

Bridging the Digital Divide: Mobile Access to Personal Health Records Among Patients With Diabetes

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Although more than 200,000 health-promoting mobile apps are available for patient download, with 1.7 billion users worldwide, research is needed to identify the clinical usefulness of mobile tools in self-management and care quality for patients.^{1,2} Importantly, the majority of these apps lack any integration with patients' ongoing healthcare services and providers.^{3,4} Apps that are integrated with a clinical electronic health record (EHR) and that make patient-reported data available to clinicians may hold the most promise to improve well-coordinated, high-quality healthcare delivery. Within healthcare, this timely expansion to mobile-connected devices complements the growing availability of personal health records (PHRs). PHRs could be particularly relevant for patients with chronic conditions, such as diabetes, who require ongoing self-management that can be facilitated via PHRs.

However, the long-standing digital divide, defined as the gulf between individuals with and without ready access to the internet, is well documented.⁵ EHR requirements from CMS (Stage 3 Meaningful Use objectives) include that physicians provide patients with electronic access to their health records and tailored patient education via a Web-based tethered PHR that is linked to the patient's EHR, also known as a patient portal.⁶ Although Meaningful Use financial incentives continue to promote the widespread adoption of PHRs among eligible providers, they do not require that PHRs be easily accessible via mobile devices.⁶ Therefore, with only computer-based access, many patients might be left out.

Previous research shows that use of computer-based PHRs has been consistently lower among racial and ethnic minorities and patients with lower education and health literacy levels.⁷⁻¹³ Recently, the diffusion of smartphone technology has increased mobile access to the internet and apps among individuals most likely to be affected by the digital divide, including racial/ethnic minorities and those with lower socioeconomic status (SES).¹⁴ Mobile-accessible PHRs can help engage patients in managing their health through convenient and timely access to personal health data, provider messaging, refilling prescriptions, or scheduling appointments.¹⁵

ABSTRACT

OBJECTIVES: Some patients lack regular computer access and experience a digital divide that causes them to miss internet-based health innovations. The diffusion of smartphones has increased internet access across the socioeconomic spectrum, and increasing the channels through which patients can access their personal health records (PHRs) could help bridge the divide in PHR use. We examined PHR use through a computer-based Web browser or mobile device.

STUDY DESIGN: Cross-sectional historical cohort analysis.

METHODS: Among adult patients in the diabetes registry of an integrated healthcare delivery system, we studied the devices used to access their PHR during 2016.

RESULTS: Among 267,208 patients with diabetes, 68.1% used the PHR in 2016; 60.6% of all log-ins were via computer and 39.4% were via mobile device. Overall, 63.9% used it from both a computer and mobile device, 29.6% used only a computer, and 6.5% used only a mobile device. After adjustment, patients who were black, Hispanic, or Asian; lived in lower socioeconomic status (SES) neighborhoods; or had lower engagement were all significantly more likely to use the PHR only from a mobile device ($P < .05$). Patients using the PHR only via mobile device used it less frequently.

CONCLUSIONS: Mobile-ready PHRs may increase access among patients facing a digital divide in computer use, disproportionately reaching racial/ethnic minorities and lower SES patients. Nonetheless, even with a mobile-optimized and app-accessible PHR, differences in PHR use by race/ethnicity and SES remain. Continued efforts are needed to increase equitable access to PHRs among patients with chronic conditions.

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TAKEAWAY POINTS

In an integrated delivery system, mobile access to personal health records (PHRs) may increase their use among patients with limited computer access, but differences in PHR use by race/ethnicity and neighborhood socioeconomic status (SES) remain.

- ▶ Seventy percent of PHR users accessed it with a mobile device at least once in 2016, with nearly 40% of all log-ins done using a mobile device.
- ▶ Patients who were black, Hispanic, or Asian or who lived in lower SES neighborhoods were significantly more likely to use the PHR exclusively via a mobile device. Still, these groups of patients were less likely to use the PHR at all in 2016.

