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# Evidence-Based Interventions and Colorectal Cancer Screening Rates: The Colorectal Cancer Screening Program, 2015–2017

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## Abstract

**Introduction:** The Centers for Disease Control and Prevention administers the Colorectal Cancer Control Program to increase colorectal cancer screening rates among people aged 50–75 years in areas where rates are lower than state or national levels. The aim of this study is to better understand the effectiveness of specific Colorectal Cancer Control Program components.

**Methods:** The study population included clinics enrolled in the Colorectal Cancer Control Program during Years 1 and 2. Clinic data collected by the Centers for Disease Control and Prevention annually from 2015 to 2017 for program evaluation were used. The outcome variable was screening rate change through Program Year 2, and predictor variables were a new implementation or enhancement of evidence-based interventions and other program components. The analysis, conducted in 2020, used ordinary least square and generalized estimating equations regressions and first difference models to estimate the associations of independent variables with the outcome.

**Results:** Of the total 336 clinics, 50%–70% newly implemented or enhanced different evidence-based interventions. Among these, client reminders were most highly associated with the increase in screening rates (8.0 percentage points). Provider reminder was not significantly associated with any change in screening rates. Among all program components, having a colorectal cancer screening champion was most highly (8.4 percentage points) associated with screening rate change. Results from different models were slightly different but in agreement.

**Conclusions:** Client reminders, provider assessment and feedback, and colorectal cancer screening champions were associated with increased clinic-level colorectal cancer screening rates.

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Universal implementation of these strategies can substantially increase colorectal cancer screening rates in the U.S.

## INTRODUCTION

Cancer is the second leading cause of death in the U.S., and among cancers that affect both men and women, colorectal cancer (CRC) is the second leading cancer.[1] Screening reduces CRC morbidity and mortality and is recommended by the U.S. Preventive Services Task Force for adults aged 50–75 years.[2] In 2018, only 68.8% of those adults were up to date with screening, with lower rates among some racial or ethnic populations and among those with lower SES and those without access to insurance or a regular healthcare provider.[3,4] CRC screening rates are significantly lower among patients served by Federally Qualified Health Center (FQHC) clinics: in 2018, their rates averaged 44.1%.[5]

The Centers for Disease Control and Prevention (CDC) administers the Colorectal Cancer Control Program (CRCCP)[6] with the goal of increasing CRC screening rates among people aged 50–75 years in areas where rates are low. In 2015, the CRCCP funded 30 awardees to partner with primary care clinics to support the implementation of evidence-based interventions (EBIs) recommended by *The Community Guide*[7] and other supporting activities (SAs). During the first 2 years of implementation (July 2015–June 2017), clinics participating in the CRCCP reported an average increase in CRC screening rates of 8.3 percentage points.[8] For comparison, the screening rate increased by 1.4 percentage points nationally from 2016 to 2018.[9]

The CRCCP awardees collaborate with clinics to select from 4 priority EBIs (i.e., client reminders, provider reminders, provider assessment and feedback, and reducing structural barriers) and 4 SAs (i.e., small media, provider education and development, community health workers, and patient navigation). Awardees are also encouraged to establish a CRC screening policy and identify CRC screening champions to promote screening in each of their partner clinics. Awardees provide resources (e.g., technical assistance, funding) to clinics to both implement new EBIs and enhance (i.e., strengthen the existing) EBIs.

Although all CRCCP components are evidence based and are supported by the literature, there is little evidence on the relative effectiveness of each component (i.e., individual EBIs) when implemented simultaneously with other strategies and in the unique context of a real-world setting, such as CRCCP, which primarily serves low-income, medically underserved populations. In addition, it is not known whether enhanced EBIs are associated with increased CRC screening rates to the same extent as newly implemented EBIs. Finally, although Program Year (PY)1 results indicate that the CRCCP can contribute to increased CRC screening rates,[10] it is not well understood which specific program components are associated with screening rate increases.

The goal of this study is to better understand the effectiveness of the CRCCP components. Specifically, the purpose is to identify the key drivers of screening rate changes by measuring the association between program components and the primary program outcome, clinic-level CRC screening rate changes.

