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Adherence to Competing Strategies for Colorectal Cancer Screening Over 3 Years

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Abstract

Objectives—We have shown that, in a randomized trial comparing adherence to different colorectal cancer (CRC) screening strategies, participants assigned to either fecal occult blood testing (FOBT) or given a choice between FOBT and colonoscopy had significantly higher adherence than those assigned to colonoscopy during the first year. However, how adherence to screening changes over time is unknown.

Methods—In this trial, 997 participants were cluster randomized to one of the three screening strategies: (i) FOBT, (ii) colonoscopy, or (iii) a choice between FOBT and colonoscopy. Research assistants helped participants to complete testing only in the first year. Adherence to screening was defined as completion of three FOBT cards in each of 3 years after enrollment or completion of

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Specific author contributions: Peter S. Liang and John M. Inadomi had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Angela Fagerlin, Rodney A. Hayward, Jennifer P. Thomas, Sandeep Vijan, and John M. Inadomi; acquisition, analysis, or interpretation of data: Peter S. Liang, Chelle L. Wheat, Anshu Abhat, Alison T. Brenner, Jennifer P. Thomas, Sandeep Vijan, and John M. Inadomi; drafting of the manuscript: Peter S. Liang and John M. Inadomi; critical revision of the manuscript for important intellectual content: Peter S. Liang, Chelle L. Wheat, Anshu Abhat, Alison T. Brenner, Angela Fagerlin, Rodney A. Hayward, Jennifer P. Thomas, Sandeep Vijan, and John M. Inadomi; statistical analysis: Peter S. Liang and Chelle L. Wheat; obtained funding: Rodney A. Hayward, Sandeep Vijan, and John M. Inadomi; administrative, technical, or material support and study supervision: Jennifer P. Thomas and John M. Inadomi.

colonoscopy within the first year of enrollment. The primary outcome was adherence to assigned strategy over 3 years. Additional outcomes included identification of sociodemographic factors associated with adherence.

Results—Participants assigned to annual FOBT completed screening at a significantly lower rate over 3 years (14%) than those assigned to colonoscopy (38%, $P<0.001$) or choice (42%, $P<0.001$); however, completion of any screening test fell precipitously, indicating the strong effect of patient navigation. In multivariable logistic regression analysis, being randomized to the choice or colonoscopy group, Chinese language, homosexuality, being married/partnered, and having a non-nurse practitioner primary care provider were independently associated with greater adherence to screening ($P<0.01$).

Conclusions—In a 3-year follow-up of a randomized trial comparing competing CRC screening strategies, participants offered a choice between FOBT and colonoscopy continued to have relatively high adherence, whereas adherence in the FOBT group fell significantly below that of the choice and colonoscopy groups. Patient navigation is crucial to achieving adherence to CRC screening, and FOBT is especially vulnerable because of the need for annual testing.

Introduction

US guidelines recommend screening average-risk individuals for colorectal cancer (CRC) with one of the several tests ([1,2]), and colonoscopy and fecal occult blood testing (FOBT) are the most widely used methods. Each test has different characteristics in terms of efficacy, safety, cost, and tolerability, but both FOBT ([3–6]) and colonoscopy ([7,8]) have been shown to decrease CRC incidence and mortality. We previously reported that, after 1 year in a trial of competing CRC screening strategies, participants assigned to FOBT or given a choice between FOBT and colonoscopy had significantly higher adherence than those assigned to colonoscopy ([9]). In addition, we found differences in screening by race/ethnicity and language group. We were interested in examining the natural history of screening adherence after the conclusion of the interventional portion of the trial and whether racial/ethnic and linguistic differences would persist over time. Longitudinal adherence is particularly important for FOBT, as it should be repeated every 1–2 years, and the rate of attrition has important implications for the long-term effectiveness of this screening modality. In contrast, a single colonoscopy provides a high level of protection for up to 10 years. We present updated data on CRC screening adherence during the 3 years following initial enrollment.

Methods

Patients and study design

The study design of this cluster randomized trial has been previously described ([9]). In brief, 997 participants at average-risk for CRC between 50 and 79 years of age were randomized to one of the three screening strategies: (i) three guaiac FOBT cards annually, (ii) colonoscopy, or (iii) a choice between annual FOBT and colonoscopy. Exclusion criteria included a history of CRC in a first degree relative, personal history of CRC, adenoma, or inflammatory bowel disease, presence of symptoms requiring endoscopy, having undergone appropriate CRC screening (FOBT within 1 year, sigmoidoscopy or barium enema within 5 years, or colonoscopy within 10 years), medical comorbidity precluding endoscopy, or