With many healthcare innovations, specifically advancements in PHRs, changes have favored those who have social advantages, such as higher education, greater income or wealth, more knowledge of how to navigate the healthcare system, and nonminority race/ethnicity. In this manuscript, we focus specifically on a different type of technological innovation: the introduction of PHRs that are more easily accessible using mobile devices.

Diabetes is more prevalent among individuals of lower SES and racial/ethnic minorities.¹⁶ Patients with diabetes often have other chronic conditions with complex clinical needs that require ongoing self-management.¹⁷⁻¹⁹ Diabetes self-management is crucial and requires extensive self-monitoring, adherence to medications, proper diet, and adequate exercise.²⁰ Any practical realization of a model for coordinated safe care must rely on timely availability and use of comprehensive electronic clinical information that is not only available to providers through an EHR, but also to patients through a PHR.²¹⁻²³ Previous studies have found that PHR use was associated with improved diabetes quality measures.^{15,24-26} Thus, mobile-accessible PHRs could be particularly relevant for patients with diabetes. Yet, in the absence of mobile-accessible PHRs, we found that lack of computer access accounted for most of the variation in PHR use by race and income.¹³ Consequently, we expect that mobile access to PHRs may facilitate PHR use among individuals who are mobile dependent. Little is known about the use of PHRs that are easily accessible and optimized for use via mobile devices.

Within an integrated delivery system that provided all members with multiple channels to access their PHR, we examined the channel through which an adult population of patients with diabetes used their PHR (ie, through a computer-based Web browser, smartphone-accessible website, or mobile apps). We also assessed the association between patient characteristics and PHR use via mobile device.

METHODS

Setting

Kaiser Permanente Northern California is an integrated delivery system that provides comprehensive care, including inpatient,

outpatient, and pharmacy services, to more than 3 million members via employer-sponsored, individual, or publicly sponsored insurance. Members who register to use the password-protected patient PHR can access it free of charge via computer browser, mobile-optimized website, or mobile app. The computer-based Web portal has been available to members for more than 10 years, and the mobile-optimized website and Android or iOS apps have been available to members

since 2013. The PHR offers patients a number of services, including the ability to exchange secure messages with providers on their healthcare team, view lab results, request medication refills, view portions of their health records, schedule office visits, and pay bills. The mobile-accessible and computer browser versions of the PHR offer comparable functions, although features changed slightly over time.

Study Population

Our study population included all adult (≥ 18 years) members of an integrated delivery system, Kaiser Permanente Northern California, who were in the health plan diabetes clinical registry as of the last quarter of 2015. We chose to focus on patients with diabetes in order to examine patients with a chronic condition who would likely have ongoing need for healthcare services and self-management functions available in PHRs. This analysis was part of a larger study focused on how patients with diabetes use technology to manage their care. We included all patients who maintained continuous health plan coverage in 2016. Because our study focused on patient characteristics, we excluded PHR use via designated proxies.

Data and Measures

We used automated datasets to capture PHR use by channel (mobile app, mobile website, or computer browser) in 2016 among the full study population. To calculate PHR use counts, we identified use episodes by counting the number of days during the year with any PHR use (eg, multiple log-ins in 1 day counted as a single episode). In addition, we measured if patients used 3 key PHR functions (order prescription refill, send secure message, or view lab result) at any time in 2016. We also used EHR data to capture patient characteristics (age, gender, race/ethnicity) and linked patients' residential addresses to 2010 US Census measures of education and income to define neighborhood SES at the Census block group level. Census block groups are defined as neighborhoods of lower SES if at least 20% of residents have household incomes below the federal poverty level or at least 25% of residents 25 years or older have less than a high school education.²⁷ We also identified patients' additional chronic conditions, other than diabetes, during the

last quarter of 2015 using the health plan's clinical chronic condition registries for asthma, coronary artery disease, heart failure, and hypertension. As an indicator of patient engagement in 2015, we used clinical quality registries to create an overall measure of patients' histories of adherence to chronic condition medications (with 80% or more days covered by medications) and to preventive care recommendations (up-to-date flu shot, blood pressure measure, low-density lipoprotein [LDL] cholesterol measure, and glycated hemoglobin [A1C] measure for those with diabetes). We categorized patients as being highly engaged in their care if they were adherent to their chronic condition oral medications for diabetes, hypertension, or cholesterol ($\geq 80\%$ of days covered) and recommended preventive care services (flu vaccine and A1C, LDL cholesterol, and blood pressure screening) in 2015.

