

# Race/Ethnicity, Personal Health Record Access, and Quality of Care

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**R**obust Internet-based patient portals and personal health records (PHRs) provide patients with access to personal health information and supporting patient education materials, provide secure messaging with providers, and offer functions to schedule appointments and refill prescriptions.<sup>1</sup> In 2010, 7% of Americans used a PHR, although much higher registration rates occurred in integrated systems with robust and well-established PHRs, such as the Veterans Health Administration and Kaiser Permanente (KP).<sup>2-4</sup> PHRs hold promise to enhance care quality, improve patient-provider relationships, and encourage healthy lifestyle behaviors.<sup>5,6</sup> For instance, we previously demonstrated that among more than 35,000 patients with diabetes and/or hypertension, the use of secure e-mail with providers through a PHR was associated with improved Healthcare Effectiveness Data and Information Set (HEDIS) scores.<sup>7,8</sup> The relationship between patient portal use and improved glycemic control and other quality measures among patients with diabetes has also been documented.<sup>9-12</sup>

Racial/ethnic disparities in PHR registration and use exist<sup>1,13-21</sup>; however, few recent studies designated Latinos or Hispanics as a racial/ethnic category and included patients whose preferred language was not English.<sup>1,13,21</sup> Race/ethnicity is one factor of many that likely influences PHR registration; recent studies also uniformly examined age and gender. However, healthcare utilization was only measured in an underserved population,<sup>21</sup> and health status was measured by the presence of a limited number of chronic conditions.<sup>1,21</sup> To the best of our knowledge, no evidence exists as to the impact of written language preference on registration rates, which is logically more germane to using a PHR than is spoken language.<sup>21</sup> Finally, no published studies document the quality impact of PHR use across racial/ethnic groups. An important question is, if patients with differing race/ethnicity have equivalent PHR use, do they experience similar clinical benefits?<sup>22</sup>

We had several hypotheses:

1. Registration rates among non-Hispanic whites would be higher than among members of any other

## ABSTRACT

### Objectives

To estimate the impact of race/ethnicity and written language preference on registration for a personal health record (PHR) that included emailing providers, viewing lab results, refilling prescriptions, and other functionalities, and the impact of PHR use on quality across racial/ethnic groups with comparable access.

### Study Design and Methods

Retrospective observational design among 3,173,774 adults. Factors affecting registration were assessed using logistic regression, and propensity score matching techniques assessed the impact of language preference on registration and PHR use on quality of care. Difference-in-differences methods assessed the significance of between-group changes in Healthcare Effectiveness Data and Information Set (HEDIS) scores, such as glycosylated hemoglobin and lipid screening and control.

### Results

Race/ethnicity most strongly predicted PHR registration. After adjusting for multiple factors, Asian American, Latino American, and African American members remained 23%, 55%, and 62% less likely to register, respectively, than non-Hispanic white members. Preference for Spanish as a written language predicted poor PHR adoption. The probability of registration was 0.451 (95% CI, 0.449-0.453) for English language–preferring Latinos and 0.174 (95% CI, 0.173-0.176) for Spanish language–preferring Latinos. For non-Hispanic whites, Latinos, and African Americans using the PHR, HEDIS scores increased after PHR use by 1.3 to 12.7 percentage points, compared with differences of –1.1 to 8.1 percentage points among nonusers. All but 2 difference-in-differences between PHR users and nonusers were statistically significant.

### Conclusions

Nonwhite race/ethnicity and Spanish language preference independently predict poor PHR adoption. PHR use is associated with higher quality healthcare, and when PHR use is equivalent across racial/ethnic groups, so is quality of care.

*Am J Manag Care. 2015;21(2):e103-e113*

racial/ethnic group. Other factors would affect registration rates, such as age, gender, disease burden, healthcare utilization, length of membership, and distance to the nearest medical office, but race/ethnicity would have the strongest influence on registration rates. To test this hypothesis, we examined registration rates and the impact of race/ethnicity relative to other factors.

2. Non-English language preference would reduce the likelihood of PHR registration, regardless of race/ethnicity. To test this, we assessed the impact of English and Spanish language preference among Latinos on registration.
3. Once barriers to access were removed, quality benefits of PHR use would accrue equally across racial/ethnic groups. To test this, we assessed the effect of PHR use on healthcare quality across racial/ethnic groups with comparable PHR access.

