

# Lay Health Educators Increase Colorectal Cancer Screening Among Hmong Americans: A Cluster Randomized Controlled Trial

Elisa K. Tong, MD<sup>1</sup>; Tung T. Nguyen, MD<sup>2</sup>; Penny Lo, BS<sup>3</sup>; Susan L. Stewart, PhD<sup>4</sup>; Ginny L. Gildengorin, PhD<sup>2</sup>; Janice Y. Tsoh, PhD<sup>5</sup>; Angela M. Jo, MD<sup>6</sup>; Marjorie L. Kagawa-Singer, PhD<sup>7</sup>; Angela U. Sy, DrPH<sup>8</sup>; Charlene Cuaresma, MPH<sup>8</sup>; Hy T. Lam, BS<sup>2</sup>; Ching Wong, BS<sup>2</sup>; Mi T. Tran, BA<sup>2</sup>; and Moon S. Chen Jr, PhD<sup>1</sup>

**BACKGROUND:** Asian Americans have lower colorectal cancer (CRC) screening rates than non-Hispanic white individuals. Hmong Americans have limited socioeconomic resources and literacy. The current randomized controlled trial was conducted to determine whether bilingual/bicultural lay health educator (LHE) education could increase CRC screening among Hmong Americans. **METHODS:** A cluster randomized controlled trial was conducted among Hmong Americans in Sacramento, California. LHEs and recruited participants were randomized to intervention or control groups. The intervention group received CRC education over 3 months delivered by an LHE. The control group received education regarding nutrition and physical activity delivered by a health educator. The outcomes were changes in self-reported ever-screening and up-to-date CRC screening after 6 months. **RESULTS:** All 329 participants were foreign-born with mostly no formal education, limited English proficiency, and no employment. The majority of the participants were insured and had a regular source of health care. The intervention group experienced greater changes after the intervention than the control group for ever-screening ( $P = .068$ ) and being up-to-date with screening ( $P < .0001$ ). In multivariable regression analyses, the intervention group demonstrated a greater increase than the control group in reporting ever-screening (adjusted odds ratio, 1.73; 95% confidence interval, 1.07-2.79) and being up-to-date with screening (adjusted odds ratio, 1.71; 95% confidence interval, 1.26-2.32). Individuals who had health insurance were found to have >4 times the odds of receiving screening, both ever-screening and up-to-date screening. A higher CRC knowledge score mediated the intervention effect for both screening outcomes. **CONCLUSIONS:** A culturally and linguistically appropriate educational intervention delivered by trained LHEs was found to increase CRC screening in an immigrant population with low levels of education, employment, English proficiency, and literacy. *Cancer* 2016;000:000-000. © 2016 American Cancer Society.

**KEYWORDS:** colorectal cancer, disparities, Hmong, lay health educator, screening.

## INTRODUCTION

Colorectal cancer (CRC) incidence and mortality can be reduced through screening tests, but screening participation is reported to be suboptimal for racial/ethnic minorities and even more so for those with limited English proficiency.<sup>1</sup> In national surveys, fewer Asians have reported CRC screening compared with non-Hispanic whites, even after adjustment for socioeconomic status, access, and language barriers.<sup>2</sup> In California, Asian Americans are less likely to be screened for CRC compared with non-Hispanic white individuals, despite narrowing disparities between 2003 and 2009.<sup>3</sup> Only 64.4% of eligible Californians reported being up to date for CRC screening in the 2013 Behavioral Risk Factor Surveillance System.<sup>4</sup>

To overcome cultural and language barriers, bilingual/bicultural lay health educators (LHEs) who are community members receiving training in health topics have been effective in delivering community-based interventions.<sup>5</sup> LHE interventions have been effective among Vietnamese American and Chinese American individuals for increasing screening rates for CRC<sup>6</sup> and other cancers in randomized controlled trials.<sup>7,8</sup> However, to the best of our knowledge, such trials have

**Corresponding author:** Elisa K. Tong, MD, University of California at Davis, 4150 V St, Ste 2400, University of California at Davis, Sacramento, CA 95817; Fax: (916) 734-2732; [ektong@ucdavis.edu](mailto:ektong@ucdavis.edu)

<sup>1</sup>Department of Internal Medicine, University of California at Davis, Sacramento, California; <sup>2</sup>Department of Internal Medicine, University of California at San Francisco, San Francisco, California; <sup>3</sup>Hmong Women's Heritage Association, Sacramento, California; <sup>4</sup>Department of Public Health Sciences, University of California at Davis, Sacramento, California; <sup>5</sup>Department of Psychiatry, University of California at San Francisco, San Francisco, California; <sup>6</sup>University of New Mexico at Albuquerque, Albuquerque, New Mexico; <sup>7</sup>Fielding School of Public Health and Asian American Studies Center, University of California at Los Angeles, Los Angeles, California; <sup>8</sup>University of Hawai'i at Manoa, Manoa, Hawaii

We thank Youa Lo and May Chee Lo for their research staff assistance with data collection and the rest of the Hmong Women's Heritage Association for their community partnership in support of this study.