Statistical Analysis

We studied patient characteristics associated with the channel(s) used to access the PHR during 2016 (computer and mobile, computer only, and mobile only). We used multivariable logistic regression to measure the association between PHR use (any use in 2016 vs no use) and patient characteristics, as well as multinomial logistic regression to measure the association between device used (mobile only, computer only, or mobile and computer) among PHR users and patient characteristics (age, gender, race/ethnicity, neighborhood SES, number of chronic conditions, and health engagement). For both models, we calculated the adjusted percentage of patients using the PHR and device type by patient characteristics, assuming patients in the subgroup had the same other characteristics as the full study population (margins command in Stata). We included the main effects of each covariate and first order interaction of all covariates (except for age group and number of other chronic conditions due to an empty cell problem). All analyses were conducted using Stata 14 (StataCorp LP; College Station, Texas).

The Kaiser Foundation Research Institute Institutional Review Board reviewed and approved the study protocol.

RESULTS

Table 1 shows characteristics of the 267,208 patients with diabetes included in the study and their adjusted rates of PHR use in 2016. In that year, 49.1% were 65 years or older, 47.7% were female, 43.7% were white, 22.6% were Asian, 21.6% were Hispanic, 10.2% were black, 24.0% lived in low SES neighborhoods, and 75.1% had multiple chronic conditions. Nearly one-third of all study patients (31.9%) did not use the PHR in 2016. More than half (58.0%) of patients were categorized as highly engaged, meaning that they were adherent to their oral medications for chronic conditions and received the flu vaccine and recommended screenings for A1C, LDL cholesterol, and blood pressure in 2015.

TABLE 1. Patient Characteristics Overall and Adjusted Percentage Who Used the PHR in 2016, by Characteristic

	All Patients (N = 267,208)	% Used PHR ^a (n = 181,981)
	Column %	Adjusted Row % (95% CI)
Age, years		
18-29	1.4%	84.7% (82.4%-86.9%)
30-44	7.8%	83.6% (83.1%-84.2%)
45-64	41.8%	73.1% (72.9%-73.4%)
≥ 65	49.1%	60.9% (60.6%-61.2%)
Gender		
Male	52.3%	68.4% (68.2%-68.7%)
Female	47.7%	67.8% (67.6%-68.1%)
Race/ethnicity		
White	43.7%	78.4% (78.2%-78.6%)
Black	10.2%	57.8% (57.2%-58.4%)
Hispanic	21.6%	54.3% (53.9%-54.7%)
Asian	22.6%	67.7% (67.4%-68.1%)
Other	1.9%	62.2% (60.9%-63.6%)
Neighborhood socioeconomic status		
Higher	74.8%	71.1% (70.9%-71.3%)
Low	24.0%	59.5% (59.1%-59.9%)
Unknown	1.1%	67.4% (65.6%-69.1%)
Number of chronic conditions		
1	24.9%	68.9% (68.5%-69.3%)
2	54.3%	68.0% (67.7%-68.2%)
3	16.2%	69.1% (68.7%-69.5%)
4	4.2%	67.2% (66.4%-68.1%)
5	0.5%	66.5% (64.0%-69.0%)
High health engagement^b		
No	42.0%	64.2% (63.9%-64.5%)
Yes	58.0%	71.0% (70.8%-71.3%)

