

## Evidence of a Patient Centered Medical Home (PCMH) Improving the Health of Chronically Ill Patients in the Mississippi Delta

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### Abstract

Using proprietary data of patient records from four medical clinics in the Mississippi Delta, this research utilizes a natural experiment design to explore if the patient centered medical home (PCMH) has a positive effect on chronic disease maintenance for low SES, majority African-American patients in a rural and medically underserved region. The patients are divided into two cohorts, those attending PCMH clinics (level 2) and those attending non-PCMH clinics. Each cohort is comprised of similar demographic, socioeconomic, and health (large proportion of diabetics) characteristics. HbA1c scores of the cohorts are compared at two time periods, baseline and six-month follow-up. PCMH patients report more uncontrolled diabetes at baseline but the trend reverses at follow-up, providing evidence that the PCMH model of primary care produces positive health outcomes for patients with diabetes in the sample area.

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## Introduction :

Under the current model of primary care delivery in the United States, nearly three out of four American adults report difficulty getting an appointment, health care advice by phone, or off-hours care without going to an emergency room<sup>1</sup>. In order to meet this growing need for a more efficient and effective health care system in the United States, particularly in primary care, the patient-centered medical home (PCMH) model strives to strengthen the foundation of primary care services by improving the patient experience, improving the population's overall health, and reducing the cost of care<sup>2,3</sup>. PCMH effectiveness has been documented in these areas, as there have been reductions in health care costs, unnecessary utilization of emergency department (ED) visits, inpatient hospitalizations, hospital<sup>4,5</sup>; improved LDL<sup>6</sup>, blood pressure, and HbA1c.<sup>7,8</sup>

The current evidence suggests that the PCMH model is working, but there remains an important gap in the literature regarding PCMH effectiveness in rural communities. Rural communities exhibit higher rates of chronic illness and mortality than urban communities,<sup>9,10</sup> and racial and ethnic minorities in rural communities exhibit higher rates of disease and death than white rural Americans, making them doubly disadvantaged<sup>11</sup>. Our research fills this place- and race-based gap in the literature by examining HbA1c improvement over time for patients with diabetes between PCMH and non-PCMH clinics located in an area of high health disparity.

### Why PCMH Matters in Mississippi and Rural America More Broadly

The Mississippi Delta is a prime example of a rural region experiencing a dearth of health care availability, as the majority of Delta counties are classified as health professional shortage areas<sup>12</sup>. The shortage of physicians is particularly damaging because

Delta counties exhibit high rates of hospitalizations due to diabetes complications<sup>13</sup>. Additionally, the targeted service area has a majority African-American population, who experiences significantly higher incidence rates of type 2 diabetes and premature death than non-Hispanic whites<sup>14</sup>, in large part a result of disparities in access and quality of care<sup>15,16</sup>. The region is also among the poorest in the nation, creating another significant layer of health disadvantage<sup>17</sup>. Overall, given the Delta's complex combination of medical, social, and economic disadvantages, it represents a community in dire need of health intervention.

We believe that if the PCMH model can be effective in the Mississippi Delta, among a population of medically underserved and majority minority and low income individuals; then it is worth consideration for other rural areas looking to improve patient outcomes. Evaluating the effectiveness of the PCMH model to treat chronic conditions in rural America is important because there are more than 3,000 rural HPSAs in the United States. Rural Americans report worse health outcomes than urban Americans on nearly all major health metrics due in large part to a severe shortage of health care<sup>18,19</sup>, which is best illustrated by the fact that twenty percent of the U.S. population lives in rural areas, but only 9% of physicians practice there<sup>20</sup>. Not unrelated is the issue of declining life expectancy, recently documented by the CDC<sup>21</sup>. One of the many reasons behind this unusual decline is the enormous mortality disparity between blacks and whites, which is exacerbated in many rural communities. There is thought that targeting improvement efforts at the nation's most vulnerable groups remains the most promising approach to confronting the national mortality crisis. The American Academy of Family Physicians (AAFP) has called for PCMH evaluations that are more rigorous about taking into account the socioeconomic diversity and health

disparities of patient populations<sup>22</sup>. Our work does exactly that by evaluating the comparative improvement in rurally located, high need, majority African American diabetic patient outcomes between PCMH and non-PCMH clinics.

## Methods

We examine the effectiveness of the PCMH model of primary care on patient outcomes as a natural experiment. Patient records come from six Mississippi Delta clinics divided into two cohorts, PCMH (two clinics, both classified as level 2 PCMH clinics) and non-PCMH clinics (four clinics). We analyze data from 143 patients attending the PCMH clinics and 1,040 patients from the non-PCMH clinics. The demographics of the sample population include 85.3% African American for the PCMH clinics and 74.9% African American for the non-PCMH clinics. The clinics in this study are the only major health care facilities for residents of this part of the Mississippi Delta. Patient data from each clinic is collected between 2007 and 2012, and any patient with at least two visits in a six-month period are included in the analysis. Aggregated cohort-level measures of first visit ( $T_1$ ) and follow-up visit ( $T_2$ ) HbA1c are analyzed. HbA1c is the score typically used to diagnose diabetes as it measures the average blood sugar levels over a period of several weeks.

