consistent with 3 domains of the PCMH model and any categories of healthcare expenditures. A national study examining PCMH model characteristics and healthcare utilization using 2007-2010 data also found that the empirical evidence did not indicate whether PCMH model reduce healthcare costs in terms of emergency department visits and inpatient admissions (Xin H. , Kilgore, Menachemi, & Sen, 2014). There was also a study from a PCMH pilot in New Hampshire that reported no statistically significant finding for costs between PCMH and non-PCMH group (Flieger, 2017). However, this was different from the result from Colorado PCMH pilots which still showed that patients in PCMH pilots had significantly lower emergency department expenditures comparing to non-PCMH practices (Kaushal, Edwards, & Kern, 2015).

Even though whether an individual received care consistent with 3 domains of the PCMH model was no longer significantly associated with healthcare expenditures after controlling for covariates, many of the social determinants of health still showed some meaningful associations. The characteristics of those which were associated with the increase in healthcare expenditures were generally the same as the characteristics of those which were associated with the increase in health service utilization. The more health service utilization a person had, the more healthcare expenditures were incurred. Thus, those who were female,

older, white, and having more education tended to have higher healthcare expenditures. Having more comorbidities was also associated with higher healthcare expenditures. It was reported that treating patients with chronic illness was four times more costly than treating patients without chronic conditions (Christensen, et al., 2013). Self-perceived health status also had a strong association with healthcare expenditures. It was reported that a single item, self-rated health measure could robustly stratify populations and predict health expenditures generally as good as more complex models (DeSalvo, et al., 2009). Those without any health insurance who were less likely to receive non-emergency health services also tended to have lower expenditures in these categories. Again, after including all of these social determinants of health in the model, the effect of whether an individual received care consistent with PCMH model might not be as significant for total healthcare expenditures and total emergency department expenditures as it was in the univariate model.

Quality of care

Even though the PCMH model was originally designed to help improve chronic disease outcomes, this study found no evidence of the association between the receipt of care consistent with 3 domains of the PCMH model as perceived by patients and healthcare quality for diabetic patients, as measured by proper disease management in terms of HbA1c test, blood cholesterol test, dilated eye examination, feet examination, and flu vaccination, both with and without controlling for patient characteristics. Another nationwide study also found that whether a person had a PCMH as a usual source of care did not appear to be

associated with most preventive care and quality measure including receiving flu vaccination (Bowdoin, Rodriguez-Monguio, Puleo, Keller, & Roche, 2016). The same results were also found in studies from PCMH pilots in New Hampshire and Colorado which reported no statistically significant evidence for quality measures including dilated eye exam, HbA1c testing, and lipid control for patients with diabetes between PCMH and non-PCMH group (Flieger, 2017; Rosenthal, Friedberg, Singer, Eastman, Li, & Schneider, 2013). One pilot study even found that the PCMH group had lower rate of HbA1c testing (Rosenthal, et al., 2015). However, there were a few studies that found the evidence of better quality of care for diabetic patients such as higher rate of HbA1c testing and LDL screening (DeVries, Chia-Hsuan, Sridhar, Hummel, Breidbart, & Baron, 2012).

One of the reasons for the mixed result of quality outcomes for diabetes patients was that different models produced different outcomes (McGinley & Gabbay, 2016). PCMH model is a general idea of domains that are believed to improve care. It depends on each practice to adopt the concept and implement interventions according to the PCMH goals. Moreover, each location has its own unique patient and community characteristics in addition to different payment models. Thus, the outcomes can vary based on the different focus of each practice.

Another reason that this study found no evidence of the association between the receipt of care consistent with the PCMH model and healthcare quality for diabetic patients in terms of proper disease management might be because the comparison group also has usual source of care. Once diabetic patients have a visit with their usual provider, regardless

of the PCMH characteristics of the facilities and patient characteristics such as demographics, socioeconomic status, and self-perceived health status, they still receive care according to clinical guidelines. One factor that seemed to be important is health insurance status since those with private insurance tended to have higher odds of having blood cholesterol test and dilated eye examination compared to those with public insurance and the uninsured. However, the difference in quality of care between PCMH and non-PCMH groups might be more prominent if clinical outcomes were evaluated as more care coordination is required from a multidisciplinary team to manage the disease well than to provide tests and examinations. For example, there was evidence that the PCMH model helped improve clinical outcomes such as HbA1c level, LDL level, and blood pressure in diabetic patients (Gabby, Bailit, Mauger, Wagner, & Siminerio, 2011; Christensen, et al., 2013) and thus reduce the proportion of the population with bilateral blindness, foot amputations, myocardial infarctions, and mortality rate (Pagan & Carlson, 2013).

