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Low Health Literacy and Cancer Screening among Chinese Americans in California

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Abstract

Objectives. Cancer is the leading cause of death among Asian Americans. Chinese Americans comprise the largest Asian American ethnic group. Low health literacy (LHL) is associated with lower cancer screening rates, but this association has not been studied in Chinese Americans. We examined the relationship between LHL and meeting US Preventive Service Task Force (USPSTF) guidelines for cervical, colorectal, and breast cancer screening among Chinese Americans.

Design. Observational study of Chinese respondents from the 2007 California Health Interview Survey, a population-based survey.

Setting. California, USA

Participants. We analyzed up-to-date screening receipt by low health literacy for age/gender groupings targeted by USPSTF cancer screening guidelines (cervical: women ages 21-65, n=632; colorectal: men or women ages 50-75, n=480; and breast: women ages 50-74, n=326).

Outcomes. Relationships were tested using multivariable logistic regression models controlling for US nativity, age, sex, marital status, insurance, education, living in a rural area, poverty and limited English proficiency (LEP). The combined effects of having both LHL and LEP were specifically examined. LHL, LEP, cancer screening and control variables were from self-reported measures.

Results. Up-to-date cancer screening percentages among Chinese Americans were 77.8% for cervical, 50.9% for colorectal, and 85.5% for breast. LHL was associated with lower odds of meeting screening guidelines for cervical (OR:0.38;95%CI:0.17-0.86) and breast (OR:0.25;95%CI:0.13-0.48) cancer with LEP and other demographic variables controlled. Respondents with both LHL and LEP were significantly less likely to have up-to-date colorectal (OR:0.12; 95%CI:0.05-0.25) and breast cancer screening (OR:0.45;95%CI:0.23-0.86) than those with neither health communication barrier.

Conclusions. In Chinese Americans, LHL was negatively associated with up-to-date breast and cervical cancer screening, and the combination of LHL and LEP was negatively associated with up-to-date colorectal and breast cancer screening. Efforts to promote cancer screening among Chinese Americans should consider and address both LHL and LEP.

Strengths and Limitations of This Study

- This study provides new information about the important, distinct roles of low health literacy and limited English proficiency in cancer screening guideline adherence among Chinese Americans using a population-based sample.
- We found that low health literacy was negatively associated with up-to-date breast and cervical cancer screening among Chinese Americans.
- We also found that the combination of low health literacy and limited English proficiency was negatively associated with up-to-date colorectal and breast cancer screening among Chinese Americans.
- This study took place in California and used self-reported health literacy measures. Future work should consider the generalizability of these findings across other communities and other health literacy domains.
- Efforts to promote screening in Chinese American communities should consider the health communication barriers of low health literacy and LEP separately and in combination to improve screening rates in these populations.

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Cancer is the leading cause of death among Asian Americans (1). Chinese Americans comprise the largest Asian ethnic group in the United States (US) (2) and have particularly low cancer screening rates (3, 4). For instance, Chinese American women are less likely than many Asian American and Pacific Islander women to report having a recent Pap smear or mammogram (3, 4). Underuse of colon cancer screening is also seen among Chinese American men and women (5). Gaining a better understanding of the predictors of cancer screening among distinct Asian American populations, such as Chinese Americans, is important for targeted cancer control interventions (6, 7).

Health literacy, "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services for appropriate health decisions," (8) is an established correlate to cancer screening (9, 10). Low health literacy is associated with limited knowledge about cancer screening, lack of desire for screening, and poorer access (11-19). Limited research has focused on low health literacy in cancer screening among Chinese Americans specifically.

An additional issue to consider for cancer screening in Chinese Americans is limited English proficiency (LEP). Over half (58%) of Chinese Americans have LEP, a major health communication barrier (20). Previous studies have found that LEP is associated with lower rates of cancer screening generally and specifically in Chinese Americans (21-23). For instance, 57% of Chinese American women with limited English-proficiency reported having a Pap test compared to 76% with English-proficiency (23). A recent analysis of a population-based database in California found that Asian Americans with both LEP and low health literacy, or with LEP-only, were significantly less likely to be screened compared to those with neither limited literacy nor LEP (19).

This study had two primary aims. The first was to examine the relationship between low health literacy and meeting the US Preventive Service Task Force (USPSTF) guidelines for cervical, colorectal, and breast cancer screening among Chinese Americans in California (24,

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25, 26). These three cancers share four traits—they represent significant public health problems, have strong methods for early detection, have evidence that screening is useful, and show disparities among Asian American groups (3-8). The second aim was to quantify the combined burdens of low health literacy and limited English proficiency on meeting the guidelines. Evidence suggests that the combination of these two health communication barriers may indicate a particular vulnerability to not receiving recommended cancer screening (19).

Methods

Sample. The 2007 California Health Interview Survey (CHIS) (27) was used. The CHIS is a random-digit-dial telephone survey administered by UCLA Center for Health Policy Research. The CHIS is a representative sample of California, which is home to 4 out of every 10 Asian Americans in the US (28). The CHIS interviews in Mandarin and Cantonese (29) allowing for participation by Chinese individuals with limited English Proficiency. CHIS English proficiency and cancer screening variables have been used extensively in other studies on this subject (30-34).

Outcomes. Breast Cancer: In the 2007 CHIS, following National Health Interview Survey protocol (35), women 30 years and older were asked if they ever had a mammogram. Those who had received one were asked "How long ago did you have your most recent mammogram?" USPSTF (24) defines meeting breast cancer screening guidelines as having a mammogram in the past 1-2 years for women aged 50-74. Cervical Cancer: Women 18+ who were not currently pregnant and had never had a hysterectomy were asked if they ever had a Pap smear. If yes, they were asked "How long ago did you have your most recent Pap smear test?" Following USPSTF (25) guidelines, meeting cervical cancer screening was defined as a Pap smear in the past 1-3 years for women aged 21-65. Colorectal Cancer: Compliance with colorectal screening guidelines was obtained for all participants 50 years and older based on a series of cancer screening variables concerning FOBT in the past year, a flexible sigmidoscopy or double-contrast barium enema in the past 5 years, or a colonoscopy in the past 10 years, per

USPSTF guidelines (26). Respondents who reported a colorectal cancer (CRC) test were asked if they completed the test due to a problem. (Approximately 4-8%, depending on the specific CRC test, did so.) Meeting colorectal cancer screening guidelines was defined as "yes" for the compliance guideline variable for men and women 50-75 excluding the 4-8% who took a CRC test due to a problem, as utilization for diagnostic purposes may be subject to different factors than screening.

Low Health Literacy. Health literacy in the 2007 CHIS was assessed by two questions: (1) "When you get written information at a doctor's office, would you say that it is very easy, somewhat easy, somewhat difficult, or very difficult to understand?" and (2) "When you read the instructions on a prescription bottle, would you say that it is very easy, somewhat easy, somewhat difficult, or very difficult to understand?" Respondents could report not getting written information (<4% of all respondents) or not using prescription medicine (<2% of all respondents). In the full sample, <1% of the sample lack a response to either question. Low health literacy was defined as responding that either one of these two tasks were "somewhat" or "very difficult" to understand (19, 36, 37).

Limited English Proficiency. Respondents who spoke any language(s) at home besides English were asked: "Since you speak a language other than English at home, we are interested in your own opinion of how well you speak English. Would you say you speak English very well, well, not well, or not at all?" LEP was defined as self-reporting speaking English "not well" and "not at all." This LEP variable is considered a superior measure for language barriers in health (38), has strong face validity, and is standard in many studies (39, 40).

Low Health Literacy and LEP Combined Burdens. Previous research has found that having both low health literacy and LEP together is associated with notably poor rates of colorectal cancer screening (19) as well as other health disparities, such as poor health (37). Thus, a four-category variable was created using low health literacy and LEP combinations,

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coded 1=both LEP and low health literacy, 2=only LEP, 3=only low health literacy, and 4=neither LEP nor low health literacy.