# METHODS

## Study Population

The study population included clinics enrolled in the CRCCP during PY1 and active through the end of the second PY (PY2, July 2016–June 2017). The data included baseline and annual records of each clinic; these data are used by CDC for program monitoring and evaluation. CDC provided detailed guidance for reporting the data, including calculating and validating the screening rates.[11] Data were self-reported by clinics and were rigorously vetted by CDC to minimize errors and biases. Awardees were contacted by CDC's data team to address concerns with clinic data and could provide corrected data when needed. CRCCP awardees worked closely with clinics to accurately calculate the screening rates and could conduct audits of the screening rate data. The baseline record includes information on fixed clinic characteristics (e.g., type, size, location). The annual record collects information on program implementation, such as new implementation or enhancement of EBIs/SAs during the year. Table 1 provides the definitions of the EBIs, SAs, clinic screening policy, and screening champion. The data set has been described previously.[12] Clinics were excluded if they did not report a baseline, PY1, and PY2 annual record or if they did not provide screening rate information. The baseline period covers 12 months before the CRCCP, whereas the intervention covered by this study occurred during PY1 and PY2 of the program. The outcome was measured at the end of PY2. The study data were collected annually in 2015–2017, and analysis was conducted in 2020.

## Measures

The outcome variable was the percentage point change in the clinic-level screening rate between baseline and the end of the intervention period (i.e., the rate at the end of PY2 minus the rate at baseline). The *clinic-level screening rate* was defined as the percentage of clinic patients aged 50–75 years (i.e., all individuals with at least 1 visit to the clinic during the year) who are up to date with CRC screening according to the U.S. Preventive Services Task Force recommendations.[2] Independent variables included CRCCP components during PY1 or PY2: newly implemented EBIs, enhanced EBIs, combinations of newly implemented and enhanced EBIs, change in the number of SAs, and the existence of screening champions and CRC screening policy. A combination of newly implemented and enhanced EBIs assumes that new implementation or enhancement of EBIs affect the outcome in the same way and that they can be treated as the same. Except for a change in the number of SAs, all independent variables were dichotomized, including (1) whether a clinic newly implemented an EBI (4 variables, 1 for each EBI), (2) whether those same EBIs were enhanced (4 variables), (3) whether a clinic screening policy was in place at the end of the PY, and (4) whether a screening champion was in place at the end of the PY. An EBI was enhanced if it was in place in the previous year and if CRCCP resources were used toward its implementation in the subsequent year. Newly implemented EBI and enhanced EBI variables are used separately and as a single, combined variable, (i.e., newly implemented or enhanced EBI). The combined variable is an indication of clinics' efforts to improve outcomes using either strategy. Change in the number of SAs was included as a count variable. Although not part of the analytical model, several clinic variables were used to describe the study population. They included clinic types (e.g., FQHC), clinic size (for

those aged 50–75 years), percentage of the uninsured patient population (aged 50–75 years), primary CRC screening test type used (e.g., fecal immunochemical test, colonoscopy), and clinic distribution of free fecal kits.

### Statistical Analysis

This study used a retrospective observational and longitudinal design. The data were in panel form for 2 time points over a period of 3 years. First difference (FD) estimator[13] of the linear panel data regression model was used to estimate the associations of independent variables with the outcome. FD estimation is a panel data method used to eliminate the confounding effect of fixed factors in a regression model. To implement the FD estimator, the FD of the outcome and independent variables were created by subtracting the baseline value from the PY2 value so that FD variables only reflected the change between 2 periods. Note that FD eliminates or drops all time-invariant variables, such as clinic type, which were collected at baseline only. Consequently, only the time-dependent variables, such as new implementation or enhancement of EBIs, remained as independent variables. The estimation equation was implemented without a constant, which ruled out the presence of a secular time trend (i.e., rate change over time without an intervention). The time trend was not included because it was assumed to be confounded with the intervention period, making it unidentifiable. The data were analyzed using ordinary least square (OLS) and generalized estimating equations (GEEs) techniques. Because clinics were clustered within health systems, the GEE technique was used to address the issue of clustering. A total of 4 different models were used in the analysis: Model 1, OLS with separate EBI variables (i.e., any newly implemented and enhanced EBI used as separate variables); Model 2, GEE with separate EBI variables; Model 3, OLS with combined EBI variables (i.e., any newly implemented or enhanced EBIs used as a single variable); and Model 4, GEE with combined EBI variables. All analyses were performed using Stata, version 14.

