Association of the Implementation of the Patient-Centered Medical Home with Quality of Life in Patients with Multimorbidity

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Abstract

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Background: The patient-centered medical home (PCMH) has clinical benefits for chronic disease care, but the association with patient-reported outcomes such as health-related quality of life (HRQoL) is unexplored in patients with multimorbidity (two or more chronic diseases).

Objective: To examine if greater clinic-level PCMH implementation was associated with higher HRQoL in multimorbid adults.

Design: Retrospective cohort study.

Participants: 22,095 multimorbid patients who received primary care at 944 Veterans Affairs (VA) clinics.

Main Measures: Our exposure was the Patient Aligned Care Team Implementation Progress Index (PI^2) for the clinic in 2012, a previously validated composite measure of PCMH implementation. Higher PI^2 scores indicate better performance within eight PCMH domains. Outcomes were patient-reported HRQoL measured by the physical and mental component scores (PCS and MCS) from the Short Form-12 patient experiences survey in 2013-2014. Interaction of the outcomes with total hospitalizations and primary care visit count were also examined. Generalized estimating equations were used for main models after adjusting for patient and clinic characteristics.

Results: The cohort average age was 68 years, mostly male (96%), and had an average of 4.4 chronic diagnoses. Compared to patients seen at the lowest scoring clinics for PCMH implementation, care in the highest scoring clinics was associated with a higher adjusted marginal mean PCS [42.3 (95% CI 41.3–43.4) vs. 40.3 (95% CI 39.1–41.5), P=0.01)], but a lower MCS [35.2 (95% CI 34.4–36.1) vs. 36.0 (95% CI 35.3–36.8), P=0.17]. Patients with prior hospitalizations seen in clinics with higher compared to lower PI^2 scores had a 2.7 point greater MCS (95% CI 0.6–4.8; P=0.01).

Conclusions: Multimorbid patients seen in clinics with greater PCMH implementation reported higher physical HRQoL, but lower mental HRQoL. The association between PCMH implementation and mental HRQoL may depend on complex interactions with disease severity and prior hospitalizations.

Introduction

Patients with multimorbidity, or those with two or more chronic diseases, are increasing in prevalence, constituting more than 50% of those over 65 years.[1] Multimorbid patients have a higher risk for adverse outcomes, mortality, and utilization.[2,3] The clinical, behavioral, and social complexity[4] of these patients increases pressure on traditional primary care practices to provide more comprehensive primary care. The patient-centered medical home (PCMH) is a care delivery model integrating team-based care with health system and community resources, and was created to respond to the additional needs of patients living with chronic illness.[5] The PCMH has significant benefits for quality of care and utilization.[6–8] These benefits may be particularly impactful for multimorbid patients, given the intersection of chronic disease and contextual needs within these patients.[9] Specific PCMH components could affect health outcomes in multimorbid patients, with care tailored to comorbidity burden.[9–11] For example, for a patient with complex diabetes and undiagnosed depression, clinics implementing the PCMH model could provide increased comprehensive assessment and risk-stratified care management, leading to improved screening and treatment of depression and impacting a patient's function, self-care, and overall psychologic well-being.

Assessing the potential benefit of the PCMH model for multimorbid patients is challenging given the heterogeneity of disease, biopsychosocial needs, and patient goals in this group.[12,13] Health-related quality of life (HRQoL) is an important patient-reported outcome universally applicable to multimorbid patients and is a priority for research and healthcare related to multimorbidity.[14,15] Care aspects often included in the PCMH, such as team-based

care, self-management, and patient-provider communication, have been independently associated with improved HRQoL in chronically ill patients.[16–18] However, prior research has not assessed the impact of these elements combined, nor potential benefits from their synergy within the PCMH as a whole.

In 2010, the VA initiated implementation of a PCMH model across all primary care clinics, the Patient Aligned Care Team (PACT) initiative. However, implementation was not uniform across clinics in the VA.[7] Patients seen at clinics with greater PCMH implementation received better quality clinical care, had reduced preventable hospitalizations, and reported higher satisfaction.[7,8] Yet the impact of PACT on multimorbid patients has not been evaluated, especially for relevant outcomes such as HRQoL. Therefore, the goal of this study was to examine if greater clinic-level PCMH implementation was associated with higher HRQoL within a cohort of multimorbid Veterans.