Covariates. For multivariable models, control variables included: Age (continuous 18-75), sex (male or female, as relevant), education (less than high school, high school graduate, college graduate, more than college), poverty ($\leq$100%, of poverty vs. not), living in a rural area (vs. not), current insurance (vs. none), being born in the US (vs. elsewhere), and marital status (married vs. other). These variables are associated with health literacy, limited English proficiency and/or cancer screening in other studies (41).

Language Concordance. Based on previous research (42), we also examined the role of patient-provider language concordance in compliance with cancer screening guidelines specifically among those with limited English proficiency. The patient-provider language concordance variable had two groups: (1) other-language concordant (patients and providers spoke the same non-English language) or (2) language discordant (patient did not share a language with their provider) (19, 43). For Chinese Americans with LEP, we first considered whether the language concordance variable had a significant relationship with each type of cancer screening in bivariate models. Then, for screening types in which a significant relationship was found for language concordance, language concordance was included in final multivariable models.

Samples. This study includes 3 samples as different age groups and gender combinations are targeted by a distinct set of screening guidelines. Following the USPSTF guidelines (24-26), the cervical cancer sample included women ages 21-65, the breast cancer sample included women ages 50-74, and the colorectal cancer sample included men or women ages 50-75. All samples excluded individuals with missing health literacy measures and/or missing information regarding the screening outcome of interest. The unweighted sample sizes are as follows: cervical: 632; colorectal: 480; and breast: 326.

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Statistical Methods. The 2007 CHIS public-use data file was used for all analyses. All data were analyzed in STATA 10.0 (44) using appropriate weighting methods to both correct for the complex sample design and to provide population-level estimates (45). We first report descriptive statistics and cancer screening by low health literacy, compared using chi-square analyses. We then ran multivariable logistic regression models predicting cancer screening for each sample by low health literacy with LEP and other variables (US nativity, age, sex, marital status, insurance, education, living in a rural area, and poverty) controlled. To test the relative influence of low health literacy and LEP, all tests of statistical significance were two sided.

We then ran the same models including the four LEP and low health literacy combination groupings to examine and quantify the combined low health literacy and LEP burdens on cancer screening. Having neither low health literacy nor LEP was the reference group.

This study was deemed exempt by the University of Hawaii IRB.

Results

As seen in Table 1, 85.5% met breast cancer screening guidelines, 77.8% met cervical screening guidelines, and 50.9% met colorectal screening guidelines. Low health literacy was almost 30% or higher among all samples. LEP was above 40% in the breast cancer and CRC cancer screening samples, and almost 30% in the cervical cancer group. Many individuals had both LEP and low health literacy: 29% in the breast screening sample; 17% in the cervical sample, and 27% in the CRC sample. Of interest, 84% or more of each sample was born outside of the USA, 45-60% of each sample had a college degree (although perhaps from another country), 12-16% were living at or under 100% of the federal poverty level, and about 8-15% were uninsured.

As seen in Table 2, in fully adjusted models including low health literacy and LEP, low health literacy was significantly (p<0.05) associated with lower odds of meeting breast (OR: 0.25; 95% CI:0.13-0.48) and cervical (OR: 0.38; 95% CI:0.17-0.86) cancer screening guidelines,

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but was not significantly associated with meeting colorectal cancer screening guidelines (OR: 0.63; 95% CI:0.35-1.17). LEP was independently significant in the breast cancer screening model. No other variables were significantly associated with mammography in the multivariable model. Age (older) and marital status (married) predicted screening in the cervical cancer sample. Age (older) predicted screening in the CRC screening model.

Data on compliance with screening guidelines by the four low health literacy-LEP combination groups are shown graphically in Figure 1. For breast cancer, 69.2% of those with both LEP and low health literacy met screening guidelines, while the other three groups had over 88% screening rates (Figure 1). For CRC screening, only 39% of those with both LEP and low health literacy met screening guidelines, compared to 61% of those with neither LEP nor low health literacy. However, for cervical cancer screening, the LEP and low health literacy group was not the group with the lowest percent reaching screening guidelines. Instead, the group with lowest percent reaching screening guidelines was those with low health literacy only.

Findings from the multivariable logistic models considering the four low health literacy-LEP combination groups (adjusted for control variables) for each screening type are provided in Table 3. In fully adjusted models, following the patterns in Table 1 and Figure 1, those with both LEP and low health literacy were significantly less likely to meet breast cancer screening guidelines (OR: 0.45; 95% CI: 0.23-0.86) and colorectal cancer screening (OR: 0.12; 95% CI:0.05-0.25) than those with neither LEP nor low health literacy (Table 3).

Considering language concordance (not shown in table), in descriptive analyses among those with LEP, not having a language concordance provider was significantly associated with poorer screening for mammography specifically (61% with no concordant provider vs 86% with a concordant provider, p=0.01).). In the multivariable model with four low health literacy-LEP categories with meeting mammography screening guidelines as the outcome, the language concordant variable remained statistically significant (OR: 0.35; 95% CI: 0.13-0.94), as did the combined low health literacy/LEP variables. However, language concordance was not

associated with Pap or CRC screening in descriptive analyses and was not included in multivariable models.

Discussion

Our study shows that health literacy is associated with low breast and colorectal cancer screening among Chinese Americans. Those with both LEP and low health literacy appear to be at particular high risk for not meeting colorectal and breast cancer screening guidelines. We also find that English proficiency and health literacy appear to have distinct relationships with the three types of cancer screening.

Our findings suggest that for breast and colorectal cancer interventions in particular, strategies to improve health literacy (such as simplifying health information) or to increase the health-literate nature of the health care organization (such as confirming understanding at all points of patient contact) (46-47) may increase screening in Chinese Americans, particularly in concert with other proven strategies (48-49). It also suggests that including health literacy in multivariable studies of factors associated with Chinese American cancer screening may be important to understand all significant contributors to screening behavior in this group.

We also find that Chinese Americans with the combined barriers of LEP and limited health literacy are a particularly vulnerable population for colorectal and breast cancer screening. This supports previously findings of linguistic barriers to care and low cancer screening rates among Chinese Americans with LEP (50-52) with further insight about the additional burden of low health literacy. Of relevance, in a previous study of LEP and low health literacy with CHIS data, Chinese reported the highest rates of both low health literacy and LEP compared to other racial/ethnic groups (37).

Those with both LEP and low health literacy may fall outside many existing pathways of health communication as both English or adapted Chinese language print materials may not be accessible. Promising research has found that multifaceted, culturally and linguistically appropriate interventions, including health educators in the primary care setting, can improve

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cancer screening in Chinese American populations (53-54). Such interventions may be critically important for those with LEP and low health literacy in order to illuminate screening access opportunities and to combat misconceptions about screening (such as whether women who are not sexually active should be screened) (53-54).

Our research found distinct relationships for low health literacy and LEP by screening type. This may be related to differential health literacy and health communication demands by screening type. The three cancer screening types vary in procedural complexity, direct patient involvement, and/or the number of contact or communication points needed to complete the screening. For cervical cancer screening with a Pap test, the procedure is often completed in a single medical visit with minimal preparation by the patient. Our results showed low health literacy without added burdens from LEP was a barrier to this test. For mammography, the complexity of screening completion is higher, as it can require navigating (and potentially scheduling) a separate visit often at a different location than the doctor's office. Our findings showed that while low health literacy has an independent association with low mammography screening, the combined burdens from both low health literacy and LEP exacerbate the barriers for obtaining mammography. CRC screening is the most complex of our tested screening procedures, involving multiple contact points and including pre-visit preparations (such as stool collection and handling for Fecal Occult Blood Test or Fecal Immunochemical Test, or dietary preparations prior to colonoscopy). These screening procedures demand literacy skills to comprehend and implement instructions. Among Chinese Americans, CRC screening had the lowest adherence rate among the three cancers studied, and the combined burdens of low health literacy and LEP were associated with lower rates of up-to-date CRC screening in this population.