The data include de-identified person-level information on clinic classification (PCMH or not), patient age (in years), race (African American or not), and patient clinical data associated with diabetes (HbA1c, systolic/diastolic blood pressure, LDL). Sex is not included in the analysis due to the unavailability for a

large amount of patients. Some data (from both PCMH and non-PCMH clinics) originated from paper-based clinical documents, and many of the hand-written notes indicating sex are illegible. The dependent variable is HbA1c level at  $T_1$  and six-month follow-up. The two cohorts are directly comparable as (1) both cohorts have large diabetic populations, and (2) both cohort populations are similar demographically and socioeconomically.

Regarding the health status of each cohort, cohort 1 (PCMH) has 87% of its patients exhibiting a mean  $T_1$  HbA1c level of 6.5 or higher, and cohort 2 (non-PCMH) has 70% of its patients at or above 6.5. We compare the study cohorts to examine the effectiveness of PCMH to non-PCMH clinics in terms of the probability that a patient exhibits a change in critical diabetes HbA1c threshold from at or above 6.5 HbA1c to below 6.5 HbA1c, indicating better management of disease. Logistic regression analyses are used to assess change in HbA1c over time by cohort; controlling for age, race, and  $T_1$  clinical scores of blood pressure and cholesterol.

## Results :

Table 1 provides background descriptive statistics for the PCMH and non-PCMH cohorts. The non-PCMH cohort includes four clinics, and therefore had a larger patient load with all of the qualifying data (primarily based on more than one clinic visit) ( $N = 1,040$ ) than the two-clinic PCMH cohort ( $N = 143$ ). The demographic makeup of the two cohort populations is similar, as both serve primarily African American patients (PCMH: 85.3%; non-PCMH: 74.9%). On average, PCMH patients were 10 years younger than non-PCMH patients

**Table 1. Descriptive Statistics for PCMH and Non-PCMH Patients**

Clinic Cohort	N	# Afr. Amer. (%)	Age in Years (SD)	# Diabetic (%) at T1	# Diabetic (%) at 6 Mo.	T1 Systolic BP (SD)	T1 Diastolic BP (SD)	T1 LDL (SD)
PCMH	118	106 (90%)	51 (12)	103 (87%)	83 (70%)	137 (20)	85 (12)	108 (37)
Non-PCMH	213	167 (78%)	61 (12)	150 (70%)	164 (77%)	134 (22)	76 (12)	102 (40)
Total	331	173(69%)	57 (13)	253 (76%)	247 (75%)	135 (22)	79 (12)	103 (39)

(mean of 51 years old versus mean of 61 years old, respectively). Prior research suggests that this age difference may be insignificant from a clinical standpoint considering that patients above the age of 45 are considered the highest risk of developing diabetes<sup>23</sup>. These patients are quite unhealthy regardless of age, as indicated by a T<sub>1</sub> cohort-level percentage of diabetics (6.5 HbA1c) of 87% (PCMH) and 70% (non-PCMH). However, these proportions changed at the 6-month follow-up: 70% of PCMH patients exhibited diabetic HbA1c levels while 77% of non-PCMH patients exhibited diabetic HbA1c levels. Both patient cohorts were similar in terms of systolic blood pressure levels, diastolic blood pressure levels, and LDL readings (Table1).

Logistic regression models predicting the odds of being diabetic controlling for clinic setting, age, race, systolic/diastolic blood pressure, and LDL levels were performed at T<sub>1</sub> (Table 2) and 6-month follow-up (Table 3). Table 2 shows that the only associated variable with being diabetic at T<sub>1</sub> (p<.05) is age (OR = 0.96; 95% CI = 0.93 – 0.981; p <0.001), controlling for clinic setting, race, and T<sub>1</sub> clinical scores. In this analysis clinic setting is approaching significance but does not meet the .05 threshold.