estimated life expectancy of <10 years. Participants were identified from the San Francisco Community Health Network, a safety net public health system. Three research assistants fluent in the participants' preferred language—English, Spanish, Cantonese, or Mandarin—obtained consent for participation in the trial, completion of a baseline survey, and follow-up through medical record review. Each research assistant attended multiple didactic sessions led by the principal investigator (J.M.I.), during which the risks and benefits of different screening strategies, barriers to screening, and strategies to increase adherence were extensively discussed. Research assistants were also trained to perform essential tasks of patient navigation, including explaining each CRC screening strategy in the preferred language of the participant, helping participants to schedule procedures, explaining bowel preparation instructions, arranging transportation after colonoscopy, and answering questions about the CRC screening tests ([10]), but they did not complete a formal patient navigation training program. FOBT cards were mailed to the research staff for assessment of adherence before being submitted for laboratory processing. Screening tests were provided regardless of insurance status or the ability to pay through “Healthy San Francisco.” Sociodemographic, health-related, and outcomes data were collected from the surveys and medical record. Additional follow-up for screening outcomes was conducted through medical record review and direct contact with participants to confirm non-completion of CRC screening tests. Because of the absence of funding, the research assistants did not assist with testing logistics after the initial year of enrollment. This study was approved by the institutional review board at the University of California, San Francisco, and the University of Washington. All authors had access to the study data and reviewed and approved the final manuscript.

Study outcomes

The primary outcome was adherence to the assigned screening strategy in the three study groups over the 3 years subsequent to enrollment. Adherence was defined as either annual FOBT for 3 years, with colonoscopy if FOBT was positive (FOBT strategy), or one colonoscopy during the first 12 months after enrollment (colonoscopy strategy). Individuals who completed a competing strategy before their assigned strategy were considered non-adherent. In addition, we compared adherence among the study groups with two secondary outcomes: (i) biennial FOBT, defined as two FOBTs over 3 years, and (ii) any screening strategy, regardless of assigned group. Participants who did not complete any screening test within the first 12 months of enrollment were considered non-adherent for all analyses. We used multivariable logistic regression to identify predictors of adherence overall and, in a secondary analysis, stratified by the study group.

Statistical analysis

Adherence rates were compared pairwise using the χ^2 test. Individuals with missing data were considered to be non-adherent. For logistic regression analysis, only variables with *P*-values <0.05 on univariable analysis were entered into the multivariable model. To preserve model validity, we confirmed that the number of events per variable was >10 ([11]). All logistic regression analyses were adjusted for potential within-primary care provider clustering using a multilevel mixed-effects model. To adjust for multiple testing, results were

considered significant if the two-sided *P*-value was <0.01. Stata version 12.1 (StataCorp, College Station, TX) was used for all analyses.

Results

Participant characteristics

Of the 997 participants who had enrolled in the trial, 26 (3%) were lost to follow-up over 3 years (Figure 1). Thirty-eight (4%) of the remaining 971 participants died, but none of the deaths were from CRC. The mean participant age was 58.4 years, and 53% were women (Table 1). This racially/ethnically diverse group comprised 34% Latino and 30% Asian participants, most of whom were Chinese. Linguistically, 55% of participants preferred English, 27% preferred Spanish, and 18% preferred Chinese. A majority (57%) of individuals had an annual household income under $10,000, 67% had completed at least a high school-level education, and 34% were employed. Baseline participant characteristics across study groups were generally similar, although a greater proportion of those in the FOBT group had nurse practitioners (NPs) as primary care providers (PCPs) and a greater proportion in the colonoscopy group was married/partnered.

Adherence to screening

In the FOBT and choice groups, a small proportion of participants who were considered non-adherent (4 and 7% in year 1; 5 and 5% in year 2; and 2 and 0% in year 3) returned guaiac cards but either performed the cards incorrectly or did not complete a colonoscopy after a positive result (Figure 1). Figure 2 shows each group's adherence to assigned screening strategy 1, 2, and 3 years after enrollment. In the FOBT group, 67% of individuals completed screening in the first year, 27% adhered to screening during both of the first 2 years, and 14% remained adherent all 3 years. In the choice group, adherence was 69% during the first year (38% by the FOBT strategy), 49% over 2 years (18% by FOBT), and 42% over all 3 years (12% by FOBT). Adherence in the colonoscopy group was 38% after 1 year and by definition remained constant for all 3 years. As colonoscopy was still available to participants in the colonoscopy and choice arms, however, adherence was tracked, and only 10 additional patients (8 in the colonoscopy group, 2 in the choice group) completed the colonoscopy strategy over the next 2 years of follow-up. For the primary outcome of adherence to assigned screening strategy during 3 years, the FOBT group completed screening at a significantly lower rate than either the colonoscopy or the choice groups ($P<0.001$); adherence between the colonoscopy and the choice groups did not significantly differ ($P=0.28$).