Strengths and Limitations

One strength of this study is that the data came from a nationally representative sample of the non-institutionalized US adult population. In contrast, most previous studies were limited to a few states as they evaluated the PCMH model pilots implement in specific areas or in specific population groups such as children or those in the VA system. This study provides a broader view of the association of PCMH characteristics among non-institutionalized US adult population and the result can be generalizable to all of this

population in the US. Socioeconomic and demographic data available in MEPS data also provide opportunities to adjust for possible confounding factors that might affect healthcare utilizations, costs, and quality.

In addition, MEPS data contain many survey questions that reflect important PCMH characteristics. Therefore, it is a unique opportunity to measure PCMH characteristics through the perspective of patient experience as patient experience is now widely used as a measure for healthcare quality (Principles for the National Quality Strategy). Patient experience with PCMH characteristics is essential in evaluating PCMH model because if the patients cannot fully perceive that they are receiving care that is consistent with the PCMH model, then the attempt to improve health services is likely to be less effective (Xin H. , Kilgore, Menachemi, & Sen, 2014). When patients recognize the additional efforts of the providers to provide whole-person care and patient-centered care as in PCMH model, it improves patient satisfaction (Stockbridge, Philpot, & Pagán, 2014), which contributes to better interaction and cooperation with healthcare providers to achieve healthcare system efficiency (Xin H. , Kilgore, Menachemi, & Sen, 2014).

However, this study also has a few limitations. First, because the data used in the analysis are the existing survey data that were not designed specifically to capture effectiveness of PCMH model, the accredited PCMH practices cannot be defined. Instead, a published set of criteria to identify whether a patient received healthcare services from a practice with PCMH characteristics was used (Bowdoin, Rodriguez-Monguió, Puleo, Keller,

& Roche, 2016). Additional studies using MEPS data are needed to validate accredited PCMH providers in MEPS data.

A second limitation is that not all PCMH characteristics were included in the survey questionnaire. MEPS data does not have complete ranges of survey questions to capture all of PCMH domains. Therefore, not all PCMH attributes can be assessed. Only 3 aspects of PCMH model (comprehensive care, patient-centered care, and accessible care) could be investigated in this study. More survey items related to other PCMH domains and the three foundation supports, including health information technology, workforce, and finance, should be developed and included in national surveys so that all characteristics of PCMH can be captured.

Third, there is no specific information regarding primary care providers. The PCMH model was designed for the primary care team as patient's principal healthcare providers with coordination with specialists when needed. However, with MEPS data, it cannot be determined whether the usual source of care who was being evaluated for PCMH characteristics was a primary care provider.

Fourth, since the household component of the MEPS data was self-reported, it is possible that there might have been recall bias. The subjectivity of the response may lead to inappropriate PCMH categorization. There are also some limitations of the generalizability of the study. The results of this study cannot be applied to children under 18 years old. Also, since homeless, institutionalized people and those who lived in the nursing home were not included in the MEPS survey, no assumptions can be made for these populations.

Moreover, this study has a short observational time. One year is too short to see the effect of the PCMH model on healthcare utilizations, costs, and quality. No change can occur instantly. With no information on the length of time of the PCMH implementation, in addition to other projects with goals to improve healthcare system that might be implemented at the same time, it is difficult to determine and isolate the sole effect of PCMH model.

Even though the results of this study mainly show no evidence of associations between receiving care consistent with 3 domains of the PCMH model based on patients' perspective and healthcare utilizations, costs, and quality in general population, it still cannot be concluded that there are no associations. There are other potential benefits of PCMH model that were not evaluated in this study. There are other utilizations, costs, and quality outcomes that should be evaluated, especially those related to chronic diseases. Since PCMH model was originally designed to take care of people with chronic diseases, it seems to be associated with positive outcomes in patients with chronic illness rather than general population (Pagan & Carlson, 2013; Gabby, Bailit, Mauger, Wagner, & Siminerio, 2011). In addition, even though this study finds no evidence of associations in overall PCMH characteristics, it cannot be concluded that there are no associations between each of the PCMH characteristics or domains and healthcare utilization, costs, and quality. More studies are needed to assess the influence of individual PCMH attributes on these outcomes.