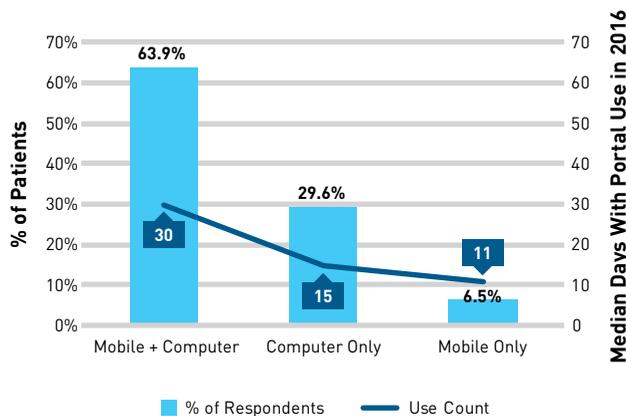
PHR indicates personal health record.

^aAdjusted percentages and 95% CIs calculated using logistic regression results, assuming patients in each subgroup have the same distribution of other characteristics as the full study population.

^bPatients were defined as highly engaged in their care if they were adherent to both their chronic condition medications and recommended preventive care services in 2015.

During 2016, 181,981 patients (68.1% of the total number) accessed their PHR 8.9 million times: 60.6% of log-ins were via a computer, 19.9% via mobile device browser, and 19.5% via smartphone apps. Of all PHR users, 6.5% used it only with a mobile device, 29.6% only with a computer, and 63.9% used both a computer and mobile device (**Figure 1**). Patients who accessed the PHR only via a mobile device used it less frequently (median of 11 days with PHR use) than those using only a computer (15 days) or both a

FIGURE 1. Percentages of Patients by Device(s) Used to Access Their PHR; Median Count of Days With PHR Use in 2016^a



PHR indicates personal health record.

^aTo calculate PHR use counts, we identified use episodes by counting the number of days during the year with any PHR use (ie, multiple log-ins in 1 day counted as a single episode).

TABLE 2. Among PHR Users (n = 181,981), Percentage of Patients Who Used Key PHR Functions, by Device(s) Used in 2016

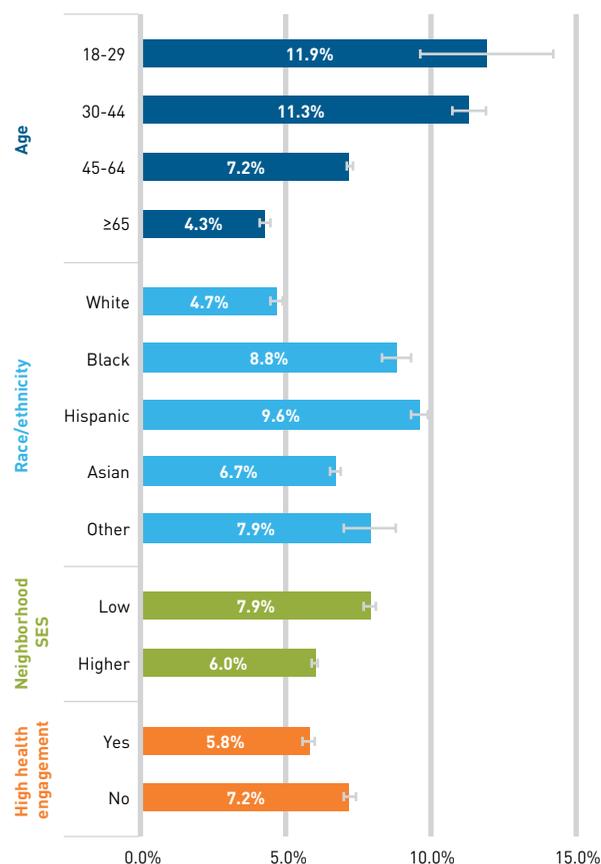
	All PHR Users	PHR Users by Device(s) Used in 2016		
		Computer and Mobile	Computer Only	Mobile Only
Ordered a prescription refill	66.0%	73.7%	54.8%	40.5%
Sent secure message to a provider	75.8%	84.1%	63.2%	51.8%
Viewed lab result	81.0%	85.7%	78.5%	46.4%

PHR indicates personal health record.

computer and mobile device (30 days). Most PHR users used it to view lab results (81.0%), send a secure message (75.8%), and order a prescription refill (66.0%). For the 3 key functions, use was highest among patients who accessed the PHR via both a computer and mobile device and lowest among those who used only a mobile device (Table 2).