Previous studies have suggested that patient-provider language concordance can improve screening disparities (42). In our multivariable model for mammography screening guidelines, language concordance and the combination of low health literacy and LEP were

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statistically significant. This indicates that both are distinctly associated with mammography. Language concordance was not significantly associated with cancer screening among Chinese Americans for colon or cervical cancer screening, even in descriptive analyses.

This study has many strengths, such as a population-based data set with significant numbers of Chinese Americans, including those with LEP. However, some issues should be considered during interpretation. The health literacy items have been used in a number of previous studies (19, 36, 37) and were taken from the Commonwealth Fund's 2006 Quality of Care Survey (55), but they are self-reported and only focus on some aspects of health literacy. It would be useful to see how other domains, such as the ability not just to understand, but also to communicate, are described by Chinese Americans and how these might be impacted by LEP. Our CHIS data lack some variables, including cultural and health belief-related factors, associated with cancer screening in Chinese Americans (56, 57). Future study should consider the role of health literacy along with these variables.

Cancer screening among Chinese Americans also varies by geographic location. For instance, in Hawaii, Chinese Americans have higher cancer screening compliance than many other racial/ethnic groups, and higher rates of screening than are seen in these data from California (58). It would be helpful to see if the role of health literacy and/or LEP also varies, or if other factors are at play. These areas also have distinct patterns of immigration and differential percentages of Chinese relative to the larger population that may also be important in explaining these findings (2).

Conclusions

This study provides important new information about the role of low health literacy and limited English proficiency in cancer screening guideline adherence among Chinese Americans. Health literacy is increasingly recognized as an important factor in health care access and cancer screening in particular and is distinct from, but associated with, limited English proficiency. Efforts to promote screening in Chinese American communities should consider the

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health communication barriers of low health literacy and LEP separately and in combination to

improve screening rates in these populations.

Contributorship Statement

TS conceived and designed the study, obtained the funding, and drafted the manuscript. JT helped to draft the manuscript, interpret analyses, and contextualize study findings. TD participated in the study design and coordination and helped to draft the manuscript. JD participated in the design of the study, performed the statistical analysis, and helped to draft the manuscript. KB participated in the study design and coordination, and helped to draft the manuscript. All authors read and approved the final manuscript.

Competing Interests Statement

The authors have no competing interests to report.

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Data Sharing

The 2007 CHIS public use data files used in this study can be downloaded at no cost from http://healthpolicy.ucla.edu/chis/data/Pages/overview.aspx. For any additional questions about specific study analyses and data (e.g., variable specification), please email tsentell@hawaii.edu.

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Table 1: Descriptive Data for Cancer Screening Samples data in 2007 CHIS for Chinese Respondents

Samples	Breast Cancer Screening	Cervical Cancer Screening	CRC Screening
Inclusions	Females, age 50-74	Females, age 21-65	Females and Males, age 50-75
Unweighted N	326	632	480
	%	%	%
Met Screening Guidelines	85.5	77.8	50.9
Low Health Literacy (LHL)	36.3	29.7	37.6
Limited English Proficiency (LEP)	46.9	28.7	41.1
LHL and LEP combinations			
Both LHL and LEP	29.0	17.4	27.0
LHL-only	17.9	11.2	14.1
LEP-only	7.2	12.3	10.6
Neither LHL and LEP	45.9	59.1	48.3
Education			
Less than HS	20.7	9.0	13.4
High School Grad	34.1	30.1	32.8
College Grad	26.5	33.9	28.4
More than College Degree	18.9	27.0	25.5
Age Group			
Young (18-24)	--	11.0	--
Middle (25-64)	70.4	87.0	67.0
Older (65+)	29.6	1.9	33.0
Control Variables			
Not Born in USA	90.0	83.5	89.0
$\leq$100% Fed Poverty Level	16.1	11.7	14.8
Rural	2.1	4.9	1.90
Insured	89.9	84.7	91.6
Married	81.1	66.8	86.1
Female	100	100	52.5

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Table 2: Logistic Models Predicting met CRC Screening Guidelines by Health Literacy in 2007 California Health Interview Survey among Chinese

Samples	Breast Cancer Screening OR (95% CI)	Cervical Cancer Screening OR (95% CI)	CRC Screening OR (95% CI)
Low Health Literacy	0.25 (0.13-0.48)*[1]	0.38 (0.17-0.86)*	0.63 (0.35-1.17)
Limited English Proficiency	0.42 (0.19-0.96)*	0.81 (0.29-2.28)	0.66 (0.35-1.23)
Education			
Less than HS	1.58 (0.37-6.79)	0.97 (0.25-3.74)	0.52 (0.14-1.96)
High School Grad	1.04 (0.34-3.16)	1.12 (0.35-3.59)	1.01 (0.46-2.23)
College Grad	0.53 (0.17-1.59)	0.98 (0.36-2.68)	0.79 (0.34-1.83)
More than College Degree			
Control Variables			
Born in USA	0.62 (0.14-2.69)	0.97 (0.33-2.85)	0.89 (0.43- 1.84)
Age	1.01 (0.95-1.07)	1.06 (1.03-1.10)*	1.04 (1.00-1.09)*
Female	--	--	0.92 (0.52-1.63)
≤100% Fed Poverty Level	1.48 (0.50-4.36)	0.85 (0.26-2.77)	0.99 (0.36-2.78)
Rural	1.65 (0.28-9.76)	0.37 (0.06-2.25)	1.13 (0.24-5.28)
Married	0.79 (0.30-2.09)	2.31 (1.11-4.84)*	0.76 (0.26-2.18)
Insured	1.92 (0.63-5.81)	1.67 (0.62- 4.49)	2.59 (0.96-6.99)

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[1] Factors significant p<.05 are noted with an asterisk.

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Figure 1: Percent That Met Cancer Screening Guidelines by Low Health Literacy (LHL) and Limited English Proficiency (LEP) among Chinese respondents the 2007 CHIS[2]

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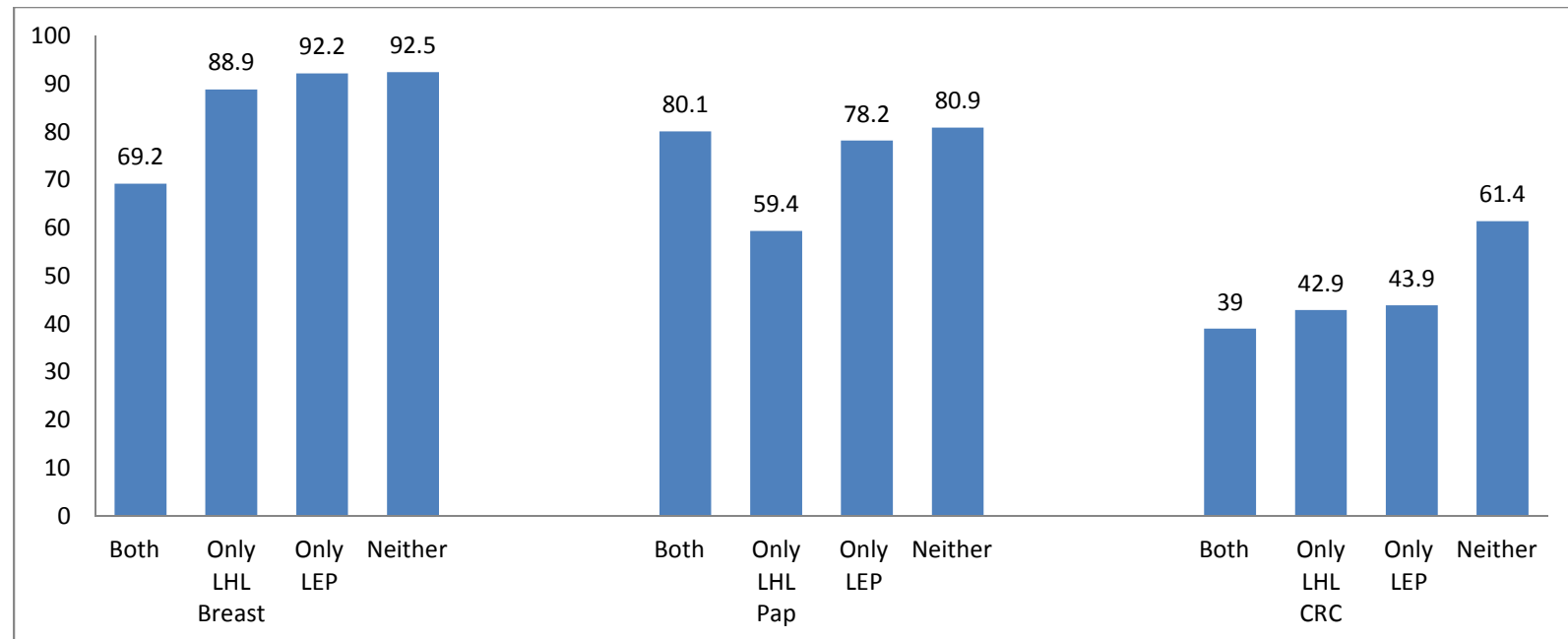
[2] Unweighted sample sizes for the LEP/LHL combos by screening type. Breast: LHL+LEP: 75; LHL only: 32; LEP only: 40; Neither: 179; Pap: LHL+LEP: 101; LHL only: 79; LEP only: 61; Neither: 391; CRC: LHL+LEP: 103; LHL only: 61; LEP only: 52; Neither: 272

