A Patient Portal-Based Commitment Device to Improve Adherence with Screening for Colorectal Cancer: a Retrospective Observational Study

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BACKGROUND: Despite significant investment in colorectal cancer (CRC) screening, 40% of US adults are not up-to-date. Commitment devices, which are psychologically tailored approaches to enforce health goals, may be an effective method to increase CRC screening.
OBJECTIVE: Compare the effectiveness of a commitment device (patient self-ordering fecal immunochemical test (FIT) kits) to standard CRC screening outreach.
DESIGN: A retrospective observational study.
PARTICIPANTS: Participants were > 49 years and < 75 years, had no history of CRC, and were eligible for CRC screening.
INTERVENTION: An electronic screening reminder with an embedded order button allowed participants to order FIT kits directly from a patient portal. Those who used the order button were promptly sent a kit; those who did not were later mailed kits.
MAIN MEASURES: Primary outcome was completion of FIT kits. Secondary outcomes included number of days to completion, completion of follow-up for positive results, and CRC diagnosis; we also examined prior use of FIT kit. We used inverse probability of treatment weights to control for pretreatment imbalances.
KEY RESULTS: The cohort comprised 176,231 participants: 53% female; median age was 59; 11% were Asian, 21% Hispanic/Latino, 7% black, 51% White, 3% other/mixed race. Approximately 10% ($N = 16,918$) used the button. Using inverse probability of treatment weights, we found that those who used the button had 3.8 times the odds of completing a kit compared to participants who did not (odds ratio, 3.77; 95% confidence interval, 3.57–3.98). Within the button group, 63% of those eligible completed a FIT kit in the year prior to the button compared to 87% in the year after the button became available ($p < 0.0001$).
CONCLUSION: The ability to self-order screening kits may act as a commitment device that increases CRC screening. Scalable tools leveraging existing patient portals such as this can complement existing CRC outreach strategies.

KEY WORDS: colorectal cancer screening; commitment device; patient portal; patient self-management.

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INTRODUCTION

Background

Colorectal cancer (CRC) screening is our most effective tool for reducing CRC incidence and mortality, with a grade A recommendation from the United States Preventive Service Task Force.[1] CRC is the second leading cause of cancer-related deaths in the USA, and mortality risk is significantly higher in unscreened individuals; thus, it is a national priority to increase CRC screening rates.[2] The Centers for Disease Control have a goal of regular CRC screening in 80% of eligible patients over the age of 50.[3] Unfortunately, approximately 40% of US adults are not up to date on CRC screening[4,5] despite the availability of several screening modalities including home fecal occult blood test (FOBT) and fecal immunochemistry (FIT) kits and multiple CRC screening outreach campaigns. A recent systematic review and meta-analysis compared the effectiveness of different strategies to increase CRC screening.[6] FOBT and FIT outreach, patient navigation, and clinician-directed interventions all resulted in net CRC screening increases, with multicomponent interventions demonstrating the greatest increase.[6] However, CRC outreach programs are often constrained by costs and resource limitations.[7,8] Thus, there is a need to develop and test novel, scalable strategies that complement multi-component CRC screening outreach programs to increase CRC screening.

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Advances in health information technology, including growing use and sophistication of online patient portals, present new opportunities for participation in CRC screening.[9] Patient engagement is associated with increased uptake of preventive care,[10,11] and patient portals have been shown to facilitate improvements in medication adherence, patient self-management, hospital readmissions, patient experience, and disease prevention.[12–18] Novel patient-facing tools designed for online portals have potential to increase use of CRC screening as part of multi-component CRC screening outreach strategies.

A relatively unexplored area in CRC screening is the use of commitment devices. Originally from the field of behavioral economics, commitment devices were initially described as tying the individual to behavioral acts by behavior change.[19] This definition has been expanded to include multiple approaches to enforce individual's voluntarily imposed health goals (e.g., health screenings, exercise, weight loss) until they have accomplished their goals.[20] For example, arranging to exercise with friends is a commitment device that would help meet a voluntary fitness goal; not showing up leads to disappointment of friends (consequence of the behavior).[20] Commitment devices can be conceptualized as a type of patient engagement strategy to help ensure health goals such as cancer screenings are met.