Adjusted percentages of patients who used the PHR, calculated using results from the multivariable logistic regressions, are shown in Table 1. After adjustment, a larger percentage of patients who were younger (84.7% for ages 18-29 years), white (78.4%), living in higher SES neighborhoods (71.1%), and highly engaged (71.0%) used the PHR in 2016 compared with those who were older (60.9% for ≥65 years), black (57.8%), Hispanic (54.3%), Asian (67.7%), living in lower SES neighborhoods (59.5%), and not highly engaged in their care (64.2%) (all *P* < .05).

FIGURE 2. Adjusted Percentages of Patients Using the PHR Only by Mobile Device, by Patient Characteristics in 2016^a



PHR indicates personal health record; SES, socioeconomic status.

^aAdjusted percentages and 95% CIs calculated using logistic regression results, assuming patients in each subgroup have the same distribution of other characteristics as the full study population. The model also adjusted for number of chronic conditions and gender.

Figure 2 shows the adjusted percentages of PHR users who accessed their PHR only from a mobile device by patient characteristics. After adjustment, a higher percentage of patients who were black (8.8%), Hispanic (9.6%), Asian (6.7%), living in lower SES neighborhoods (7.9%), younger (11.9% for ages 18-30 years), or not highly engaged in their health (7.2%) used the PHR only via a mobile device in 2016 relative to those who were white (4.7%), from higher SES neighborhoods (6.0%), older (4.3% for ≥65 years), or highly engaged (5.8%) (all *P* < .05).

DISCUSSION

In 2015, a Pew survey found that 64% of US adults owned a smartphone and 19% relied exclusively on smartphones for internet access.²⁸ In our study of use of a mobile-accessible PHR among

patients with diabetes, most users (70%) accessed their PHR with a mobile device at least once and nearly 40% of all PHR log-ins were done via a mobile device. Among PHR users, nearly 7% accessed the PHR exclusively via a mobile device. These users accessed the PHR less frequently than those who used computers. In addition, nearly one-third of patients did not use the PHR at all in 2016. Patients who were black, Hispanic, or Asian; who lived in lower SES neighborhoods; or who had lower engagement in their care were significantly more likely to access the PHR exclusively using a mobile device in 2016, which is consistent with findings from other reports of mobile-dependent individuals.²⁸ It is possible that many of the patients who accessed the PHR only by mobile device were dependent on that device for internet access and would not have had convenient computer access to use the PHR if a mobile option had not been available.

In our previous analysis conducted in 2010, before the PHR was mobile-accessible, we found that computer internet access explained most of the variation in use of secure messaging via the PHR by race/ethnicity and income.¹³ Thus, the current finding that mobile access is disproportionately reaching members living in lower SES neighborhoods and racial/ethnic minorities is encouraging and suggests that mobile PHR access may, in fact, be helping to bridge the digital divide by reducing disparities in PHR use.

Of note, we found that patients with diabetes who were not considered to be highly engaged in their health (ie, not previously adherent to chronic condition medications and recommended preventive care services) were significantly more likely to use the PHR exclusively via a mobile device. For patients coping with diabetes and other chronic conditions, which require substantial self-management practices, health engagement is critical to maintaining their health.²⁹ Recent studies of PHR use among patients with diabetes found that it is associated with improved self-management practices and glycemic control.^{15,24-26} Mobile PHR use could be an important gateway for potentially reaching those patients who previously had limited engagement with preventive care and medication adherence.