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Table 3: Logistic Models Predicting met CRC Screening Guidelines by Health Literacy and LEP combinations in 2007 California Health Interview Survey among Chinese

	Breast Cancer Screening	Cervical Cancer Screening	CRC Screening
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Low Health Literacy and Limited English Proficiency			
Low Health Literacy and LEP	0.12 (0.05-0.25)*[3]	0.36 (0.13-1.03)	0.45 (0.23-0.86)*
LEP Only	0.77 (0.22-2.67)	0.59 (0.15-2.25)	0.49 (0.21-1.14)
Low Health Literacy Only	0.59 (0.19-1.78)	0.30 (0.12-0.76)*	0.44 (0.20-0.95)*
Neither			
Education			
Less than HS	1.49 (0.32-6.88)	0.85 (0.21-3.41)	0.51 (0.14-1.87)
High School Grad	0.92 (0.29-2.94)	1.10 (0.34-3.52)	1.01 (0.46- 2.22)
College Grad	0.46 (0.15-1.40)	1.00 (0.36-2.76)	0.77 (0.33-1.79)
More than College Degree			
Control Variables			
Born in USA	0.67 (0.17-2.67)	0.92 (0.31-2.71)	0.86 (0.42-1.80)
Age	1.01 (0.95-1.07)	1.06 (1.03-1.10)*	1.04 (1.00-1.09)*
Female	--	--	0.93 (0.52-1.66)
≤100% Fed Poverty Level	1.52 (0.50-4.64)	0.88 (0.27- 2.86)	0.96 (0.35- 2.61)
Rural	1.33 (0.23-7.60)	0.39 (.07-2.28)	1.16 (0.27-4.93)
Married	0.80 (0.29-2.16)	2.23 (1.04-4.75)*	0.78 (0.28-2.15)
Insured	1.81 (0.59-5.57)	1.73 (0.65-4.59)	2.66 (0.95-7.43)

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[3] Factors significant p<.05 are noted with an asterisk.

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Low Health Literacy and Cancer Screening among Chinese Americans in California: A Cross-Sectional Analysis

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Low Health Literacy and Cancer Screening among Chinese Americans in California: A Cross-Sectional Analysis

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Running Title: Health Literacy and Cancer Screening in Chinese Americans

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Abstract

Objectives. Cancer is the leading cause of death among Asian Americans. Chinese Americans comprise the largest Asian American ethnic group. Low health literacy (LHL) is associated with lower cancer screening rates, but this association has not been studied in Chinese Americans. We examined the relationship between LHL and meeting US Preventive Service Task Force (USPSTF) guidelines for cervical, colorectal, and breast cancer screening among Chinese Americans.

Design. Observational study of Chinese respondents in the 2007 California Health Interview Survey, a population-based survey. Interview languages included English, Cantonese and Mandarin.

Setting. California, USA

Participants. Chinese respondents in age/gender groupings appropriate for USPSTF cancer screening guidelines (cervical: women ages 21-65, n=632; colorectal: men or women ages 50-75, n=488; and breast: women ages 50-74, n=326).

Outcomes. Relationships were tested using multivariable logistic regression models controlling for health care access and demographic factors, including limited English proficiency (LEP). The combined effects of having both LHL and LEP were specifically examined. LHL was measured by 2-items on perceived ease-of-use of written medical materials. All study variables were self-reported.

Results. Cancer screening percentages among Chinese Americans were 77.8% for cervical, 50.9% for colorectal (47.9% for women and 54.2% for men), and 85.5% for breast. LHL was associated with lower odds of meeting breast cancer screening guidelines (OR:0.41;95%CI:0.20-0.82). Respondents with both LHL and LEP were significantly less likely to have up-to-date colorectal (OR:0.49;95%CI:0.25-0.97) and breast cancer screening (OR:0.21;95%CI:0.08-0.54) than those with neither health communication barrier. In all multivariable models, having seen a physician in the past year was a significant predictor of an up-to-date screening.

Conclusions. In Chinese Americans, LHL and LEP were negatively associated with up-to-date breast and colorectal cancer screening, independent of a recent physician visit. Efforts to promote cancer screening among Chinese Americans should consider and address LHL, LEP, and physician access barriers.

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Strengths and Limitations of This Study

- This study provides new information about the important, distinct roles of low health literacy and limited English proficiency in cancer screening guideline adherence among Chinese Americans using a population-based sample.

- We found that low health literacy was negatively associated with up-to-date breast cancer screening among Chinese Americans.

- We also found that the combination of low health literacy and limited English proficiency was negatively associated with up-to-date colorectal and breast cancer screening among Chinese Americans.

- This study took place in California and used self-reported health literacy measures. Future work should consider the generalizability of these findings across other communities and other health literacy domains.

- Efforts to promote screening in Chinese American communities should consider the health communication barriers of low health literacy and limited English proficiency separately and in combination to improve screening rates in these populations.

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Cancer is the leading cause of death among Asian Americans (1). Chinese Americans comprise the largest Asian ethnic group in the United States (US) (2) and have particularly low cancer screening rates (3, 4). For instance, Chinese American women are less likely than many Asian American and Pacific Islander women to report having a recent Pap smear or mammogram (3, 4). Underuse of colon cancer screening is also seen among Chinese American men and women (5). Gaining a better understanding of the predictors of cancer screening among distinct Asian American populations, such as Chinese Americans, is important for targeted cancer control interventions (6, 7).

Health literacy, "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services for appropriate health decisions," (8) is an established correlate to cancer screening (9, 10). Low health literacy is associated with limited knowledge about cancer screening, lack of desire for screening, and poorer access to care (11-19). Limited research has focused on low health literacy in cancer screening among Chinese Americans specifically.

An additional issue to consider for cancer screening in Chinese Americans is limited English proficiency (LEP). Over half (58%) of Chinese Americans have LEP, a major health communication barrier (20). Previous studies have found that LEP is associated with lower rates of cancer screening generally and specifically in Chinese Americans (21-23). For instance, 57% of Chinese American women with LEP reported having a Pap test compared to 76% who were English proficient (23). A recent analysis of a population-based database in California found that Asian Americans with both LEP and low health literacy, or with LEP-only, were significantly less likely to be screened compared to those with neither limited literacy nor LEP (19).

This study had two primary aims. The first was to examine the relationship between low health literacy and meeting the US Preventive Service Task Force (USPSTF) guidelines for cervical, colorectal, and breast cancer screening among Chinese Americans in California (24, 25, 26). These three cancers share four traits—they represent significant public health

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problems, have strong methods for early detection, have evidence that screening is useful, and show disparities among Asian American groups (3-8). The second aim was to quantify the combined burdens of low health literacy and limited English proficiency on meeting the guidelines. Evidence suggests that the combination of these two health communication barriers may indicate a particular vulnerability to not receiving recommended cancer screening (19).

