Community-Clinical Linkage Intervention to Improve Colorectal Cancer Screening Among Underserved Korean Americans

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ABSTRACT

Korean Americans report the lowest and declined rates of colorectal cancer (CRC) screening, compared to general population in the United States. The present study aimed to evaluate the efficacy of a community-based multifaceted intervention designed to improve CRC screening among Korean Americans. A cluster-randomized trial involving 30 Korean church-based community organizations (n = 925) was conducted. Fifteen churches were assigned to intervention (n=470) and the other 15 to control (n = 455) groups. Main components of the intervention included interactive group education, patient navigation, physician engagement, and provision of fecal immunochemical test (FIT) kit. CRC screening rates were assessed at a 12-month follow-up. Participants in the intervention group were significantly more likely to receive CRC screening (69.3%) as compared with those in the control group (16%). The intervention was particularly effective in promoting FIT among the more disadvantaged individuals in the Korean American community. Regression analysis revealed that controlling for the intervention effect, male gender, high school education, annual income of $20,000–40,000 were significantly associated with increased screening by FIT, whereas English inefficiency was significantly and lack of health insurance was marginally significantly associated with decreased screening by colonoscopy/sigmoidoscopy. Culturally and linguistically appropriate multifaceted intervention combining FIT provision with community-clinical linkage has a potential to be a cost-effective and practical approach to effectively targeting hard-to-reach disadvantaged minority populations and enhance CRC screening to reduce cancer disparities.

KEYWORDS: colorectal cancer (CRC) screening, Korean American, Intervention, FIT, community-based participatory research

INTRODUCTION

Colorectal cancer (CRC) is the second most common cancer among Korean Americans, after lung cancer for Korean men and breast cancer for Korean women (Miller et al., 2008). In the United States, CRC incidence rates have decreased over the past decade, with the change of rates by more than 4% per year in both men and women (American Cancer Society, 2017). However, unlike the general trend, the CRC incidence rates among Korean Americans have increased with the annual percent change (APC) of 3.6% between 1988 and 2007 (Giddings et al., 2012; Lee et al., 2007). Despite the high burden from CRC among Korean Americans, CRC screening rates in this population are significantly lower than the national average (Maxwell and Crespi, 2009; Maxwell et al., 2010; Hwang, 2013; Oh and Jacobsen, 2014).

Currently, several screening tests can be used to find polyps or colorectal cancer. The fecal immunochemical test (FIT) uses antibodies to detect blood in the stool, which is an early sign of cancer. Colonoscopy and sigmoidoscopy both use a thin flexible lighted tube with a camera at the end to check for polyps or cancer inside the rectum and the colon. The difference between the two procedures is that a flexible sigmoidoscopy examines the left lower third of the colon with a short tube, while colonoscopy examines the entire colon with a longer tube (Center for Disease Control and Prevention, 2017). The prevalence of CRC screening in accordance with guidelines among the general US population 50 years of age and older and overall Asian Americans in 2015 was 62.6% vs 49.4% (American Cancer Society, 2014). However, a systematic review of thirteen studies on CRC screening among Korean Americans published until May 2013 (Oh and Jacobsen, 2014) indicated that only one in four Korean Americans aged 50 and older reported having ever had FIT and approximately 40% reported having ever had a sigmoidoscopy or colonoscopy in different studies. In addition, screening rates decreased for both colonoscopy and FIT in Korean Americans,

while the rates increased or were stable in the US general population (Maxwell and Crespi, 2009).

The factors contributing to the low rates of and declining trend in screening among Korean Americans are complex. Inadequate knowledge about screening, screening methods, and its benefits, as well as low perceived risks of CRC have been identified as major factors related to low rates of screening among Koreans (Juon et al., 2003; Ma et al., 2009; Maxwell et al., 2010). These studies suggest that Korean Americans may be less familiar with utilizing health care system to detect health problems before the onset of symptoms than other groups, emphasizing the need for education of the benefit of screening before symptoms develop. In addition, the decline of CRC screening rates of this population has been associated with limited access to health system due to lack of insurance, language inefficiency, and lack of transportation (Jo et al., 2008; Lee and Im, 2013; Lee and Lee, 2013).

With the high CRC burden combined with low rates of screening uptake due to multilevel barriers, Korean Americans, particularly, disadvantaged groups with limited English proficiency and low income are an important target group for implementation of innovative and culturally tailored programs to enhance CRC screening. Collaboration among multisector stakeholders, the community members and leaders, clinical providers and researchers, has great potential to enhance cancer screening for this population. Community-based organizations (CBOs) who work directly with the target population serve as a venue for promotion of knowledge and awareness of CRC screening and reduction of barriers to screening (Israel et al., 2005). Engaging CBOs and clinical providers (primary care practices, PCPs) can deliver screening test more effectively by reaching the underserved and hard-to-reach individuals who rarely visit doctors for preventive care. Therefore, implementation of CRC screening in this

underserved population requires establishing strategic partnerships between community and clinical settings and sharing their infrastructure and capacity to enhance engagement of potential patients and PCPs in CRC screening, and follow-up care (Ockene et al., 2007; Krist et al., 2013; Persson, 2016).