**DOI:** 10.1002/cncr.30265, **Received:** June 2, 2016; **Revised:** July 5, 2016; **Accepted:** July 27, 2016, **Published online** Month 00, 2016 in Wiley Online Library ([wileyonlinelibrary.com](http://wileyonlinelibrary.com))

rarely been conducted among Hmong Americans, who have some of the highest rates of poverty (27.4%)<sup>9</sup>; low levels of education<sup>10</sup>; and limited literacy, even in the Hmong language.<sup>10,11</sup> Our team members previously conducted an LHE intervention of in-home education and patient navigation that increased screening for hepatitis B among 260 Hmong adults,<sup>12</sup> and an LHE intervention that increased breast cancer screening among 434 Hmong women.<sup>13</sup>

The objective of the current study was to conduct an LHE-delivered educational intervention to promote CRC screening among Hmong Americans and to evaluate the intervention's impact on CRC screening compared with an attention control with nutrition and physical activity (NPA) education. We hypothesized that participants in the intervention group would report higher increases in ever-screening and being up-to-date with CRC screening compared with those in the control group.

## MATERIALS AND METHODS

### *Community and Academic Partnership*

Using a community-based participatory research (CBPR) approach,<sup>14</sup> we partnered with the Hmong Women's Heritage Association (HWHHA), a community-based organization that has provided services for Hmong families since 1994. Since 2000, the HWHHA and the academic research team have been engaged in a CBPR partnership through the Asian American Network for Cancer Awareness, Research, and Training, a national CBPR network funded by the National Cancer Institute's Center to Reduce Cancer Health Disparities.<sup>12-14</sup> The HWHHA was a full partner in the implementation, evaluation, and dissemination of the current study.

### *Study Design and Setting*

We used a 2-arm cluster randomized controlled trial, with clustering at the level of the LHEs, who were recruited through Hmong radio announcements and HWHHA clients. After receiving training regarding participant recruitment, LHEs recruited participants through their own social networks. Some participants were recruited through radio announcements and HWHHA clients. LHEs were randomized by a computer program to either the intervention or control arm after completing recruitment. The LHEs assigned to the intervention arm were trained to deliver CRC prevention information, whereas the LHEs assigned to the control arm delivered no intervention. The control group participants received NPA education from a health educator. This design enabled a comparison of a LHE intervention versus usual care with attention

control while ensuring that the control group benefited from research participation. All participants attended 2 small-group educational sessions lasting approximately 90 minutes each and separated by 2 months, received 2 follow-up calls approximately 1 month after each session, and completed surveys at baseline and at 6 months. The study was conducted from March 2012 through August 2015 in Sacramento, California. Human subject approval was obtained by the Institutional Review Board of the University of California at San Francisco. The current study is registered at ClinicalTrials.gov (trial registration identifier: NCT01904890).

The current study was powered to detect a net effect size of 0.20 between the intervention and control groups in the percentage of individuals ever-screened for CRC, assuming an effect size of 0.25 in the intervention group and 0.05 in the control group, an LHE cluster size of 12 participants, an intracluster correlation coefficient of 0.05, and an attrition rate of 0.05. We determined the number of participants per LHE based on our prior LHE studies.<sup>7,15</sup>

### *LHEs and Trial Participants*

The study was implemented over 3 time periods (waves). Each LHE participated in only 1 wave. Inclusion criteria initially were for the LHEs to be Hmong and aged  $\geq 50$  years, similar to the trial participants, but due to recruitment problems, the lower age cutoff was changed to 18 years starting in wave 2. The LHEs were native Hmong speakers who also could speak English and their educational background ranged from some high school to college graduates; some LHEs had prior experience acting as LHEs in previous HWHHA projects. Intervention and control LHEs received an identical first training session by the HWHHA but in separate groups to minimize contamination. The first session included a description of the LHE program, roles, and responsibilities, and training in participant recruitment. The LHEs were trained concerning the protection of human subjects in recruitment and participation but did not administer informed consent. After the training, each LHE recruited 12 to 15 participants using a script describing the purpose of the project and the scope of participant involvement. After completing recruitment and being randomized, the intervention LHEs received a second training session to conduct small-group sessions and deliver CRC information. The control LHEs did not receive a second training session because the HWHHA staff delivered the NPA information. Pre-training and posttraining surveys assessed the effect of training on LHE knowledge and confidence, and

additional training was administered as needed. Each LHE was paid \$1200 at the conclusion of the last data collection to reflect the value of their cultural expertise and the time involved in the research.

Eligibility criteria for participants included being aged 50 to 75 years, self-identifying as Hmong, speaking Hmong or English, living and intending to stay in the area for at least 6 months, having no personal history of CRC, having no medical problems preventing them from attending sessions, and being willing to participate in a study regarding CRC screening or NPA. Participants were recruited regardless of their prior CRC screening history to reflect the general community and minimize selection bias. Only 1 person per household could be a participant. At the time of the first educational session, bilingual research staff obtained informed consent by reading from a written document outlining study activities, risks, and benefits. Surveys were administered verbally by research staff given the low literacy level of the participants. Participants were paid \$60 for their research participation, with \$20 paid after the first session (baseline survey) and \$40 paid after the third and final session (6-month survey).

#### ***Development of the Program and Materials***

The CBPR team developed a LHE training program, manual, and flipchart for CRC based on prior interventions.<sup>6,16</sup> The development of the CRC materials was guided by the social cognitive theory<sup>17,18</sup> and the transtheoretical model,<sup>19</sup> specifically addressing: 1) knowledge of CRC risk and prevention; 2) expectations regarding CRC screening (positive anticipatory outcomes of screening)<sup>17,18</sup>; 3) self-efficacy (confidence that one can obtain screening)<sup>17-19</sup>; and 4) intention (motivation and readiness to obtain screening).<sup>19</sup> The CRC flipchart promoted the goal of obtaining any CRC screening at the time interval recommended by the US Preventive Services Task Force.<sup>20</sup> The flipchart described the need for and benefits of screening, the different screening tests, US Preventive Services Task Force recommendations for screening frequency, and barriers to screening through brief educational and culturally appropriate messages. System barriers, such as access to care, were addressed with a list of locally available services, but the current study was not designed to offer patient navigation services. The HWA provided appropriate cultural images and used double simultaneous forward translation<sup>21</sup> for the flipchart into Hmong from English, with review by 2 focus groups and the research team. For the control group, the content of the NPA PowerPoint (Microsoft Corporation, Redmond, Wash)