## METHODS

We used a retrospective observational design to investigate the impact of race/ethnicity on PHR registration relative to other factors, and a propensity score–matched pair cohort design to investigate the impact of written language preference on registration and the effect of PHR use on quality of care in racial/ethnic groups with comparable PHR access.

### Personal Health Record

Kaiser Permanente (KP) is the largest not-for-profit integrated healthcare delivery system in the United States, serving 9 million members. KP's PHR, My Health Manager, is integrated with the electronic health record (EHR), KP HealthConnect. Features include access to portions of the medical record, test results, patient education, prescription refills, appointment scheduling, and the ability to securely e-mail providers. Patients must register for and activate an account to sign on to use these features. Access is free to all members who receive marketing information about the PHR, regardless of their race/ethnicity.

The PHR is currently available primarily in English. Although many patient education materials are available in Spanish, English is currently the only language option for complete navigation and for access to the health record, including test results, prescription refills, appointment scheduling, and secure e-mail with providers. As of March 2013, 65% of all age-eligible KP members were PHR-registered. The PHR has become a significant mode of care delivery; 28% of contacts between patients and primary care providers occur by secure e-mail.

### Study Cohorts

To investigate the impact of race/ethnicity on PHR registration relative to other factors, we included all patients 18 years and older with active KP memberships on December 31, 2010, and with complete data for all variables of interest. To investigate the impact of written language preference on registration, we limited the population to Latino patients—the only group composed of enough individuals with varying self-reported language preferences (English and Spanish). To assess the impact of PHR use on quality, we included Latino, non-Hispanic white, and African American members with diabetes or hypertension from 1 region (KP Southern California, KPSC) who registered for the PHR and activated their accounts between January 1, 2006, and October 31, 2010, and who had active memberships between January 1, 2009, and December 31, 2010.

### Outcome Measures, Covariates, and Data Sources

A main outcome measure was PHR registration. We defined members as registered if they had ever signed up for PHR access. Quality outcome measures were scores on 7 HEDIS effectiveness-of-care measures: 6 comprehensive diabetes control measures (lipid and glycemic screening and control, and retinopathy and nephropathy screening) and 1 control measure for diagnosed hypertension.<sup>23</sup> Baseline HEDIS scores came from the calendar year before the one in which members registered for the PHR and follow-up scores came from the subsequent calendar year. Quality outcomes were examined in relationship to PHR use, which we defined as registration for and activation of an account.<sup>7</sup>

We included covariates that may have also affected registration and were used to create propensity score-matched pairs: race/ethnicity, age, gender, language preference, distance to the nearest medical office building, number of annual office visits, illness burden (measured by current DxCG risk scores derived from proprietary [Verisk Health, Inc] software forecasting risk-adjusted utilization<sup>24</sup>), and KP membership tenure. Data on age, gender, diagnoses, membership tenure, distance to the nearest medical office, illness burden, utilization of office visits, PHR registration, HEDIS effectiveness-of-care measures, and self-reported race/ethnicity and language preference were all obtained from the EHR.

### Propensity Score Matching

*Impact of language preference on registration.* We calculated a propensity score for each Latino member

with a self-reported preference for English or Spanish as a written language, using SAS 9.2 (SAS Institute, Inc, Cary, North Carolina). The propensity score included the independent variables of age, gender, DxCG score, tenure, number of annual office visits, distance from nearest medical office building, and region. We used the greedy matching algorithm without replacement to create 209,873 matched pairs out of 211,995 Latino members preferring Spanish and 521,235 Latino members preferring English.<sup>25</sup> Propensity scores were matched to the second decimal place (**Table 1**).

**Impact of PHR use on quality across racial/ethnic groups with comparable access.** We used propensity score matching within Latino, non-Hispanic white, and African American populations because they yielded sufficient sample sizes. For each HEDIS measure, we calculated a propensity score for each member with diabetes or hypertension. The propensity score included the independent variables of age, gender, illness burden, tenure, number of annual office visits, distance from nearest medical office building, and baseline HEDIS score. We used greedy matching without replacement to pair each member who used the PHR to a member of the same race/ethnicity who had not used it.<sup>20</sup> The number of propensity score-matched pairs within racial/ethnic groups varied by measure, from 4481 (A1C control among African Americans with diabetes) to 28,612 (blood pressure control among non-Hispanic whites with hypertension). Propensity scores were matched to the second decimal place, and no difference in baseline periods was allowed. **Table 2** provides an example of the pre- and post matching balance for 1 measure (A1C screening) among Latinos.<sup>25</sup>

### Statistical Analysis

Logistic regression was used to assess factors affecting PHR registration for the entire population. Registration was the dependent variable, and race/ethnicity, age, gender, illness burden, number of annual office visits, distance from the nearest medical office, region, and tenure were independent variables. Modeling was performed with SAS 9.2.