The federal government has invested more than \$30 billion to promote the widespread adoption of EHRs and tethered PHRs as a way to improve access and quality of care.³⁰ However, these financial incentives do not require that PHRs be easily accessible via mobile devices. In fact, eligible providers caring for patients in regions with low broadband internet access are exempted from Meaningful Use objectives related to PHRs.⁶ Although it is possible for patients with smartphones to access any available computer-based PHR using their mobile devices, websites that are not optimized for mobile use can be exceedingly difficult to navigate using the relatively small-sized smartphone screens. To the extent that PHR use can improve chronic care management and clinical outcomes,³¹⁻³⁴ limiting PHR access to patients with easy access to internet-connected computers could contribute

to existing disparities in healthcare access and outcomes. Policy makers should consider extending Meaningful Use PHR objectives to require easy access via mobile devices.

Nonetheless, even with a mobile-accessible PHR, we found that differences in use remained, with black, Hispanic, and Asian patients and those living in lower SES neighborhoods still significantly less likely to have used the PHR at all in 2016. This finding is similar to those of previous studies of PHRs that were not mobile-accessible.^{7,10,13,35,36} Mobile-dependent internet users often face important constraints to accessing the internet, such as data usage limits and small screens. It is possible that these constraints limited any PHR use or frequency of use among mobile-dependent individuals. Although smartphones have increased mobile access to the internet among underserved groups, they may be insufficient to fully bridge the digital divide.²⁸

Policy makers and healthcare administrators should continue to increase the accessibility of PHRs by making them easy to navigate and available on multiple platforms in order to reach patients with limited computer access or literacy. Increasing promotion of and education about mobile-accessible PHR availability and its salience to health management, particularly for patients with chronic conditions, could help to further bridge the divide in PHR use. Still, it is likely that PHR use may not be preferred by all patients, so it is equally important to make alternative methods for easily accessing care available.

Limitations

This study has some limitations. It was conducted with members of a single health plan in northern California. Results may differ in other healthcare settings, such as those with higher poverty rates or that provide services to the uninsured. Also, because our results were based on cross-sectional data, they should be interpreted as associations only. We were not able to confirm causality. Our study did not have any direct measure of the types of internet-connected devices patients have easy access to and relied only on the type of device used to access the PHR itself. Thus, we made the assumption that patients who use a device to access the PHR have access to such a device. Although we picked a patient population with diabetes in order to examine patients with a chronic condition who would likely have ongoing need for the healthcare services and self-management functions available in PHRs and we adjusted for number of chronic conditions, individual clinical need varied by patients and over time.

CONCLUSIONS

Our findings suggest that offering mobile access to PHRs may increase engagement with healthcare among vulnerable patients facing a digital divide in computer technology access. Patients who were of nonwhite race/ethnicity, lived in lower SES neighborhoods,

and had lower prior health engagement were more likely to rely exclusively on mobile devices to access the PHR. Nonetheless, even with access to a mobile-optimized and app-accessible PHR, differences in PHR use by race and neighborhood SES remain. Continued efforts are needed to increase equitable access to PHRs and electronic patient self-management technologies among patients with chronic conditions who may not have convenient computer access. ■

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eAppendix

eAppendix Table 1. Patient Characteristics of Personal Health Record (PHR) Users By Device Used for Sign-On (column %)

		PHR users by device			Patients with no PHR use in 2016
		Mobile	Computer	Both Mobile and Computer	
Total		11,906 4.5%	53,780 20.1%	116,295 43.5%	85,227 31.9%
Age	18-<30	3.6%	0.6%	1.9%	0.8%
	30-<45	17.9%	3.0%	10.9%	5.2%
	45-<65	51.0%	35.8%	46.6%	37.6%
	65+	27.5%	60.7%	40.6%	56.4%
Gender	Male	51.1%	56.6%	51.8%	50.5%
	Female	48.9%	43.5%	48.2%	49.6%
Race/ Ethnicity	White	32.4%	55.7%	49.3%	30.1%
	Black	12.4%	7.6%	8.4%	13.9%
	Hispanic	28.9%	14.1%	16.9%	31.9%
	Asian	24.0%	21.1%	23.6%	21.9%
	Other	2.4%	1.6%	1.8%	2.2%
Neighborhood Socioeconomic Status	Higher	70.5%	80.2%	79.7%	65.4%
	Low	28.5%	18.6%	19.1%	33.5%
	Unknown	1.0%	1.2%	1.1%	1.1%
Number of Chronic Conditions	1	31.8%	21.9%	27.0%	23.0%
	2	51.8%	56.1%	52.9%	55.3%
	3	12.9%	17.1%	16.0%	16.3%
	4	3.1%	4.4%	3.7%	4.7%
	5	0.4%	0.5%	0.4%	0.6%
High Health Engagement ^a	No	50.4%	36.0%	40.7%	46.2%
	Yes	48.0%	63.9%	58.6%	53.8%

