

## Brief Communication

# Mobile-accessible personal health records increase the frequency and timeliness of PHR use for patients with diabetes

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### ABSTRACT

Personal health records (PHRs) offer patients a portal to view lab results, communicate with their doctors, and refill medications. Expanding PHR access to mobile devices could increase patients' engagement with their PHRs. We examined whether access to a mobile-optimized PHR changed the frequency and timeliness of PHR use among adult patients with diabetes in an integrated delivery system. Among patients originally using the PHR only by computer, PHR use frequency increased with mobile access. Non-White patients were more likely to view their lab results within 7 days if they had computer and mobile access compared with computer only; however, there were no statistically significant differences among White patients. More frequent and timely mobile access to PHR data and tools may lead to convenient and effective PHR engagement to support patient self-management. Future studies should evaluate whether PHR use with a mobile device is associated with changes in self-management and outcomes.

**Key words:** personal health records, mobile health, patient engagement, chronic care management

### INTRODUCTION

Tethered personal health records (PHRs) offer patients the ability to check lab results, communicate with their doctors, and refill medications.<sup>1–4</sup> Expanding PHR access to mobile devices creates new channels for PHR access, potentially allowing more patients to engage with their own care more often or in a timelier manner. More convenient PHR access via mobile devices could be especially beneficial for patients with a chronic condition, such as diabetes, that requires intense self-management practices. Among patients with diabetes, PHR use is associated with improved care quality, including glyce-mic levels,<sup>5</sup> testing,<sup>4</sup> and adherence.<sup>6</sup> Moreover, recent studies have shown that more frequent and timely use of specific portal functions

is associated with greater quality and outcome improvements for patients with chronic conditions.<sup>1,3,7–10</sup>

Federal meaningful use stage 3 objectives require that providers offer patients timely access to view their health information via a secure portal. However, it does not require that providers offer a PHR that is accessible via a mobile-optimized website or smartphone application (app). There has been little research on the availability of mobile-accessible PHRs and how they affect PHR use patterns. We examined access to a mobile-optimized PHR in an integrated delivery system, a technology early-adopter in a state with a highly connected population.<sup>11</sup> Among patients with diabetes, we examine how mobile access changed the overall frequency of PHR use and timeliness of viewing lab results. We hypothesized that the

convenience of mobile PHR access would increase the frequency and timeliness of portal use.

## METHODS

### Setting

Kaiser Permanente Northern California (KPNC) is an integrated healthcare delivery system that provides comprehensive care to more than 3 million members. Members who register to use the password-protected, secure patient PHR can access it free of charge via computer browser, mobile-optimized website, or mobile app. The portal has been available since late 2005, and the mobile-optimized website and Android or iOS apps have been offered since 2013. The portal offers patients the ability to exchange secure messages with providers, view lab results, request medication refills, view their health records, schedule office visits, and pay medical bills.

### Study population

The study population included adult (18 years or older) KPNC members who were in the health plan diabetes clinical registry in the last quarter of 2013 (N = 229 130) and were continuously enrolled in 2014 to 2016 (N = 189 396). We focused on patients with diabetes because they have ongoing healthcare needs that can be facilitated by the portal. National guidelines recommend that patients with diabetes receive a glycated hemoglobin (HbA1c) test at least once yearly. We conducted 2 separate analyses to examine the frequency of use and timeliness of viewing an HbA1c lab result through the portal. Additional exclusion criteria are described below.

### Data

We used portal administrative data to capture PHR use channel (mobile device or computer) and lab result viewing and electronic health record (EHR) data for patient characteristics. We linked patients' residential addresses to the 2010 U.S. Census measures of education and income to define neighborhood socioeconomic status (SES).

**Frequency.** To examine changes in frequency of PHR use after the addition of mobile access, we included patients who had been using only a computer to access the PHR for at least 12 months, and then newly started using a mobile device to access the portal at any point during 2015. For each patient, we identified the month of their first mobile PHR use as the index month, then we defined the 12 months before the index month as the baseline period and 12 months after the index month as the mobile-access period. Since our goal was to examine the persistent impact of adding mobile access rather than the initiating event, we excluded a 3-month clear-out period from our analysis of monthly login days (excluding the first month of mobile access and also the month pre- and post first mobile use). To measure frequency, we counted the number of days per month that patients used their PHR (login days).