Table 3 shows the odds of being diabetic at 6-month follow-up, controlling for clinic setting, age, race, and T<sub>1</sub> clinical scores. In this model, a key change in association occurs. Age continues to be significantly associated with likelihood of being diabetic, but unlike

**Table 3:** Full model parameter estimates where outcome is 6-month diabetic status

Variable	Odds Ratio	95% Confidence	P-Value
Clinic	0.49	0.27 – 0.88	0.017
Age	0.98	0.95 – 1.00	0.04
Race (African American)	0.64	0.34 – 1.20	0.176
Baseline: Systolic BP	1.01	0.99 – 1.02	0.399
Baseline: Diastolic BP	1	0.97 – 1.04	0.859
Baseline: LDL	1	0.96 – 1.01	0.479

**Table 2:** Full model parameter where outcome is diabetic status at T<sub>1</sub>

Variable	Odds Ratio	95% Confidence	P-Value
Clinic (PCMH)	1.85	0.71 – 3.74	0.073
Age	0.96	0.93 – 0.98	0
Race (African American)	0.8	0.42 – 1.59	0.52
Baseline: Systolic BP	1.01	0.99 - 1.03	0.196
Baseline: Diastolic BP	0.99	0.97 - 1.03	0.89
Baseline: LDL	1	0.99 - 1.01	0.845

the previous model, clinical setting is now significantly associated at the .05 level as well (OR = 0.49; 95% CI = 0.27 to 0.88; p =0.017). A comparison of the odds ratios of clinic across the two models reveal that PCMH patients have higher average HbA1c scores at baseline and significantly lower average HbA1c scores at 6-month follow-up, controlling for age, race, and T<sub>1</sub> blood pressure and cholesterol scores. In other words, the cohort of PCMH patients was healthier than that of non-PCMH patients at T<sub>1</sub> but is healthier than non-PCMH patients at 6-month follow-up.

Additional analyses are conducted to confirm the original results. Both logistic regression models are fitted to include *only* clinic status and age. The parameter estimates for the newly fitted models are shown in Tables 4 and 5, and both clinic setting and age remain significantly associated with diabetic HbA1c levels at T<sub>1</sub> and 6-month follow-up. Furthermore, the interaction between clinic setting and age is explored to further parse out the role of age in predicting diabetic status, and no significant interaction effect is found at either T<sub>1</sub> (p > 0.42) or 6-month follow-up (p > 0.78). This provides further evidence that improvement in HbA1c is due to clinic setting rather than age or any other control variable. The positive result for diabetics in PCMH clinics is robust to several different statistical models.

**Discussion :**

**Table 4:** Finalized model parameter estimates for T<sub>1</sub> diabetic status

Variable	Odds Ratio	95% Confidence Interval	P-Value
Clinic (PCMH)	1.99	1.04 – 3.93	0.04
Age	0.96	0.94 – 0.98	0.001

**Table 5:** Finalized model parameter estimates for 6-month diabetic status

Variable	Odds Ratio	95% Confidence Interval	P-Value
Clinic (PCMH)	0.55	0.31 – 0.97	0.037
Age	0.98	0.96 – 1.00	0.027

This research demonstrates that the patient centered approach of the PCMH model is an effective form of primary care in a poor, minority, and unhealthy rural community. There are several important takeaways from this research. First, the effectiveness of the PCMH is evident in multiple facets. From a descriptive standpoint, the percentage of patients from T<sub>1</sub> to 6-month follow-up exhibiting an HbA1c score of 6.5 or higher changed by 24 percentage points between the two types of clinics. A higher percentage of PCMH patients were initially considered diabetic according to this threshold, but after patients were allowed time for follow-up visits, substantially fewer PCMH patients exhibited the 6.5 HbA1c threshold. This is a dramatic turnaround, hence the motivation for conducting further analyses controlling for all possible covariates to make sure, to the best of our knowledge, that the positive results are due to clinic setting rather than other confounding factors. Using several subsequent causal analyses, the positive results remained. In addition to the statistical analyses that were conducted, the study design reinforces the validity of the results. More specifically, this is not sample data. It is real, population data on patient outcomes with a built-in experimental and control group, i.e. the PCMH clinics and non-PCMH clinics. Considering that the control measures were limited, the study design comparing the T<sub>1</sub> state of health and demographic characteristics is the best way to ensure that there were no major differences between

the cohort populations. Additionally, the PCMH clinics were initially established around the 2007 time period, so changes in T<sub>2</sub> data for PCMH patients in the “experimental” clinics can be logically credited to the changes in the operational structure of the clinics themselves, i.e. the clinic setting truly matters. Our results compare favorably to other findings where PCMH patients exhibited 7.4% better LDL control (<100) than non-PCMH patients<sup>24</sup>, PCMH clinics have an 8.5% increase in patients with LDL-C less than 130, a 4% increase in patients with BP less than 140/90, and a 2.5% decrease in the number of patients with A1C greater than 9<sup>25</sup>. PCMHs are specifically helpful in improving quality outcomes for patients with diabetes; performing 4.2%-8.3% better on HbA1c testing and 4.3%-8.5% better on LDL-C testing<sup>26</sup>.