^aPatients defined as highly engaged in their care if they were adherent to both their chronic condition medications and recommended preventive care services in 2015.

eAppendix Table 2. Patient Characteristics by Device Type Used in 2016 to Access Personal Health Record (PHR) in 2016

		Mobile only			Computer only			Both Mobile and Computer		
		adj %	95% CI		adj %	95% CI		adj %	95% CI	
Age	18-<30	11.9%	9.6%	14.2%	10.8%	8.3%	13.2%	77.4%	74.2%	80.6%
	30-<45	11.3%	10.7%	11.8%	9.4%	8.8%	9.9%	79.4%	78.6%	80.2%
	45-<65	7.2%	7.1%	7.4%	23.9%	23.6%	24.2%	68.9%	68.6%	69.2%
	65+	4.3%	4.1%	4.4%	39.3%	38.9%	39.7%	56.5%	56.1%	56.8%
Gender	Male	6.4%	6.2%	6.5%	31.3%	31.1%	31.6%	62.3%	62.0%	62.6%
	Female	6.5%	6.4%	6.7%	27.4%	27.1%	27.7%	66.1%	65.7%	66.4%
Race/ Ethnicity	White	4.7%	4.5%	4.8%	30.9%	30.6%	31.2%	64.4%	64.1%	64.7%
	Black	8.8%	8.3%	9.3%	28.3%	27.6%	29.1%	62.9%	62.1%	63.7%
	Hispanic	9.6%	9.3%	9.9%	27.1%	26.5%	27.6%	63.3%	62.8%	63.9%
	Asian	6.7%	6.5%	6.9%	27.8%	27.4%	28.2%	65.5%	65.0%	66.0%
	Other	7.9%	7.0%	8.9%	28.9%	27.2%	30.5%	63.2%	61.5%	65.0%
Neighborhood Socioeconomic Status	Higher	6.0%	5.9%	6.1%	29.3%	29.1%	29.5%	64.7%	64.4%	64.9%
	Low	7.9%	7.7%	8.2%	30.5%	30.0%	31.0%	61.6%	61.1%	62.1%
	Unknown	5.6%	4.6%	6.7%	31.0%	28.9%	33.1%	63.4%	61.2%	65.6%
Number of Chronic Conditions	1	6.1%	5.9%	6.3%	31.0%	30.6%	31.5%	62.9%	62.4%	63.4%
	2	6.5%	6.4%	6.7%	29.9%	29.6%	30.2%	63.6%	63.3%	63.9%
	3	6.4%	6.1%	6.7%	27.3%	26.8%	27.8%	66.3%	65.7%	66.8%
	4	7.3%	6.5%	8.0%	26.3%	25.4%	27.3%	66.4%	65.3%	67.5%
	5	7.3%	5.2%	9.3%	24.3%	21.6%	27.1%	68.4%	65.2%	71.6%
Health Engagement ^a	No	7.2%	7.0%	7.3%	29.7%	29.4%	30.1%	63.1%	62.8%	63.5%
	Yes	5.8%	5.6%	6.0%	29.4%	29.1%	29.6%	64.9%	64.6%	65.2%

Note: Adjusted percentages calculated using results from the multinomial logistic regression, assuming patients in the subgroup having the same other characteristics as the full study population.

^aPatients defined as highly engaged in their care if they were adherent to both their chronic condition medications and recommended preventive care services in 2015.