The same analyses were conducted using all the 4 estimation models for FQHC clinics only. FQHCs were selected for subanalysis because they constituted a significant proportion of the study clinics and because the sample size was large enough for the statistical analysis. Also of interest was whether findings held in FQHCs given that they serve populations experiencing health disparities and that they generally have low CRC screening rates.

## RESULTS

Of the 423 clinics recruited in PY1, 336 (79%) were eligible for this study. Table 2 provides the summary statistics of all the study variables, including the fixed baseline variables. Most clinics (75.9%) were FQHCs or community health centers. Clinic size ranged from <500 patients aged 50–75 years (28.6%) to >1,500 patients aged 50–70 years (33.9%). About half of the clinics (55.4%) offered fecal occult blood test or fecal immunochemical test as the primary screening test. Almost one third of the clinics (27.7%) distributed free fecal (fecal occult blood test/fecal immunochemical test) kits.

The proportions of clinics implementing each type of EBI increased from baseline to PY2. For example, 81.4% of the clinics implemented provider reminders by the end of PY2 compared with 70.5% of the clinics at baseline. Of clinics implementing new EBIs,

16.4% implemented provider reminders, whereas 37.5% implemented reducing structural barriers. Client reminders and provider assessment and feedback were more often newly implemented or enhanced (72.3% and 72.0%, respectively) among clinics than provider reminders (51.8%) and reducing structural barriers (61.6%). The average number of newly implemented SAs increased only by 0.2 during the intervention period (data not shown). Overall, the average clinic-level screening rate increased by 11.7 percentage points from baseline (33.5%) to PY2 (45.2%). Clinic-level screening rates tended to increase from baseline to the end of PY2 for most clinic types, regardless of clinic size, the proportion of uninsured patients, or the primary screening test type used. Screening rates also increased by almost every program component or variable used in the analysis.

Table 3 includes the results from the FD estimator using OLS and GEE models with separate variables (Models 1 and 2). In the OLS model, having a CRC screening champion was most highly associated with screening rate change (8.4–percentage point increase, $p<0.01$), followed by newly implemented client reminders (8.0–percentage point increase, $p<0.01$). In the GEE model, the associations of CRC screening rate changes and having a screening champion (6.4–percentage point increase, $p<0.05$) and client reminder (6.6–percentage point increase, $p<0.01$) were slightly smaller but remained statistically significant at the 5% level. The only other variable that remained statistically significant in both the OLS and GEE models was provider assessment and feedback with estimated coefficients of 5.1 ($p<0.01$) and 4.9 ($p<0.05$), respectively. Among the newly implemented EBIs, client reminders had the most substantial association with the screening rate change, followed by reducing structural barriers.

Results from OLS and GEE combined variable models (Models 3 and 4) are presented in Table 4. In both regression models, client reminders and provider assessment and feedback had significant associations with change in clinic screening rates at the 5% level. Provider assessment and feedback had the highest association with estimated coefficients 6.7 ($p<0.001$) and 5.9 ($p<0.01$), respectively, in the OLS and GEE models. The variables that were only significant in the OLS model included reducing structural barriers (4.9, $p<0.01$), having a CRC screening policy (5.2, $p<0.05$), and having a CRC screening champion (7.0, $p<0.05$). In the OLS model, all program components, except provider reminders, were positively associated with the outcome. Results from the GEE model showed a slight decrease in estimated coefficients and a slight increase in $p$-values. Although some variables (e.g., reducing structural barriers, screening policy) were not statistically significant (at the 5% level) in the GEE model, the estimates and $p$-values were in the same direction.

The subanalysis results were more robust because most associations between EBIs and rate change were even greater than in the main analysis. In the OLS separate variable model, screening policy was associated with a 6.4–percentage point ($p<0.05$) increase in rates. In the GEE separate variable model, the associations for new implementation (5.3 points, $p<0.05$) and enhancement (6.3 points, $p<0.05$) of reducing structural barriers, screening policy (6.6 points, $p<0.05$), and having a screening champion (8.2 points, $p<0.01$) were statistically significant. In the GEE combined model, the associations with screening policy (6.0 points, $p<0.05$) and a champion (6.6 points, $p<0.05$) were also statistically significant.