**Timeliness.** To examine timeliness of PHR use with mobile access among patients with diabetes, we included patients who were registered to use the portal and had a new HbA1c lab result released to their PHR in 2015. New lab results trigger an email notification to the patient with a link to view it on the portal. For these analyses, we defined patients' access to the PHR by categorizing the type of device used to log in to the portal during a baseline period of 12 months prior to the lab value release (computer only or both computer and mobile access). Few patients used a mobile device only in

the baseline period (<1%); therefore, they were excluded from the analyses. We measured the time between release of a lab result (first one in 2015) and the time that they viewed the result using the portal.

### Analyses

**Frequency.** For the longitudinal period shown in Figure 1, we used monthly counts of login days as the outcome variable and applied the fixed-effects estimation method using the Linear Unobserved Effects Model<sup>12,13</sup> to assess the relationship between device access and mean monthly login days adjusted for calendar month (categorical variable), number of months after mobile access, and whether the patient had any clinical event (office visit, phone visit, emergency department, or hospitalization) in the prior month (time-changing) to account for recent health issues. This provided a generalization of difference-in-difference analysis appropriate for the staggered implementation of the device-type exposure variable in our study design.

**Timeliness.** We used logistic regression to measure the association between patients' access and the probability of viewing their lab results within 7 days, adjusting for patient's age, race, neighborhood SES, and the number of chronic conditions. We included an interaction term between mobile PHR access and race (White vs. Non-white) to allow for potentially different effects of device by race. We used results from the model to compute the marginal adjusted percent of patients who viewed their lab results within 7 days of release by race and device.

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

## RESULTS

### Frequency

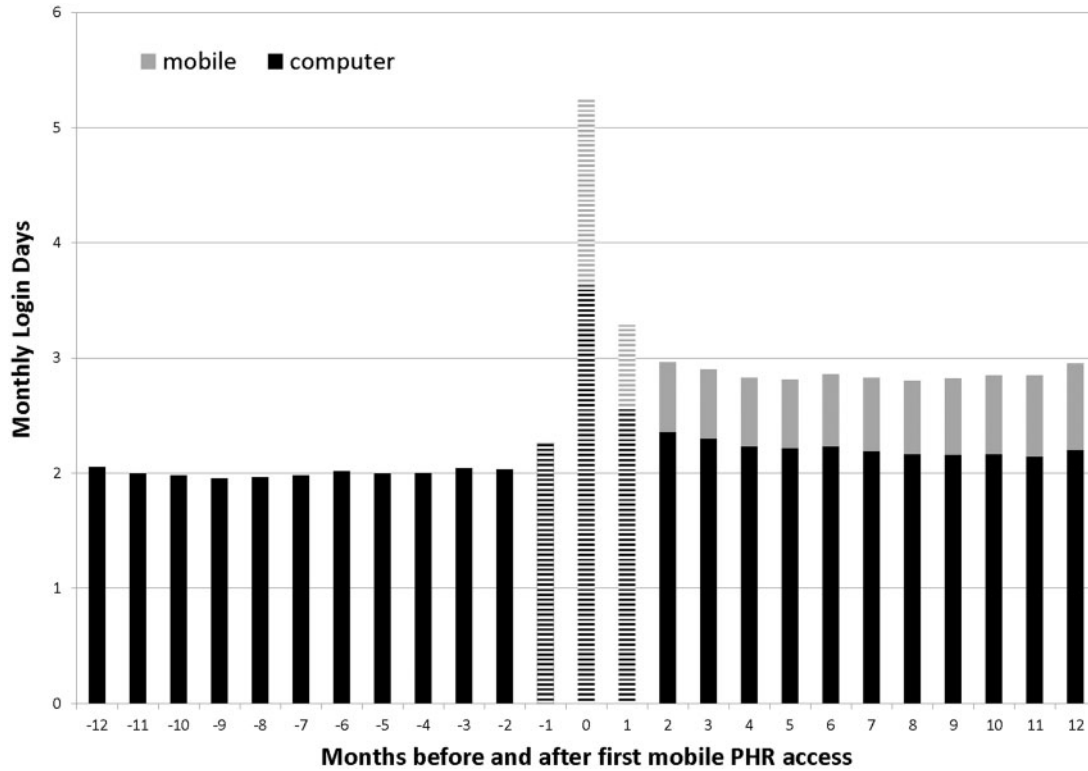
There were 18,529 patients with diabetes who accessed their PHR by computer only in the baseline year and added mobile PHR access in 2015 (Table 1). Overall, 50.3% were of White non-Hispanic race/ethnicity, 18.7% lived in lower SES neighborhoods, and 20% had 3 or more chronic conditions.