CONCLUSION

This study provides additional evidence regarding the effectiveness of characteristics of 3 domains of the PCMH model, which are comprehensive care, patient-centered care, and accessible care, regarding healthcare utilization, expenditure, and quality of care based on patients' perspective. Among US non-institutionalized adults in this study, less than one-fifth perceived that they received care consistent with all 3 domains of the PCMH model. The leading factor that contributed to the low rate of PCMH attributions was lack of accessible care, specifically the availability of office hours at nights or on the weekends from their usual source of care. While univariate models show significant associations between the receipt of care consistent with 3 domains of the PCMH model and number of health service utilizations (ambulatory visits, emergency room visits, and prescription medication refills) and healthcare expenditures (total healthcare expenditures and total emergency department expenditures), no associations were found after controlling for individual demographic and socioeconomic characteristics in all but one measure. Number of ambulatory visits decreased slightly with the perception of receiving care consistent with 3 domains of the PCMH model. No significant difference was observed in either adjusted or unadjusted model for number of hospital discharges, total inpatient expenditures, total ambulatory expenditures, total pharmaceutical expenditures, or healthcare quality for diabetic patients (HbA1c testing, blood cholesterol testing, dilated eye examination, feet examination, and flu vaccination).

However, there was evidence of associations between those outcomes and several social health determinant factors such as age, gender, education, insurance coverage, and

self-report health status. With the intertwined impact of social determinants of health on health outcomes and all other health-related projects that are happening at the same time, looking at just a presence of PCMH characteristics may not provide all the evidence that we need for variety of health outcomes. The efforts around PCMH are only the beginning since it has only been a few years since the concept was widely recognized (McGinley & Gabbay, 2016). However, it should not be the only efforts to improve healthcare. We need long-term policy-relevant research for outcomes of the PCMH approach (Rittenhouse, Thom, & Schmittiel, 2010).

Even though the advantage of this study is that it used a nation-wide survey data from patient's perspective to assess PCMH characteristics and attributes, there are still some limitations including the limited amount of PCMH related information in existing surveys. More studies are needed to validate accredited PCMH providers in MEPS data as well as to develop a more comprehensive survey questionnaire to capture more complete view of PCMH in a national survey. Moreover, additional research on the impacts of specific PCMH attributes on health outcomes in both general population and specific population with chronic illness would provide a better understanding of the impact of the PCMH model on achieving quality care at sustainable costs.

APPENDICES

Appendix A: Defining Patient-Centered Medical Home

Domain	Variable	Description (question)	Type (Code)
Usual provider	haveus42	Usual source of care (USC) (Is there a particular doctor's office, clinic, health center, or other place that the individual usually goes to if he/she is sick or needs advice about his/her health?)	Binary 1 Yes 2 No Recode as Binary 1 Yes 0 No
	provty42	Provider type (Is the individual's provider a person, facility, or person in a facility?)	Category -1 Inapplicable 1 Facility 2 Person 3 Person in Facility provider Recode as Binary 1 Person or facility 0 Inapplicable

Domain	Variable	Description (question)	Type (Code)
	plctyp42	USC type of place (Is the usual source of care a hospital clinic, hospital emergency room, or non-hospital place?)	Category 1 Hospital clinic/OP 2 Hospital ER 3 Non-hospital place Recode as Binary 1 Non-ER 0 ER
Comprehensive Care	treatm42	ac26: prov ask about other treatments (Does the provider usually ask about prescription medications and treatments other doctors may give you?)	Binary 1 Yes 2 No Recode as Binary 1 Yes 0 No
	minorp42	ac22: go to usc for new health problems (Is the provider the person or place family members would go to for routine or minor health problems?)	