## DISCUSSION

This study examined the relationships between CRCCP components and clinic-level screening rate change from baseline to the end of PY2. This could be the first analysis of the effect of implementing different EBIs over a 2-year period among a large sample of clinics serving low-income, medically underserved populations. An earlier study reported a 4.4–percentage point increase in average screening rate after 1 year of CRCCP implementation,[10] whereas this study observed an increase of 11.3 percentage points over 2 years. Results from this study suggest increased effectiveness of the EBIs with longer and possibly improved implementation in the second year after the initial start-up phase. The results from subanalysis including FQHCs were even more robust, suggesting that these EBIs may have higher effectiveness among those clinics and their patients.

Results show that implementing client reminders, implementing provider assessment and feedback, and having CRC screening champions may be the most important drivers of increased CRC screening rates. These 3 program components require different resources and differ with a focus on patients, providers, and organizations. The study findings support that clinics may choose to implement strategies best suited for their unique circumstances and availability of resources.

For comparison, the study estimate for client reminders is similar to estimates of effect size reported previously.[14,15] A recent systematic review and meta-analysis of 14 RCTs of client reminders by Dougherty and colleagues[16] found an average effect size of 3 percentage points (95% CI=0, 5). The finding of this study on client reminders is within or above the range reported by that study. One systematic review reported that delivery of provider assessment and feedback increased fecal occult blood test screening from 12.3 to 23.0 percentage points during a 5-year period.[17,18]

This study's findings that provider reminders are not associated with any increase in CRC screening rates are consistent with the findings of previous studies, including those of RCTs and observational studies.[15,19,20] However, Dougherty et al.[16] reported that the average impact of provider reminders based on 8 RCTs was 13 percentage points, which was much higher than this study's finding. In this study, provider reminder did not have statistically significant associations with screening rate change, which might be because the study clinics served predominantly low-income, medically underserved populations who faced greater patient-level barriers to complete testing.

By capturing a clinic's implementation of a new EBI or its enhancement in a single variable, this study yielded findings consistent with models in which new and enhanced EBIs were considered separately. This combined variable indicates that if a clinic directed any additional resources toward a specific EBI, regardless of whether the EBI was already in place or implemented new, then screening rates increased. This study observed that interventions still work even if the degree of fidelity is not known, offering important implications for public health efforts to enhance the existing EBIs.

These findings raise the question of implementation fidelity. If implementation adheres completely to the content, frequency, duration, and coverage of an intervention, then fidelity

is high.[21] There is a growing body of literature on implementation fidelity[22] that highlights the importance of quality EBI implementation. More research can help measure and ensure high fidelity of implementation of interventions intended to increase CRC screening.

Another consistent theme emerging from these analyses is the role of screening champions. Having a clinic CRC screening champion was among the most important program components associated with increased CRC screening both in this analysis and in the earlier analysis.[10] The literature supporting the importance of champions in public health program effectiveness continues to grow.[23] Champions may be critical to improving CRC screening practice by promoting and prioritizing screening efforts, supporting sustained practice improvements guided by a vision and commitment, and making sure that individual practice changes fit together into a meaningful whole.[24] However, it is not well understood how champions bring about the changes (i.e., the change mechanism) in CRC screening. There are likely different ways in which champions can improve outcomes. Additional research could investigate the roles of champions as an implementation strategy[25] and the change mechanism (i.e., their functions) in affecting screening rates.

### Limitations

Several limitations of this study are noted. The clinics' data are self-reported with the potential for over-reporting of outcomes because of social desirability bias. Clinic screening champions and policy variables are based on PY1 and PY2 data only because baseline data on those variables were not collected. Although all the 4 EBIs are CDC recommended, clinics chose which of these 4 EBIs to newly implement or enhance. Implementation quality of EBIs was not accounted for in these analyses, and it is acknowledged that there may be heterogeneity in their implementation. The interventions happened during PY1 and PY2, meaning that some clinics had interventions for longer periods than others. It might take longer than the observation period used in the study to realize the full impact of those interventions.