presentation concerned healthy nutrition (food types and portion and serving sizes) for cardiovascular health and diabetes prevention, based on prior interventions,<sup>6,16</sup> and did not include any information regarding CRC. CRC LHEs were trained to deliver brief follow-up telephone calls to check in on participants regarding questions about CRC and stages of change (readiness to obtain screening). The follow-up telephone calls for the control group were conducted by NPA LHEs who asked participants about their diet.

#### ***Measures***

Surveys were conducted immediately before and 6 months after the first session. Sociodemographic measures included age, sex, birthplace, years in the United States, education, employment, marital status, English language proficiency, and household income. Access was measured by participants reporting whether they had health insurance, had a primary physician, had a regular source of health care, and whether they had seen a physician within the past year. Health status was measured by self-rated health (excellent, very good, good, fair, or poor) and whether a physician had told the participant that he/she had cancer. CRC-related measures included awareness of CRC and screening (colon cancer, colonoscopy, sigmoidoscopy, and fecal occult blood test [FOBT]), knowledge regarding CRC screening, and self-report of test receipt and when the test was obtained. For the multivariable regression analyses, a knowledge score from 5 questions regarding CRC screening was created (score of 0-5 total): 1) heard of colon polyps; 2) frequency of testing for FOBT (yearly); 3) frequency of testing for sigmoidoscopy (every 5 years); 4) frequency of testing for colonoscopy (every 10 years); and 5) age at initiation of CRC screening of 50 years.

#### ***Statistical Analysis***

The main outcome measures were self-reports of: 1) CRC ever-screening (ever had FOBT, sigmoidoscopy, or colonoscopy); and 2) self-reported up-to-date CRC screening (FOBT at 1 year, sigmoidoscopy at 5 years, or colonoscopy at 10 years). Comparison of the study arms with respect to participant characteristics and preintervention/postintervention changes in the percentage screened and awareness were evaluated with generalized linear models. Multivariable logistic regression models were created for reporting ever receiving any CRC screening and being up-to-date with CRC screening as a function of time (post-intervention vs pre-intervention), study arm, and their interactions, adjusted for participant characteristics. To

assess the mediating effects of knowledge, we also created multivariable models of knowledge score and then added knowledge score as a covariate to the models of ever-screening and up-to-date CRC screening. All participants were included in analyses regardless of prior CRC screening history. Generalized estimating equations were used in all models to account for clustering by the LHE. Analyses were conducted on an intention-to-treat basis, with baseline values carried forward for dropouts. All analyses

were conducted with SAS statistical software (version 9.3; SAS Institute Inc, Cary, NC); statistical significance was assessed at a *P* level of .05 (2-sided).

RESULTS

Number of LHE and Trial Participants

Figure 1 shows the Consolidated Standards of Reporting Trials (CONSORT) diagram for participant flow. The study had 29 Hmong LHEs recruited by the community partner. The LHEs ranged in age from 21 to 55 years, 82.7% were women, and 14 of the LHEs were in the intervention group. One LHE in the control group dropped out before study activities began, and that LHE's 2 participants were assigned to another control group LHE. Of 429 eligible participants, 93 (21.7%) refused to participate, and 329 participants were randomized to the intervention (161 participants) and control (168 participants) arms. The retention rate at the 6-month follow-up was 98%, with 5 participants who could not be contacted.

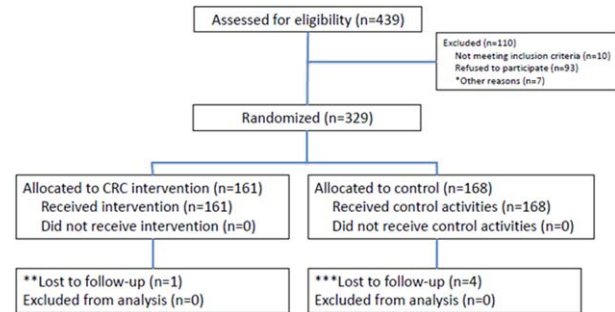


Figure 1. Consolidated Standards of Reporting Trials (CONSORT) diagram of a cluster randomized controlled trial of a lay health educator intervention to promote colorectal cancer (CRC) screening among Hmong Americans.