However, there is clear paucity of culturally and linguistically appropriate CRC community clinical linkage intervention (CCL), designed to improve CRC screening among Korean Americans. To our knowledge, no study has investigated the impact of the CCL intervention for CRC screening in Korean Americans, except for the one we conducted in a small scale quasi-experimental design (Ma et al., 2009). In our previous study, we reported that a culturally and linguistically tailored church-based intervention combined with patient navigation assistance and physician engagement (including screening reminder, scheduling appointment, transportation assistance to clinic sites, navigation for screening, follow up care and medical record verification) was effective in increasing CRC screening rate. Building on our preliminary data (Ma et al., 2009), the present study was designed to evaluate the impact of a large-scale cluster group randomized trial on CRC screening.

Regarding CRC screening methods or modalities, colonoscopy is most commonly recommended in the United States. Colonoscopy has a high sensitivity for polyps and cancer, but is invasive, cumbersome, expensive, and thus, has limited availability in many underserved minority populations (Lieberman et al., 2000; Inadomi et al., 2012; Elmunzer et al., 2015). Although FIT has less sensitivity for polyps and cancer than colonoscopy, it has advantage of being non-invasive, easy-to-do at home, inexpensive, and more readily available as a first step of detecting abnormality. Indeed, when offered or recommended, individuals, particularly from underserved communities, were more likely to complete FIT than colonoscopy,

suggesting that FIT based outreach was more effective than colonoscopy-based outreach in increasing screening rates among underserved populations (Inadomi et al., 2012; Gupta et al., 2013; Singal et al., 2016). According to these studies, a programmatic method with less invasiveness and more availability with minimal resources and infrastructure such as FIT appears to be a promising intervention modality for improvement of CRC screening among underserved populations.

This article evaluated the primary outcome, efficacy of a culturally and linguistically appropriate community- clinical linkage intervention that included provision of FIT, group education, patient navigation, and physician engagement on CRC screening.

METHODS

Participants

Korean Americans (N = 925) enrolled in this study were members of Korean churches (N = 30) in Philadelphia and New Jersey regions that serve a predominately underserved immigrant population. More than 78% of Koreans in the US are affiliated with churches (Chang, 2003; Ma et al., 2009; Min, 2002) and the churches serve as one of the community-based organizations facilitating discussion of and participation in various cultural, social and personal activities. Thus, Korean church is one of the important venues to deliver culturally appropriate intervention to provide health education and promote CRC screening among Korean Americans. Participants were eligible to participate in this study if they: (1) were self-identified Korean Americans; (2) were 50 years and older; (3) did not have a colorectal polyp, CRC cancer, or a family history of CRC (first degree relative); and (4) non-adherent to CRC screening guidelines (never had any CRC screening or were overdue for screening). Based on the CRC screening guidelines recommended by the ACS, "overdue" was defined by no FIT in the past year

or no sigmoidoscopy in the past five years, no double-contrast barium enema in the past five years, or no colonoscopy within the past ten years.

Procedures

The study was designed as a collaborative partnership among an academic institution, Korean churches, community-based organizations (CBOs), and healthcare providers/organizations. A framework for community-clinical linkages was used to guide the current study and collaboratively established CRC screening program and referral systems that connect individuals with abnormal screening results to clinical care. As part of collaboration, Korean churches provided facilities and resources to promote awareness and knowledge about CRC screening through provision of education sessions and FIT kits. Academic researchers coordinated each stage of study by linking community and clinical settings and provided navigation services as needed.

Participants who performed FIT testing were asked to mail the samples in a provided envelope to their providers. Participants do not have regular physicians or health insurance, were encouraged to mail the samples to the partnering clinicians or health centers of our network. Participants with an abnormal FIT result were notified with a letter written by a clinician and referred to diagnostic colonoscopy. The CAH research team at Temple University has an established network of participating clinical partners who provide a range of health services either at reduced cost to patients who are uninsured or underinsured. Thus, those who had no primary care physician or medical insurance were sent to the collaborating clinical partners for the diagnostic test. This study was approved by the Temple University Institutional Review Board.

Study design

The study utilized a two-arm cluster randomized design with churches as the unit of randomization (Fig 1). Based on organization profile information provided by collaborating church leaders, we paired the 30 churches by size and geographic location. Then, each CBO of the 15 pairs was randomly assigned to the intervention or control group. We conducted baseline evaluation, post-intervention assessment, and a 12-month follow-up on screening outcome. Baseline and post-intervention assessments were administered in person while the 12-month follow-up assessments were conducted by telephone interviews and primary outcome of screening was verified through medical record.