Figure 1 shows the unadjusted average number of logins in the 12 months before and after adding mobile access. On average, excluding the clear-out period, when using the portal by computer, patients used the PHR 2.00 days per month. After adding access from a mobile device, patients on average used the PHR 2.86 days per month. After adjustment, patients used the PHR 0.78 (95% CI: 0.74-0.83) more days per month after initiating mobile PHR access.

### Timeliness

The timeliness analysis included 116 624 patients who had a new HbA1c lab result released to their PHR in 2015 and had used the PHR in the baseline period (Table 1). Overall, 51.2% had accessed the PHR from both a computer and mobile device and 48.8% used a computer only.

Figure 2 shows the adjusted percent of patients who viewed their HbA1c results within 7 days of release by device access (computer only vs. computer+mobile) and race (White vs. non-White). Non-White patients were more likely to view their lab results within 7 days if they had computer and mobile access (63.8%) compared with computer only access (58.8%,  $P < 0.001$ ); however, there were no statistically significant differences among White patients (72.3% for computer only vs. 72.6% for computer+mobile,  $P = 0.439$ ).



**Figure 1.** Frequency: Average monthly days of portal use before and after first mobile-PHR use (unadjusted, N = 18 529). Note: The dashed bars represent the 3-month clear-out period (ie, the first month of mobile access and also the month pre- and post first mobile use), which is excluded from the analyses.

**Table 1.** Patient characteristics by study outcome (frequency and timeliness)

		Frequency	Timeliness
Age <sup>a</sup>	N	18 529	116 624
	18-44	6.7%	9.2%
	45-64	47.8%	45.4%
	65-75	29.8%	30.2%
Gender	75+	15.6%	15.2%
	Male	53.3%	53.2%
Race/ethnicity	Female	46.7%	46.8%
	White	50.3%	52.5%
	Black	8.5%	8.2%
	Hispanic	16.4%	15.7%
Neighborhood socioeconomic status <sup>b</sup>	Asian	23.3%	22.0%
	Other	1.6%	1.6%
	Lower	18.7%	18.5%
	Higher	80.4%	80.6%
Number of other chronic conditions <sup>a</sup>	Missing	0.9%	1.0%
	1 (diabetes only)	24.2%	24.2%
	2	55.8%	55.7%
	3+	20.0%	20.1%

<sup>a</sup>Based on the last quarter of 2013; <sup>b</sup>missing if residence address could not be accurately geocoded.

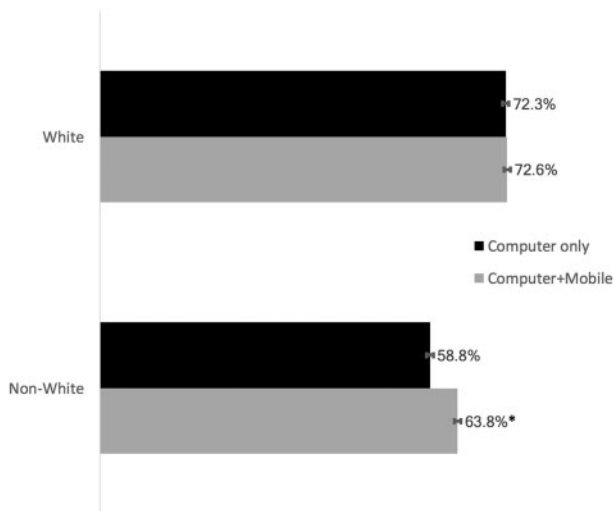
**DISCUSSION**

We found that the addition of mobile PHR access was associated with more frequent portal use overall and with a greater likelihood of viewing lab results within 7 days among non-White (but not White) patients. Still, White patients were more likely to view their

lab results within 7 days regardless of device access. This suggests that offering mobile PHR access may be a promising way to increase portal engagement, particularly among non-White patients.