Methods

    Sample. The 2007 California Health Interview Survey (CHIS) (27) was used. The CHIS is a random-digit-dial (RDD) telephone survey administered by UCLA Center for Health Policy Research. It is representative of the non-institutionalized population of California, which is home to 4 out of every 10 Asian Americans in the US (28). The 2007 CHIS multi-stage sample design included landline and cellular telephone numbers (29). For the landline RDD sample, the state was divided into 44 geographic sampling strata from which residential telephone numbers were selected. Within each household, one adult (18 years and over) respondent was randomly selected. The separate RDD cellular sample was drawn from telephone numbers assigned to cellular service and stratified by area code (29). The CHIS interviews in Mandarin and Cantonese (30), allowing for participation by Chinese individuals with limited English proficiency. CHIS English proficiency and cancer screening variables have been used extensively in other studies on this subject (31-35).

    Outcomes. Breast Cancer: In the 2007 CHIS, following National Health Interview Survey protocol (36), women 30 years and older were asked if they ever had a mammogram. Those who had received one were asked, "How long ago did you have your most recent mammogram?" USPSTF (24) defines meeting breast cancer screening guidelines as having a mammogram in the past 1-2 years for women aged 50-74**.** Cervical Cancer: Women 18+ who were not currently pregnant and had never had a hysterectomy were asked if they ever had a Pap smear. If yes, they were asked, "How long ago did you have your most recent Pap smear

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test?" Following USPSTF (25) guidelines, meeting cervical cancer screening was defined as a Pap smear in the past 1-3 years for women aged 21-65**.** <u>Colorectal Cancer:</u> Compliance with colorectal screening guidelines was obtained for all participants 50 years and older based on a series of cancer screening variables concerning FOBT in the past year, a flexible sigmoidoscopy or double-contrast barium enema in the past 5 years, or a colonoscopy in the past 10 years, per USPSTF guidelines (26). Respondents who reported a colorectal cancer (CRC) test were asked if they completed the test due to a problem. (Approximately 4-8%, depending on the specific CRC test, did so.) Meeting colorectal cancer screening guidelines was defined as "yes" for the compliance guideline variable for men and women 50-75 excluding the 4-8% who took a CRC test due to a problem, as utilization for diagnostic purposes may be subject to different factors than screening*.*

Low Health Literacy. Health literacy in the 2007 CHIS was assessed by two questions: (1) "When you get written information at a doctor's office, would you say that it is very easy, somewhat easy, somewhat difficult, or very difficult to understand?" and (2) "When you read the instructions on a prescription bottle, would you say that it is very easy, somewhat easy, somewhat difficult, or very difficult to understand?" Respondents could report not getting written information (<4% of all respondents) or not using prescription medicine (<2% of all respondents). In the full sample, <1% of the sample lack a response to either question. Low health literacy was defined as responding that either one of these two tasks were "somewhat" or "very difficult" to understand (19, 37-38). These items are similar to validated health literacy self-report measures (39) that perform well in identifying low health literacy relative to standard instruments and these particular items have been used in a number of previous studies (19, 37-38).

Limited English Proficiency. Respondents who spoke any language(s) at home besides English were asked: "Since you speak a language other than English at home, we are interested in your own opinion of how well you speak English. Would you say you speak English

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very well, well, not well, or not at all?" LEP was defined as self-reporting speaking English "not well" and "not at all." This LEP variable is considered a superior measure for language barriers in health (40), has strong face validity, and is standard in many studies (41, 42).

Low Health Literacy and LEP Combined Burdens. Previous research has found that having both low health literacy and LEP together is associated with notably poor rates of colorectal cancer screening (19) as well as other health disparities, such as poor health (38). Thus, a four-category variable was created using low health literacy and LEP combinations, coded 1=both LEP and low health literacy, 2=only LEP, 3=only low health literacy, and 4=neither LEP nor low health literacy.

Covariates. For multivariable models, control variables included: Age (continuous 18-75), sex (male or female, as relevant), education (less than high school, high school graduate, college graduate, more than college), poverty ($\leq$100%, of poverty vs. not), living in a rural area (vs. not), current insurance (vs. none), being born in the US (vs. elsewhere), and marital status (married vs. other). These variables are associated with health literacy, limited English proficiency and/or cancer screening in other studies (43). As insurance coverage does not necessarily guarantee health care access, we also included the dichotomous item (yes=1 or no=0) for "Visited a doctor in the past 12 months?"[1]

Language Concordance. Based on previous research (44), we also examined the role of patient-provider language concordance in compliance with cancer screening guidelines specifically among those with limited English proficiency. The patient-provider language concordance variable had two groups: (1) other-language concordant (patients and providers spoke the same non-English language) or (2) language discordant (patient did not share a language with their provider) (19, 45). For Chinese Americans with LEP, we first considered

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[1]We tested other potential control variables, including language of interview (English vs. Cantonese or Mandarin) and years in the US (<5 years, 5-10 years, 15+ years) for those born outside the US. However, these were not included in final models because of collinearity with LEP and birthplace variables.

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whether the language concordance variable had a significant relationship with each type of cancer screening in bivariate models. Then, for screening types in which a significant relationship was found for language concordance, language concordance was included in final multivariable models.

Samples. This study included three samples as different age groups and gender combinations are targeted by a distinct set of screening guidelines. Following the USPSTF guidelines (24-26), the cervical cancer sample included women ages 21-65, the breast cancer sample included women ages 50-74, and the colorectal cancer sample included men or women ages 50-75. All samples excluded individuals with missing health literacy measures and/or missing information regarding the screening outcome of interest. The unweighted sample sizes are as follows: cervical: 632; colorectal: 488; and breast: 326.

Statistical Methods. The 2007 CHIS public-use data file was used for all analyses. All data were analyzed in STATA 10.0 (46) using appropriate weighting methods to both correct for the complex sample design and to provide population-level estimates using the CHIS variables provided for this purpose in the public-use data file (47). Population-total weighting information is derived using data from the California Department of Finance's 2007 Population Estimates and 2007 Population Projections across 11 demographic, geographic, household composition, and socio-economic factors (47).

We first report descriptive statistics and cancer screening by low health literacy, compared using chi-square analyses. We then ran multivariable logistic regression models predicting cancer screening for each sample by low health literacy with LEP including control variables (US nativity, age, sex, marital status, insurance, education, living in a rural area, poverty, and recent doctor visit). All tests of statistical significance were two sided.

We then ran the same models including the four LEP and low health literacy combination groupings to examine and quantify the combined low health literacy and LEP burdens on cancer screening. Having neither low health literacy nor LEP was the reference group.

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This study was deemed exempt by the University of Hawaii IRB.

Results

As seen in Table 1, 85.5% met breast cancer screening guidelines, 77.8% met cervical screening guidelines, and 50.9% met colorectal screening guidelines (47.9% for women and 54.2% for men). Low health literacy was almost 30% or higher among all samples. LEP was above 40% in the breast cancer and CRC cancer screening samples, and almost 30% in the cervical cancer group. Many individuals had both LEP and low health literacy: 29% in the breast screening sample; 17% in the cervical sample, and 27% in the CRC sample. Of interest, 84% or more of each sample was born outside of the USA, 45-60% of each sample had a college degree (although perhaps from another country), 12-16% were living at or under 100% of the federal poverty level, and about 8-15% were uninsured. Across all samples, a little more than 80% had visited a doctor in the past year.

As seen in Table 2, in adjusted models including low health literacy and LEP separately, a recent physician's visit was highly associated with up-to-date cancer screening in all three samples with an odds ratio greater than 2 in all three models. Independent of a recent physician's visit, low health literacy was significantly (p<0.05) associated with lower odds of meeting breast cancer screening guidelines (OR: 0.41; 95% CI:0.20-0.82), was marginally associated with meeting cervical cancer screening guidelines (OR: 0.46; 95% CI:0.21-1.02; p=0.55), and was not significantly associated with meeting colorectal cancer screening guidelines (OR: 0.70; 95% CI:0.38-1.30). No other variables were significantly associated with mammography or CRC screening in the multivariable models. Age (older) and marital status (married) predicted screening in the cervical cancer sample.