Methods

Overview

This was a retrospective cohort study with respondents to the VA Survey of Healthcare Experiences of Patients (SHEP) in 2013-2014, the source of the HRQoL physical and mental health outcomes. Respondents were linked to their designated primary care clinic in 2012 to allow at least one year of clinic experience and sufficient follow-up time to assess slow-progressing outcomes in chronic disease.[19] PCMH implementation was assessed for primary care clinics in 2012 using a previously validated measure, the Patient Aligned Care Team Implementation Progress Index (PI^2).[7] We used generalized estimating equations to estimate the effect of PCMH implementation on HRQoL outcomes.

This analysis was conducted as part of the VA's evaluation efforts for the PACT model and was considered a quality improvement project rather than research activity. Therefore, our study was not subject to institutional review board approval nor waiver.

Cohort Selection

We identified 27,813 patients over 18 years old who responded to the long form of the SHEP between April 1, 2013 and September 30, 2014 (Figure 1). We excluded patients if they were not Veterans (n = 60),[20] did not have at least one visit to a primary care clinic in 2012 (n = 521), those missing numeric covariates or for whom HRQoL outcomes were unable to be imputed (n = 677, < 3%), and those who did not meet the definition of multimorbidity (n = 4,585). Multimorbidity was defined as two or more chronic diseases (by ICD-9 encounter codes within the Agency for Healthcare Research and Quality's Chronic Condition Index) in two or more body systems.[21,22] A pre-specified subgroup was defined as patients with three or more chronic diseases in three or more body systems. The final cohort consisted of 22,095 patients.

Health-Related Quality of Life

The SHEP is a VA survey routinely administered by mail to a stratified random sample of outpatients with encounters in the past month.[23] The average response rate in 2014 was 45.4% (SD = 3.6%). Survey respondents for 2013-2014 were slightly older (68.1 vs. 63.9 years), with fewer female (4.6 vs. 6.2%), and more non-Hispanic white (85.7 vs. 74.2%) than general PACT users.[19] The long form of the SHEP includes a validated patient-reported measure of HRQoL, the Short Form-12 (SF-12), which has been adapted into the VR-12 for use by the VA and RAND.[24,25] The VR-12 assesses limitation or interference due to physical or emotional

symptoms with daily activities over the past 4 weeks. It includes 12 questions with possible responses on a 1 to 5 or 6 Likert scale. We transformed survey item responses with a validated algorithm to mental and physical composite scores (MCS and PCS respectively), ranging from 0 to 100 (with higher scores indicating better outcomes).[26] The minimum meaningful change for a patient (i.e. minimal clinically important difference, MCID) is 2.2 points for the PCS and 2.0 points for the MCS.[27] We imputed incomplete responses using established methods of modified estimation regression.[28] If multiple long-form SHEP surveys were completed, the first was used.

Clinic-Level PCMH Implementation

PCMH implementation was measured using the PACT Implementation Progress Index (PI^2), a composite clinic-level score capturing the extent to which elements of the PACT model were implemented by clinics. Further details on the PI^2 score have been previously described.[7] Briefly, the PI^2 score combines administrative and survey data to calculate standardized z-scores for eight PCMH domains (access; care continuity; care coordination; comprehensiveness; self-management support; patient-centered care and communication; shared decision-making; and delegation, staffing, and team function). Each clinic received an overall PI^2 score based on the total domains in the top compared to the bottom quartile of z-scores. The overall score ranges from -8 as the lowest performing (all domains in the bottom quartile) to 8 as the top performing score (all domains in the top quartile). PI^2 categories were created by categorizing the overall score along previous divisions (-5 to -7; -2 to -4; -1 to 1; 2 to 4; 5 to 8).[7] Scores for a designated primary care clinic were recorded in fiscal year 2012 (FY2012, October 1, 2011 to September 30, 2012).