Previous research found that PHR use is associated with improvements in diabetes care quality, including treatment adherence.<sup>6</sup> Moreover, users with more frequent and longer-term use experienced additional improvements in glycemic testing and levels compared to less engaged users.<sup>1,3,7,14</sup> Although many of these prior studies focused on use of one specific PHR function, secure messaging, results suggest trends in improvements in self-management behaviors that can be facilitated by other PHR functions.<sup>1,3,7,14</sup> Thus, providers interested in optimizing the potential benefits of portals should aim to encourage patients to sign up and be more engaged in ongoing use. Our findings suggest that by providing a mobile-accessible PHR to patients, practices may be able to increase the frequency and timeliness of PHR use and potentially improve patients' self-management practices and outcomes. Still, more research is needed to understand the clinical significance of these changes in PHR use patterns.

Recent studies also show that patients are interested in using mobile apps<sup>15</sup> and many prefer mobile apps to computer-based portals to facilitate self-management.<sup>16</sup> A survey of diverse, low SES patients found that the majority of respondents (86%) expressed a strong interest in using a mobile app to help with self-management of a chronic condition.<sup>15</sup> In addition, a qualitative study among Black and Latino KPNC members found that many expressed a preference for using the mobile app to access the PHR because of the additional convenience and simplified interface.<sup>16</sup> This added convenience and easier interface may be driving our findings that by adding mobile device access, the portal was associated with more



**Figure 2.** Timeliness: Adjusted percent of patients who viewed their HbA1c within 7 days of release by PHR device access and race/ethnicity (N = 116 624). Note: We computed the marginal adjusted percent of patients who viewed their HbA1c results within 7 days by applying the coefficients from the logistic regression models as if all respondents were (1) White and had computer only; (2) White and had computer and mobile access; (3) non-White and had computer only; and (4) non-White and had computer and mobile access. \* $P < 0.001$  comparing computer only to computer and mobile PHR access by race category.

frequent login days overall and timelier viewing of lab results among non-White patients.

Interestingly, our timeliness analysis found the addition of mobile PHR access was associated with significant increase in the likelihood of viewing HbA1c results within 7 days among non-White (but not White) patients. Still, even with mobile and computer access, non-White patients were less likely to view their lab results within 7 days compared to White patients regardless of device. In a previous study, we found that most portal users accessed their PHR via a mobile device and that patients who were Black, Hispanic, or Asian, living in lower SES neighborhoods or with lower health care engagement were significantly more likely to access it exclusively using a mobile device.<sup>17</sup> Moreover, patients using the portal only via a mobile device used it less frequently than those with computer access.<sup>17</sup> Combined, our findings suggest that while the additional convenience of PHR access via a mobile device may increase engagement with portals among racial minorities and poorer patients, disparities in use remain.

This study has a few limitations. Our study was conducted with members of a single integrated delivery system in northern California. Results may differ in other healthcare settings or patient populations. Also, our findings are based on observational data and should not be interpreted as causal. Still, our study includes a large, diverse patient population with detailed data on device(s) used to access the PHR. In addition, we were able to adjust for several important confounders, including SES and clinical characteristics. In the frequency analysis, we were also able to control for all time-stable patient characteristics, adjusted for time-varying clinical events in the prior month, and used a clear-out period to minimize the effect of a potentially triggering clinical event associated with a patient's first mobile PHR access. Future research should examine if the addition of mobile PHR access is associated with changes in care processes (eg, medication or lab screening adherence) and outcomes (eg, glycemic levels).

In a setting offering convenient PHR access through a mobile-optimized website and mobile app, patients increased the overall frequency of portal use after starting to access the portal through a mobile device in addition to a computer. Non-white patients who used both a computer and mobile device to access their portal were significantly more likely to view their lab results within 7 days than those using only a computer to access it. Future studies should evaluate whether PHR use via a mobile device is associated with changes in self-management behaviors and outcomes. Offering mobile-optimized portals may be a promising way for healthcare practices to increase engagement with PHRs among low-frequency users.

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## CONTRIBUTORS

All authors contributed to the conception and design of the project and interpretation of results. JH performed the statistical analyses. IG wrote the first draft of the manuscript. Other authors provided feedback on the manuscript and approved the manuscript.

*Conflict of interest statement.* None declared.

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