Intervention and control conditions

The intervention was designed to improve CRC screening among participants who are non-adherent to CRC screening guidelines by addressing multilevel barriers. Main intervention components included interactive group education, navigation services and engagement of health care providers for referrals, and linkage to care. The *interactive group education* was aimed to increase participant overall understanding of CRC, screening methods, and utilization of available resources such as home test kit and navigation services, with the ultimate goal of increasing screening rates. Bilingual health educators facilitated discussion on CRC susceptibility and severity among Korean Americans and the U.S. general population, benefits of CRC screening, and CRC screening options and their associated clinical procedures, as well as the pros and cons of each option. To increase their motivation for CRC screening and awareness of the different methods, FIT home kit was offered to the participants with instructions in Korean. Although it is provided to all participants in intervention group, they were encouraged to choose any screening methods convenient for them. *Clinical partners* provided clinical support and ensured successful screening assessment and follow-ups by offering more flexible hours of clinic operation with bilingual medical staff on site. *Patient navigation assistance* was also offered based on participants' needs. The range of assistance included scheduling

appointments with clinical partners for sigmoidoscopy/ colonoscopy for screening and diagnosis after a FIT positive result, assisting paper work and communication with a physician, and arranging transportation.
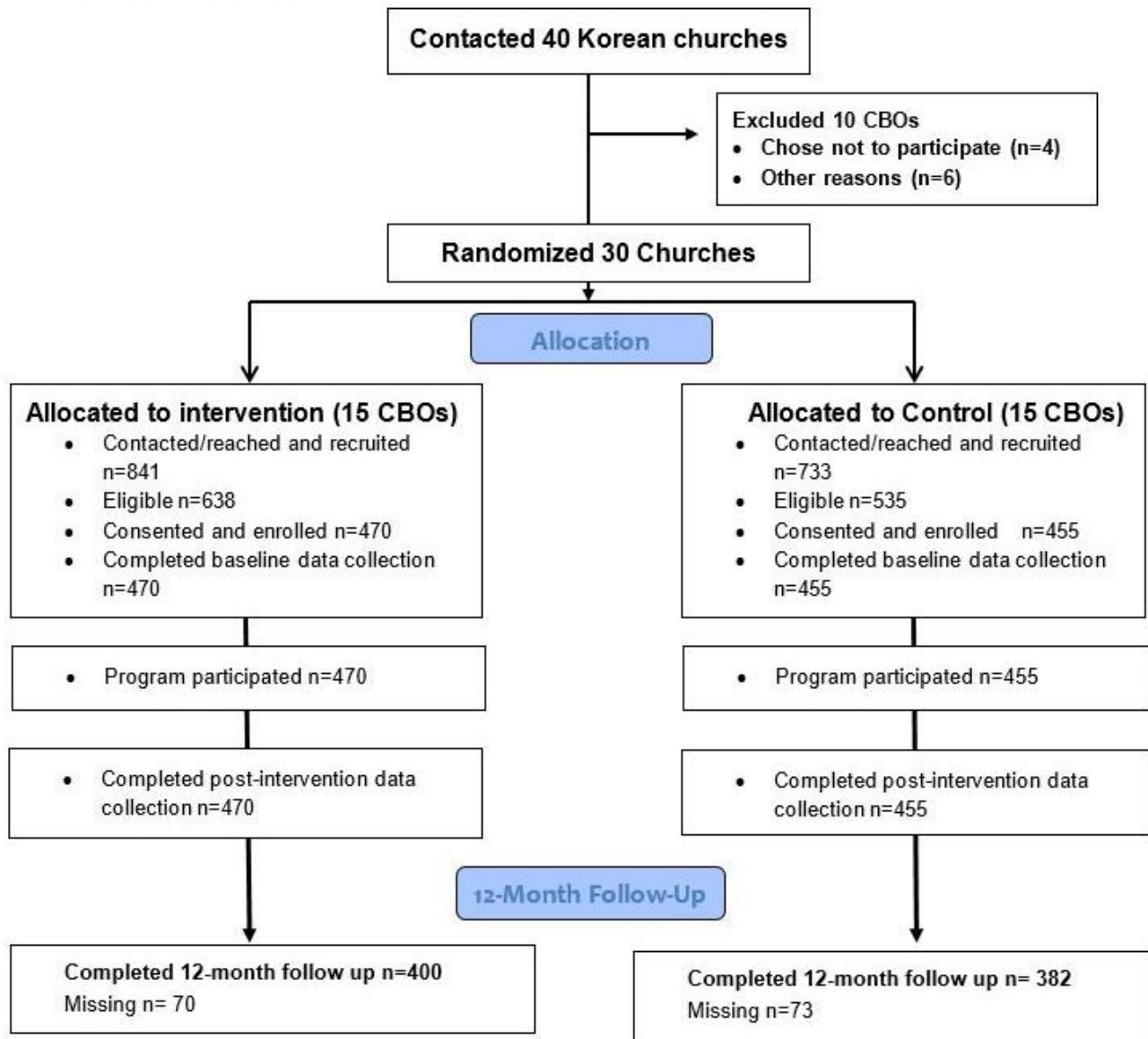

Figure 1. Study design flow chart.