To get the propensity score-matched data for the impact of language preference on registration, we calculated probabilities from the proportions of registered and unregistered members and bootstrapped the confidence intervals (CIs).<sup>26</sup> Similarly, we used bootstrapping methods to compute CIs for HEDIS scores, and compared outcomes for propensity score-matched African American, Latino, and non-Hispanic white members

with diabetes and/or hypertension who had and had not used the PHR. We assessed both the absolute value of changes before and after PHR use, and the difference-in-differences. We received an institutional review board waiver for this quality assessment project.

## RESULTS

**Impact of race/ethnicity and other factors on PHR registration.** Among 3,173,774 members meeting our inclusion criteria, 1,764,121 (56%) were registered to use the PHR (**Table 3**). Women, people 30 years or older, and non-Hispanic white members were more likely to register than men, younger individuals, and members of any other race/ethnicity. Of registered members, 57% were female, and 59% were aged 20 to 64 years. Among registered members, 10% made no office visits during the year, compared with 18% of unregistered members.

The strongest predictors of PHR registration were race/ethnicity, number of annual office visits, age, and language preference, in decreasing order of strength. Other significant predictors—but to a lesser degree—were gender, illness burden, distance to the nearest medical office, and tenure. In terms of race/ethnicity, the odds of a member being non-Hispanic white and registered were greater than the odds of being any other race/ethnicity and registered. Asian/Pacific Islander members were 23% less likely, Hispanic members were 55% less likely, and African American members were 62% less likely to have registered than were non-Hispanic white members (**Table 4**). Preference for a written language other than English was also associated with substantial reductions in the likelihood of registration, and more annual office visits were associated with very substantial increases in the likelihood of registration. Age and gender also affected registration rates.

KP does not routinely collect data on income and education, and we did not include these variables in our analyses. However, to assess the extent to which excluding income and education might have affected our results, we repeated the logistic regression analysis using imputed data for these variables. The results varied insignificantly (**eAppendix Table**, available at [www.ajmc.com](http://www.ajmc.com)).

**Impact of language on PHR registration.** More than 90% of registered members preferred English as their primary language. Among 209,873 matched pairs of English language- and Spanish language-preferring Hispanic members, the probability of registration was 0.451 (95% CI, 0.449-0.453) for the former and 0.174 (95% CI, 0.173-0.176) for the latter.

**Impact of race/ethnicity on quality measures.** A total of 171,054 KPSC members with diabetes had complete data and were included; 41% registered for the PHR between January 1, 2006, and October 31, 2010. Similarly, 279,019 members with hypertension had complete data and were included; 42% registered during the same time period. The number of propensity score-matched pairs varied by measure, from 5098 (screening for retinopathy among African Americans with diabetes) to 28,061 (blood pressure control among non-Hispanic whites with hypertension).

Absolute increases in HEDIS scores before and after PHR use ranged from 1.3 to 12.7 percentage points (Table 5). Among nonusers, differences in HEDIS scores over the same time period ranged from a decrease of 1.1 percentage points to an increase of 8.1 percentage points. For users and nonusers, the largest improvements occurred in low-density lipoprotein cholesterol control and retinopathy screening among members with diabetes and in blood pressure control among members with hypertension. The difference-in-differences analysis revealed that greater improvements in HEDIS scores occurred across all racial/ethnic groups in PHR users, as compared with nonusers (Table 5). All but 2 of the differential increases were statistically significant.

## DISCUSSION

Among more than 3 million KP members, racial and ethnic disparities in PHR registration existed after adjusting for potential confounding variables; nonwhite race/ethnicity independently predicted nonregistration. Spanish-language preference also independently predicted a substantially lower likelihood of PHR registration. However, quality benefits of PHR use accrued equally across racial/ethnic groups with comparable PHR access.