When adherence to FOBT was defined as biennial testing, screening completion rates by assigned group were 39% in the FOBT group and 56% in the choice group. Under the biennial FOBT definition, adherence in the choice group was statistically higher than that in the FOBT and colonoscopy groups ($P<0.001$), whereas there was no difference between the FOBT and colonoscopy groups ($P=0.85$). The completion rate for any screening strategy irrespective of the strategy assigned/chosen, using the annual FOBT definition, was 16% in the FOBT group and 42% in both the colonoscopy and choice groups (Supplementary Figure 1 online). Using the biennial FOBT definition, adherence was 40% in the FOBT

group, 51% in the colonoscopy group, and 56% in the choice group. In both cases, adherence was significantly lower in the FOBT group than in the colonoscopy and the choice groups ($P<0.01$), and there was no statistical difference between the latter two groups ($P>0.10$). Cross-over FOBT use among colonoscopy group participants was higher than colonoscopy use among FOBT group participants, especially in the first 2 years.

Predictors of adherence

Neither of the two measures of immigration status we evaluated—being US-born (odds ratio (OR)=0.92, 95% confidence interval (CI): 0.66–1.29) and being a long-term immigrant vs. having immigrated within 7 years of enrollment (OR=1.09, 95% CI: 0.62–1.92)—were significant predictors of adherence. We included the nine socioeconomic and health-related variables that were significantly associated with adherence on univariable analysis in the multivariable model (Table 2). Assignment to the colonoscopy (OR=3.71, 95% CI: 2.34–5.90) and choice (OR=4.81, 95% CI: 3.19–7.25) groups, preference for Chinese language (OR=2.91, 95% CI: 1.49–5.67), homosexuality (OR=4.25, 95% CI: 1.87–9.64), and being married/partnered (OR=1.70, 95% CI: 1.14–2.52) were independently associated with adherence. Conversely, compared with individuals with attending physician PCPs, those with NP PCPs were less adherent to screening (OR=0.43, 95% CI 0.23–0.81). Compared with the youngest age group, the 60–69 years age group (OR=1.49, 95% CI: 1.02–2.18) also showed a positive association with adherence, although this did not meet our pre-specified criterion for significance of $P<0.01$. We repeated univariable analyses to identify predictors of adherence to assigned screening strategy using the biennial FOBT definition, and nine significant variables were entered into the multivariable model. In the adjusted model, only choice group (OR=1.87, 95% CI: 1.28–2.73) and homosexuality (OR=3.68, 95% CI: 1.94–6.99) remained significantly associated with adherence (Supplementary Table 1). Adherence did not differ depending on which research assistant performed patient navigation in either univariable or multivariable analyses. In addition, we performed sensitivity analyses without adjustment for clustering by PCP, and the direction and magnitude of associations remained unchanged.

Predictors of adherence were different when stratified by the study group (Supplementary Table 2). In the FOBT group, Chinese language (OR=12.73, 95% CI: 1.37–118.55) was the only variable that reached marginal significance in the adjusted model. Age 60–69 (OR=3.33, 95% CI: 1.47–7.52) was the only significant predictor of adherence in the colonoscopy group. In the choice group, Chinese language (OR=4.14, 95% CI: 1.49–11.46) and homosexuality (OR=8.23, 95% CI: 2.88–23.49) were significantly associated with adherence.

Discussion

In this randomized trial of a racially/ethnically and linguistically diverse population, we found a substantial reduction in adherence to CRC screening over a 3-year period. Because of the need for annual or biennial screening, the FOBT strategy was most greatly impacted. Screening adherence remained highest in the choice group at each year of follow-up, although by 3 years there was no statistical difference between the choice and colonoscopy

groups. As the major difference between the initial and the subsequent 2 years of follow-up was the presence of research assistants, we assume that their role of patient navigation was crucial in achieving the high uptake seen in the initial year. Adherence was positively associated with assignment to the choice and colonoscopy groups, Chinese language, homosexuality, and being married/partnered and negatively associated with having NPs as PCPs.

Our study provides real-world adherence rates for longitudinal FOBT after an intervention. As participants did not receive assistance with test completion (patient navigation) after the first year, findings from the subsequent 2 years represent a natural history study of screening behavior when insurance or the ability to pay for screening is not a factor. We found a substantial reduction in adherence in both the FOBT group and the FOBT arm of the choice group, demonstrating consistent attrition to screening by FOBT across study groups. Furthermore, the decrease in adherence persisted after year 2 into year 3, which suggests that without intervention further attrition is likely. Previous interventional studies have reported longitudinal adherence rates for annual FOBT ranging from 38% in a randomized trial ([12]) to 55% in a population-based study ([13]), both of which also followed participants for 3 years. Notably, both of these studies used fecal immunochemical testing (FIT) rather than the guaiac tests used in our study, and studies have demonstrated 11–13% higher adherence to fecal immunochemical testing compared with guaiac FOBT ([14,15]). However, the Minnesota Colon Cancer Control Study also used annual guaiac FOBT and reported 46% adherence over 11 screening cycles ([3]). A key difference between these three studies and ours is that the earlier studies all actively followed participants and facilitated screening by providing FOBT kits, and therefore these adherence rates do not reflect real-world scenarios where screening promotion and outreach is limited or unavailable. Our results are more consistent with findings from two community-based observational studies ([16,17]), which reported 25–44% adherence to a second round of FOBT among previously adherent individuals; in our study, 41% of participants in the FOBT group who were adherent in year 1 remained adherent in year 2.