Data on compliance with screening guidelines by the four low health literacy-LEP combination groups are shown graphically in Figure 1. For breast cancer, 69.2% of those with both LEP and low health literacy met screening guidelines, while the other three groups had

over 88% screening rates (Figure 1). For CRC screening, only 39% of those with both LEP and low health literacy met screening guidelines, compared to 61% of those with neither LEP nor low health literacy. However, for cervical cancer screening, the LEP and low health literacy group was not the group with the lowest percent reaching screening guidelines. Instead, the group with lowest percent reaching screening guidelines was those with low health literacy only.

Findings from the multivariable logistic models considering the four low health literacy-LEP combination groups (adjusted for control variables) for each screening type are provided in Table 3. In adjusted models, following the patterns in Figure 1, those with both LEP and low health literacy were significantly less likely to meet breast cancer screening guidelines (OR: 0.21; 95% CI:0.08-0.54) and colorectal cancer screening (OR: 0.49; 95% CI: 0.25-0.97) than those with neither LEP nor low health literacy (Table 3). Visiting a doctor in the past year was again highly predictive of screening in all three models.

Considering language concordance, in descriptive analyses among those with LEP (not shown in table), not having a language concordance provider was significantly associated with poorer screening for mammography specifically (61% with no concordant provider vs 86% with a concordant provider, p=0.01). Thus, language concordance was included in the multivariable models for mammography. However, this factor was not significant in multivariable models. Language concordance was not associated with Pap or CRC screening in descriptive analyses and was not included in multivariable models for those outcomes.

Discussion

Our study shows that health literacy is an important factor to consider for understanding low cancer screening rates among Chinese Americans. Low health literacy alone was associated with lower odds of meeting breast cancer screening guidelines and those with both LEP and low health literacy appear to be at particularly high risk for not meeting colorectal and breast cancer screening guidelines. Even after considering having a recent visit with a

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physician, having low health literacy and limited English proficiency together was an independent predictor of screening for two out of three cancer screening types. Visiting a doctor in the past year was also highly predictive of all three types of cancer screening. This highlights the importance of health care system access above and beyond insurance coverage in ensuring receipt of needed preventive care. We also note that English proficiency and health literacy appear to have distinct relationships with the three types of cancer screening.

Our findings suggest that for breast cancer interventions in particular, strategies to improve health literacy (such as simplifying health information) or to increase the health-literate nature of the health care organization (such as confirming understanding at all points of patient contact) (48-49) may increase screening in Chinese Americans, particularly in concert with other proven strategies (50-51). It also suggests that including health literacy in multivariable studies of factors associated with Chinese American cancer screening may be important to understand all significant contributors to screening behavior in this group.

We also find that Chinese Americans with the combined barriers of LEP and limited health literacy are a particularly vulnerable population for colorectal and breast cancer screening. This supports previously findings of linguistic barriers to care and low cancer screening rates among Chinese Americans with LEP (52-54) with further insight about the additional burden of low health literacy. Of relevance, in a previous study of LEP and low health literacy with CHIS data, Chinese reported the highest rates of both low health literacy and LEP compared to other racial/ethnic groups (38).

Those with both LEP and low health literacy may fall outside many existing pathways of health communication as both English or adapted Chinese language print materials may not be accessible. Promising research has found that multifaceted, culturally and linguistically appropriate interventions, including health educators in the primary care setting, can improve cancer screening in Chinese American populations (55-56). Such interventions may be critically important for those with LEP and low health literacy in order to illuminate screening access

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opportunities and to combat misconceptions about screening (such as whether women who are not sexually active should be screened) (55-56).

Our findings also reveal the critical importance of regular access to a physician. Previous studies have shown that this access factor is associated with higher rates of preventive care and early detection of disease, but that regular visits to a doctor are less common among minority racial/ethnic groups, especially those with LEP (57-58). The powerful role of this variable in our study reveals the particular importance of this factor for Chinese Americans in general, and as a way to potentially overcome the impacts of health communication barriers of LEP and low health literacy specifically. This finding has critical current policy relevance in light of the expanded insurance coverage under the Affordable Care Act. Our study emphasizes that insurance alone is only the first step to receiving needed preventing care; an actual connection with the health care system is also critical.

Our research found distinct relationships for low health literacy and LEP by screening type. This may be related to differential health literacy and health communication demands by screening type. The three cancer screening types vary in procedural complexity, direct patient involvement, and/or the number of contact or communication points needed to complete the screening. For cervical cancer screening with a Pap test, the procedure is often completed in a single medical visit with minimal preparation by the patient. Our results showed that visiting a doctor in the last year was particularly critical for receiving this procedure specifically and neither of our health communication variables was significant in the cervical cancer models when this factor was included. For mammography, the complexity of screening completion is higher, as it can require navigating (and potentially scheduling) a separate visit often at a different location than the doctor's office. Our findings showed that low health literacy has an independent association with low mammography screening and that the combined burdens from both low health literacy and LEP exacerbate the barriers for obtaining mammography. CRC screening is the most complex of our tested screening procedures, involving multiple contact

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points and including pre-visit preparations (such as stool collection and handling for Fecal

Occult Blood Test or Fecal Immunochemical Test, or dietary preparations prior to colonoscopy).

These screening procedures demand literacy skills to comprehend and implement instructions.

Among Chinese Americans, CRC screening had the lowest adherence rate among the three

cancers studied, and the combined burdens of low health literacy and LEP were associated with

lower rates of up-to-date CRC screening in this population.

Both culturally and linguistically appropriate services are likely needed to reduce health

care disparities (59). While having a recent doctor visit was highly predictive of receipt of cancer

screening, health communication variables were also important. Health care systems and

providers able to effectively address Chinese specific cultural concerns around cancer

screening are needed (55-56), especially for those with limited understanding of the U.S.

medical system (for which LEP and/or low health literacy may be proxy measures).

This study has many strengths, such as a population-based data set with significant

numbers of Chinese Americans, including those with LEP. However, some issues should be

considered during interpretation. The health literacy items have been used in a number of

previous studies (19, 37-38) and were taken from the Commonwealth Fund's 2006 Quality of

Care Survey (60), but they are self-reported and only focus on some aspects of health literacy.

Also, to our knowledge, such self-reported health literacy items have been validated in English

speakers (39) and studied in Asian groups outside the US (61), but have not been validated in

Chinese Americans specifically. It would be useful to consider differences in self-reporting

health literacy challenges across Asian groups in the US, due to known cultural differences in

responses to questionnaires, including gender differences (61). It would also be useful to see

how other health literacy domains, such as the ability not just to understand, but also to

communicate, are described by Chinese Americans and how these might be impacted by LEP.

Our CHIS data lack some variables, including cultural and health belief-related factors,

associated with cancer screening in Chinese Americans (62-63). We also lacked the sample

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size to consider the independent role of factors that are highly associated with our included study variables (especially LEP and birthplace), but likely have distinct roles with cancer screening (such as Chinese language of preference, time in the US, and other acculturation variables). Future study should consider the role of health literacy along with these variables.

Cancer screening among Chinese Americans also varies by geographic location. For instance, in Hawaii, Chinese Americans have higher cancer screening compliance than many other racial/ethnic groups, and higher rates of screening than are seen in these data from California (64). It would be helpful to see if the role of health literacy and/or LEP also varies, or if other factors are at play. These areas also have distinct patterns of immigration and differential percentages of Chinese relative to the larger population that may also be important in explaining these findings (2).

Conclusions

This study provides important new information about the role of low health literacy and limited English proficiency in cancer screening guideline adherence among Chinese Americans. Health literacy is increasingly recognized as an important factor in health care access and cancer screening in particular and is distinct from, but associated with, limited English proficiency. Efforts to promote screening in Chinese American communities should consider the health communication barriers of low health literacy and LEP separately and in combination to improve screening rates in these populations. Physician access barriers should also be considered as these appear critically important to cancer screening among Chinese Americans.