Our results, obtained from a very large and diverse population, confirm those of other studies documenting that minority status is associated with lower PHR registration rates.<sup>1,13-21</sup> An association between higher use of clinical services and PHR use is also documented elsewhere.<sup>15,21,27</sup> To the best of our knowledge, our study is the first to document the impact of written language preference on PHR registration among members of a single racial/ethnic group and equivalent quality benefits across groups with comparable PHR access.

Within a large, insured population, differences in PHR registration exist according to race/ethnicity and language preferences, but quality benefits of PHR use accrue equitably across racial/ethnic groups. The

implications are clear: initiatives or organizations promoting the use of PHRs should recognize their varying adoption. Further research is needed to understand the barriers to PHR registration within and across racial/ethnic/language-preference groups. In general, even among underserved populations, a lack of Internet or computer access is not to blame.<sup>28-30</sup> An internal KP study also found that adjusting for income and education does not reduce disparities in access. Suggested reasons for observed disparities include varying preferences for communicating with providers, lower computer literacy, and distrust of Web-based communications for sensitive health information.<sup>28,31</sup>

Explanations have also been suggested for the impact of language preferences on PHR registration. The simplest explanation is difficulty in navigating an English-based PHR. Additional barriers may include a scarcity of bilingual physicians and frequent lack of language concordance between patient and physician.<sup>32</sup> Unpublished results from KP focus groups exploring PHR registration among nonregistered Spanish-speaking members indicate that barriers unrelated to language include concerns about security of personal information; this is confirmed in the literature.<sup>2</sup> The prevalence and force of these barriers needs further investigation, as does the relationship between registration and subsequent PHR use across a variety of populations.<sup>21,15</sup>

The finding that quality benefits associated with PHR use accrue equally across racial/ethnic groups requires confirmation in additional studies, but it is an important step toward building an evidence base documenting that the benefits of technology span racial/ethnic boundaries.<sup>22</sup> Importantly, it suggests that differential registration rates may increase health disparities. A key implication of our project relates to the need for further work to ensure that access to health information technology ameliorates, rather than worsens, racial/ethnic health-care disparities.

## Limitations

Although we addressed some confounders, our findings may have been influenced by other unmeasured factors. For instance, we did not have data on Internet access, computer literacy, or cultural or other factors related to the use of PHRs. A limitation pertaining to our assessment of the impact of PHR use on quality was our inability to center individual pre- and post HEDIS scores more precisely on the time at which individuals first used the PHR. Propensity score-matched groups for the HEDIS measures varied substantially in size, which

almost certainly limited our ability to detect significant difference-in-differences in smaller groups. Baseline HEDIS scores were, in some cases, high enough that subsequent scores did not prove our hypothesis that equal PHR access would confer equal quality benefits. Finally, our project occurred in an integrated healthcare delivery system, which may limit the generalizability of our results.<sup>33</sup>

## CONCLUSIONS

The quality benefits of PHR use accrue equitably across racial and ethnic groups with comparable access, even though registration rates vary substantially. The increasing availability of PHRs may have the potential to ameliorate some racial and ethnic differences in health outcomes and health status. However, if disparities in PHR access persist, health disparities may also increase.

### Acknowledgments

We acknowledge the many KP providers enabling the integrated care experience through our patient portal, My Health Manager, that allow this potential to be true for so many members. We thank Jed Weissberg, MD, formerly of Kaiser Permanente, for his seminal question on access across different race/ethnic groups. Luther Scott's expertise in geocoding at Kaiser Permanente was pivotal to an earlier version of this work. Jennifer Green, of Kaiser Permanente, provided editorial assistance.

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**Source of Funding:** None.

**Author Disclosures:** The authors report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

**Authorship Information:** Concept and design (TG, MK, DM, VS, JW); acquisition of data (DM, LS, VS, JW); analysis and interpretation of data (MK, LS, JW); drafting of the manuscript (TG, MK); critical revision of the manuscript for important intellectual content (TG, MK, DM); statistical analysis is (DM, LS, JW); provision of study materials or patients (VS, JW); and supervision (TG, MK).

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### Take-Away Points

Although race/ethnicity and language preference disparities exist in personal health record (PHR) registration, the quality benefits of PHR use are equivalent when racial/ethnic groups have comparable access.