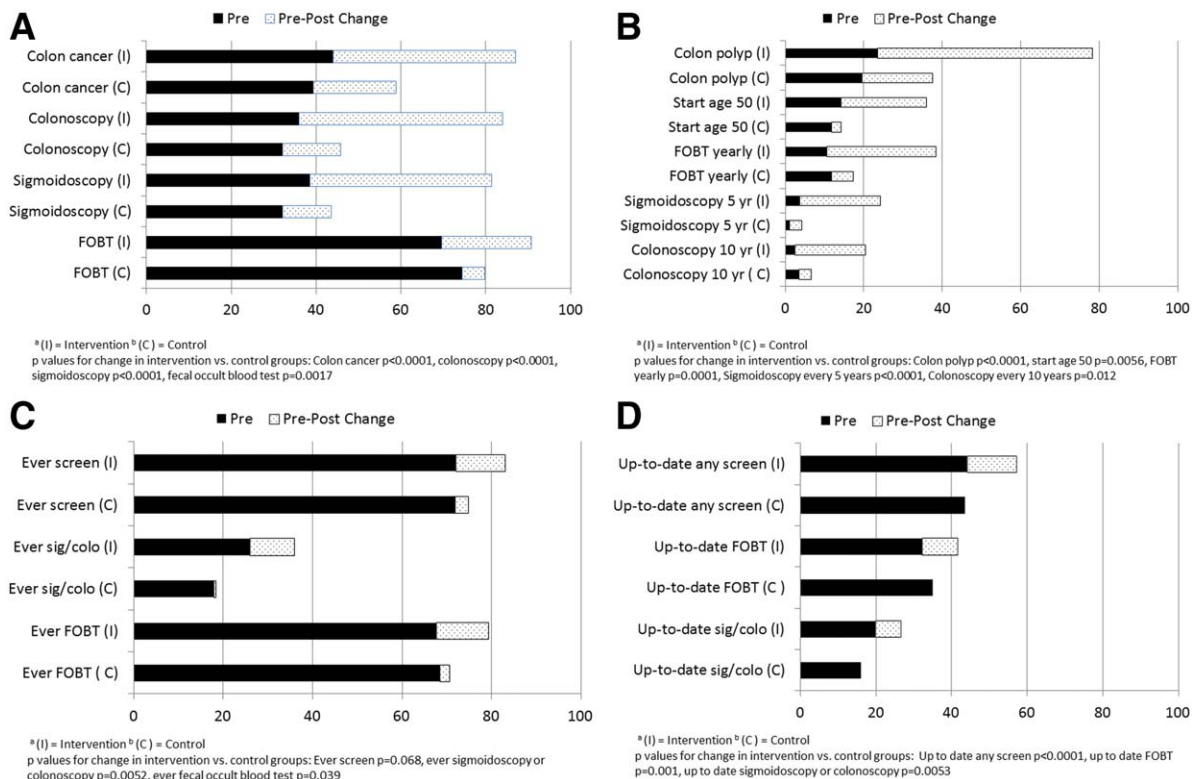
Demographics of the Trial Participants

Participants had a mean age of 60.4 years and for the most part were women and married (Table 1). All were born in

TABLE 1. Demographics of Hmong Participants in the Cluster Randomized Controlled Trial

	Total n=329	NPA Group n=168	CRC Group n=161
<b>Demographics</b>			
Age, y			
50-64	241 (73.3%)	123 (73.2%)	118 (73.8%)
65-75	88 (26.7%)	45 (26.8%)	42 (26.2%)
Female	74.2%	74.4%	73.9%
Married or living with partner	213 (65.3%)	107 (63.7%)	106 (67.1%)
<b>Acculturation</b>			
Born in Laos	100%	100%	100%
Years lived in United States			
>10	271 (83.6%)	136 (81.4%)	135 (86.0%)
≤10	53 (16.4%)	31 (18.6%)	22 (14.0%)
Speak only Hmong at home	294 (89.4%)	152 (90.5%)	142 (88.2%)
Speak English poorly or not at all	232 (70.5%)	124 (73.8%)	108 (67.1%)
<b>Socioeconomic status</b>			
No formal education	292 (88.8%)	154 (91.7%)	138 (85.7%)
Not employed	299 (90.9%)	154 (91.7%)	145 (90.1%)
Household income			
<\$20,000/y	177 (53.8%)	94 (56.0%)	83 (51.6%)
≥\$20,000/y	13 (4.0%)	7 (4.2%)	6 (3.7%)
Do not know/missing	139 (42.2%)	67 (39.9%)	72 (44.7%)
<b>Health care access</b>			
Have health insurance	313 (95.1%)	162 (96.4%)	151 (93.8%)
Have regular source of health care	310 (94.2%)	159 (94.6%)	151 (93.8%)
Saw physician within past y	279 (84.8%)	146 (86.9%)	133 (82.6%)
Has primary physician	303 (92.1%)	155 (92.3%)	148 (91.9%)
<b>Health status</b>			
General health			
Excellent/good	169 (52.8%)	86 (53.8%)	83 (51.9%)
Fair/poor	151 (47.2%)	74 (46.3%)	77 (48.1%)
Physician said you had cancer	2 (0.6%)	1 (0.6%)	1 (0.6%)

Abbreviations: CRC, colorectal cancer; NPA, nutrition and physical activity.



Laos, with 83.6% of the participants having lived in the United States for >10 years. Greater than 89% spoke only Hmong at home and 70.5% reported speaking English poorly or not at all. Participants also had low socioeconomic status: 53.8% reported annual household incomes of <\$20,000, approximately 88.8% reported no formal education, and approximately 90.9% reported no employment. Health care access was high, with 95.1% having health insurance, 94.2% having a regular source of health care, 92.1% having a primary care physician, and 84.8% having seen a physician within the past year. Nearly one-half of participants rated their general health as fair or poor. No significant differences were noted between participants in the intervention and control arms.

#### Change in Screening Knowledge and Behavior

Figure 2A shows that at baseline, the majority of participants had heard about FOBT, but the intervention group had significantly greater increases in post-intervention awareness compared with the control group (intervention group: 69.6%-90.7%; control group: 74.4%-79.8% [ $P = .0017$ ]). Fewer participants were aware of other

terms at baseline, but the intervention group also demonstrated significantly greater increases in awareness after the intervention than the control group for colon cancer (intervention group: 44.1%-87.0%; control group: 39.3%-58.9% [ $P < .0001$ ]), colonoscopy (intervention group: 36.0%-83.9%; control group: 32.1%-45.8% [ $P < .0001$ ]), and sigmoidoscopy (intervention group: 38.5%-81.4%; control group: 32.1%-43.5% [ $P < .0001$ ]).