Data Sources and Covariates

Administrative data from the VA Corporate Data Warehouse (CDW) was used for patient characteristics and utilization.[29] The VA Provider Specialty Workforce Report and the VA Site Tracking System were used for facility level data. We adjusted for several baseline patient- and facility-level covariates measured in FY2012. Patient covariates included age, sex, race/ethnicity, educational level, copay exemption as a proxy of personal income, marital status, and median household income by county of residence. At the facility level, covariates included clinic full time equivalent (FTE) providers per 10,000 patients, clinic rural or urban status, hospital- or community-based clinic affiliation, and location by U.S. Census Division. Urban designation for clinics was defined according to the Census Bureau, with non-urban designated as rural (including highly rural). We also adjusted for an indicator of quarter and year of SHEP survey response. Missing categorical covariates were coded as unknown, except as specified.

Statistical Analyses

We first compared characteristics of patients receiving care at high- versus low-performing clinics using linear regression or Pearson's Chi square. Potential confounders were explored for association with both exposure and outcome of interest. A priori, the above covariates were included in final adjusted models; nonsignificant covariates were removed for a sensitivity analysis.[30] Generalized estimating equations (GEE) were used to estimate the association between PI^2 and VR-12 scores. Models were developed with exchangeable correlation working structure to accommodate increased correlation between patients within the same practice. Conversion of regression coefficients to marginal means was performed assuming unbalanced data and required collapsing two Census Divisions (mid-Atlantic and Northeast) to

one region due to limitations in the reference grid. ANOVA was used for tests of trend. All analyses applied survey weighting to account for potential non-response bias and inference to representative populations. Standard errors for coefficient estimates were heteroskedastic robust. Hypothesis testing was two sided with an alpha of 0.05. Analyses were performed on R 3.5.0 (www.r-project.org).

Secondary analyses included examination of the relationship between HRQoL with the eight PI^2 domains and a number of sensitivity analyses. In the exploratory analyses of the PI^2 domains, we estimated eight separate models with the domain-level score as the primary explanatory variable, adjusting for covariates as above. Domain-level z-scores were categorized into low (bottom quartile), average (middle two quartiles), or high-performing (top quartile) to capture potential non-linear relationships. Sensitivity analyses included: 1) stratifying by age <65 and $\geq$65 years to approximate the effect of Medicare enrollment 2) varying the minimum patient counts per cluster (from $\geq$5 to $\geq$8 patients per clinic); 3) excluding nonsignificant covariates; and 4) excluding patients with imputed VR-12 scores (15.7% of patients).

Two effect modification analyses were used to examine the interaction of total hospitalizations and primary care visits during 2012, respectively, with PCMH implementation. Total hospitalizations served as a proxy for severity of illness[31] that was clinically recognizable, could potentially interact with care delivery (e.g. lead to changes in case management intensity) and was applicable to all patients without regard to diagnoses. Primary care visit count was used to explore if a dose-response relationship existed, with higher counts approximating greater PACT exposure.

Results

Patients were on average 68.4 years old, mostly male (96%) and non-Hispanic white (83%) (Table 1). Patients receiving care from clinics with the highest PI^2 scores were less likely to be minority race/ethnicity, copayment exempt, reside in urban areas, receive care from hospital-based clinics, or live in counties with lower median household income. Clinics with the highest PI^2 scores served fewer patients and had more providers per 10,000 patients.

The cohort had a mean MCS of 35.7 (SD = 10.0) and PCS of 41.1 (SD = 11.1). In unadjusted analysis, compared to clinics with the lowest PCMH implementation, patients seen in clinics with the highest implementation had a 3.6 point greater PCS (95% CI 1.6 to 5.6, $P<0.001$) and a 1.6 point lower MCS (95% CI -2.9 to -0.3, $P=0.02$) (Table 2). After adjustment, compared to the lowest performing clinics, patients seen in the highest performing clinics had an average PCS 2.1 points higher (95% CI 0.5 to 3.6, $P=0.01$). There was also a significant linear trend over the PI^2 categories between increased PCMH implementation and higher average PCS ($P<0.001$). In comparison to clinics with the least PCMH implementation, those seen in clinics with the most PCMH implementation had an average MCS 0.8 points lower (95% CI -1.9 to -0.3, $P=0.17$). Across all PI^2 categories, there was a significant linear trend between higher categories of PI^2 and lower MCS ($P=0.03$).