- After adjusting for multiple factors, Asian Americans, Latino Americans, and African Americans remained 23%, 55%, and 62% less likely to register, respectively, for the PHR than non-Hispanic whites.
- The probability of registration was 0.451 (95% CI, 0.449-0.453) for English language-preferring Latinos and 0.174 (95% CI, 0.173-0.176) for Spanish language-preferring Latinos.
- PHR use is associated with higher quality healthcare; when PHR use is equivalent across racial/ethnic groups, so are quality gains.

■ **Table 1.** Pre- and Post Matching Characteristics of Spanish- and English-Preferring Latinos

	Full Cohort Preference		Propensity Score-Matched Cohort Preference	
	Spanish (n = 211,995)	English (n = 521,235)	Spanish (n = 209,873)	English (n = 209,873)
<b>Women, %</b>	57	58	57	56
<b>Age in years, %</b>				
18-19	3	5	3	3
20-44	33	51	34	36
45-64	47	32	47	46
>65	17	12	16	15
<b>DxCG score, %</b>				
<1	49	51	49	51
≥1 and <5	35	33	35	34
≥5	17	16	17	16
<b>Distance from home to nearest medical office building, %</b>				
<5 miles	53	46	52	53
5 to <20 miles	43	47	43	42
≥20 miles	5	7	5	5
<b>Annual doctor office visits, %</b>				
0	14	14	14	15
1-5	57	57	57	59
6-15	24	24	24	22
≥16	5	5	5	4
<b>Membership tenure, years, mean</b>	4.17	4.24	4.20	4.13

DxCG scores predict risk-adjusted utilization and indicate illness burden.

**Table 2.** Pre- and Post Matching Characteristics of Latinos Who Did and Did Not Use the PHR, Matched for A1C Screening HEDIS Measure

	Full Cohort		Propensity Score-Matched Cohort	
	PHR Users (n = 14,375)	Nonusers (n = 32,832)	PHR Users (n = 10,084)	Nonusers (n = 10,084)
<b>Women, %</b>	50	50	50	50
<b>Age, %</b>				
18-19	0	0	0	0
20-44	22	12	18	18
45-64	57	58	59	59
≥65	21	29	23	22
<b>Distance from home to nearest medical office building, mean, miles</b>	8.6	7.6	8.5	8.6
<b>Annual doctor office visits, %</b>				
0	2	4	2	2
1-5	48	52	46	46
6-15	37	34	39	38
≥16	12	10	13	13
<b>Membership tenure, years, %</b>				
<3 years	11	12	5	5
≥3 years	89	88	95	95
<b>DxCG risk score, %</b>				
<1	22	24	21	21
≥1 and <5	41	41	39	40
≥5	37	35	40	39
<b>A1C screening completed before PHR use, %</b>	94	95	94	93
<b>Language preference, %</b>				
English	79	50	79	79
Spanish	20	50	21	21

A1C indicates glycated hemoglobin; HEDIS, Healthcare Effectiveness Data and Information Set; PHR, personal health record. Matching occurred within Latino, non-Hispanic white, and African American populations for each HEDIS measure, resulting in 21 balance tables. DxCG scores predict risk-adjusted utilization and indicate illness burden.

■ **Table 3.** Characteristics of Personal Health Record—Registered and Unregistered Members

	<b>Registered (N = 1,764,121)</b>	<b>Unregistered (N = 1,409,653)</b>
<b>Women, n (%)</b>	1,006,993 (57)	725,887 (53)
<b>Age, n (%)</b>		
18-19	21,987 (1)	67,207 (5)
20-44	593,857 (35)	436,783 (32)
45-64	766,345 (46)	520,599 (38)
≥65	381,932 (22)	385,064 (28)
<b>Race/ethnicity, n (%)</b>		
White	1,108,116 (63)	602,134 (43)
African American	142,928 (8)	190,326 (14)
Latino	291,334 (17)	456,209 (32)
Asian/Pacific Islander	202,380 (11)	147,643 (10)
Native American/Alaskan	4895 (0)	4225 (0)
Multi-racial	14,468 (1)	9116 (1)
<b>Language preference, n (%)</b>		
English	1,606,954 (96)	1,144,376 (84)
Spanish	37,661 (2)	178,852 (13)
Chinese	8645 (1)	10,995 (1)
Vietnamese	3046 (0)	4449 (0)
Other	12,544 (1)	18,222 (1)
<b>DxCG score, n (%)</b>		
<1	682,467 (40)	644,697 (46)
1 to <5	632,656 (37)	436,494 (31)
≥5	417,193 (24)	309,450 (22)
<b>Distance from home to nearest medical office building, n (%)</b>		
<5 miles	725,944 (43)	629,026 (46)
5 to <20 miles	804,099 (48)	630,667 (46)
≥20 miles	152,251 (9)	103,023 (8)
<b>Annual doctor office visits, n (%)</b>		
0	166,157 (10)	244,420 (18)
1-5	911,341 (53)	743,311 (53)
6-15	516,100 (30)	323,430 (23)
≥16	135,423 (8)	78,456 (6)
<b>Membership tenure, n (%)</b>		
<3 years	299,296 (18)	230,340 (17)
≥3 years	1,406,176 (82)	1,143,979 (83)