Objectives

In this study, we evaluated the impact of an interactive interface within a patient portal that allowed patients to directly order a FIT kit with the click of a button within an integrated healthcare system, Kaiser Permanente Southern California (KPSC). As for many healthcare systems, CRC screening is an important initiative within KPSC, which has a 10-year goal to reduce CRC mortality by 50%.[21] Under the current KPSC regional outreach strategy, eligible KSPC members who fit the KPSC guidelines for CRC screening receive mailed FIT kits annually at no cost, as well as outreach including a letter from the primary care provider introducing the kit and urging the member to complete it, and auto-reminder calls, reminder postcards, and reminder secure email messaging if screening is not complete, with materials available in English and Spanish. Clinician-directed strategies to increase CRC screening rates include point-of-care reminders built into the EHR. This has resulted in screening rates of over 80% for KPSC.[8] However, gaps in screening exist within KPSC. In this study, we hypothesized that participants who use the order button will have higher rates of screening completion compared to non-users, with the order button acting as a commitment device. We evaluated completion of the FIT kit, number of days to completion, completion of recommended follow-up for positive FIT kit results, and CRC diagnoses. We also evaluated measures of patient engagement to examine if engagement was associated with use of the button, including past use of the patient portal, missed appointments, and total utilization of outpatient care, as well as past FIT kit use.

METHODS

Study Design and Participants

We conducted a retrospective observational study among KPSC members eligible for CRC screening. Eligible patients were > 49 years of age and < 75 years old, had no history of CRC, had not completed CRC screening using any modality within the past 12 months, and had not completed a colonoscopy within the past 10 years or sigmoidoscopy within the past 5 years. (Note that KPSC members are identified as eligible 2–3 months prior to their 50th birthday, hence the inclusion of > 49 years.) Patients on hospice or palliative care were excluded. All materials were available in English and Spanish.

Setting

KPSC provides comprehensive care to over 4.6 million members with a long-standing electronic health record (EHR). The EHR features an online patient portal (kp.org) which provides patient access to appointments, results, and information about past visits. The patient portal also features the Online Personal Action Plan (oPAP). The oPAP was designed to enhance patient engagement, potentially improving efficacy of outreach efforts for prevention and other health services. The oPAP synthesizes information from the EHR to provide tailored information about recommended services including cancer screenings, immunizations, heart health, and other preventive care services. It features interactive content with links to enable patient actions. The oPAP has been shown to be an effective tool for closing care gaps, such as overdue HbA1c testing for diabetes management and overdue screenings.[22]

Intervention

In 2016, the oPAP team developed the interactive order button interface for the portal. A CRC screening reminder with the embedded button allows patients due for a FIT kit to order the kit directly from the patient portal. Email reminders for CRC screening with the embedded FIT kit order button were sent to eligible KPSC members due for their annual CRC screening. Those who used the order button were promptly sent a FIT kit and removed from the regional FIT kit mailing list. Those who did not use the button were mailed kits as part of the standard CRC screening outreach strategy. We included any eligible member who used the button to order a FIT kit up to October 2, 2017, in the button-user group; non-users were the comparison group. The index date was either the date the reminder was sent out or the date the button was first clicked, whichever came first. Participants were followed over time from initial invitation to completion of the FIT kit, other colorectal screening, terminated membership, death, or until May 1, 2018. All study activities were approved by the KPSC Institutional Review Board (IRB #11624).

Variables

Our primary outcome was completion of the FIT kit. Secondary outcomes included number of days to complete the kit and completion of recommended follow-up for positive results. We identified completion of the FIT kit using current procedural terminology (CPT) codes from the EHR and results of the test were designated as either "positive" or "negative," or were indeterminate. Time to completion was calculated using the result date. We also evaluated diagnosis of CRC during the study period. We identified newly diagnosed cancers using ICD-10 diagnosis codes (C18.0, C18.2–9, C19.X, C20.X) and confirmed with chart review. For those diagnosed with CRC during the study period, we extracted pathological cancer stage from pathology reports (American Joint Committee on Cancer 8th edition).

We identified covariates from the EHR including demographic information on age, gender, race/ethnicity, need for interpreter, and primary medical center. Preferred primary medical center was determined using utilization records within the prior year. Zip code was used to estimate preferred (closest) medical center for members with no healthcare utilization data. We also included a weighted Charlson Comorbidity Index (CCI) score.[23] The CCI was calculated using utilization data from the EHR 1 year prior to the index date, and the weighted score was generated using age and diagnostic (ICD) data; scores were categorized as 0, 1, 2, 3, and ≥ 4.