Domain	Variable	Description (question)	Type (Code)
	preven42	ac22: go to usc for preventive health care (Is the provider the person or place family members would go to for preventive health care?)	
	reffrl42	ac22: go to usc for referrals (Is the provider the person or place family members would go to for referrals to other health professionals?)	
	ongong42	ac22: go to usc for ongoing health problems (Is the provider the person or place family members would go to for ongoing health problems?)	
Patient-Centered Care	explop42	ac30: prov explains options to you (Does the provider presents and explains all options to you?)	Binary 1 Yes 2 No Recode as Binary 1 Yes 0 No

Domain	Variable	Description (question)	Type (Code)
	respct42	ac27: prov shows respect for treatments other doctors may give (Does the provider ask about and show respect for medical, traditional, and alternative treatments that the person is happy with?)	Category 1 Never 2 Sometimes 3 Usually 4 Always Recode as Binary
	decide42	ac28: prov asks you to help make decisions (Does the provider ask the person to help make decisions between a choice of treatments?)	1 Yes (usually, always) 0 No (never, sometimes)

Domain	Variable	Description (question)	Type (Code)
Accessible	phnreg42	ac23: how diff contact usc by phone	Category
Care		(How difficult is it to contact the	1 Very difficult
		provider by phone during office hours?)	2 Somewhat difficult
			3 Not too difficult
			4 Not at all difficult
			Recode as Binary
			1 No (not too difficult/not at all difficult)
			0 Yes (very difficult/somewhat difficult)
	offhou42	ac24: usc has office hrs nghts/wkends	Binary
		(Does the provider have office hours at	1 Yes 2 No
		night or on the weekends?)	Recode as Binary

Domain	Variable	Description (question)	Type (Code)
	prvspk42	ac31: prov speaks person's language (Does the provider speak the person's language or provide translator services?)	1 Yes 0 No

Appendix B: Dependent variables

Domain	Variable	Description	Type
Healthcare utilization (aim 1)	obtotv16	# office-based provider visits 16	Count variables
	optotv16	# outpatient dept provider visits 16	
	ertot16	# emergency room visits 16	
	ipdis16	# hospital discharges, 2016	
	rxtot16	# presc meds incl refills 16	
Healthcare expenditure (aim 2)	totexp16	total health care exp 16	Continuous (\$)
	obvexp16	total office-based exp 16	
	optexp16	total outpatient fac + dr exp 16	
	ertexp16	total er facility + dr exp 16	
	iptexp16	tot hosp ip facility + dr exp 16	
	rxexp16	total rx-exp 16	
Healthcare quality in diabetic patients (aim 3)	dsdia53	diabetes diag by health professionals (Have you ever been told by a doctor or other health professional that you have diabetes or sugar diabetes?)	Binary 1 Yes 2 No Recode as binary 1 Yes 0 No

Domain	Variable	Description	Type
	dsa1c53	dcS: times tested for a-one-c in 2016 (During 2016, how many times did a doctor or other health professional check your blood for glycosylated hemoglobin or “hemoglobin A-one-C?)	Count variable Recode as binary 1 Yes 0 No
	dsft1653	dcS: had feet checked during 2016 (During 2016, did a doctor or other health professional checks your feet for any sores or irritations?)	Binary 1 Yes 2 No Recode as binary 1 Yes 0 No
	dsey1653	dcS: dilated eye exam in 2016 (During 2016, did you have an eye exam in which your pupils are dilated? This would have made you temporarily sensitive to bright light.)	

Domain	Variable	Description	Type
	dsch1653	<p>dcs: blood cholesterol checked in 2016</p> <p>(During 2016, did you have your blood cholesterol checked?)</p>	
	dsfl1653	<p>dcs: got flu vaccination in 2016</p> <p>(During 2016, did you get a flu vaccination (shot or nasal spray)?)</p>	

Appendix C: Covariate lists

Domain	Variable	Description	Type
Age	age16x	Age as of 12/31/2016	Continuous (yrs)
Sex	sex	Sex	Binary 1 Male 2 Female
Race/Ethnicity	racethx	Race/Ethnicity	Category 1 Hispanic 2 NH-White 3 NH-Black 4 NH-Asian 5 NH-other race / multiple race
Location	region16	Census region	Category 1 Northeast 2 Midwest 3 South 4 West
Marital status	marry16x	Marital status as of 12/31/2016	Category – Recode as Binary 1 Married 0 Single