DxCG scores predict risk-adjusted utilization and indicate illness burden.

**Table 4.** Odds Ratios for Personal Health Record Registration

	Odds Ratio	95% CI	
		Lower Bound	Upper Bound
<b>Gender</b>			
Female	reference		
Male	0.78	0.78	0.79
<b>Race/ethnicity</b>			
White, non-Hispanic	reference		
American Indian/Alaskan Native	0.59	0.56	0.62
Asian/Pacific Islander	0.77	0.76	0.78
African American	0.38	0.38	0.38
Latino	0.45	0.45	0.46
Multi-racial	0.81	0.79	0.82
<b>Age in years</b>			
20-44	reference		
18-19	0.23	0.23	0.24
45-64	0.95	0.94	0.95
≥65	0.47	0.46	0.47
<b>Membership tenure in years</b>			
≥3	reference		
<3	0.99	0.99	0.99
<b>DxCG score</b>			
<1	reference		
≥1	1.09	1.08	1.09
<b>Annual doctor office visits</b>			
0	reference		
1-5	1.88	1.86	1.89
6-15	2.51	2.49	2.54
≥16	2.81	2.78	2.85
<b>Distance from home to nearest medical office building</b>			
<5 miles	reference		
≥5 miles	1.07	1.06	1.07
<b>Written language preference</b>			
English	reference		
Spanish	0.22	0.22	0.23
Chinese	0.53	0.51	0.54
Vietnamese	0.44	0.42	0.47
Other	0.45	0.44	0.46

DxCG scores predict risk-adjusted utilization and indicate illness burden.

■ **Table 5.** HEDIS Scores Before and After PHR Use Among Racial/Ethnic Groups With Comparable Access

	Matched Pairs, #	PHR users, %		Nonusers, %		Difference-in-Differences, Percentage Points (95% CI)
		Pre	Post	Pre	Post	
<b>Testing for hemoglobin A1C control in diabetes</b>						
African American	5109	94.7	96.6	94.3	94.7	<b>1.6 (0.5-2.7)</b>
Latinos	10,084	93.6	95.9	93.1	93.8	<b>1.6 (0.8-2.5)</b>
Whites	15,005	93.8	96.9	93.8	94.4	<b>2.5 (1.8-3.1)</b>
<b>A1C &lt;9% in diabetes</b>						
African American	5100	78.6	83.2	78.4	77.9	<b>5.1 (3.3-6.8)</b>
Latinos	10,100	76.8	81.0	76.0	75.2	<b>5.1 (3.8-6.4)</b>
Whites	15,014	84.0	88.5	83.6	82.8	<b>5.4 (4.4-6.3)</b>
<b>Testing for LDL-C control in diabetes</b>						
African American	5111	93.5	95.0	93.5	92.4	<b>2.6 (1.4-3.9)</b>
Latinos	10,115	92.5	93.8	92.4	92.0	<b>1.8 (0.8-2.7)</b>
Whites	14,957	93.9	95.4	93.8	92.8	<b>2.5 (1.8-3.2)</b>
<b>LDL-C control &lt;100 mg/dL in diabetes</b>						
African American	5118	55.5	67.3	55.5	61.0	<b>6.3 (4.1-8.4)</b>
Latinos	10,115	56.2	66.9	55.6	63.7	<b>2.6 (1.0-4.2)</b>
Whites	14,981	60.2	72.2	60.6	67.6	<b>4.9 (3.7-6.2)</b>
<b>Screening for retinopathy in</b>						
African American	5098	66.5	79.2	66.7	72.2	<b>7.1 (4.8-9.4)</b>
Latinos	10,107	69.9	78.6	69.7	75.0	<b>3.4 (1.9-5.0)</b>
Whites	15,011	69.8	80.2	69.6	73.7	<b>6.3 (5.0-7.6)</b>
<b>Medical attention for nephropathy in diabetes</b>						
African American	5111	96.5	97.8	96.5	96.8	<b>1.0 (0.2-1.9)</b>
Latinos	10,111	95.3	96.6	95.0	96.0	0.4 (-0.3 to 1.2)
Whites	14,993	95.0	98.1	94.6	96.7	<b>1.0 (0.4-1.5)</b>
<b>Blood pressure control in members with diagnosed hypertension</b>						
African American	7347	75.3	82.2	75.5	80.3	<b>2.1 (0.4, 3.8)</b>
Latinos	8611	79.1	85.8	78.3	84.0	1.0 (-0.4 to 2.5)
Whites	28,061	78.1	85.4	77.7	83.2	<b>1.9 (1.0-2.7)</b>