Lacking a survey-based measure of patient engagement, we relied on proxy measures of engagement including number of patient portal logins in the past year, no-show outpatient appointments in the past year, and overall outpatient healthcare utilization in the past year. These variables were selected based on association with patient engagement demonstrated in the scientific literature, including the association of higher engagement and increased use of health services[24–26] and use of patient portals.[27–29]

Statistical Analysis

Initial binary comparisons of demographic and engagement characteristics were calculated with chi-square tests. To evaluate potential differences in completion of FIT kits between those who used the order button and those who did not, we used propensity score methods to control for pretreatment imbalances commonly seen in observational studies.[30,31] A logistic regression was run with the inverse probability of treatment weights to balance the study groups with respect to demographic and utilization characteristics.[32] Odds ratios with 95% confidence intervals were computed to compare the odds of completing a FIT kit among those who used the button compared to eligible members who had active logins on the patient portal but did not use the button. Additionally, to evaluate the potential effect of engagement, we compared the odds of completing a FIT kit among those who logged in to the patient portal but did not use the button to those who had zero logins during the study period. Missing values were included in an "unknown" category, ensuring that propensity score weighting could be conducted on all observations. Propensity scores were computed using the R package Toolkit for Weighting and Analysis of Nonequivalent Groups (TWANG), using age, gender, race and ethnicity, need for a language interpreter, preferred medical center, number of patient portal logins in the past year, no-show outpatient appointments in the past year, overall outpatient healthcare utilization in the past year, and the CCI. The

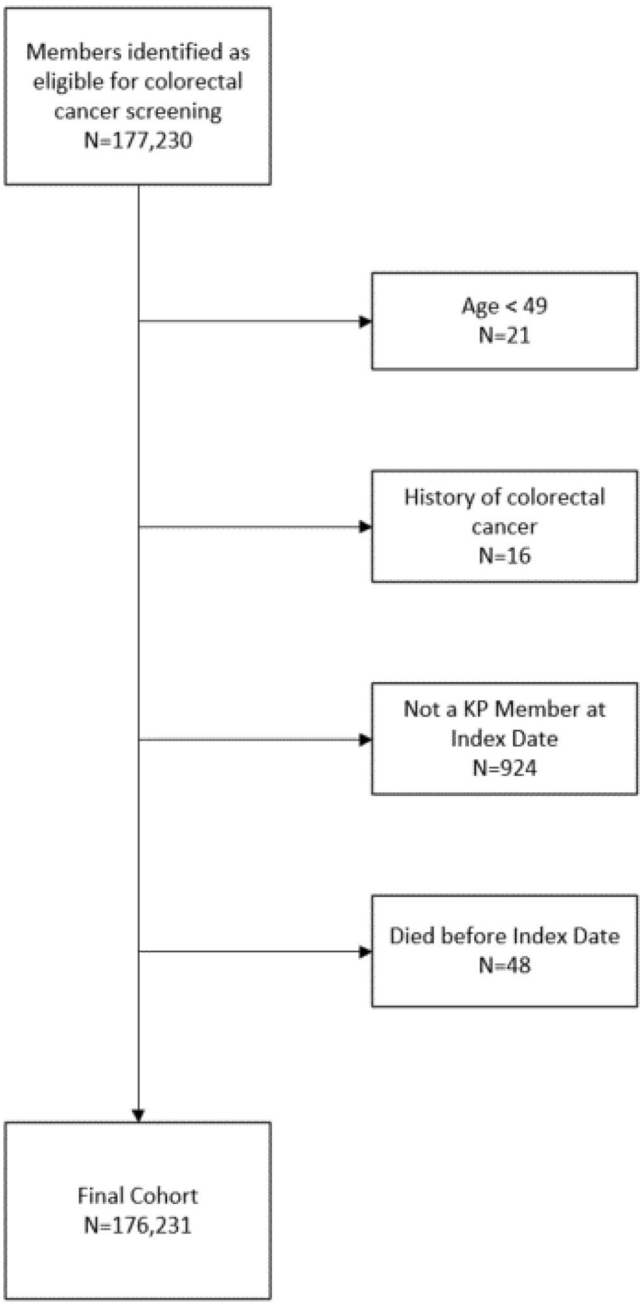

Fig. 1 Cohort diagram, Kaiser Permanente Southern California members eligible for annual fecal immunochemistry testing kits for colorectal cancer screening, $N = 176,231$.

Table 1 Patient Demographics and Engagement Characteristics of Kaiser Permanente Southern California Members Eligible for Home Colorectal Cancer Screening and Received the Self-Order Button Message on the Patient Portal Between December 14, 2016, and July 19, 2017, Unweighted Data, *N* = 176,231