During the first year of the study, research assistants played a crucial role in helping participants complete the screening tests. Nearly half of the participants preferred Spanish or Chinese as the language of communication, and our research assistants functioned as language-concordant peer patient navigators for the purpose of the study. The withdrawal of these patient navigators after the first year of enrollment played a major role in the large and persistent attrition in screening by FOBT in years 2 and 3. Colonoscopy completion was also affected, but because of our definition of adherence (procedure must have been performed in the first year of the study) and the duration of colonoscopy effect on CRC prevention, this is not highlighted in our results. Nevertheless, because screening is recommended every 10 years for colonoscopy and every 1 to 2 years for FOBT, patient navigation for colonoscopy is inherently less frequent than that for FOBT. Patient navigation has been shown to increase CRC screening among racial/ethnic minorities ([18–20]) and can produce sustainable improvement over time. In a study of longitudinal patient navigation over a 5-year period, a clinic serving low-income minorities and immigrants not only increased its overall screening rate from 49 to 69% but also nearly eliminated the deficit in screening compared with nearby practices ([21]). In addition, a patient navigator program in another urban public

hospital system serving low-income minorities showed that not only was the program cost-effective but also that it can yield a financial benefit to providers ([22]). Therefore, peer patient navigation may be a cost-effective strategy to maintain a high level of adherence in a CRC screening program, especially in a racially/ethnically and linguistically diverse population.

Whereas US guidelines ([1,2]) recommend screening by FOBT on an annual basis, screening programs in Canada ([23]) and 19 member nations of the European Union ([24]) use biennial testing. Randomized trials from both the US and Europe have shown that biennial FOBT also reduces CRC mortality ([4,5,25]). In these trials, in which participants received reminders to undergo FOBT, adherence through three to six cycles of biennial screening ranged from 38 to 60%. Adherence to biennial FOBT in our study was 39% through only two cycles of screening and would be expected to decrease with additional follow-up, which again demonstrates that attrition to CRC screening in clinical practice is much greater than previously appreciated. These results are critically important as the benefits of FOBT are estimated to be similar to endoscopic methods only if there is very high longitudinal adherence to the FOBT strategy ([26]). Among European countries that utilize biennial FOBT for population-based screening, participation ranges from 20% in the Czech Republic to 52% in the UK and to 71% in Finland ([27]). Applying the attrition rate for biennial FOBT from our study, the projected adherence to the FOBT screening strategy over 2 cycles of testing would be 12% in the Czech Republic, 30% in the UK, and 41% in Finland. These projected rates are clearly suboptimal, and therefore monitoring and maintenance of longitudinal adherence to FOBT will be especially important in most non-US nations where FOBT is the only available strategy for average-risk CRC screening.

Participants who were offered a choice between colonoscopy and FOBT continued to have the highest rate of adherence at 3 years of follow-up, despite encountering a level of attrition that was comparable to the FOBT group. In addition, a number of participants assigned to the FOBT and colonoscopy groups opted for the competing strategy, which reinforces the value of choice. As our initial study and others have shown, offering individuals a choice of screening tests is an important strategy to increase overall screening rates ([9,28]). The choice strategy may be particularly effective for countries that offer screening through both biennial FOBT and colonoscopy, such as Austria, the Czech Republic, and Germany, as we found it led to significantly higher adherence than either biennial FOBT or colonoscopy.

National screening rates among Asians (46%) are the lowest of any racial/ethnic group in the United States ([29]), and a study in California showed that Chinese have one of the lowest screening rates among Asian ethnic subgroups ([30]). Therefore, our finding that Chinese speakers were significantly more likely to adhere to screening is unexpected. Greater duration of residency among Asian immigrants has been associated with increased CRC screening ([31]), but in our study there was no difference between US-born and immigrant participants overall or between recent and long-term immigrants. Rather, as adherence among Spanish speakers was also higher than that of the reference English group, these results suggest that peer navigation may have enabled linguistic minorities to overcome the language barrier to health-care access. Indeed, studies show that patient navigation is especially effective for non-English speakers ([21,32]). Although both language and race/

ethnicity were significant predictors of adherence in unadjusted analysis, only language remained significant in the full model. This suggests that language may be a more reliable measure of cultural influences on health behavior than race/ethnicity, especially in immigrant populations.