Domain	Variable	Description	Type
Education	hideg	Highest degree when first entered MEPS	Category – Recode as Binary 1 HS or above 0 Less than HS
Income	povcat15	Family income as % of poverty line - category	Category 1 Poor (<100% FPL) 2 Near poor (100-125% FPL) 3 Low (125-200% FPL) 4 Middle (200-400% FPL) 5 High (\geq 400% FPL)
Insurance	inscov16	Health insurance coverage indicator 15	Category 1 Any private 2 Public only 3 Uninsured

Domain	Variable	Description	Type
Health status	rthlth42	Self-perceived health status	Category
		PE00A: Please think about your health between (start date) and (end date). In general, compared to other people of your age, would you say that your health is excellent, very good, good, fair, or poor?	1 Excellent 2 Very good 3 Good 4 Fair 5 Poor
Comorbidities		For these questions, please think about your health over your lifetime. Have you ever been told by a doctor or other health professional that you had (a disease)?	Each = Binary (Yes/No) Recode to become one Binary variable 1 Have comorbidities 0 Do not have comorbidities
	hibpdx	High blood pressure diag (>17)	
	chddx	Coronary hrt disease diag (>17)	

Domain	Variable	Description	Type
	angidx	Angina diag (>17)	
	midx	Heart attack (MI) diag (>17)	
	ohrtdx	Other heart disease diag (>17)	
	strkdx	Stroke diag (>17)	
	emphdx	Emphysema diag (>17)	
	choidx	High cholesterol diag (>17)	
	cancerdx	Cancer diag (>17)	
	diabdx	Diabetes diag (>17)	
	arthdx	Arthritis diag (>17)	
	asthdx	Asthma diag	

Appendix D: Variables addressing complex survey analysis

Domain	Variable	Description
Complex survey	perwt16f	Final person weight – 2016
	saqwt16f	Final SAQ person weight – 2016
	diabw16f	Final diabetes care supplement weight
	varstr	Variance estimation stratum – 2016
	varpsu	Variance estimation psu – 2016

Appendix E: Multivariate regressions for healthcare utilization

	Ambulatory Visits		Emergency Room Visits		Hospital Discharges		Medication Prescription Refills	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
PCMH	-0.0741	0.0404	-0.0596	0.0728	0.0608	0.0947	0.0073	0.0329
Age	0.0111***	0.0010	0.0003	0.0017	0.0143***	0.0024	0.0146***	0.0007
Female	0.2517***	0.0304	0.2400***	0.0592	0.3522***	0.0784	0.1277***	0.0243
Race/Ethnicity								
Hispanic (baseline)								
Non-Hispanic White	0.2738***	0.0476	0.1308	0.0718	0.3600***	0.0999	0.3206***	0.0467
Non-Hispanic Black	-0.1460*	0.0565	0.1219	0.0793	0.1459	0.1097	0.1401**	0.0532
Others/Multiple races	-0.0948	0.0564	0.2198	0.1370	0.1336	0.1398	0.1220	0.0627
Census region								
Northeast (baseline)								
Midwest	-0.1480**	0.0500	0.2030*	0.0856	0.1285	0.1138	0.0817	0.0472
South	-0.2047***	0.0444	0.0971	0.0757	0.1430	0.1051	0.0931	0.0429
West	-0.0550	0.0453	-0.0345	0.0886	-0.0082	0.1096	-0.0535	0.0579
Married	-0.0578*	0.0290	-0.2853***	0.0611	-0.1184	0.0710	-0.0909**	0.0258
At least high school education	0.3459***	0.0530	0.1468*	0.0718	0.1363	0.1137	-0.0202	0.0329
Family income								
Poor/Near poor (baseline)								
Low income	0.0096	0.0548	-0.0673	0.0931	-0.1233	0.1085	-0.0573	0.0445
Middle income	-0.0234	0.0495	-0.0567	0.0812	-0.1765	0.1013	-0.1728***	0.0424
High income	0.1587**	0.0514	-0.2030*	0.0956	-0.1776	0.1176	-0.1441**	0.0509
Health insurance status								
Any private (baseline)								
Public only	0.0328	0.0400	0.3979***	0.0717	0.2684**	0.0978	0.2289***	0.0324
Uninsured	-0.4483***	0.1133	-0.0970	0.1276	-0.4283	0.2224	-0.2197*	0.0924