	Button group *N* = 16,918 (10%)	Non-button group *N* = 159,313 (90%)	Total *N* = 176,231	*p* value
Age				< 0.0001
< 55	4591 (27.1%)	55,112 (34.6%)	59,703 (33.9%)	
55–59	3111 (18.4%)	36,211 (22.7%)	39,322 (22.3%)	
60–64	3046 (18%)	28,798 (18.1%)	31,844 (18.1%)	
65–70	2472 (14.6%)	18,356 (11.5%)	20,828 (11.8%)	
70+	3698 (21.9%)	20,836 (13.1%)	24,534 (13.9%)	
Gender				0.0006
Female	9247 (54.7%)	84,857 (53.3%)	94,104 (53.4%)	
Race and ethnicity				< 0.0001
White	10,489 (62%)	79,139 (49.7%)	89,628 (50.9%)	
Asian	1484 (8.8%)	17,507 (11%)	18,991 (10.8%)	
Black	1220 (7.2%)	10,660 (6.7%)	11,880 (6.7%)	
Hispanic	2604 (15.4%)	34,921 (21.9%)	37,525 (21.3%)	
Other	420 (2.5%)	5289 (3.3%)	5709 (3.2%)	
Unknown	701 (4.1%)	11,797 (7.4%)	12,498 (7.1%)	
Needs interpreter				< 0.0001
Yes	33 (0.2%)	1549 (1%)	1582 (0.9%)	
Preferred MC				< 0.0001
MC1	1256 (7.4%)	13,020 (8.2%)	14,276 (8.1%)	
MC 2	379 (2.2%)	3861 (2.4%)	4240 (2.4%)	
MC 3	847 (5%)	9069 (5.7%)	9916 (5.6%)	
MC 4	546 (3.2%)	8438 (5.3%)	8984 (5.1%)	
MC 5	246 (1.5%)	1908 (1.2%)	2154 (1.2%)	
MC 6	2109 (12.5%)	19,515 (12.2%)	21,624 (12.3%)	
MC 7	1121 (6.6%)	10,133 (6.4%)	11,254 (6.4%)	
MC 8	402 (2.4%)	3852 (2.4%)	4254 (2.4%)	
MC 9	941 (5.6%)	9562 (6%)	10,503 (6%)	
MC 10	14 (0.1%)	172 (0.1%)	186 (0.1%)	
MC 11	27 (0.2%)	336 (0.2%)	363 (0.2%)	
MC 12	904 (5.3%)	8982 (5.6%)	9886 (5.6%)	
MC 13	1472 (8.7%)	13,888 (8.7%)	15,360 (8.7%)	
MC 14	3818 (22.6%)	27,915 (17.5%)	31,733 (18%)	
MC 15	915 (5.4%)	9402 (5.9%)	10,317 (5.9%)	
MC 16	573 (3.4%)	6419 (4%)	6992 (4%)	
MC 17	287 (1.7%)	2816 (1.8%)	3103 (1.8%)	
MC 18	1048 (6.2%)	9803 (6.2%)	10,851 (6.2%)	
Unknown	13 (0.1%)	222 (0.1%)	235 (0.1%)	
Patient portal successful logins 1 year prior				< 0.0001
0	1700 (10%)	52,052 (32.7%)	53,752 (30.5%)	
1–9	5916 (35%)	68,401 (42.9%)	74,317 (42.2%)	
10–19	3698 (21.9%)	19,857 (12.5%)	23,555 (13.4%)	
20–29	2164 (12.8%)	8662 (5.4%)	10,826 (6.1%)	
30–39	1270 (7.5%)	4197 (2.6%)	5467 (3.1%)	
40–49	732 (4.3%)	2287 (1.4%)	3019 (1.7%)	
50+	1438 (8.5%)	3857 (2.4%)	5295 (3%)	
Missed appointments in 2016				< 0.0001
0	12,579 (74.4%)	117,780 (73.9%)	130,359 (74%)	
1	2361 (14%)	21,015 (13.2%)	23,376 (13.3%)	
10+	145 (0.9%)	1561 (1%)	1706 (1%)	
2–4	1474 (8.7%)	14,981 (9.4%)	16,455 (9.3%)	
5–9	359 (2.1%)	3976 (2.5%)	4335 (2.5%)	
Outpatient visits in 2016				< 0.0001
0	1653 (9.8%)	26,830 (16.8%)	28,483 (16.2%)	
1–9	5476 (32.4%)	63,210 (39.7%)	68,686 (39%)	
10–19	4096 (24.2%)	32,655 (20.5%)	36,751 (20.9%)	
20–29	2191 (13%)	15,674 (9.8%)	17,865 (10.1%)	
30–39	1260 (7.4%)	8121 (5.1%)	9381 (5.3%)	
40–49	792 (4.7%)	4592 (2.9%)	5384 (3.1%)	
50+	1450 (8.6%)	8231 (5.2%)	9681 (5.5%)	
Weighted Charlson Index				< 0.0001
0	10,660 (63%)	113,078 (71%)	123,738 (70.2%)	
1	2927 (17.3%)	23,599 (14.8%)	26,526 (15.1%)	
2–3	2342 (13.8%)	15,313 (9.6%)	17,655 (10%)	
4+	989 (5.8%)	7323 (4.6%)	8312 (4.7%)	

MC medical center

average treatment effect (ATE) was estimated using KS Max as a stopping method.