Among individual PI^2 domains, clinics with higher scores for communication, continuity, and shared decision-making had significant trends towards higher physical, but lower mental HRQoL in adjusted models. The absolute difference for both the PCS and MCS, between highest and lowest-implemented clinics for these domains was less than 1.1 points (range 0.5 – 1.1). None of the remaining six PI^2 domains were significantly associated with either HRQoL outcome (supplementary eTable 1).

Narrowing the definition of multimorbidity to three or more chronic diseases produced similar results, as did stratification by age above or below 65 years (stratification by age shown in supplementary eTable 2). None of the remaining sensitivity analyses led to qualitatively different findings.

In effect modifier analyses, the interaction between PI^2 categories and total primary care visits in 2012 was not statistically significant for either HRQoL outcome. Additionally, the interaction between total hospitalizations in 2012 and PI^2 categories was not significant for the PCS. However, among patients who had been hospitalized at least once, the average MCS was 2.7 points greater for those seen in clinics with the greatest PCMH implementation compared to those with the least (95% CI 0.6 to 4.8, *P*=0.01); the linear trend between greater PCMH implementation and higher MCS averages in hospitalized patients was also significant (*P*=0.02). Conversely, for patients without hospitalizations, the average MCS was 1.2 points lower (95% CI -2.4 to -0.05, *P*=0.04) for those seen in clinics with the greatest PCMH implementation compared to those with the least (Table 3).

Discussion and conclusions:

We found greater PCMH implementation was associated with better physical HRQoL for multimorbid patients enrolled in one of the largest integrated U.S health systems. Greater PCMH implementation was associated with higher mental HRQoL among multimorbid patients with a prior hospitalization, but a lower mental HRQoL among those without. Improvements in physical HRQoL may in part be driven by greater implementation of shared decision-making, communication, and continuity components in the PCMH.

To our knowledge, this is the first study examining the influence of the PCMH on HRQoL in multimorbid primary care patients. Previous studies have demonstrated PCMH models to be associated with improved HRQoL. However, these studies included only specific age- or disease-defined subgroups such as geriatrics,[32,33] diabetes,[34] or high-risk populations.[35] Domains of the PCMH which may be most closely associated with HRQoL, based on our findings, are shared decision-making, communication, and continuity. Tentative connections between HRQoL and these aspects of care have been found previously. Shared decision making has been inconsistently associated with improved HRQoL for select diseases such as asthma or diabetes.[36,37] Improved continuity of care has been shown to be associated with better patient-provider communication, which may in turn may be associated with HRQoL.[8,38,39]

Our findings regarding the difference in physical HRQoL between low- and high-implementation clinics are clinically relevant to patients, as it approaches the MCID. As an example, the difference is similar to the effect on perception of health status from a new diagnosis of asthma.[27] Improved patient adherence to care recommendations may be an explanation for our findings related to physical HRQoL,[40,41] based on the mechanisms suggested by the domain-specific findings in our study and prior literature.[36,38] Higher quality care from clinics with better PCMH implementation[6–8] may also be a mechanism for improved physical HRQoL.