## CONCLUSIONS

This study examined the association of CRCCP components with CRC screening rates among many clinics serving populations with low screening rates. The study found that client reminders, provider assessment and feedback, and CRC screening champions were associated with increased clinic-level CRC screening rates. Universal implementation of these strategies can substantially increase CRC screening rates in the U.S.

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**Table 1.**

Evidence-Based Interventions and Supporting Activities for Clinics in Colorectal Cancer Screening Program, 2015–2017

| Intervention/activities | Definition[a] |
|---|---|
| Evidence-based interventions | |
| Client reminders | Text-based (i.e., letter, postcard, e-mail) or telephone messages advising people that they are due (reminder) or overdue (recall) for screening. |
| Provider reminders | Prompts to inform healthcare providers that it is time for a patient's cancer screening test (reminder) or that the patient is overdue for screening (recall). |
| Provider assessment and feedback | Evaluation of provider performance in offering and delivering screening to patients (assessment) and sharing the results with providers (feedback). |
| Reducing structural barriers | Reducing or eliminating noneconomic burdens or obstacles that impede access to screening by addressing things such as distance to service delivery (e.g., modifying clinic hours, offering services in alternative or nonclinical settings) or administrative procedures. |
| Supporting activities | |
| Small media | Distribution of videos and printed materials such as letters, brochures, and newsletters. |
| Patient navigation | Individualized assistance offered to patients to help overcome healthcare system barriers and facilitate timely access to quality screening, follow-up, and initiation of treatment if diagnosed with cancer. |
| Professional development/ provider education | Interventions such as distribution of educational materials or continuing medical education directed at healthcare staff and providers to increase their knowledge and to change attitudes and practices around cancer screening. |
| CHWs | Community-based workers have a deep understanding of and are often from the community they serve. CHWs educate people about and promote cancer screening and provide peer support to people referred to cancer screening. |
| Other | |
| Clinic screening policy | A screening policy in clinics or health systems includes a defined set of guidelines and procedures in place and in use to support CRC screening, a team responsible for implementing the policy, and a quality assurance structure. |
| Screening champion | A champion is an individual who takes a leadership role in a public health effort. Other variables include frequency of monitoring the CRC screening rate and frequency of implementation support provided to the clinic. |

[a]Based on definitions from *The Guide to Community Preventive Services*.

CHW, community health worker; CRC, colorectal cancer.

**Table 2.**

Descriptive Statistics of Participating Clinics and Implementation of Intervention Components

| Variables | Baseline[a] | | PY2 | | Average change in clinic screening rate baseline to PY2 N=336 |
|---|---|---|---|---|---|
| | Frequency N=336, *n* (%) | Average screening rate *n*=336 | Frequency N=336, *n* (%) | Average screening rate N=336 | |
| All clinics | 336 (100) | 33.5 | 336 (100) | 45.2 | 11.7 |
| Clinic type | | | | | |
| CHC/FQHC | 255 (75.9) | 30.8 | 255 (75.9) | 43.5 | 12.7 |
| Health system/hospital owned | 44 (13.1) | 45.4 | 44 (13.1) | 59.8 | 14.4 |
| Private/physician owned | 18 (5.4) | 45.7 | 18 (5.4) | 40.1 | −5.6 |
| Health department | 19 (5.6) | 30.1 | 19 (5.6) | 42.4 | 12.3 |
| Clinic size | | | | | |
| Small (<500 patients) | 96 (28.6) | 26.3 | 96 (28.6) | 39.6 | 13.3 |
| Medium (500–1,500 patients) | 126 (37.5) | 33.1 | 126 (37.5) | 45.0 | 11.9 |
| Large (>1,500 patients) | 114 (33.9) | 39.7 | 114 (33.9) | 49.9 | 10.2 |
| Uninsured patients | | | | | |
| <5% | 102 (30.4) | 37.2 | 102 (30.4) | 45.8 | 8.6 |
| 5%−20% | 102 (30.4) | 33.0 | 102 (30.4) | 44.9 | 11.9 |
| >20% | 99 (29.5) | 31.3 | 99 (29.5) | 47.5 | 16.2 |
| Unknown | 33 (9.8) | 30.1 | 33 (9.8) | 35.3 | 5.2 |
| Primary test type | | | | | |
| FOBT/FIT | 186 (55.4) | 29.0 | 186 (55.4) | 43.0 | 14.0 |
| Colonoscopy | 96 (28.6) | 40.5 | 96 (28.6) | 46.6 | 6.1 |
| Varies | 48 (14.3) | 36.8 | 48 (14.3) | 51.0 | 14.2 |
| Unknown | 6 (1.8) | 30.7 | 6 (1.8) | 46.1 | 15.4 |
| Clinic distributed free FIT kit | 93 (27.7) | 32.1 | 93 (27.7) | 48.3 | 16.2 |
| All EBIs (newly implemented or existing)[b] | | | | | *p*-value[c]=0.035 |
| Client reminder | 175 (52.1) | 36.7 | 251 (77.9) | 46.2 | 9.5 |
| Provider reminder | 237 (70.5) | 34.9 | 262 (81.4) | 46.2 | 11.3 |
| Provider assessment and feedback | 201 (59.8) | 36.0 | 238 (73.9) | 47.8 | 11.8 |
| Reducing structural barrier | 159 (47.3) | 34.2 | 249 (77.3) | 44.8 | 10.6 |