To determine if the button led to patients completing CRC screening who had not been up-to-date on screening in the past, we compared the number of those in the button group who completed the FIT kit within the prior year to those in the button group who completed a FIT kit after the button became available using McNemar's test. Analyses were conducted in SAS, version 9.4, and R, version 3.2.2.

RESULTS

Participants

The cohort consisted of 176,231 participants (Fig. 1); we excluded those erroneously identified including 21 who were < 49 years, 16 who had a history of colorectal cancer, 924 participants who were not members at the index date, and 48 who died before the index date. Overall, 53% of the cohort were female; the median age was 59, with 34% aged 49–55, 22% aged 56–59, 18% aged 64, 12% aged 65–70, and 14% aged 71 or older (Table 1); 11% were Asian, 21% Hispanic/Latino, 7% black, 51% White, 3% other/mixed race, and 7% unknown. Over the course of the study period, approximately 4% terminated KP membership ($N = 6295$) and < 1% died ($N = 669$).

Descriptive Data

Approximately 10% ($N = 16{,}918$) used the oPAP button to request a FIT kit. In bivariate comparisons, we found significant differences between the button and non-button groups on both demographics and proxy measures of engagement. A significantly higher proportion of the button group were white race (62% in the button group vs. 50% non-button), and were over the age of 71 (22% vs. 13%); a significantly smaller proportion of the button group were aged 49–55 (27% vs. 35%), were Asian (9% vs. 11%) or Hispanic (15% vs. 22%), or required an interpreter (2% vs. 4%). For proxy measures of engagement, the button group had a significantly higher proportion of ≥ 20 patient portal logins in the past year (33% vs. 12%) as well as a significantly higher proportion of frequent outpatient utilization, defined as 20 or more outpatient visits in the past year (34% vs. 23%). Those in the button group had a significantly higher proportion of those with a CCI score of 2 or 3 (14% vs. 10%) and ≥ 4 (6% vs. 4%).

Primary Outcome

Among those in the button group, 83% completed a FIT kit, compared to 37% of the non-button group (Fig. 2). Using the inverse probability of treatment weights to balance the groups