As shown in Figure 2B, at baseline very few participants knew anything about CRC guidelines, such as initiating screening at age 50 years or knowing the frequency of tests. Post-intervention, the intervention group had significantly greater increases in knowledge compared with the control group for colon polyps (intervention group: 23.6%-78.3%; control group: 19.6%-37.5% [ $P < .0001$ ]), initiating screening at age 50 years (intervention group: 14.3%-36.0%; control group: 11.9%-14.3% [ $P = .0056$ ]), undergoing FOBT yearly (intervention group: 10.6%-38.5%; control group: 11.9%-17.3% [ $P = .0001$ ]), undergoing a sigmoidoscopy every 5 years (intervention group: 3.7%-24.2%; control group: 1.2%-4.2% [ $P < .0001$ ]), and undergoing a

**TABLE 2.** Multivariable Regression Analyses of CRC Screening Behaviors and Knowledge as a Mediator in the Hmong Lay Health Educator Trial (N=329)

	Ever-Screen	Ever-Screen with Knowledge	Up-to-Date Screen	Up-to-Date Screen With Knowledge
	AOR (95% CI)		AOR (95% CI)	
CRC group (post vs pre)	1.95 (1.40-2.72) <sup>a</sup>	1.41 (0.91-2.19)	1.73 (1.34-2.21) <sup>a</sup>	1.01 (0.67-1.51)
NPA group (post vs pre)	1.13 (0.79-1.62)	1.05 (0.71-1.56)	1.01 (0.84-1.20)	0.88 (0.73-1.06)
CRC change vs NPA change	1.73 (1.07-2.79) <sup>b</sup>	1.35 (0.79-2.30)	1.71 (1.26-2.32) <sup>a</sup>	1.14 (0.75-1.73)
Age ≥ 65 y	1.13 (0.66-1.93)	1.23 (0.73-2.07)	0.88 (0.55-1.41)	1.02 (0.64-1.63)
Male	0.79 (0.45-1.40)	0.77 (0.44-1.36)	1.17 (0.71-1.91)	1.12 (0.68-1.84)
>10 y in United States	1.16 (0.64-2.11)	1.10 (0.61-2.00)	0.90 (0.60-1.33)	0.82 (0.54-1.24)
Married	1.26 (0.89-1.78)	1.24 (0.88-1.75)	1.11 (0.74-1.66)	1.08 (0.72-1.63)
Seen physician within past y	1.25 (0.52-3.01)	1.20 (0.51-2.82)	3.38 (1.88-6.06) <sup>a</sup>	3.25 (1.81-5.84) <sup>a</sup>
Employed	0.67 (0.29-1.53)	0.67 (0.31-1.45)	1.23 (0.46-3.31)	1.21 (0.48-3.02)
Income				
≥\$20,000 vs <\$20,000	2.23 (0.50-10.0)	1.99 (0.44-8.94)	1.39 (0.44-4.35)	1.11 (0.37-3.34)
DK vs <\$20,000	0.81 (0.57-1.16)	0.82 (0.58-1.17)	0.95 (0.64-1.40)	0.97 (0.67-1.42)
Insured	4.47 (2.18-9.17) <sup>a</sup>	4.22 (2.10-8.48) <sup>a</sup>	4.97 (1.35-18.3) <sup>b</sup>	4.24 (1.24-14.52) <sup>b</sup>
Formal education	0.95 (0.51-1.78)	0.92 (0.50-1.69)	0.74 (0.34-1.57)	0.71 (0.35-1.44)
Ability to speak English (poorly/not at all vs fluent/well/so-so)	0.75 (0.43-1.30)	0.78 (0.45-1.36)	0.68 (0.45-1.03)	0.73 (0.48-1.12)
General health (≥good vs fair/poor)	0.90 (0.58-1.40)	0.90 (0.58-1.41)	0.93 (0.63-1.36)	0.94 (0.64-1.38)
Knowledge of CRC (5-point scale)	NA	1.29 (1.08-1.55) <sup>c</sup>	NA	1.49 (1.24-1.79) <sup>a</sup>

Abbreviations: 95% CI, 95% confidence interval; CRC, colorectal cancer; DK, Don't Know; NA, not applicable; NPA, nutrition and physical activity; AOR, adjusted odds ratio; pre, pre-intervention; post, post-intervention.

All models used generalized estimating equations to account for clustering of participants by lay health educator and included 645 pre-intervention and post-intervention observations.

<sup>a</sup> $P < .001$ .

<sup>b</sup> $P = .02$ .

<sup>c</sup> $P = .006$ .

colonoscopy every 10 years (intervention group: 2.5%-20.5%; control group: 3.6%-6.5% [ $P = .012$ ]).

Figure 2C shows that between the pre-intervention and post-intervention periods, the intervention group had significantly greater increases than the control group with regards to ever having undergone an FOBT (intervention group: 67.7%-79.5%; control group: 68.5%-70.8% [ $P = .039$ ]) and sigmoidoscopy or colonoscopy (intervention group: 26.1%-36.0%; control group: 18.5%-17.9% [ $P = .0052$ ]). The increase in the intervention group compared with the control group in ever-screening for CRC was borderline significant (intervention group: 72.1%-83.2%; control group: 72.0%-75.0% [ $P = .068$ ]).