| Variables | Baseline[a] | | PY2 | | Average change in clinic screening rate baseline to PY2 N=336 |
|---|---|---|---|---|---|
| | Frequency N=336, *n* (%) | Average screening rate *n*=336 | Frequency N=336, *n* (%) | Average screening rate N=336 | |
| Newly implemented EBIs in PY1 or PY2[a] | | | | | |
| Client reminder | 108 (32.1) | 30.8 | 108 (32.1) | 46.5 | 15.7 |
| Provider reminder | 55 (16.4) | 32.4 | 55 (16.4) | 44.3 | 11.9 |
| Provider assessment and feedback | 100 (29.8) | 29.9 | 100 (29.8) | 45.6 | 15.7 |
| Reducing structural barrier | 126 (37.5) | 33.8 | 126 (37.5) | 47.2 | 13.4 |
| Enhanced EBIs in PY1 or PY2[a] | | | | | |
| Client reminder | 204 (60.7) | 31.6 | 204 (60.7) | 43.1 | 11.5 |
| Provider reminder | 159 (47.3) | 36.3 | 159 (47.3) | 48.9 | 12.6 |
| Provider assessment and feedback | 205 (61.0) | 34.8 | 205 (61.0) | 48.1 | 13.3 |
| Reducing structural barrier | 123 (36.6) | 32.6 | 123 (36.6) | 45.6 | 13.0 |
| Newly implemented or enhanced EBIs in PY1 or PY2[a] | | | | | |
| Client reminder | 243 (72.3) | 34.1 | 243 (72.3) | 46.3 | 12.2 |
| Provider reminder | 174 (51.8) | 36.6 | 174 (51.8) | 48.8 | 12.2 |
| Provider assessment and feedback | 242 (72.0) | 34.8 | 242 (72.0) | 48.2 | 13.4 |
| Reducing structural barrier | 207 (61.6) | 33.6 | 207 (61.6) | 47.3 | 13.7 |
| Number of supporting activities (newly implemented or existing) | | | | | *p*-value[c] <0.001 |
| 0 | 94 (28.0) | 30.2 | 51 (15.2) | 41.3 | 11.1 |
| 1 | 90 (26.8) | 30.7 | 115 (34.2) | 38.7 | 8.0 |
| 2 | 68 (20.2) | 38.3 | 101 (30.1) | 51.6 | 13.3 |
| 3 | 83 (24.7) | 36.4 | 47 (14.0) | 51.7 | 15.3 |
| 4 | 1 (0.3) | 14.3 | 22 (6.5) | 43.1 | 28.8 |
| Has CRC screening champion | | 33.1 | 278 (86.3) | 45.4 | 12.3 |
| Has CRC screening policy | | 32.9 | 251 (77.5) | 44.6 | 11.7 |

[a]The frequencies of the variables that did not change between the baseline and PY2 are the same because the rates are based on the same clinics.

[b]Missing EBI status was treated as EBI not in place.

[c]Based on chi-square test of change in proportions between baseline and PY2.