	Ambulatory Visits		Emergency Room Visits		Hospital Discharges		Medication Prescription Refills	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Health Status								
Excellent (baseline)								
Very good	0.2361***	0.0454	0.2290	0.1174	0.3331*	0.1378	0.4114***	0.0404
Good	0.4998***	0.0461	0.6350	0.1173***	0.8359***	0.1338	0.7532***	0.0430
Fair	0.7564***	0.0528	1.0964	0.1266***	1.4327***	0.1301	1.1305***	0.0448
Poor	1.1240***	0.0840	1.6884	0.1405***	2.2095***	0.1617	1.4359***	0.0568
Comorbidities	0.4744***	0.0396	0.4048	0.0806***	0.1963	0.1273	1.1297***	0.0441
Constant	0.2476**	0.0913	-2.7252	0.1815***	-4.4847***	0.2472	0.1216	0.0848

* p-value < 0.05; ** p-value < 0.01; *** p-value < 0.001

Appendix F: Multivariate regressions for healthcare expenditure

	Total healthcare expenditures		Total ambulatory expenditure		Total ED expenditure		Total inpatient expenditure		Total pharmaceutical expenditure	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
PCMH	-0.0133	0.0576	0.0192	0.0762	-0.1868	0.1205	0.0684	0.1469	0.0556	0.1128
Age	0.0143***	0.0013	0.0132***	0.0015	-0.0051	0.0029	0.0165***	0.0037	0.0169***	0.0024
Female	0.2437***	0.0417	0.3285***	0.0523	0.1419	0.1103	0.5204***	0.1222	0.0798	0.0837
Race/Ethnicity										
Hispanic (baseline)										
Non-Hispanic White	0.3694***	0.0649	0.3377***	0.0820	-0.0814	0.1364	0.1438	0.1531	0.5396***	0.1270
Non-Hispanic Black	0.0413	0.0828	-0.0317	0.1135	-0.1240	0.1619	-0.0726	0.2036	0.0928	0.1560
Others/Multiple races	0.0391	0.0787	0.0510	0.1412	0.0963	0.1888	-0.0289	0.2216	-0.0157	0.1350
Census region										
Northeast (baseline)										
Midwest	-0.0269	0.0591	-0.0444	0.0692	0.2849*	0.1203	0.2276	0.1587	-0.0806	0.1237
South	0.0129	0.0589	-0.1194*	0.0581	0.4419**	0.1377	0.2239	0.1536	0.0002	0.1166
West	0.0742	0.0571	0.1077	0.0785	0.0431	0.1338	0.2938	0.1726	-0.1530	0.1386
Married	-0.1045*	0.0446	0.0388	0.0475	-0.2707**	0.0907	0.1970	0.1223	-0.2646**	0.0905
At least high school education	0.1966*	0.0814	0.4184***	0.0888	0.2632*	0.1250	0.4742*	0.1786	0.1075	0.0965
Family income										
Poor/Near poor (baseline)										
Low income	-0.1394	0.0883	-0.0241	0.1014	0.0052	0.1759	-0.4338*	0.1907	-0.1777	0.1237
Middle income	-0.1624*	0.0742	-0.0211	0.0956	0.0177	0.1588	-0.3102	0.1711	-0.2863*	0.1167
High income	0.0389	0.0782	0.2794**	0.0907	0.0366	0.1508	-0.5067**	0.1819	-0.1011	0.1165

	Total healthcare expenditures		Total ambulatory expenditure		Total ED expenditure		Total inpatient expenditure		Total pharmaceutical expenditure	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Health insurance status										
Any private (baseline)										
Public only	0.0695	0.0536	-0.0637	0.0673	-0.1199	0.0911	0.2240	0.1313	0.1337	0.0818
Uninsured	-								-	
Health Status										
Excellent (baseline)										
Very good	0.3392***	0.0672	0.3494***	0.0675	0.2283	0.1715	0.4346	0.1602**	0.6041***	0.1346
Good	0.7329***	0.0699	0.7112***	0.0728	0.7432***	0.2018	1.1174	0.1628***	0.8577***	0.1156
Fair	1.2250***	0.0829	1.1058***	0.0921	1.1431***	0.1604	1.8035	0.2037***	1.3686***	0.1184
Poor	1.8245***	0.0964	1.6646***	0.1337	1.8134***	0.2091	2.5465	0.2062***	1.8780***	0.1387
Comorbidities										
Constant	0.5706***	0.0570	0.5420***	0.0597	0.6582***	0.1295	0.4452	0.1833*	1.2485***	0.1099
	6.4536***	0.1578	5.1369***	0.1671	4.3191***	0.2586	4.2756	0.3478***	4.5181***	0.2765