The intervention group had significantly greater increases in being up-to-date with CRC screening (intervention group: 44.1%-57.1%; control group: 43.5%-43.5% [ $P < .0001$ ]), FOBT (intervention group: 32.3%-41.6%; control group: 35.1%-34.5% [ $P = .001$ ]), and sigmoidoscopy or colonoscopy (intervention group: 19.9%-26.7%; control group: 16.1%-14.3% [ $P = .0053$ ]) (Fig. 2D).

#### **Multivariable Regression Analyses Regarding Screening Behavior and Knowledge as Mediator**

Table 2 shows the multivariable regression analyses for the intervention effect. From the pre-intervention to the

post-intervention period, the LHE intervention group demonstrated significant increases in ever-screening (adjusted odds ratio [AOR], 1.95; 95% confidence interval [95% CI], 1.40-2.72) and being up-to-date with screening (AOR, 1.73; 95% CI, 1.34-2.21). The LHE intervention group was superior to the control group, who did not demonstrate significant changes in screening outcomes, for ever-screening (OR, 1.73; 95% CI, 1.07-2.79) and being up-to-date with screening (OR, 1.71; 95% CI, 1.26-2.32). When knowledge score was added to the models, the intervention effect became nonsignificant. For every point increase on the knowledge score on a point scale of 0 to 5, the odds of ever-screening (OR, 1.29; 95% CI, 1.08-1.55) and being up to date with screening (OR, 1.49; 95% CI, 1.24-1.79) were significantly increased, which supported knowledge being a mediator of the intervention effect. Having health insurance was found to be highly associated with screening outcomes in all models, with an OR  $>4$ , whereas having seen a physician within the past year was found to be associated with being up-to-date with screening.

#### **DISCUSSION**

The results of the current study demonstrated that a culturally and linguistically appropriate educational

intervention delivered by trained LHEs is effective in increasing both ever-screening and being up-to-date with CRC screening among Hmong Americans. The up-to-date screening rate (57.1%) reported after the intervention among Hmong Americans is comparable to what has been reported post-intervention for similar interventions with Vietnamese Americans (56%)<sup>6</sup> and Chinese Americans (55.7% for FOBT),<sup>16</sup> and approaches the rate reported for the general population who are fluent in English (59.6%).<sup>2,22</sup> Taken together, these studies indicate that LHE interventions that are culturally and linguistically appropriate are effective in increasing CRC screening among Asian American individuals with limited English proficiency. The intervention effect sizes in the current study are comparable to those of clinic-based interventions to increase CRC screening among disadvantaged populations with direct offering of FOBT kits.<sup>23-25</sup> However, the postintervention CRC up-to-date screening rate of 57% falls below the National Colorectal Cancer Roundtable's screening goal of 80%.<sup>22</sup> Although > 70% of the participants at baseline reported ever-screening (mostly with FOBT), it is possible that the 6-month time period of the current study was too short for participants to schedule and complete a physician's appointment or obtain a sigmoidoscopy or colonoscopy.

The finding of knowledge as a mediator of lay health education in this population is significant in that it provides evidence of a pathway for increasing CRC screening. Previous research<sup>26,27</sup> has demonstrated an association between changes in knowledge and intention to obtain screening, but to the best of our knowledge few studies to date have shown a direct association between changes in knowledge and screening outcomes. The LHEs' verbal and visual flipchart delivery of education regarding CRC screening helps to address the fact that Hmong Americans in general have low educational levels and limited literacy, even in their own language.<sup>10</sup> Visual tools previously have been described as effective teaching methods for the Hmong community to promote screening for breast and cervical cancer.<sup>28,29</sup> In addition, the sociocultural relationship between LHEs and their participants may be helpful in encouraging participation in questions or discussions concerning screening.<sup>30</sup> For example, LHEs might help to address any conflicting cultural beliefs and norms regarding cancer screening, such as any uncertainty about Western treatments<sup>10</sup> for the Hmong participant.

The results of the current study also demonstrate that even among a population with high health care access, having health insurance remains a significant factor

associated with the receipt of CRC screening. Nevertheless, economic barriers may extend beyond health insurance, because publicly insured adults have reported barriers such as cost and coverage.<sup>31</sup> One Hmong study regarding barriers to care reported that, more so than medical mistrust or discrimination, the issues of a lack of health insurance, making copayments, language, and those related to scheduling appointments were important.<sup>32</sup> LHEs in the current study provided mostly informational and social support, not logistical support. Patient navigators<sup>33</sup> could lead to a larger intervention effect, but that would require more resources. With the Centers for Medicare and Medicaid Services "Final Rule for Strengthening Medicaid, The Children's Health Insurance Program and The New Health Insurance Marketplace (CMS-2334-F)" opening up payment opportunities for preventive services by nonlicensed individuals,<sup>34</sup> this effort might be more feasible in future. An enhanced intervention for the future might incorporate this LHE-delivered intervention to address changes in attitude and knowledge, plus a patient navigation component to address logistical support for increased CRC screening rates.