CHC, Community Health Center; CRC, colorectal cancer; EBI, evidence-based intervention; FIT, fecal immunochemical test; FOBT, fecal occult blood test; FQHC, Federally Qualified Health Center; PY, Program Year.

**Table 3.**

Regression Analysis Results of Change in Screening Rate

| Variables | Regression model: Ordinary least square | | | | Regression model: Generalized estimating equations | |
|---|---|---|---|---|---|---|
| | Coefficient[a] | t | *p*-value | 95% CI | Coefficient[a] | *p*-value |
| EBI newly implemented | | | | | | |
| Client reminder | **8.0** *** | (4.06) | 0.000 | 4.14, 11.92 | **6.6** ** | 0.003 |
| Provider reminder | −3.1 | (−1.44) | 0.150 | −7.34, 1.13 | −1.5 | 0.506 |
| Provider assessment and feedback | 2.7 | (1.51) | 0.133 | −0.82, 6.18 | 1.8 | 0.370 |
| Reducing structural barriers | **5.1** ** | (2.97) | 0.003 | 1.74, 8.53 | 3.4 | 0.096 |
| EBI enhanced | | | | | | |
| Client reminder | 2.9 | (1.69) | 0.092 | −0.47, 6.24 | 4.3 | 0.073 |
| Provider reminder | −1.2 | (−0.62) | 0.534 | −5.09, 2.64 | −1.3 | 0.583 |
| Provider assessment and feedback | **5.1** ** | (2.85) | 0.005 | 1.59, 8.67 | **4.9** * | 0.014 |
| Reducing structural barriers | **4.4** * | (2.12) | 0.035 | 0.31, 8.57 | 4.4 | 0.081 |
| Other | | | | | | |
| CRC screening policy | 5.1 | (1.94) | 0.053 | −0.07, 10.24 | 4.8 | 0.098 |
| CRC screening champion | **8.4** ** | (2.98) | 0.003 | 2.84, 13.88 | **6.4** * | 0.043 |
| Change in number of SAs | 1.1 | (1.09) | 0.277 | −0.86, 3.00 | 1.5 | 0.159 |
| $R^2$ | 0.45 | | | | | |

*Notes*: Boldface indicates statistical significance at (*$p$<0.05, **$p$<0.01, ***$p$<0.001). The dependent variable includes a change in screening rate from baseline to Program Year 2 (sample size=336).

[a]The coefficients are interpreted as percentage point change in screening rate.

CRC, colorectal cancer; EBI, evidence-based intervention; SA, supporting activity.

**Table 4.**

Regression Analysis of Change in Screening Rate, Combining the Implementation of New or Enhancing EBIs

| Variables | Regression model:Ordinary least square | | | | Regression model: Generalized estimating equations | |
|---|---|---|---|---|---|---|
| | Coefficient[a] | t | *p*-value | 95% CI | Coefficient[a] | *p*-value |
| EBI newly implemented or enhanced | | | | | | |
| Client reminder | **3.7** * | (2.29) | 0.023 | 0.52, 6.88 | **4.9** * | 0.026 |
| Provider reminder | −2.2 | (−1.28) | 0.201 | −5.57, 1.18 | −1.2 | 0.573 |
| Provider assessment and feedback | **6.7** *** | (3.86) | <0.001 | 3.31, 10.19 | **5.9** ** | 0.002 |
| Reducing structural barriers | **4.9** ** | (2.66) | 0.008 | 1.26, 8.48 | 3.1 | 0.149 |
| Other | | | | | | |
| CRC screening policy | **5.3** * | (2.04) | 0.043 | 0.18, 10.32 | 4.4 | 0.124 |
| CRC screening champion | **7.0** * | (2.45) | 0.015 | 1.37, 12.62 | 5.7 | 0.075 |
| Change in the number of SAs | 0.6 | (0.76) | 0.449 | −1.02, 2.31 | 0.9 | 0.354 |
| $R^2$ | 0.45 | | | | | |

*Notes*: Boldface indicates statistical significance at (*$p$<0.05, **$p$<0.01, ***$p$<0.001). The dependent variable includes a change in screening rate from baseline to Program Year 2 (sample size=336).

[a]The coefficients are interpreted as percentage point change in screening rate.

CRC, colorectal cancer; EBI, evidence-based intervention; SA, supporting activity.