Our findings for mental HRQoL were surprising. The main outcome of lower mental HRQoL reported by patients seen in clinics with greater PCMH implementation did not approach the MCID for the MCS. Despite unclear clinical significance, our findings may be due to unmeasured differences in mental health care. Mental health integration in primary care predated PCMH implementation in the VA and was not explicitly captured by the PI^2. A higher PI^2 thus

may reflect a focus on care processes that divert attention or resources away from mental health, potentially also explaining the inverse directionality shown between the MCS and PCS. Unfortunately, we were unable to determine clinic-specific factors such as access to psychiatry in this study. Another unexpected finding was variation in the mental HRQoL among those with remote prior hospitalizations. Those who had previously been hospitalized did have a higher MCS above the threshold of MCID. These patients may be a distinct subgroup from those without hospitalizations, potentially representing those with more severe physical disease. Given our broadly defined cohort, differences among subgroups are expected. Patients with greater disease burden are more likely to use primary care services than those with fewer diseases, particularly face to face visits.[19] However, visit frequency (and by extension, disease burden) alone is an insufficient explanation – we would have anticipated primary care visit count to interact with the level of PCMH implementation on HRQoL outcomes. More likely, the type of services used and substance of interactions with the PCMH differ among subgroups – such as triggering the PCMH to deliver more intensive case management after hospitalizations.

Our study has several limitations. We utilized administrative coding of diagnoses, which has been shown to potentially result in misclassification.[42] Differences in the coding of diagnoses across health systems may result in variation in the study sample compared to studies conducted in non-VA settings.[21] We were also limited to VA data for these analyses; however, we have attempted to approximate dual-use of Medicare by stratifying by age. Another potential limitation is that residual confounding or unobserved factors may influence our results. Differences in patient and clinic characteristics existed at baseline, particularly in socioeconomic measures. For example, lower socioeconomic status has been linked to decreased HRQoL[43] and racial subgroups may experience differences in PCMH care.[44] Therefore, unobserved differences

in patient characteristics between PI^2 categories may affect results despite our attempts to adjust for confounding. Finally, while the methodology for deriving VR-12 and SF-12 scores has been previously validated, our findings may have been influenced by the scoring algorithm, as suggested by prior research.[45] The algorithm we applied transforms raw item scores to a total score for the MCS and PCS using an uncorrelated (orthogonal) factor solution when the component scores may in fact be correlated. This could result in an imposed inverse trend between the MCS and PCS. Unfortunately, no alternative algorithm for scoring is in widespread use.

In summary, we found the PCMH model affected physical and mental HRQoL differently in patients with multimorbidity – improving physical HRQoL for all patients, but mental HRQoL only for those with prior hospitalizations. Patient-reported outcomes like HRQoL are valuable for this vulnerable, clinically diverse population, and improving patient HRQoL is a priority for national organizations and healthcare systems alike.[14,46] Translating these results to clinical practice might include increased use of decision aides, efforts to reduce provider turnover, dedicated communication training, or patient-driven agenda setting in primary care encounters. Our findings are among the first to add HRQoL to the known benefits of the PCMH, further supporting a trajectory of patient-centered change within systems considering or utilizing similar primary care delivery models.

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Conflict of Interest:

No additional conflicts of interest, financial or otherwise, to disclose.

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Figure 1. Inclusion of patients in cohort of multimorbid Veterans seen in primary care clinics in 2012 with responses to patient-experiences survey in 2013 or 2014.