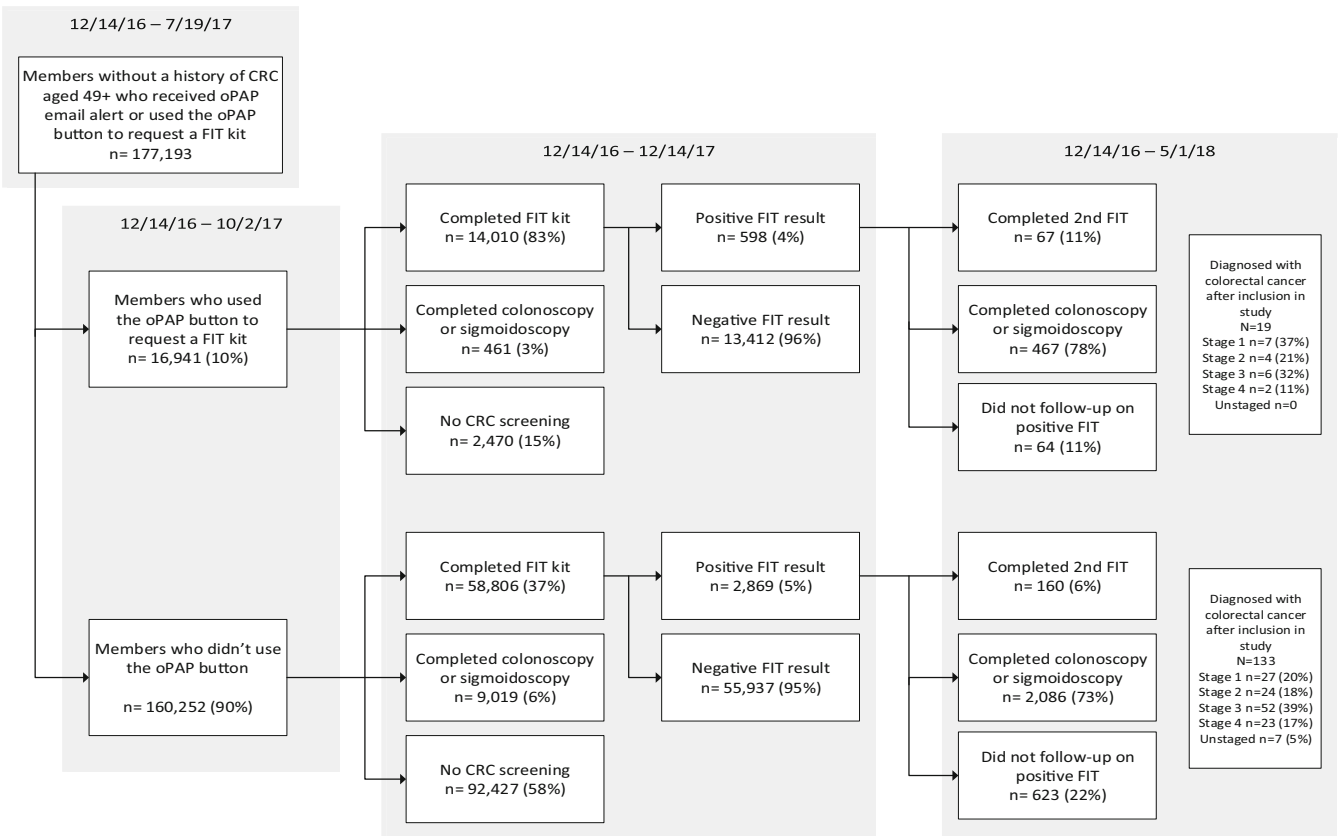

Fig. 2 Flow diagram of button and non-button group completion of initial and follow-up colorectal cancer screening, $N = 176{,}231$.

Table 2 Weighted Patient Demographics and Engagement Characteristics of Kaiser Permanente Southern California Members Eligible for Home Colorectal Cancer Screening and Received the Self-Order Button Message on the Patient Portal Between December 14, 2016, and July 19, 2017, *N* = 176,231

	Logged in, no button *N* = 98,306 (62%)	Did not log in, no button *N* = 61,007 (38%)	Button group *N* = 16,918 (11%)	Rao-Scott chi-square *p* value
Age				0.6557
< 55	59,801 (34%)	59,738 (34.4%)	57,971 (34.1%)	
55–59	39,149 (22.3%)	38,945 (22.4%)	37,153 (21.8%)	
60–64	31,635 (18%)	31,436 (18.1%)	31,294 (18.4%)	
65–70	20,699 (11.8%)	20,133 (11.6%)	20,261 (11.9%)	
70+	24,360 (13.9%)	23,284 (13.4%)	23,523 (13.8%)	
Gender				0.2102
Female	93,777 (53.4%)	92,476 (53.3%)	89,502 (52.6%)	
Male	81,867 (46.6%)	81,060 (46.7%)	80,700 (47.4%)	
Race and ethnicity				0.1077
White	89,536 (51%)	88,060 (50.7%)	89,014 (52.3%)	
Asian	18,882 (10.8%)	18,719 (10.8%)	18,602 (10.9%)	
Black	11,834 (6.7%)	11,622 (6.7%)	11,173 (6.6%)	
Hispanic	37,330 (21.3%)	37,181 (21.4%)	34,257 (20.1%)	
Other	5642 (3.2%)	5496 (3.2%)	5414 (3.2%)	
Unknown	12,420 (7.1%)	12,457 (7.2%)	11,742 (6.9%)	
Needs interpreter				0.0228
Yes	6589 (3.8%)	6706 (3.9%)	5444 (3.2%)	
No	167,496 (95.4%)	165,243 (95.2%)	163,567 (96.1%)	
Unknown	1559 (0.9%)	1587 (0.9%)	1191 (0.7%)	
Preferred medical center				0.9972
MC 1	14,278 (8.1%)	14,094 (8.1%)	13,864 (8.1%)	
MC 2	4307 (2.5%)	4146 (2.4%)	4237 (2.5%)	
MC 3	9894 (5.6%)	9813 (5.7%)	9535 (5.6%)	
MC 4	8814 (5%)	8875 (5.1%)	7906 (4.6%)	
MC 5	2179 (1.2%)	1970 (1.1%)	2238 (1.3%)	
MC 6	21,543 (12.3%)	21,013 (12.1%)	20,676 (12.1%)	
MC 7	11,253 (6.4%)	11,212 (6.5%)	11,107 (6.5%)	
MC 8	4209 (2.4%)	4291 (2.5%)	3892 (2.3%)	
MC 9	10,522 (6%)	10,439 (6%)	10,313 (6.1%)	
MC 10	176 (0.1%)	168 (0.1%)	144 (0.1%)	
MC 11	357 (0.2%)	344 (0.2%)	377 (0.2%)	
MC 12	9871 (5.6%)	9759 (5.6%)	9388 (5.5%)	
MC 13	15,390 (8.8%)	15,333 (8.8%)	15,167 (8.9%)	
MC 14	31,642 (18%)	31,195 (18%)	30,629 (18%)	
MC 15	10,164 (5.8%)	10,051 (5.8%)	9983 (5.9%)	
MC 16	6870 (3.9%)	6855 (4%)	6642 (3.9%)	
MC 17	3097 (1.8%)	3150 (1.8%)	3042 (1.8%)	
MC 18	10,855 (6.2%)	10,609 (6.1%)	10,933 (6.4%)	
Unknown	222 (0.1%)	221 (0.1%)	129 (0.1%)	
KP.org successful logins 1 year prior				0.0974
0	53,413 (30.4%)	53,586 (30.9%)	49,954 (29.3%)	
1–9	74,171 (42.2%)	73,889 (42.6%)	72,843 (42.8%)	
10–19	23,509 (13.4%)	23,160 (13.3%)	23,239 (13.7%)	
20–29	10,829 (6.2%)	10,429 (6%)	10,700 (6.3%)	
30–39	5440 (3.1%)	5182 (3%)	5308 (3.1%)	
40–49	3009 (1.7%)	2716 (1.6%)	2957 (1.7%)	
50+	5272 (3%)	4573 (2.6%)	5200 (3.1%)	
Missed appointments in 2016				0.1059
0	129,973 (74%)	127,898 (73.7%)	127,845 (75.1%)	
1	23,315 (13.3%)	23,144 (13.3%)	22,038 (12.9%)	
10+	1691 (1%)	1717 (1%)	1430 (0.8%)	
2–4	16,411 (9.3%)	16,457 (9.5%)	15,131 (8.9%)	
5–9	4253 (2.4%)	4320 (2.5%)	3758 (2.2%)	
Outpatient visits in 2016				0.8898
0	28,358 (16.1%)	28,182 (16.2%)	27,949 (16.4%)	
1–9	68,563 (39%)	68,388 (39.4%)	65,874 (38.7%)	
10–19	36,588 (20.8%)	36,460 (21%)	35,888 (21.1%)	
20–29	17,785 (10.1%)	17,347 (10%)	16,876 (9.9%)	
30–39	9396 (5.3%)	9063 (5.2%)	9203 (5.4%)	
40–49	5342 (3%)	4925 (2.8%)	5323 (3.1%)	
50+	9612 (5.5%)	9171 (5.3%)	9088 (5.3%)	
Weighted Charlson Index				0.5008
0	123,261 (70.2%)	123,200 (71%)	120,470 (70.8%)	
1	26,515 (15.1%)	26,022 (15%)	25,536 (15%)	
2–3	17,618 (10%)	16,761 (9.7%)	16,390 (9.6%)	
4+	8249 (4.7%)	7553 (4.4%)	7806 (4.6%)	