There are several limitations to the current study. First, the results from Hmong living within one county in California may not be generalizable to all Hmong Americans, although Sacramento has the third largest Hmong population in the United States.<sup>11</sup> Second, the small community could have created contamination of the control group; however, that would reduce the intervention effect size and therefore if this contamination was present, it would strengthen the conclusions. Third, it is possible that LHEs may choose participants who may be more likely to undergo screening, but we attempted to account for this selection bias by blinding LHEs and participants to study arm assignment until after recruitment was completed. Fourth, the current study includes individuals who were up-to-date with screening at baseline, but the increase in being up-to-date was significantly greater in the intervention group in the multivariate regression analyses. Finally, the study outcomes are self-reported, which may lead to social desirability bias among intervention participants to report CRC screening. Validation of self-reports would have been ideal, but would have been difficult given study budget limitations due to the large number of health care providers in this community. However, a CRC education intervention for Filipino American individuals found that the intervention effect for CRC screening was upheld when self-report bias was taken into account.<sup>35</sup>

## Conclusions

The significant contribution of the current study is that it demonstrates the effectiveness of LHEs in increasing CRC screening behavior through greater knowledge among Hmong Americans, a population with significant socioeconomic and health disparities. The strengths of the current study include the cluster randomized controlled trial study design, the high participation and retention rates, and the diverse participant sample. To meet the national goal of 80% CRC screening among immigrant populations such as the Hmong, there is an urgent need for increased training of bilingual, bicultural LHEs to deliver culturally and linguistically appropriate CRC education that can help to improve community engagement with health care services. Further research could help to identify what is needed to reduce additional barriers to CRC screening in the Hmong community and describe the elements of what makes LHEs work and their cost-effectiveness.<sup>5,36</sup> Future studies also may consider studying the use of LHEs for the management of other non-cancer health issues<sup>5,37-39</sup> for the Hmong population.

## FUNDING SUPPORT

Supported by a grant from the National Cancer Institute (U54 CA153499). The opinions expressed in this article reflect those of the authors and are not necessarily those of the National Cancer Institute.

## CONFLICT OF INTEREST DISCLOSURES

The authors made no disclosures.

## AUTHOR CONTRIBUTIONS

**Elisa K. Tong:** Conceptualization, methodology, formal analysis, writing-original draft, visualization, and project administration. **Tung T. Nguyen:** Conceptualization, methodology, formal analysis, writing-original draft, supervision, project administration, and funding acquisition. **Penny Lo:** Conceptualization, methodology, validation, investigation, writing-original draft, and project administration. **Susan L. Stewart:** Conceptualization, methodology, software, validation, formal analysis, writing-original draft, visualization, supervision, and funding acquisition. **Ginny L. Gildengorin:** Conceptualization, methodology, software, validation, formal analysis, and writing-review and editing. **Janice Y. Tsoh:** Conceptualization, methodology, formal analysis, and writing-original draft. **Angela M. Jo:** Conceptualization, methodology, and writing-review and editing. **Marjorie L. Kagawa-Singer:** Conceptualization, methodology, and writing-review and editing. **Angela U. Sy:** Conceptualization, methodology, and writing-review and editing. **Charlene Cuaresma:** Conceptualization, methodology, and writing-review and editing. **Hy T. Lam:** Conceptualization, methodology, software, validation, resources, data curation, writing-review and editing, and project administration. **Ching Wong:** Conceptualization, methodology, resources, writing-review and editing, and project administration. **Mi T. Tran:** Validation,

data curation, writing-review and editing, and project administration. **Moon S. Chen Jr:** Writing-original draft, supervision, and funding acquisition.

## REFERENCES

- Gupta S, Sussman DA, Doubeni CA, et al. Challenges and possible solutions to colorectal cancer screening for the underserved. *J Natl Cancer Inst.* 2014;106:dju032.
- Liss DT, Baker DW. Understanding current racial/ethnic disparities in colorectal cancer screening in the United States: the contribution of socioeconomic status and access to care. *Am J Prev Med.* 2014;46:228-236.
- Fedewa SA, Sauer AG, Siegel RL, Smith RA, Torre LA, Jemal A. Temporal trends in colorectal cancer screening among Asian Americans. *Cancer Epidemiol Biomarkers Prev.* 2016;25:995-1000.
- California Department of Public Health. Snapshot: BRFSS Data, A Quick Look at California's Health Behaviors. Sacramento, CA: California Department of Public Health; 2016.
- Kim K, Choi JS, Choi E, et al. Effects of community-based health worker interventions to improve chronic disease management and care among vulnerable populations: a systematic review. *Am J Public Health.* 2016;106:e3-e28.
- Nguyen BH, Stewart SL, Nguyen TT, Bui-Tong N, McPhee SJ. Effectiveness of lay health worker outreach in reducing disparities in colorectal cancer screening in Vietnamese Americans. *Am J Public Health.* 2015;105:2083-2089.
- Nguyen TT, Le G, Nguyen T, et al. Breast cancer screening among Vietnamese Americans: a randomized controlled trial of lay health worker outreach. *Am J Prev Med.* 2009;37:306-313.
- Taylor VM, Jackson JC, Yasui Y, et al. Evaluation of a cervical cancer control intervention using lay health workers for Vietnamese American women. *Am J Public Health.* 2010;100:1924-1929.
- White House Initiative on Asian Americans and Pacific Islanders. Key Facts and Figures on Asian Americans and Pacific Islanders. <https://www.whitehouse.gov/administration/eop/aapi/data/facts-and-figures>. Accessed August 2, 2016.
- Lee HY, Vang S. Barriers to cancer screening in Hmong Americans: the influence of health care accessibility, culture, and cancer literacy. *J Community Health.* 2010;35:302-314.
- Pfeifer M, Sullivan J, Yang K, Yang W. Hmong Population and Demographic Trends in the 2010 Census and 2010 American Community Survey. Washington, DC: Hmong National Development; 2013.
- Chen MS, Fang DM, Stewart SL, et al. Increasing hepatitis B screening for Hmong adults: results from a randomized controlled community-based study. *Cancer Epidemiol Biomarkers Prev.* 2013;22:782-791.
- Kagawa-Singer M, Tanjasiri SP, Valdez A, Yu H, Foo MA. Outcomes of a breast health project for Hmong women and men in California. *Am J Public Health.* 2009;99(suppl 2):S467-S473.
- Braun KL, Nguyen TT, Tanjasiri SP, et al. Operationalization of community-based participatory research principles: assessment of the National Cancer Institute's community network programs. *Am J Public Health.* 2012;102:1195-1203.
- Mock J, McPhee SJ, Nguyen T, et al. Effective lay health worker outreach and media-based education for promoting cervical cancer screening among Vietnamese American women. *Am J Public Health.* 2007;97:1693-1700.
- Nguyen TT, Love MB, Liang C, et al. A pilot study of lay health worker outreach and colorectal cancer screening among Chinese Americans. *J Cancer Educ.* 2010;25:405-412.
- Bandura A. *Social Foundations of Thought and Action: A Social Cognitive Theory.* Englewood Cliffs, NJ: Prentice Hall; 1986.
- Bandura A. Social cognitive theory: an agentic perspective. *Annu Rev Psychol.* 2001;52:1-26.
- Prochaska JO, Velicer WF. The transtheoretical model of health behavior change. *Am J Health Promot.* 1997;12:38-48.
- US Preventive Services Task Force. Screening for colorectal cancer: U.S. Preventive Services Task Force recommendation statement. *Ann Intern Med.* 2008;149:627-637.