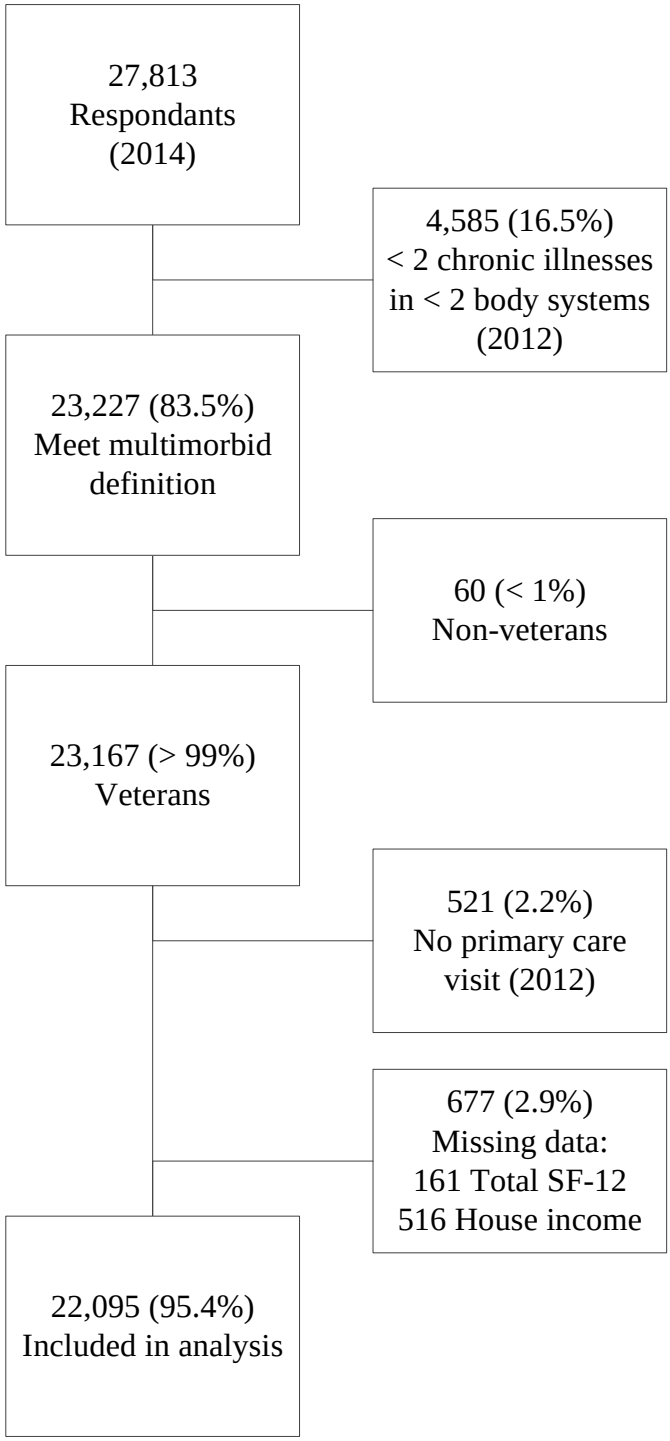

Table 1. Clinic and patient characteristics, overall and by quartile of clinic performance by Patient Aligned Care Team Implementation Progress Index (PI^2) score, 2012.

	Overall Mean (SD)*	**Top Category PI^2**	**Bottom Category PI^2**	***P***
Patients, No.	22,095	2,075	1,879	-
Age, y	68.4 (11.1)	69.1 (10.9)	67.5 (11.2)	<0.001
Male, No. (%)	21,189 (96)	2,018 (97)	1,796 (96)	0.006
Race/ethnicity, No. (%)				
Non-Hispanic white	18,345 (83)	1,784 (86)	1,481 (79)	
Non-Hispanic black	1,794 (8)	121 (6)	183 (10)	0.001†
Hispanic	1,080 (5)	99 (5)	122 (7)	
Other/unknown	876 (4)	71 (3)	93 (5)	
School, No. (%)				
< High school (HS)	2,450 (11)	259 (13)	187 (10)	
HS grad	7,971 (36)	785 (38)	678 (36)	0.03†
Some college	7,790 (35)	669 (32)	674 (36)	
≥ 4 y degree	3,765 (17)	352 (17)	331 (18)	
Married, No. (%)	14,379 (65)	1,342 (65)	1,230 (66)	0.02
Median household income, 1,000 USD (county-level)	48.55 (12.24)	49.46 (12.21)	46.86 (11.02)	<0.001
Total chronic diagnoses listed	4.4 (1.7)	4.3 (1.7)	4.2 (1.6)	0.03
Clinic visits				
Primary care	4.6 (4.4)	4.8 (4.5)	4.6 (4.6)	0.17
Specialty care	1.1 (2.5)	1.1 (3.0)	1.0 (2.2)	0.41
Mental health	2.9 (10.0)	2.4 (7.5)	2.8 (8.8)	0.08
All-cause VA hospitalizations	0.09 (0.41)	0.09 (0.41)	0.08 (0.36)	0.34
Clinics, total	944	83	90	-
Patient copay exempt, No. (%)	2,607 (12)	266 (13)	179 (10)	0.001
Rural, No. (%)	7,634 (35)	1,116 (54)	621 (33)	0.001
CBOC, No. (%)§	16,737 (76)	1,782 (86)	1,483 (79)	0.001
PCPs per 10k patients‖	13.1 (1.9)	13.2 (1.8)	12.8 (1.6)	<0.001
U.S. Census Division, No. (%)				
New England	1,358 (6.1)	206 (9.9)	27 (1.4)	
Middle Atlantic	2,756 (12.5)	457 (22.0)	139 (7.4)	
East North Central	3,419 (15.5)	311 (15.0)	176 (9.4)	
West North Central	2,415 (10.9)	236 (11.4)	113 (6.0)	
South Atlantic	3,737 (16.9)	354 (17.1)	291 (15.5)	<0.001
East South Central	1,779 (8.1)	119 (5.7)	273 (14.5)	
West South Central	2,259 (10.2)	87 (4.2)	366 (19.5)	
Mountain	2,298 (10.4)	153 (7.4)	221 (11.8)	
Pacific	2,074 (9.4)	152 (7.3)	273 (14.5)	