We found a strong association between homosexuality and screening adherence, and nearly all homosexual participants in our study were men. State-level surveys have either found a positive association ([33]) or no association ([34]) between male homosexuality and CRC screening, and our study is the first randomized trial to report this relationship. Given the small sample size in our study—only 10% of participants were homosexual—it would be premature to speculate on potential social or medical reasons for this observed difference, but future research is warranted. Our finding that married/partnered individuals were more likely to be adherent to screening is consistent with previous studies and indicates the importance of social support in the utilization of preventive care ([35–37]).

We also found that participants under the care of NPs were significantly less likely to be adherent to CRC screening than those under the care of attending physicians, and reduced screening was seen consistently in all three study groups. Lower CRC screening rates for patients of NPs have been reported previously ([38,39]) as has lack of knowledge about screening guidelines among NPs ([39]). In contrast, nurse-led care compares favorably with physician-led care in hypertension management, hospitalization rates, and overall mortality ([40,41]). This apparent discrepancy may reflect the relative complexity of CRC screening guidelines or that NPs prioritize other more widely-accepted quality measures in primary care. Expanded health-care coverage under the Affordable Care Act will increase the number of NPs in primary care, and greater emphasis on CRC education is needed to ensure a high level of screening.

The stratified analysis of predictors of adherence by the study group showed some interesting differences between the three groups and the combined results. Specifically, language did not predict adherence in the colonoscopy group, and homosexuality was only associated with adherence in the choice group. However, although it is plausible that predictors of adherence may be different for each screening strategy, the wide confidence intervals seen in this secondary analysis indicate that our study was not adequately powered to address this question, and we would caution against overinterpreting these results.

We acknowledge several study limitations. First, as our study was not designed to evaluate patient navigators, our research assistants were not formally trained as such. However, training for patient navigation is not standardized, and our research assistants performed nearly all the patient navigator tasks assessed by the Centers for Disease Control and Prevention's Colorectal Cancer Control Program ([42]). Therefore, we believe that the research assistants fulfilled the role of patient navigators in this study. Second, we cannot exclude the possibility that attrition in adherence to the FOBT strategy was due to unmeasured patient or provider factors rather than the withdrawal of patient navigation. Patients may have felt abandoned by the withdrawal of resources and consequently become less adherent, as health provider recommendation and social support are both associated with increased adherence ([43]). Nevertheless, the higher rates of serial FOBT screening

reported in other studies suggest that patient navigation and reminders can offset attrition to screening by FOBT. Finally, the racial/ethnic and linguistic diversity of our participants may limit the generalizability of our findings. However, given the rapidly evolving demographic landscape in the United States, health concerns pertaining to minorities will become increasingly more important to the general populace, as the proportion of racial/ethnic minorities continues to grow.

In summary, in a trial of competing CRC screening strategies, participants who were given a choice between FOBT and colonoscopy maintained the highest rate of adherence after 3 years of follow-up. Adherence decreased sharply for participants randomized to the FOBT strategy after the withdrawal of patient navigation. Patient navigation appears to be especially effective for racial/ethnic and linguistic minorities and may be an important intervention to achieve and sustain a high level of CRC screening.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Study Highlights

What is Current Knowledge

- Individuals who are offered one-time colorectal cancer (CRC) screening with a fecal occult blood test (FOBT) or a choice between FOBT and colonoscopy have higher rates of test completion than those offered colonoscopy alone.
- Adherence rates over time to these competing screening strategies are unknown but are important for establishing the programmatic effectiveness of each strategy.
- Racial/ethnic minorities and non-English speakers have lower prevalence of CRC screening, but these disparities may be reduced by patient navigation.

What is New Here

- Without a mechanism to maintain adherence to screening, adherence to FOBT over 3 years was significantly lower than to colonoscopy alone or a choice between FOBT and colonoscopy.
- Following a limited period of patient navigation, there were no racial/ethnic differences in CRC screening, and non-English speakers were more likely to complete screening than English speakers.
- These data suggest that patient navigation may be helpful in maintaining both long-term adherence to CRC screening and reducing disparities.