In the control condition, participants (n = 455) received a group education session in a similar format with that of the intervention group delivered by trained Korean community health educators. Different from the intervention group, the education focused on general health education and primary prevention issues, including routine health examinations and screening for various diseases such as cancer. Korean version of standard printed materials and guidelines related to the education contents were also provided, including CRC screening guidelines.

Measures

This study assessment was designed to evaluate the multilevel intervention including individual participants' level, CBO organization level and clinical linkage to care level, as a result of

education, patient navigation, and physician engagement for linkage to care. At participants' level, we assessed participants' satisfaction on each component of intervention, screening behaviors and knowledge improvement. In addition, as a process outcome, we assessed the adherence of main stakeholders (CBOs, Patient Navigators and clinical providers) to basic CBPR principles of collaboration in various stages of the project implementation. Since the main purpose of this article was to report the efficacy of the intervention on participants' screening behaviors, we only reported CRC screening as primary outcome measures and relevant results.

Participant characteristics. Demographic information such as age gender, education, marital status, household income, employment was collected at baseline. Acculturation related information such as years living in the US and the English ability was also collected. In addition, information on health insurance and regular physician status was collected to learn the levels of health care access of the participants.

Barriers to screening. Barriers to CRC screening were evaluated by asking them the question: "If you have never had any of the screening such as stool blood test, sigmoidoscopy or colonoscopy, what are the major reasons?" The choices include 'Do not know what it is', 'Do not know where to get it', 'Do not have time', and 'Feel healthy and do not think needing a test.'

Screening behavior. The primary outcome was CRC screening status (completion of either FIT kit, sigmoidoscopy, or colonoscopy) at the 12-month follow-up. Bilingual interviewers contacted participants at 12-month follow-up and assessed screening behavior using self-report ("Over the past 12 months, have you had a test for colorectal cancer?"; yes/no, and "If you had, what is the test?"; stool blood test using FIT

kit/colonoscopy/sigmoidoscopy). Participants who reported receiving FIT were verified with the list of those who returned the stool sample and received the test results from the collaborating clinical laboratory. Participants who reported receiving colonoscopy or sigmoidoscopy were asked to provide a medical release consent to allow project staff to contact their health care providers to validate self-reported testing. Participants who received positive FIT results and were referred to diagnostic colonoscopy were also followed-up.

Data analysis

Participant characteristics were described using frequencies and percentages within each of the treatment groups (intervention versus control). The chi-square test was used to assess whether the distributions differed between the treatment groups. The chi-square test was also used to compare the proportion of participants in the intervention and control groups who completed CRC screening within 12 months of the intervention. The proportion of participants who completed screening was compared by different CRC screening methods and by recruitment sites. To investigate whether the intervention was particularly effective in disadvantaged individuals, the comparison of screening rates between intervention and control groups was conducted only among the disadvantaged group (i.e., high school or less education, income of <$40,000, no insurance etc.). Finally, logistic regression analyses were conducted to explore the factors associated with FIT and colonoscopy/sigmoidoscopy. In the models, the covariance matrix was adjusted to account for clustering of individuals at the church level. All analyses were performed in SAS version 9.3 assuming a type 1 error of 0.05.

RESULTS

Participant characteristics

Overall, there were slightly more women (59.2%) than men enrolled in the study. Majority of participants were married (80.4%) and did not speak English well (74.1 %). Roughly half were college or higher level educated (50.4), insured (49.7%), and had a regular physician (55.5%). More than half were employed (56.8%) and earned less than $40,000 (66.1%). Table 1 describes and compares sociodemographic characteristics for the intervention and control groups. More participants in the control group than in the intervention group earned greater than $40,000 in annual income (28.1% vs. 21.2%; p = 0.050), and had health insurance (55.5% vs. 46%; p = 0.005). The distribution of other demographic, acculturation, and health access variables were not significantly different between groups.