*Mean (SD), except where otherwise indicated. †*P*-value for all categories combined comparing top PI^2 versus bottom PI^2, using robust methods. ‡Post-Traumatic Stress Disorder. §Community based outpatient clinic. ‖ Primary care providers per 10,000 patients.

Table 2. Association between physical component score (PCS) and mental component score (MCS) in 2013-2014 with Patient Aligned Care Team Implementation Progress Index (PI^2) category of primary care clinic in 2012.

	Marginal Mean, 95% CI	***P** (Term)**	***P*† (Trend)**
PCS			
Unadjusted			
PI^2 -7 to -5	38.7 (37.1 – 40.3)	–	<0.001
PI^2 -4 to -2	39.0 (38.0 – 39.9)	0.76	
PI^2 -1 to 1	40.1 (39.4 – 40.8)	0.12	
PI^2 2 to 4	39.9 (38.6 – 41.1)	0.26	
PI^2 5 to 8	42.3 (41.1 – 43.5)	<0.001	
Adjusted‡			
PI^2 -7 to -5	40.3 (39.1 – 41.5)	–	<0.001
PI^2 -4 to -2	40.4 (39.7 – 41.1)	0.89	
PI^2 -1 to 1	40.8 (40.2 – 41.3)	0.47	
PI^2 2 to 4	40.3 (39.6 – 41.1)	0.95	
PI^2 5 to 8	42.3 (41.3 – 43.4)	0.01	
MCS			
Unadjusted			
PI^2 -7 to -5	37.5 (36.6 – 38.5)	–	0.03
PI^2 -4 to -2	37.9 (37.1 – 38.7)	0.60	
PI^2 -1 to 1	36.9 (36.4 – 37.4)	0.22	
PI^2 2 to 4	37.1 (36.2 – 38.0)	0.53	
PI^2 5 to 8	36.0 (35.0 – 36.9)	0.02	
Adjusted‡			
PI^2 -7 to -5	36.0 (35.3 – 36.8)	–	0.03
PI^2 -4 to -2	36.3 (35.7 – 36.9)	0.55	
PI^2 -1 to 1	36.0 (35.6 – 36.4)	0.89	
PI^2 2 to 4	36.2 (35.6 – 36.7)	0.76	
PI^2 5 to 8	35.2 (34.4 – 36.1)	0.17	

**P* value for individual term compared to lowest-performing PI^2 category. †*P* value for linear trend across all levels of PI^2. ‡Adjusted models include patient age, sex, race/ethnicity, marital status, copay exemption status, educational level, median household income by zip code, clinic size as providers per 10,000 patients, clinic rural/urban status, community-based or VA medical center clinic status, clinic location by Census division, and a variable for survey quarter/year.

Table 3. Moderation of association of physical and mental component scores (PCS, MCS) with clinic Patient Aligned Care Team Implementation Progress Index (PI^2) category, by patient subgroup of prior hospitalizations in 2012.