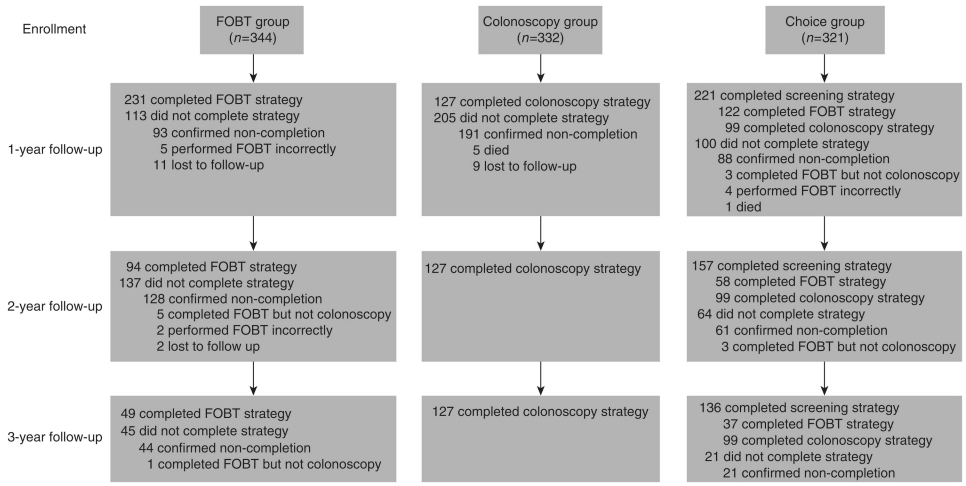

Figure 1.

Study flowchart. Number of individuals who completed the strategy is cumulative and indicates adherence to assigned group through the time of follow-up. Number of individuals who did not complete the strategy is non-cumulative and indicates data for one year.

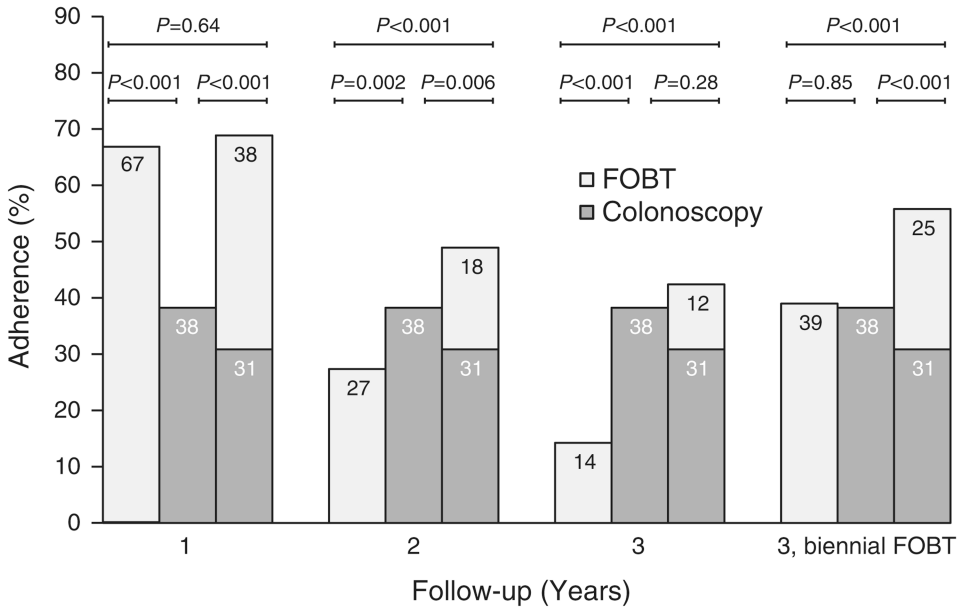

Figure 2.

Adherence to assigned colorectal cancer screening strategy. Adherence in the choice group is shown in the third bar of each follow-up period.

Table 1

Baseline participant characteristics by the study group

Variable	FOBT group (*n*=344)	Colonoscopy group (*n*=332)	Choice group (*n*=321)	Total (*n*=997)	*P* value
Age in years, mean (s.d.)	58.7 (7.3)	58.6 (6.7)	57.8 (6.4)	58.4 (6.9)	0.16
Sex, number/total number (%)					
Female	190/344 (55.2)	173/332 (52.1)	169/321 (52.7)	532/997 (53.4)	0.71
Race/ethnicity, number/total number (%)					
African American	57/344 (16.6)	61/332 (18.4)	59/321 (18.4)	177/997 (17.8)	
White	51/344 (14.8)	38/332 (11.5)	60/321 (18.7)	149/997 (14.9)	
Latino	117/344 (34.0)	123/332 (37.1)	97/321 (30.2)	337/997 (33.8)	0.36
Asian	107/344 (31.1)	97/332 (29.2)	94/321 (29.3)	298/997 (29.9)	
Other[a]	12/344 (3.5)	13/332 (3.9)	11/321 (3.4)	36/997 (3.6)	
Language, number/total number (%)[b]					
English	184/344 (53.5)	187/332 (56.3)	178/321 (55.5)	549/997 (55.1)	
Spanish	101/344 (29.4)	87/332 (26.2)	82/321 (25.6)	270/997 (27.1)	0.85
Chinese	59/344 (17.2)	57/332 (17.2)	60/321 (18.7)	176/997 (17.7)	
Other	0/344 (0)	1/332 (0.3)	1/321 (0.3)	2/997 (0.2)	
English is primary language, number/total number (%)	98/263 (37.3)	102/250 (40.8)	112/250 (44.8)	312/763 (40.9)	0.22
US born, number/total number (%)	84/263 (31.9)	90/250 (36.0)	100/250 (40.0)	274/763 (35.9)	0.16
PCP type, number/total number (%)					
Attending	100/344 (29.1)	126/332 (38.0)	120/321 (37.4)	346/997 (34.7)	
Fellow/resident	194/344 (56.4)	179/332 (53.9)	160/321 (49.8)	533/997 (53.5)	**0.02**
NP	50/344 (14.5)	27/332 (8.1)	41/321 (12.8)	118/997 (11.8)	
Education level, number/total number (%)					
No high school diploma/GED	133/344 (38.7)	111/332 (33.4)	88/321 (27.4)	332/997 (33.3)	
High school diploma/GED	96/344 (27.9)	93/332 (28.0)	92/321 (28.7)	281/997 (28.2)	0.08
Some college/technical school	56/344 (16.3)	62/332 (18.7)	71/321 (22.1)	189/997 (19.0)	
College degree or higher	59/344 (17.2)	66/332 (19.9)	70/321 (21.8)	195/997 (19.6)	
Annual household income in USD, number/total number (%)					