Barriers of screening were generally similar in distribution between the intervention and control groups, with the exception of three variables. Participants in the intervention group were more likely than those in the control group to endorse 'not being able to afford it' (28.4% vs. 22.9%; p = 0.012), and 'feeling healthy' (22.9% vs. 14.3%; p =0.001) as the reason of not having had screening. However, less participants (16.0%) of the intervention group reported 'not knowing what screening is' compared to those in the control group (21.6%; p = 0.035) (Table 1).

Screening rates by methods and sites

As shown in Table 2-1, CRC screening behaviors were significantly different between intervention and control groups. In the intervention group, a total of 277 out of 400 participants (69.3%) were screened for CRC at 12 months, compared to 61 out of 382 (16.0%) in the control group (χ^2 (1) = 226.04, p<0.001). In the intervention group, the majority (66.8%) screened by FIT, and minority screened by colonoscopy (2.0%) and sigmoidoscopy (0.3%). In contrast, in the control group a minority (1.8%) screened by FIT, and the majority screened by colonoscopy (11.5%) and sigmoidoscopy (5.8%).

As shown in Table 2-2, out of the 15 paired church sites in the study, the majority (n = 12) had screening rates significantly higher by intervention group than by control group: the screening rates in the intervention group ranged from 60.0% to 93.8%, while corresponding control group screening rates ranged from 0% to 38.9%. However, at 3 church pairs (5th, 8th, and 14th), screening rates were not significantly different between the two treatment groups, with substantially low level of screening rates (33.3% - 45.8%) compared to other sites in the intervention group. Compared to the intervention participants from the other church sites, those from the 5th, 8th, and 14th church pairs were more likely to have college or higher education (73.8% vs. 51.2%; p = 0.005), be employed (73.8 % vs. 55.7%; p = 0.01), have greater than $40,000 annual income (49.1% vs. 15.9%; p < 0.001), and have health insurance coverage (56.5% vs. 42.9%; p = 0.048).

Screening rates among disadvantaged individuals

Difference in CRC screening rates between intervention and control groups were heightened when examined among disadvantaged individuals only (Table 3). Specifically, among the participants who had an education of high school level or below, annual household income of less than $40,000, were unemployed, could not speak English, and had no health insurance or access to a regular physician, the average rates of screening were consistently over 70% in the intervention group. However, the screening rates in the control group among the disadvantaged individuals were generally lower than the overall screening rates in the control group except for the unemployed participants. The difference in screening rates between the two groups were even higher among those who faced barriers to screening such as not knowing what CRC screening is (69.4% vs. 7.8%),

not knowing where to get it (81% vs. 10%), not being able to afford it (70.6% vs. 6.3%), having a language difficulty (80% vs. 11.1%) and feeling healthy (71.4% v. 9.3).

Table 1. Characteristics of Intervention and Control Group Participants: CRC Screening Program (n=925).

Variable	Intervention Group (n=470) No. (%)	Control Group (n=455) No. (%)	P1
Age (mean years)	62.28±9.94	62.93±9.27	0.361
Gender			0.158
Male	197 (42.5)	171 (37.8)	
Female	267 (57.5)	281 (62.2)	
Marital status			0.404
Married	378 (81.5)	351 (79.2)	
Not Married	86 (18.5)	92 (20.8)	
Education			0.104
Below high school	55 (12.1)	71 (16.2)	
High school graduate	150 (32.9)	153 (34.9)	
Some college or higher	251 (55.0)	215 (49.0)	
Annual household income			0.050
Less than $20,000	157 (36.9)	139 (36.2)	
$20,000 - $40,000	178 (41.9)	137 (35.7)	
Greater than $40,000	90 (21.2)	108 (28.1)	
Employment			0.736
Employed	257 (56.2)	251 (57.4)	
Unemployed/Retired/Homemaker	200 (43.8)	186 (42.6)	
Year living in US			<0.001
Less than 10 yrs	90 (12.2)	104 (15.5)	
Between 10 and 20 yrs	145 (19.7)	178 (26.6)	
More than 20 years	501 (68.1)	388 (57.9)	
Ability to speak English			0.296
Not at all	43 (9.3)	54 (12.1)	
Not well	299 (64.7)	289 (64.8)	
Well/Very well	120 (26.0)	103 (23.1)	
Health insurance status			0.005
No	248 (53.9)	199 (44.5)	
Yes	212 (46.1)	248 (55.5)	
Regular physician status			0.411
No	191 (42.7)	171 (40.0)	
Yes	256 (57.3)	257 (60.0)	
Barriers to screening			
Do not know what it is			0.035
Unchecked	393 (84.0)	356 (78.4)	