	Mean Difference (95% CI)* **Low to High PI^2 Clinics**	***P* Term (Low to High PI^2)**	***P* Interaction**
PCS			
0 prior hospitalizations	2.09 (0.58 –3.60)	0.01	0.38
≥ 1 prior hospitalizations	0.09 (-2.38 – 2.56)	0.94	
MCS			
0 prior hospitalizations	-1.23 (-2.42 – (-0.05))	0.04	0.02
≥ 1 prior hospitalizations	2.67 (0.58 – 4.76)	0.01	

*Models are adjusted for patient age, sex, race/ethnicity, marital status, copay exemption status, educational level, median household income by zip code, clinic size as providers per 10,000 patients, clinic rural/urban status, community-based or VA medical center clinic status, clinic location by Census division, and a variable for survey quarter/year.

Appendices:

Supplementary eTable 1. Adjusted association of domains of Patient Aligned Care Team Implementation Progress Index (PI^2) by quartile of clinic performance and physical (PCS) and mental component score (MCS). Comparisons are to lowest quartile of PI^2 (<25%) as referent.

Domain	PCS			MCS		
	Average PI^2 Mean, SE	Highest PI^2 Mean, SE	*P* Trend	Average PI^2 Mean, SE	Highest PI^2 Mean, SE	*P* Trend
Access	0.59 (0.49)	0.41 (0.58)	0.07	0.06 (0.38)	0.09 (0.45)	0.29
Care coordination	0.72 (0.52)	0.68 (0.62)	0.07	-0.39 (0.38)	-0.38 (0.44)	0.14
Communication	0.47 (0.42)	0.69 (0.46)	<0.001	-0.19 (0.32)	-0.48 (0.39)	<0.001
Comprehensiveness	-0.13 (0.43)	0.05 (0.70)	0.67	0.31 (0.40)	0.66 (0.51)	0.25
Continuity	0.20 (0.40)	0.64 (0.52)	0.01	-0.23 (0.31)	-0.67 (0.41)	<0.01
Self-management support	0.07 (0.46)	-0.19 (0.61)	0.84	0.24 (0.36)	0.50 (0.45)	0.63
Shared decision-making	0.63 (0.44)	1.06 (0.51)*	<0.001	-0.43 (0.35)	-0.79 (0.43)	<0.01
Staffing, team function	-0.43 (0.41)	-0.04 (0.54)	0.61	0.19 (0.33)	0.38 (0.41)	0.28

Models are adjusted for patient age, sex, race/ethnicity, marital status, copay exemption status, educational level, median household income by zip code, clinic size as providers per 10,000 patients, clinic rural/urban status, community-based or VA medical center clinic status, clinic location by Census division, and a variable for survey quarter/year. SE = standard error using robust methods. $^{*}P$ <0.05 for component score difference compared to average PI^2 referent.

Supplementary eTable 2. Adjusted association of clinics in lowest to highest category of implementation of patient centered medical home with physical (PCS) and mental component score (MCS), stratified by age (≥ 65, n = 13,153; < 65, n = 8,942).

	Mean Difference*	95% CI	*P* for difference lowest vs. highest	*P* for trend across all 5 PI^2 quintiles
All patients, PCS	+2.1	0.5 – 3.6	0.01	<0.001
All patients, MCS	-0.8	-1.9 – 0.3	0.17	0.03
< 65 years, PCS	+ 2.1	-0.5 – 4.7	0.12	0.02
< 65 years, MCS	-0.6	-2.5 – 1.3	0.52	0.32
≥ 65 years, PCS	+1.9	0.3 – 3.6	0.02	<0.0001
≥ 65 years, MCS	-0.9	-2.0 – 0.2	0.09	<0.001

*Coefficient represents difference between lowest to highest quintile category of clinic for implementation of medical home, adjusted for patient age, sex, race/ethnicity, marital status, copay exemption status, educational level, median household income by zip code, clinic size as providers per 10,000 patients, clinic rural/urban status, community-based or VA medical center clinic status, clinic location by Census division, and a variable for survey quarter/year.