Contributorship Statement

TS conceived and designed the study, obtained the funding, and drafted the manuscript. JT helped to draft the manuscript, interpret analyses, and contextualize study findings. TD participated in the study design and coordination and helped to draft the manuscript. JD participated in the design of the study, performed the statistical analysis, and helped to draft the manuscript. KB participated in the study design and coordination, and helped to draft the manuscript. All authors read and approved the final manuscript.

Competing Interests Statement

The authors have no competing interests to report.

Data Sharing

The 2007 CHIS public use data files used in this study can be downloaded at no cost from http://healthpolicy.ucla.edu/chis/data/Pages/overview.aspx. For any additional questions about specific study analyses and data (e.g., variable specification), please email tsentell@hawaii.edu.

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Table 1: Descriptive Data for Cancer Screening Samples data in 2007 CHIS for Chinese Respondents

Samples	Breast Cancer Screening	Cervical Cancer Screening	CRC Screening
Inclusions	Females, age 50-74	Females, age 21-65	Females and Males, age 50-75
Unweighted N	326	632	488
	%	%	%
Met Screening Guidelines	85.5	77.8	50.9
Low Health Literacy (LHL)	36.3	29.7	37.6
Limited English Proficiency (LEP)	46.9	28.7	41.1
LHL and LEP combinations			
Both LHL and LEP	29.0	17.4	27.0
LHL-only	17.9	11.2	14.1
LEP-only	7.2	12.3	10.6
Neither LHL and LEP	45.9	59.1	48.3
Education			
Less than HS	20.7	9.0	13.4
High School Grad	34.1	30.1	32.8
College Grad	26.5	33.9	28.4
More than College Degree	18.9	27.0	25.5
Age Group			
Young (18-24)	--	11.0	--
Middle (25-64)	70.4	87.0	67.0
Older (65+)	29.6	1.9	33.0
Control Variables			
Born in USA	10.0	16.5	11.0
$\leq$100% Fed Poverty Level	16.1	11.7	14.8
Rural Residency	2.1	4.9	1.90
Married	81.1	66.8	86.1
Female	100	100	52.5
Insured	89.9	84.7	91.6
Visited Doctor in Past Year	84.8	80.4	82.4
Language Discordant Provider	16.9	16.4	15.4

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Table 2: Logistic Models Predicting met the US Preventive Service Task Force Cancer Screening Guidelines for Breast, Cervical and Colorectal Cancer (CRC) by Health Literacy in 2007 California Health Interview Survey among Chinese Respondents[1]

	Breast Cancer Screening OR (95% CI)	Cervical Cancer Screening OR (95% CI)	CRC Screening OR (95% CI)
Low Health Literacy	0.41 (0.20-0.82) *	0.46 (0.21-1.02)	0.70 (0.38-1.30)
Limited English Proficiency	0.49 (0.20-1.22)	0.78 (0.28-2.22)	0.66 (0.35-1.22)
Education			
Less than HS	1.37 (0.33-5.61)	1.01 (0.26-3.98)	0.51 (0.14-1.88)
High School Grad	1.19 (0.39-3.59)	1.30 (0.40-4.17)	1.02 (0.46-2.27)
College Grad	0.50 (0.17-1.52)	1.13 (0.40-3.22)	0.79 (0.34-1.81)
More than College Degree	ref	ref	ref
Control Variables			
Born in USA	0.64 (0.13-3.02)	0.96 (0.32-2.88)	0.88 (0.42-1.84)
Age	1.01 (0.96-1.07)	1.07 (1.03-1.10)*	1.04 (1.00-1.08)
Female	--	--	0.88 (0.49-1.57)
$\leq$100% Fed Poverty Level	1.44 (0.44-4.71)	0.93 (0.29-3.04)	1.00 (0.36-2.79)
Rural Residency	1.25 (0.19-8.19)	0.42 (0.08-2.20)	1.21 (0.22-6.58)
Married	0.61 (0.20-1.86)	2.37 (1.13-5.00)*	0.74 (0.26-2.12)
Insured	1.02 (0.26-3.97)	1.27 (0.42-3.80)	2.27 (0.82-6.31)
Visited Doctor in Past Year	4.68 (1.57-13.98)*	2.62 (1.35-5.11)*	2.10 (1.07-4.11)*
Language Discordant Provider	0.55 (0.20-1.54)	--	--

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[1] Factors significant p<.05 are noted with an asterisk.

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Table 3: Logistic Models Predicting met the US Preventive Service Task Force Cancer Screening Guidelines for Breast, Cervical and Colorectal Cancer (CRC) by Low Health Literacy (LHL) and Limited English Proficiency (LEP) combinations in 2007 California Health Interview Survey among Chinese Respondents[1]

	Breast Cancer Screening OR (95% CI)	Cervical Cancer Screening OR (95% CI)	CRC Screening OR (95% CI)
LHL and LEP combinations			
LHL and LEP	0.21 (0.08-0.54)*	0.41 (0.15-1.13)	0.49 (0.25-0.97)*
LEP Only	0.85 (0.27-2.72)	0.60 (0.15-2.34)	0.50 (0.21-1.17)
LHL Only	0.92 (0.24-3.57)	0.37 (0.15-0.92)*	0.50 (0.23-1.08)
Neither	Ref	ref	ref
Education			
Less than HS	1.34 (0.32-5.73)	0.92 (0.23-3.73)	0.50 (0.14-1.82)
High School Grad	1.10 (0.34-3.45)	1.28 (0.40-4.10)	1.01 (0.46- 2.26)
College Grad	0.46 (0.16-1.37)	1.14 (0.40-3.28)	0.77 (0.33-1.77)
More than College Degree	Ref	ref	ref
Control Variables			
Born in USA	0.72 (0.16-3.26)	0.91 (0.30-2.75)	0.85 (0.41-1.80)
Age	1.02 (0.96-1.07)	1.06 (1.03-1.10)*	1.04 (0.99-1.08)
Female	--	--	0.89 (0.49-1.61)
≤100% Fed Poverty Level	1.50 (0.44-5.13)	0.95 (0.29-3.08)	0.96 (0.35- 2.64)
Rural Residency	1.01 (0.17-6.06)	0.45 (0.09-2.20)	1.23 (0.25-6.07)
Married	0.66 (0.23-1.89)	2.29 (1.06-4.94)*	0.76 (0.27-2.10)
Insured	0.92 (0.23-3.66)	1.31 (0.44-3.91)	2.32 (0.81-6.64)
Visited Doctor in Past Year	4.90 (1.67-14.36)*	2.57 (1.31-5.05)*	2.04 (1.06-3.93)*
Language Discordant Provider	0.59 (0.21-1.63)	--	--

[1] Factors significant p<.05 are noted with an asterisk.

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Figure 1: Percent That Met Cancer Screening Guidelines by Low Health Literacy (LHL) and Limited English Proficiency (LEP) among Chinese respondents the 2007 CHIS[1]

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[1] Unweighted sample sizes for the LEP/LHL combos by screening type. Breast: LHL+LEP: 75; LHL only: 32; LEP only: 40; Neither: 179; Pap: LHL+LEP: 101; LHL only: 79; LEP only: 61; Neither: 391; CRC: LHL+LEP: 103; LHL only: 61; LEP only: 52; Neither: 272

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Low Health Literacy and Cancer Screening among Chinese Americans in California: A Cross-Sectional Analysis

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Keywords: Chinese, Screening, Cancer, Health Literacy, English Proficiency

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Abstract

Objectives. Cancer is the leading cause of death among Asian Americans. Chinese Americans comprise the largest Asian American ethnic group. Low health literacy (LHL) is associated with lower cancer screening rates, but this association has not been studied in Chinese Americans. We examined the relationship between LHL and meeting US Preventive Service Task Force (USPSTF) guidelines for cervical, colorectal, and breast cancer screening among Chinese Americans.