Variable	FOBT group (*n*=344)	Colonoscopy group (*n*=332)	Choice group (*n*=321)	Total (*n*=997)	*P* value
<10,000	204/339 (60.2)	186/332 (56.0)	176/318 (55.4)	566/989 (57.2)	
10,000–19,999	107/339 (31.6)	99/332 (29.8)	109/318 (34.3)	315/989 (31.9)	0.29
20,000–29,999	20/339 (5.9)	34/332 (10.2)	24/318 (7.6)	78/989 (7.9)	
≥30,000	8/339 (2.4)	13/332 (3.9)	9/318 (2.8)	30/989 (3.0)	
Insurance, number/total number (%)					
None	52/344 (15.1)	68/331 (20.5)	49/320 (15.3)	169/995 (17.0)	
Public[C]	290/344 (84.3)	257/331 (77.6)	268/320 (83.8)	815/995 (81.9)	0.12
Private	2/344 (0.6)	6/331 (1.8)	3/320 (0.9)	11/995 (1.1)	
Employed, number/total number (%)	116/344 (33.7)	103/332 (31.0)	121/321 (37.7)	340/997 (34.1)	0.20
Sexual orientation, number/total number (%)					
Heterosexual	289/321 (90.0)	157/188 (83.5)	276/320 (86.3)	722/829 (87.1)	
Homosexual	24/321 (7.5)	28/188 (14.9)	35/320 (10.9)	87/829 (10.5)	0.10
Bisexual	8/321 (2.5)	3/188 (1.6)	9/320 (2.8)	20/829 (2.4)	
Married or partnered, number/total number (%)	143/324 (44.1)	101/205 (49.3)	120/320 (37.5)	364/849 (42.9)	**0.03**
Has living children, number/total number (%)	247/327 (75.5)	178/229 (77.7)	227/321 (70.7)	652/877 (74.3)	0.15
HIV positive, number/total number (%)	52/322 (16.2)	44/187 (23.5)	71/321 (22.1)	167/830 (20.1)	0.07

FOBT, fecal occult blood testing; GED, general equivalency diploma; NP, nurse practitioner; PCP, primary care provider.

[a]Includes Native American, multiracial, and those who declined to answer.

[b]Preferred language for interview and survey.

[c]Includes Medicare, Medicaid, Healthy San Francisco, and the San Francisco Healthy Worker Health Plan.

Bold values signify $P<0.05$.

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Table 2

Regression models for adherence to assigned colorectal cancer screening strategy[a]