Checked	75 (16.0)	98 (21.6)	
Do not know where to get it			1.000
Unchecked	442 (94.4)	429 (94.5)	
Checked	26 (5.6)	25 (5.5)	
Cannot afford			0.012
Unchecked	335 (71.6)	358 (78.9)	
Checked	133 (28.4)	96 (21.1)	
Do not have time			0.339
Unchecked	413 (88.2)	410 (90.3)	
Checked	55 (11.8)	44 (9.7)	
Transportation difficulty			0.579
Unchecked	460 (98.3)	449 (98.9)	
Checked	8 (1.7)	5 (1.1)	
Language difficulty			0.698
Unchecked	453 (96.8)	442 (97.4)	
Checked	15 (3.2)	12 (2.6)	
Afraid of pain			0.243
Unchecked	439 (93.8)	434 (95.6)	
Checked	29 (6.2)	20 (4.4)	
Feel healthy			0.001
Unchecked	361 (77.1)	389 (85.7)	
Checked	107 (22.9)	65 (14.3)	
1 P-values based on Rao-Scott chi-square test excluding missing values. Rao-Scott chi-square test used to account for design effects of clustering at the site level.			

TABLE 2-1. CRC Screening Rates at 12 Months Follow-up by Screening Methods			
Outcome	Intervention Group (n=400) No. (%)	Control Group (n=382) No. (%)	P
Screened for CRC	277 (69.3)	61 (16.0)	< 0.001
Type of Screening			
FIT	267(66.8)	7 (1.8)	< 0.001
Colonoscopy	8 (2.0)	44 (11.5)	< 0.001
Sigmoidoscopy	1 (0.3)	22 (5.8)	< 0.001
P-values based on chi-square test of Fisher's exact test excluding missing values.			

TABLE 2-2. CRC Screening Rates at 12 Months Follow-up by Community Sites

| Pair | Intervention (n=400) | | Control (n=382) | | P |
	N	Test rate (%)	N	Test rate (%)	
1	33/41	80.5	2/20	10.0	<0.001
2	22/36	61.1	3/17	17.6	0.004
3	30/37	81.1	7/35	20.0	<0.001
4	16/31	51.6	0/21	0.00	<0.001
5	5/15	33.3	10/47	21.3	0.489
6	15/16	93.8	4/30	13.3	<0.001
7	13/20	65.0	1/31	3.2	<0.001
8	11/24	45.8	10/37	27.0	0.171
9	21/28	75.0	0/20	0.0	<0.001
10	30/34	88.2	7/18	38.9	0.001
11	18/21	85.7	4/17	23.5	<0.001
12	18/22	81.8	4/36	11.1	<0.001
13	22/31	71.0	3/14	21.4	0.003
14	11/24	45.8	6/18	33.3	0.530
15	12/20	60.0	0/21	0.0	<0.001

P-values based on chi-square test of Fisher's exact test excluding missing values.

TABLE 3. CRC Screening Results 12 Months Follow-up Only Among Disadvantaged Individuals

Variable	Intervention n (%)	Control n (%)	p-value
High school or below (n=365)	132/175 (75.4)	29/190 (15.3)	<0.001
Income < $40,000 (n=516)	211/287 (73.5)	37/229 (16.2)	<0.001
Unemployed (n=310)	117/161 (72.7)	31/149 (20.8)	<0.001
English- not well/not at all (n=580)	207/292 (70.9)	39/288 (13.5)	<0.001
No health insurance (n=390)	154/215 (71.6)	14/175 (8.0)	<0.001
No regular physician (n=310)	114/162 (70.4)	12/148 (8.1)	<0.001
Barriers to screening			
Do not know what it is (n=139)	43/62 (69.4)	6/77 (7.8)	<0.001
Do not know where to get it (n=41)	17/21 (81.0)	2/20 (10.0)	<0.001
Cannot afford (n=199)	84/119 (70.6)	5/80 (6.3)	<0.001
Do not have time (n=89)	29/49 (59.2)	2/40 (5.0)	<0.001
Language difficulty (n=24)	12/15 (80.0)	1/9 (11.1)	=0.001
Afraid of pain (n=44)	17/25 (68.0)	3/19 (15.8)	=0.001
Feel healthy (n=144)	64/90 (71.1)	5/54 (9.3)	<0.001