Secondly, there is a large body of research suggesting that access to health care and health disparities are highly dependent on place. Whether “place” is operationalized as rural-urban, south-non-south, state, county, or regional differences, it is clear that context matters. Despite the built-in place-based challenges this target population faces, the PCMH model dramatically improved effective maintenance of diabetes. If the PCMH model can be effective in this place, we argue that it can be effective in other places with high levels of need. These findings are particularly generalizable to other parts of rural America. Rural Americans exhibit higher rates of morbidity and mortality, suffer from chronic illnesses at higher rates than urban Americans, and have more difficulty in accessing care, particularly the case for the chronically ill<sup>27,28</sup>. Many rural communities are looking for methods to enhance patient outcomes with improved delivery of care, and these findings address a critical gap in the literature by showing the effectiveness of the PCMH model in the Mississippi Delta community.

Third, it should come as no surprise that the PCMH model is effective. By definition, the model



engages the patients in their own care, provides a more complex network of care, and increased number of resources through which to seek care, maintain health, and improve well-being. Considering that there are clinic-level factors that cannot be accounted for in statistical models, such as clinic leadership, management, and qualitative differences in quality of care, there is one key component that *can* be measured, adherence to follow-up appointments. The patient-centered approach in our “experimental” clinics is most noticeably evident in adherence to follow-up appointments. Adherence is vital to maintaining chronic disease, yet only 25% of diabetic patients nationwide adhere to six-month follow-up appointments<sup>29</sup>. Diabetic patients in this study’s non-PCMH clinics mirror the national numbers with a 23% six-month adherence rate. However, the patients in this study’s PCMH clinics adhere at a rate of 88%, an incredibly high number that contributes substantially to the comparatively positive diabetes management that these patients exhibit.

Finally, the results of this work have contributed to existing gaps in the current PCMH literature. Prior work has consistently found that the PCMH model is more financially advantageous than the traditional primary care model; it has also been shown to be beneficial for patient perception of the care they receive, but clinical outcomes as it pertains to PCMH effectiveness has not been extensively studied thus far. In addition, there is a lack of clinical evidence that has been analyzed for rural Americans in general, much less specific sub-populations of this group. If indeed the CDC<sup>30</sup> and AAFP<sup>31</sup> are correct in their assessments that the nation is facing a mortality crisis rooted in racial and socioeconomic disparities, then this work has uncovered valuable information about the ways in which disadvantaged populations can potentially improve their conditions.

### **Conclusion :**

The results of this research provide evidence of the effectiveness of the PCMH model for diabetes maintenance in a region in desperate need of improved health care availability and delivery. The residents of the Mississippi Delta suffer from levels of chronic disease higher than the national average, while also residing in a health professional shortage area that exhibits high rates of poverty and inequality. This description is applicable to much of rural America, particularly in the Southern states. This work extends what is currently known about patient centered medical homes in three key areas; (1) it demonstrates improved patient health over time using proprietary patient records of experimental (PCMH) and control groups (non-PCMH), (2) it demonstrates that the PCMH model can be effective in rural America, and (3) it demonstrates that the PCMH model can be effective in a region that suffers from many layers of health and economic disadvantage. The policy implication from this research is that the established method of primary care as a form of chronic disease maintenance is perhaps not the most effective option for patients, particularly those in rural places who frequently struggle to access care in the first place. Doctors, clinicians, medical administrators, and policy-makers should consider the PCMH model as the preferred model of primary care, particularly in places where the health needs of the population are at their greatest.

### **Limitation :**

A limitation in this analysis is that patient sex was not included. A large number of the hand written medical records were illegible and thus sex was omitted from statistical analyses. The alternative was keeping only the patient records that were legible, but that would have decreased the overall sample size significantly. We acknowledge that this is an important omission since sex is one of the most commonly measured demographic characteristics in health

research, as prior studies have demonstrated clear differences in health behaviors, health outcomes, morbidity, and mortality between men and women<sup>32</sup>. However, excluding observations without sex data, which predominantly came from the non-PCMH clinics, would have made this overall analysis impossible.

Another limitation is the use of the 6.5 HbA1c threshold for determining diabetes control. While 6.5 HbA1c is the recommended level by the American Diabetes Association<sup>33</sup>, there are limitations to this measure. Some researchers argue that there are other, more accurate numeric thresholds for diabetes and also that HbA1c may not be the ideal measurement across different populations<sup>34,35</sup>. Instead, stable glucose levels and not necessarily a numeric threshold is recommended<sup>36</sup>. However, because we wanted to investigate whether patient outcomes improved in terms of diabetes care, we used the 6.5 HbA1c level as our proxy for improving/management of diabetic outcomes.

We are aware of the limitation of the small sample size of our study, but we argue that the results shown are significant enough to warrant discussion. There is a need for further analysis of populations like that of the Mississippi Delta in order to determine the effectiveness of the PCMH model in other rural areas that may exhibit somewhat different characteristics from ours. We believe this evaluation can be a crucial first step in opening the door to a broader discussion on how to decrease the burden of mortality and income-based disparities.

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