Variable	Number/total number (%)	Univariable OR (95% CI)	*P* value	Multivariable OR (95% CI)[b]	*P* value
Study group					
FOBT	49/344 (14.2)	Reference		Reference	
Colonoscopy	127/332 (38.3)	3.69 (2.52–5.42)	**<0.001**	3.71 (2.34–5.90)	**<0.001**
Choice	136/321 (42.4)	4.37 (2.98–6.42)	**<0.001**	4.81 (3.19–7.25)	**<0.001**
Age, years					
50–59	184/616 (29.9)	Reference		Reference	
60–69	109/301 (36.2)	1.37 (1.00–1.86)	**0.05**	1.49 (1.02–2.18)	0.04
70–79	19/80 (23.8)	0.76 (0.43–1.35)	0.36	0.65 (0.31–1.37)	0.26
Sex					
Female	162/533 (30.4)	Reference		NA	
Male	150/464 (32.3)	1.05 (0.79–1.40)	0.75	NA	
Race/ethnicity					
African American	39/177 (22.0)	Reference		Reference	
White	56/149 (37.6)	2.03 (1.22–3.41)	**0.007**	1.18 (0.63–2.21)	0.61
Asian	98/298 (32.9)	1.75 (1.11–2.76)	**0.02**	0.83 (0.40–1.74)	0.63
Latino	114/337 (33.8)	1.89 (1.21–2.95)	**0.005**	0.89 (0.37–2.15)	0.79
Other[c]	5/36 (13.9)	0.57 (0.20–1.62)	0.29	0.41 (0.12–1.37)	0.15
Language[d]					
English	147/549 (26.8)	Reference		Reference	
Spanish	90/270 (33.3)	1.50 (1.06–2.13)	**0.02**	2.26 (0.97–5.27)	0.06
Chinese	74/176 (42.1)	2.11 (1.43–3.11)	**<0.001**	2.91 (1.49–5.67)	**0.002**
Other	1/2 (50.0)	3.97 (0.20–77.91)	0.36	2.08 (0.12–37.60)	0.62
English is primary language					
No	169/451 (37.5)	Reference		NA	
Yes	102/312 (32.7)	0.78 (0.56–1.09)	0.15	NA	
US born					

Variable	Number/total number (%)	Univariable OR (95% CI)	*P* value	Multivariable OR (95% CI)[b]	*P* value
No	176/489 (36.0)	Reference		NA	
Yes	95/274 (34.7)	0.92 (0.66–1.29)	0.64	NA	
PCP type					
Attending	128/346 (37.0)	Reference		Reference	
Fellow/resident	160/533 (30.0)	0.70 (0.49–0.99)	**0.05**	0.96 (0.63–1.46)	0.86
NP	24/118 (20.3)	0.42 (0.23–0.76)	**0.004**	0.43 (0.23–0.81)	**0.008**
Education level					
No high school diploma/GED	109/332 (32.8)	Reference		NA	
High school diploma/GED	75/281 (26.7)	0.70 (0.48–1.02)	0.06	NA	
Some college/technical school	56/189 (29.6)	0.84 (0.56–1.27)	0.42	NA	
College degree or higher	72/195 (36.9)	1.17 (0.79–1.74)	0.43	NA	
Annual household income, USD					
<10,000	168/566 (29.7)	Reference		NA	
10,000–19 999	101/315 (32.1)	1.09 (0.79–1.49)	0.60	NA	
20,000–29,999	28/78 (35.9)	1.32 (0.78–2.23)	0.30	NA	
≥30,000	13/30 (43.3)	1.74 (0.79–3.83)	0.17	NA	
Insurance					
None	53/169 (31.4)	Reference		NA	
Public[e]	254/815 (31.2)	1.00 (0.69–1.46)	0.99	NA	
Private	4/11 (36.4)	1.31 (0.34–4.98)	0.70	NA	
Employment					
Not working	196/657 (29.8)	Reference		NA	
Working	116/340 (34.1)	1.16 (0.86–1.57)	0.32	NA	
Sexual orientation					
Heterosexual	203/722 (28.1)	Reference		Reference	
Homosexual	49/87 (56.3)	3.70 (2.18–6.29)	**<0.001**	4.25 (1.87–9.64)	**0.001**
Bisexual	7/20 (35.0)	1.52 (0.56–4.14)	0.42	2.45 (0.78–7.65)	0.12
Married or partnered					
No	130/485 (26.8)	Reference		Reference	

Variable	Number/total number (%)	Univariable OR (95% CI)	*P* value	Multivariable OR (95% CI)[b]	*P* value
Yes	135/364 (37.1)	1.63 (1.20–2.23)	**0.002**	1.70 (1.14–2.52)	**0.009**
Living children					
No	86/225 (38.2)	Reference		Reference	
Yes	190/652 (29.1)	0.69 (0.49–0.97)	**0.03**	0.69 (0.43–1.11)	0.13
HIV status					
Negative	192/663 (29.0)	Reference		Reference	
Positive	64/167 (38.3)	1.60 (1.02–2.49)	**0.04**	1.05 (0.51–2.13)	0.90

CI, confidence interval; FOBT, fecal occult blood testing; GED, general equivalency diploma; NA, not applicable; NP, nurse practitioner; OR, odds ratio; PCP, primary care provider.

[a] All analyses are adjusted for potential clustering by primary care provider.

[b] Includes all variables with a *P*-value <0.05 in univariable analyses.

[c] Includes Native American, multiracial, and those who declined to answer.

[d] Preferred language for interview and survey.

[e] Includes Medicare, Medicaid, Healthy San Francisco, and the San Francisco Healthy Worker Health Plan.

Bold values signify $P < 0.05$.