Variable	FIT OR (95% CI)	Colono/Sigmoidoscopy OR (95% CI)
TABLE 4. Factors Associated with FIT and Colono/Sigmoidoscopy at 12 Month Follow-up (n=782)		
Intervention Group		
Intervention	151.39 (56.97, 402.26)***	0.10 (0.04, 0.24)***
Control (Ref)	1.00	1.00
Age	1.03 (0.99, 1.07)	0.99 (0.95, 1.04)
Years in US	1.05 (0.71, 1.55)	0.84 (0.52, 1.36)
Gender		
Male	2.02 (1.17, 3.49)*	1.06 (0.52, 2.15)
Female (Ref)	1.00	1.00
Marital Status		
Married	0.99 (0.48, 2.04)	0.64 (0.29, 1.41)
Not married	1.00	1.00
Education		
Below high school	1.50 (0.55, 4.04)	1.80 (0.61, 5.33)
High school graduate	2.69 (1.44, 5.03)*	0.92 (0.41, 2.06)
Some college or higher (Ref)	1.00	1.00
Annual household income		
Less than $20,000	1.80 (0.78, 4.18)	1.11 (0.38, 3.18)
$20,000 - $40,000	2.01 (1.02, 3.95)*	1.59 (0.63, 4.00)
Greater than $40,000 (Ref)	1.00	1.00
Employment		
Employed	0.934 (0.454, 1.92)	0.61 (0.27, 1.38)
Unemployed/Retired (Ref)	1.00	1.00
Ability to speak English		
Not at all	0.587 (0.16, 2.11)	0.66 (0.16, 2.65)
Not well	0.838 (0.45, 1.56)	0.45 (0.20, 0.99)*
Well/Very well (Ref)	1.00	1.00
Health insurance status		
No	2.54 (1.20, 5.37)*	0.34 (0.10, 1.18)╂
Yes (Ref)	1.00	1.00
Regular physician status		
No	0.80 (0.40, 1.59)	0.80 (0.24, 2.71)
Yes (Ref)	1.00	1.00
Analysis accounts for clustering at the church level ╂p-value < 0.1, *p-value < 0.05, **p-value <0.01, ***p-value <0.001		

Factors associated with FIT and colonoscopy

As shown in Table 4, controlling for intervention effect, several predictors were significantly associated with screening by FIT. Males were twice as likely to have screened by FIT (OR = 2.02, 95% CI 1.17–3.49, p = 0.012). Individuals who have high school education (OR = 2.69, 95% CI 1.44–5.03)

and those who had an annual income of $20,000–$40,000 (OR = 2.01, 95% CI 1.02–3.95, *p*=0.046) were more likely to be screened by FIT than those with college or higher education and those with greater than $40,000 income. Compared to individuals with health insurance, those without health insurance were 2.5 times as likely to screen by FIT (OR = 2.54, 95% CI 1.20–5.37, *p*=0.017). On the other hand, English inefficiency was significantly (OR = 0.45, 95% CI 0.20–0.99, *p*=0.031) and having no health insurance was marginally significantly (OR = 0.34, 95% CI 0.10–1.18, *p*=0.081) associated with decreased odds of screening by colonoscopy/ sigmoidoscopy.

Regarding the barriers, controlling for the demographic covariates, 'fear of pain' was associated with decreased odds of screening by FIT (OR = 0.29, 95% CI 0.09–0.98, *p*=0.050), while 'not feeling healthy' was associated with increased screening by colonoscopy / sigmoidoscopy (OR = 3.47, 95% CI 1.13–10.67, *p*=0.031).

Screening results and follow-up care

Twenty eight out of 267 (10.2%) who completed FIT in the intervention group were screened positive. All the 28 participants with abnormal FIT results completed diagnostic colonoscopy with patient navigation assistance and physician engagement in referral and facilitation the linkages to follow up care.

DISCUSSION

This study is the first large-scale cluster randomized, multifaceted community-clinical linkage intervention trial to improve CRC screening among underserved and less acculturated Korean Americans. We found that the intervention consisting of culturally appropriate education,

provision of FIT, navigation services, and physician engagement was significantly effective in increasing CRC screening, particularly among the hard-to-reach Korean Americans with limited English proficiency. Compared to the previous study that 90% of whom had public or private insurance (Tu et al., 2006), it is noteworthy that the present study achieved high screening rate among 50% participants were uninsured. The finding of the present study demonstrates the efficacy of a multilevel intervention through community-clinical linkage in this population.

Korean Americans have reported to have the lowest CRC screening rates as US general populations with a significant increase in CRC screening (Maxwell and Crespi, 2009; Maxwell et al., 2010; Hwang, 2013; Oh and Jacobsen, 2014). As the contributing factors to the CRC screening disparities in Korean Americans, large proportion of them are foreign-born, lack of health insurance, and have a lower household income, in addition to limited awareness and knowledge about CRC screening guidelines. Indeed, majority of the participants in our study who either never had CRC screening or were overdue for screening were with low income, unemployment, English inefficiency, and no health insurance. Substantial number of those who have never had CRC screening also endorsed 'cannot afford', 'not knowing what it is', and 'feeling healthy' as the main barriers to screening. The successful implementation and outcome of our intervention suggest that enhancing knowledge and access to CRC screening through community-clinical linkage is the effective way to improve CRC screening, particularly among the hard-to-reach underserved Korean American population who experience multiple barriers to screening.