A1C indicates glycated hemoglobin; HEDIS, Healthcare Effectiveness Data and Information Set; LDL-C, low-density lipoprotein cholesterol; PHR, personal health record.  
 Bolded figures indicate statistical significance.

## **eAppendix**

To gauge the impact on our results of including income and education as covariates, we used multiple imputation methods to generate these missing data in the logistic regression analysis. Census block data is routinely used to impute income and education.<sup>1</sup> We used multiple imputation to populate missing data by sampling from probability distributions developed for Kaiser Permanente (KP)'s geographically enriched member sociodemographics (GEMS) datamart.<sup>2</sup> GEMS uses a RAND Corporation-developed Bayesian Improved Surname and Geocoding algorithm, which generates these probabilities by linking a person's surname and home address to updated US Census Bureau data sets (Esri; Redlands, California) containing census block-level household income and education data. Additional member demographic data from KP HealthConnect is collected in GEMS and linked with the RAND probability distributions.

Using ad hoc code developed in SAS 9.2 (SAS Institute, Inc, Cary, North Carolina), we performed multiple Bayesian imputations, sampling for each missing value from the GEMS datamart, performing statistical analyses, and repeating the process 10 times. We averaged over the 10 imputations to generate the final estimates for each individual (**eAppendix Table**).

To verify the imputation of education and income data, reported data were limited to national marketing research surveys conducted from 2010 to 2013. We matched imputed and reported values for income for 13,962 members and matched values for education for 15,705 members. To allow for changes in income and education levels over time, since reported and imputed data were at least partially asynchronous, we considered reported and imputed income values to match if they were within 1 category of each

other (eg, identical or the next highest or lowest category). We considered reported and imputed education levels to match if the imputed education level was equivalent to or 1 or 2 categories higher than the previous self-reported level. The accuracy of imputed income data was 69.6% and of imputed education data was 68.4%.

**eAppendix Table.** Odds Ratios for PHR Registration by Race/Ethnicity, Compared with Non-Hispanic Whites, With and Without Including Imputed Income and Education (n = 3,173,774)

	<i>Original Analysis</i>			<i>Income and Education Included</i>		
	<b>Odds ratio</b>	<b>95% CI</b>		<b>Odds ratio</b>	<b>95% CI</b>	
		<b>Lower bound</b>	<b>Upper bound</b>		<b>Lower bound</b>	<b>Upper bound</b>
American Indian/ Alaskan Native	0.589	0.564	0.615	0.604	0.579	0.631
Asian/Pacific Islander	0.769	0.763	0.775	0.766	0.760	0.773
African American	0.378	0.375	0.381	0.396	0.393	0.399
Latino	0.453	0.450	0.456	0.472	0.469	0.475
Multi-racial	0.813	0.791	0.816	0.820	0.798	0.843

PHR indicates personal health record.

## REFERENCES

1. Keating NL, Landrum MB, Lamont EB, et al. Quality of care for older patients with cancer in the Veterans Health Administration versus the private sector: a cohort study. *Ann Intern Med.* 2011;154(11):727-736.
2. Rubin DB. *Multiple imputation for nonresponse in surveys.* New York, NY: J. Wiley & Sons; 1987.