21. Ponce NA, Lavarreda SA, Yen W, Brown ER, DiSogra C, Satter DE. The California Health Interview Survey 2001: translation of a major survey for California's multiethnic population. *Public Health Rep.* 2004;119:388-395.
22. Meester RG, Doubeni CA, Zauber AG, et al. Public health impact of achieving 80% colorectal cancer screening rates in the United States by 2018. *Cancer.* 2015;121:2281-2285.
23. Potter MB, Yu TM, Gildengorin G, et al. Adaptation of the FLU-FOBT program for a primary care clinic serving a low-income Chinese American community: new evidence of effectiveness. *J Health Care Poor Underserved.* 2011;22:284-295.
24. Potter MB, Walsh JM, Yu TM, Gildengorin G, Green LW, McPhee SJ. The effectiveness of the FLU-FOBT program in primary care: a randomized trial. *Am J Prev Med.* 2011;41:9-16.
25. Walsh JM, Salazar R, Nguyen TT, et al. Healthy colon, healthy life: a novel colorectal cancer screening intervention. *Am J Prev Med.* 2010;39:1-14.
26. Koo JH, Arasaratnam MM, Liu K, et al. Knowledge, perception and practices of colorectal cancer screening in an ethnically diverse population. *Cancer Epidemiol.* 2010;34:604-610.
27. Gimeno Garcia AZ, Hernandez Alvarez Buylla N, Nicolas-Perez D, Quintero E. Public awareness of colorectal cancer screening: knowledge, attitudes, and interventions for increasing screening uptake. *ISRN Oncol.* 2014;2014:425787.
28. Lor M, Bowers B. Evaluating teaching techniques in the Hmong breast and cervical cancer health awareness project. *J Cancer Educ.* 2014;29:358-365.
29. Tanjasiri SP, Kagawa-Singer M, Foo MA, et al. Designing culturally and linguistically appropriate health interventions: the "Life Is Precious" Hmong breast cancer study. *Health Educ Behav.* 2007;34:140-153.
30. Ngoc Nguyen TU, Tanjasiri SP, Kagawa-Singer M, Tran JH, Foo MA. Community health navigators for breast- and cervical-cancer screening among Cambodian and Laotian women: intervention strategies and relationship-building processes. *Health Promot Pract.* 2008;9:356-367.
31. Call KT, McAlpine DD, Garcia CM, et al. Barriers to care in an ethnically diverse publicly insured population: is health care reform enough? *Med Care.* 2014;52:720-727.
32. Thorburn S, Kue J, Keon KL, Lo P. Medical mistrust and discrimination in health care: a qualitative study of Hmong women and men. *J Community Health.* 2012;37:822-829.
33. Braun KL, Kagawa-Singer M, Holden AE, et al. Cancer patient navigator tasks across the cancer care continuum. *J Health Care Poor Underserved.* 2012;23:398-413.
34. National Center for Chronic Disease Prevention and Health Promotion. Addressing Chronic Disease Through Community Health Workers: A Policy and Systems-Level Approach. 2nd ed. Atlanta, GA: National Center for Chronic Disease Prevention and Health Promotion; 2015.
35. Maxwell AE, Crespi CM, Danao LL, Antonio C, Garcia GM, Bastani R. Alternative approaches to assessing intervention effectiveness in randomized trials: application in a colorectal cancer screening study. *Cancer Causes Control.* 2011;22:1233-1241.
36. Bensink ME, Ramsey SD, Battaglia T, et al; Patient Navigation Research Program. Costs and outcomes evaluation of patient navigation after abnormal cancer screening: evidence from the Patient Navigation Research Program. *Cancer.* 2014;120:570-578.
37. Kangovi S, Mitra N, Grande D, et al. Patient-centered community health worker intervention to improve posthospital outcomes: a randomized clinical trial. *JAMA Intern Med.* 2014;174:535-543.
38. Kim MT, Kim KB, Huh B, et al. The effect of a community-based self-help intervention: Korean Americans with type 2 diabetes. *Am J Prev Med.* 2015;49:726-737.
39. Krieger J, Song L, Philby M. Community health worker home visits for adults with uncontrolled asthma: the HomeBASE Trial randomized clinical trial. *JAMA Intern Med.* 2015;175:109-117.