Community participation played a crucial role in raising awareness, facilitating motivation about cancer screening, and reducing logistical

challenges among this population when clinical settings have the limitation that they can provide services only to individuals who visit the clinical settings. Offering education and low-cost FIT kits through community settings made it possible to reach the underserved Korean Americans and engage them in screening behaviors. On the other hand, physician engagement compensated the limited ability of community settings in delivery of clinical care and warranted quality services for the participants in need. This community-clinical linkage intervention seemed to be an essential component in enhancing screening behavior for hard-to-reach populations with multiple barriers to screening.

The finding that the intervention was particularly effective in promoting FIT is also consistent with the previous studies suggesting that when offered, FIT is accepted better than colonoscopy among the underserved populations (Inadomi et al., 2012; Singal et al., 2016). We did not design our study to compare FIT versus colonoscopy, but instead incorporated low-cost FIT kit provision into a multifaceted intervention that included education sessions addressing all types of CRC screening and navigation assistance to colonoscopy/sigmoidoscopy appointments, allowing the participants to select the methods of CRC screening. Despite the different options, the majority of the participants in the intervention group selected FIT, confirming the previous studies. Moreover, we found that the difference in screening rates between intervention and control groups were greater among those who were less educated, having less income, unemployed, unable to speak English, with no health insurance or a regular physician, suggesting that our intervention is more beneficial among the disadvantaged individuals. In contrary, relatively better-off participants did not seem to be as receptive to the resources offered by intervention.

For instance, the three paired church sites with the lowest screening rates after intervention were attended by the participants with generally higher education, higher income, and greater health care access compared to their counterparts at the other paired church sites where the screening rates were higher. These findings highlight a promising potential of a multifaceted intervention combining FIT provision with CBPR approach for enhancing screening behavior among the most socially and economically disadvantaged members in racial minority communities.

Furthermore, we found that certain demographic characteristics and barriers to screening were associated with different modalities of CRC screening. Multivariate analysis revealed that different modalities of CRC screening seemed to appeal to different subgroups of participants. Controlling for intervention effect, FIT screening behavior was associated with high school educated, lower income, males, and those without health insurance. In contrast, colonoscopy/sigmoidoscopy screening behavior was associated with participants who have health insurance and better English proficiency. Among the barriers, 'being afraid of pain' was associated with increased FIT whereas, 'not feeling healthy' was associated with increased colonoscopy. These results indicate that the less invasive, low-cost, and more convenient FIT screening test are preferred by disadvantaged groups facing generally more barriers to screening. The more invasive but more sensitive and specific colonoscopy/sigmoidoscopy screening modality seems to be preferred among individuals who typically have health care access and have health concerns. Future work is needed to gain a deeper understanding of the factors that predetermine preference of CRC screening modality among racial minorities.

There are several limitations to this study. *First,* the present study had a short follow-up period which

only studied one-time screening behavior at 12-month follow up. Since FIT screening warrants annual testing to be effective in CRC prevention (Singal et al., 2017), full understanding about screening behavior compliance requires a longer follow-up study to examine sustained adherence over time. In a previous long term comparative outreach study, the rates of screening decreased as low as 28% when participants were followed up for 3 years (Singal et al., 2017) compared to 1-time screening rate of 58.8% (Min, 2002). The authors of the study attributed the lower adherence rates in the FIT outreach group to the suboptimal completion of colonoscopy after a positive FIT result, in addition to the failures of completing subsequent yearly FIT screens after initial negative test results. However, given that 100% of those who had positive FIT test results in the intervention group underwent diagnostic colonoscopy with navigation assistance in our study, compared to 49.3% in the outreach study for 1-time screening (Min, 2002), our study shed the light on the potential impact of the intervention incorporating CBPR approach and navigation service to FIT provision on drawing long-term effect with improved sustained adherence to FIT. *Second*, despite the randomization procedures, the two groups differed on several demographic variables, including household income, health insurance status, and barriers to screening. However, participants in the control group were more likely to have higher income and health insurance, which are the factors that generally facilitate access to care. Significantly lower screening rates in the control group even with this advantage confirm the true robustness of the intervention used in the present study.

Despite the limitations, our findings support the feasibility and efficacy of a culturally and linguistically appropriate multifaceted community-clinical linkage intervention among the most underserved members in a high-risk racial minority

population. The study offers strong evidence that such an intervention approach can be a practical intervention method to effectively target hard-to-reach disadvantaged individuals who are otherwise vulnerable to CRC screening disparities. Future studies will look to investigate deeper into preference of CRC screening modality among Korean Americans and evaluate screening behavior over a longer follow-up period, as well as explore effective strategies to scale up the evidence-based community-clinical linkage intervention for broad dissemination and implementation.

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Conflict of interest statement
The author has declared that no competing or conflict of interests exist. The funders had no role in study design, writing of the manuscript and decision to publish.

Authors' contributions
Please add.

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