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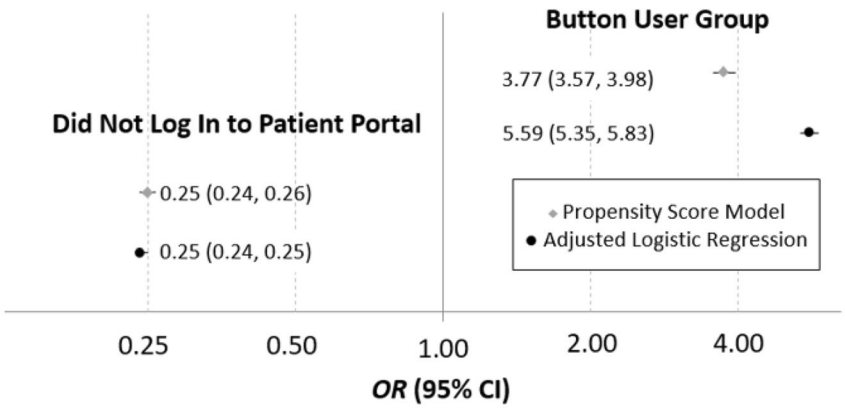

Fig. 3 Odds ratios comparing the button-user group to those who logged in to the patient portal but did not click the button.

on demographic and proxy engagement characteristics (see weighted characteristics in Table 2), we found that those who used the FIT kit button had 3.8 times the odds of completing a FIT kit in comparison to participants who logged into the patient portal during the study period but did not use the button (odds ratio (OR), 3.77; 95% confidence interval (CI), 3.57–3.98) adjusting for gender, race/ethnicity, age, interpreter needs, recently utilized medical center, prior patient portal logins, prior missed appointments, prior total utilization, and weighted CCI (Fig. 3). In the non-button group, those who did not login to the patient portal during the study period had 75% less odds of completing a FIT kit compared to those who logged in but not use the FIT kit button.