* p-value < 0.05; ** p-value < 0.01; *** p-value < 0.001

Appendix G: Multivariate regressions for healthcare quality of diabetic patient

	HbA1c		Feet examination		Dilated eye exam		Cholesterol		Flu vaccination	
	OR	SE	OR	SE	OR	SE	OR	SE	OR	SE
PCMH	0.7525	0.2478	1.2754	0.2364	0.9631	0.1545	0.7926	0.1804	1.0599	0.1967
Age	1.0171	0.0093	1.0241***	0.0054	1.0311***	0.0049	1.0296***	0.0073	1.0365***	0.0054
Female	1.0357	0.2473	0.8084	0.0958	1.4906**	0.2074	1.0456	0.1677	1.1857	0.1428
Race/Ethnicity										
Hispanic (baseline)										
Non-Hispanic White	1.7601	0.5436	1.6364**	0.2734	0.9924	0.1642	1.0842	0.2164	0.8811	0.1487
Non-Hispanic Black	0.8566	0.2771	1.7399**	0.3616	1.1288	0.2017	0.8949	0.2104	0.5439**	0.1042
Others/Multiple races	0.5115	0.1833	0.9747	0.2228	0.9757	0.2425	1.3555	0.4574	0.8060	0.1899
Census region										
Northeast (baseline)										
Midwest	0.8793	0.3201	0.8032	0.1813	1.0268	0.2284	0.7720	0.2218	0.7113	0.1545
South	1.6265	0.4990	0.6021**	0.1012	0.9221	0.1839	0.9230	0.2247	0.6385*	0.1266
West	1.7138	0.5761	0.8299	0.1901	1.2769	0.3175	0.8169	0.2297	0.8473	0.1759
Married	1.0901	0.2737	1.0664	0.1356	1.3243*	0.1541	1.1843	0.2343	1.1599	0.1701
At least high school education	1.0480	0.2834	1.0512	0.1556	1.3054*	0.1657	0.9562	0.1952	1.3710*	0.1892
Family income										
Poor/Near poor (baseline)										
Low income	0.7571	0.1928	1.0193	0.1695	1.1545	0.1874	0.7778	0.2191	0.8225	0.1698
Middle income	0.5425*	0.1353	0.9594	0.1823	0.7252*	0.1149	0.7075	0.1631	0.9020	0.1556
High income	1.6423	0.5445	1.2112	0.2558	1.2393	0.2591	0.9959	0.2910	1.0242	0.2178
Health insurance status										
Any private (baseline)										
Public only	0.7232	0.2034	0.8399	0.1345	0.6956*	0.1029	0.5205*	0.1368	1.0502	0.1649
Uninsured	0.9744	0.3673	0.9311	0.3210	0.5027**	0.1085	0.5385*	0.1584	0.6042	0.1633

	HbA1c		Feet examination		Dilated eye exam		Cholesterol		Flu vaccination	
	OR	SE	OR	SE	OR	SE	OR	SE	OR	SE
Health Status										
Excellent (baseline)										
Very good	0.5186	0.3319	1.3052	0.3690	1.3900	0.4031	2.1827*	0.8181	1.1795	0.3782
Good	0.8280	0.5212	1.0669	0.2759	1.6568	0.4665	1.7610	0.5922	1.3205	0.3961
Fair	0.8353	0.5155	1.4152	0.4274	1.7154	0.5183	1.6744	0.6253	1.3113	0.3991
Poor	0.7948	0.5486	1.7227	0.5753	1.8002	0.5937	2.0720	0.8722	1.5150	0.5916
Comorbidities	0.7261	0.3347	1.1223	0.3402	0.8973	0.2234	1.6766	0.5492	1.2214	0.3904
Constant	6.8030	7.3170	0.3644	0.1879	0.1326***	0.0684	0.6778	0.4996	0.1515**	0.0922

* p-value < 0.05; ** p-value < 0.01; *** p-value < 0.

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