Secondary Outcomes

To estimate the impact of the button for patients who had not completed CRC screening in the past, we examined past FIT kit use in the button group. We determined that 12,081 (71%) of the button-user group were KPSC members and eligible for a FIT kit in the year prior to the release of the button (Table 3). Of those, 63% (7593) completed a FIT kit prior to the availability of the button compared to 87% (10,469) in the year after the button became available (McNemar's test $p < 0.0001$), an increase of 2876 patients.

The mean number of days to FIT kit completion was 56 days in the button group compared to 90 days in the non-button group ($p < 0.001$). Overall, 4% of the both groups who completed a FIT kit required additional CRC screening for positive or inconclusive results. For those patients who had a positive FIT result requiring additional screening, 8% of the button group did not have subsequent recommended screening vs. 18% in the non-button group.

We also examined CRC diagnosis: 19 patients (≤ 1%) in the button group were diagnosed with a new primary CRC during the study period: 37% stage I, 21% stage 2, 32% stage III, and 11% stage IV. Among the non-button group, 133 (≤ 1%) had a new primary CRC diagnosed during the study period: 20% stage I, 18% stage 2, 39% stage III, 17% stage IV, and 5% unstaged.

DISCUSSION

Key Results

In this observational study, we found that a significantly greater proportion of patients who self-ordered FIT kits completed the kit compared to those who received a FIT kit as part of a mailed outreach strategy (83% vs. 37%). Using inverse probability of treatment weights to control for imbalances between the groups including demographics and proxy measures of patient engagement, we found that button users had 3.8 times the odds of completing the kit compared to the non-button group (OR = 3.77, 95% CI 3.57–3.98). Importantly, in the button group, we found that only 63% of those eligible for

Table 3 Completion of FIT Kits for Participants in the Button-User Group Who Were Eligible for a FIT Kit 1 Year Prior in Prior Year Versus Post-Button Introduction ($n = 12,081$)

		Post-button FIT		
		No	**Yes**	**Total**
One year prior FIT	No	1065	3423	4488
	Yes	547	7046	7593
	Total	1612	10,469	12,081

McNemar's test $p < 0.0001$

a FIT kit in the prior year completed a kit compared to 87% who completed a kit after the order button became available, an increase of 24% or 2876 patients. This demonstrates a potential impact of the button beyond those patients who were already engaged in CRC screening.

Strengths and Limitations

Our study has several strengths. Our large, racially/ethnically diverse cohort is a significant strength, as well as the longitudinal follow-up data on FIT kit completion, abnormal FIT results, and diagnoses of CRC. Additionally, we were able to capture multiple measures of patient engagement including outpatient utilization, missed appointments, and patient portal logins in the prior year. Our study also has limitations, the most important the observational design. Participants were not randomized to receive the button message; all participants received the message and self-selected to use the button or not. The button group differed significantly from the non-button group; there was a higher proportion of white race in the button group, as well as higher proportion of portal log-ins and higher healthcare utilization, and fewer missed appointments. We used appropriate statistical methodology for causal inference to balance the groups with available covariates, including important measures of engagement, but omitted variable bias is a possibility and may limit generalizability of results. However, our results are similar to a recent RCT of patient self-order of CRC screening.[33] Additionally, KPSC is an integrated system, and the structure of the system may be associated with screening results and not generalizable to other systems. KPSC has high baseline rates of screening and participants were likely exposed to multiple outreach strategies. This exposure may have "primed the pump" for use of the button and completion of screening; results in other settings may be different. The generalizability of the study findings might also depend on the availability and type of patient portal; generating accurate lists of eligible patients requires resources. However, as health systems and other delivery settings continue to invest in patient-facing health technology, the ability to create opportunities such as self-ordering CRC screening will increase.

Interpretations

Our findings are in line with a recent randomized controlled trial that examined the impact of patient self-ordering CRC screening using an iPad, with the ability to order either a home screening kit or a colonoscopy.[33] Participants who were randomized to the self-order arm had over twice the odds of completing screening than controls (OR = 2.5, CI 1.6–4.0). Based on these results, it is possible that the self-order button can act as an effective commitment device.[34] This may be the case even for patients who were previously not engaged in CRC screening behaviors as our findings suggest. Although effects may be modest, patients using commitment devices can be more successful at achieving health goals including smoking cessation[35] and physical activity/nutrition goals[36]; even modest increases in CRC screening rates can have an impact on CRC diagnoses and outcomes. Only 10% used the button, which is also in line with recent systematic reviews of portals which found that 10–30% of patients used a portal function.[37,38]

This work demonstrates that patient self-ordering of CRC screening may help increase CRC screening rates. Scalable health IT tools leveraging existing patient portals such as this can serve as effective complements to existing CRC screening outreach strategies.

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