Design. Observational study of Chinese respondents in the 2007 California Health Interview Survey, a population-based survey. Interview languages included English, Cantonese and Mandarin.

Setting. California, USA

Participants. Chinese respondents in age/gender groupings appropriate for USPSTF cancer screening guidelines (cervical: women ages 21-65, n=632; colorectal: men or women ages 50-75, n=488; and breast: women ages 50-74, n=326).

Outcomes. Relationships were tested using multivariable logistic regression models controlling for health care access and demographic factors, including limited English proficiency (LEP). The combined effects of having both LHL and LEP were specifically examined. LHL was measured by 2-items on perceived ease-of-use of written medical materials. All study variables were self-reported.

Results. Cancer screening percentages among Chinese Americans were 77.8% for cervical, 50.9% for colorectal (47.9% for women and 54.2% for men), and 85.5% for breast. LHL was associated with lower odds of meeting breast cancer screening guidelines (OR:0.41;95%CI:0.20-0.82). Respondents with both LHL and LEP were significantly less likely to have up-to-date colorectal (OR:0.49;95%CI:0.25-0.97) and breast cancer screening (OR:0.21;95%CI:0.08-0.54) than those with neither health communication barrier. In all multivariable models, having seen a physician in the past year was a significant predictor of an up-to-date screening.

Conclusions. In Chinese Americans, LHL and LEP were negatively associated with up-to-date breast and colorectal cancer screening, independent of a recent physician visit. Efforts to promote cancer screening among Chinese Americans should consider and address LHL, LEP, and physician access barriers.

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Strengths and Limitations of This Study

- This study provides new information about the important, distinct roles of low health literacy and limited English proficiency in cancer screening guideline adherence among Chinese Americans using a population-based sample.

- We found that low health literacy was negatively associated with up-to-date breast cancer screening among Chinese Americans.

- We also found that the combination of low health literacy and limited English proficiency was negatively associated with up-to-date colorectal and breast cancer screening among Chinese Americans.

- This study took place in California and used self-reported health literacy measures. Future work should consider the generalizability of these findings across other communities and other health literacy domains.

- Efforts to promote screening in Chinese American communities should consider the health communication barriers of low health literacy and limited English proficiency separately and in combination to improve screening rates in these populations.

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Cancer is the leading cause of death among Asian Americans (1). Chinese Americans comprise the largest Asian ethnic group in the United States (US) (2) and have particularly low cancer screening rates (3, 4). For instance, Chinese American women are less likely than many Asian American and Pacific Islander women to report having a recent Pap smear or mammogram (3, 4). Underuse of colon cancer screening is also seen among Chinese American men and women (5). Gaining a better understanding of the predictors of cancer screening among distinct Asian American populations, such as Chinese Americans, is important for targeted cancer control interventions (6, 7).

Health literacy, "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services for appropriate health decisions," (8) is an established correlate to cancer screening (9, 10). Low health literacy is associated with limited knowledge about cancer screening, lack of desire for screening, and poorer access to care (11-19). Limited research has focused on low health literacy in cancer screening among Chinese Americans specifically.

An additional issue to consider for cancer screening in Chinese Americans is limited English proficiency (LEP). Over half (58%) of Chinese Americans have LEP, a major health communication barrier (20). Previous studies have found that LEP is associated with lower rates of cancer screening generally and specifically in Chinese Americans (21-23). For instance, 57% of Chinese American women with LEP reported having a Pap test compared to 76% who were English proficient (23). A recent analysis of a population-based database in California found that Asian Americans with both LEP and low health literacy, or with LEP-only, were significantly less likely to be screened compared to those with neither limited literacy nor LEP (19).

This study had two primary aims. The first was to examine the relationship between low health literacy and meeting the US Preventive Service Task Force (USPSTF) guidelines for cervical, colorectal, and breast cancer screening among Chinese Americans in California (24, 25, 26). These three cancers share four traits—they represent significant public health

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problems, have strong methods for early detection, have evidence that screening is useful, and show disparities among Asian American groups (3-8). The second aim was to quantify the combined burdens of low health literacy and limited English proficiency on meeting the guidelines. Evidence suggests that the combination of these two health communication barriers may indicate a particular vulnerability to not receiving recommended cancer screening (19).

Methods

Sample. The 2007 California Health Interview Survey (CHIS) (27) was used. The CHIS is a random-digit-dial (RDD) telephone survey administered by UCLA Center for Health Policy Research. It is representative of the non-institutionalized population of California, which is home to 4 out of every 10 Asian Americans in the US (28). The 2007 CHIS multi-stage sample design included landline and cellular telephone numbers (29). For the landline RDD sample, the state was divided into 44 geographic sampling strata from which residential telephone numbers were selected. Within each household, one adult (18 years and over) respondent was randomly selected. The separate RDD cellular sample was drawn from telephone numbers assigned to cellular service and stratified by area code (29). The CHIS interviews in Mandarin and Cantonese (30), allowing for participation by Chinese individuals with limited English proficiency. CHIS English proficiency and cancer screening variables have been used extensively in other studies on this subject (31-35).

Outcomes. <u>Breast Cancer:</u> In the 2007 CHIS, following National Health Interview Survey protocol (36), women 30 years and older were asked if they ever had a mammogram. Those who had received one were asked, "How long ago did you have your most recent mammogram?" USPSTF (24) defines meeting breast cancer screening guidelines as having a mammogram in the past 1-2 years for women aged 50-74**.** <u>Cervical Cancer:</u> Women 18+ who were not currently pregnant and had never had a hysterectomy were asked if they ever had a Pap smear. If yes, they were asked, "How long ago did you have your most recent Pap smear

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test?" Following USPSTF (25) guidelines, meeting cervical cancer screening was defined as a Pap smear in the past 1-3 years for women aged 21-65**.** Colorectal Cancer: Compliance with colorectal screening guidelines was obtained for all participants 50 years and older based on a series of cancer screening variables concerning FOBT in the past year, a flexible sigmoidoscopy or double-contrast barium enema in the past 5 years, or a colonoscopy in the past 10 years, per USPSTF guidelines (26). Respondents who reported a colorectal cancer (CRC) test were asked if they completed the test due to a problem. (Approximately 4-8%, depending on the specific CRC test, did so.) Meeting colorectal cancer screening guidelines was defined as "yes" for the compliance guideline variable for men and women 50-75 excluding the 4-8% who took a CRC test due to a problem, as utilization for diagnostic purposes may be subject to different factors than screening*.*

Low Health Literacy. Health literacy in the 2007 CHIS was assessed by two questions: (1) "When you get written information at a doctor's office, would you say that it is very easy, somewhat easy, somewhat difficult, or very difficult to understand?" and (2) "When you read the instructions on a prescription bottle, would you say that it is very easy, somewhat easy, somewhat difficult, or very difficult to understand?" Respondents could report not getting written information (<4% of all respondents) or not using prescription medicine (<2% of all respondents). In the full sample, <1% of the sample lack a response to either question. Low health literacy was defined as responding that either one of these two tasks were "somewhat" or "very difficult" to understand (19, 37-38). These items are similar to validated health literacy self-report measures (39) that perform well in identifying low health literacy relative to standard instruments and these particular items have been used in a number of previous studies (19, 37-38).

Limited English Proficiency. Respondents who spoke any language(s) at home besides English were asked: "Since you speak a language other than English at home, we are interested in your own opinion of how well you speak English. Would you say you speak English

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very well, well, not well, or not at all?" LEP was defined as self-reporting speaking English "not well" and "not at all." This LEP variable is considered a superior measure for language barriers in health (40), has strong face validity, and is standard in many studies (41, 42).

Low Health Literacy and LEP Combined Burdens. Previous research has found that having both low health literacy and LEP together is associated with notably poor rates of colorectal cancer screening (19) as well as other health disparities, such as poor health (38). Thus, a four-category variable was created using low health literacy and LEP combinations, coded 1=both LEP and low health literacy, 2=only LEP, 3=only low health literacy, and 4=neither LEP nor low health literacy.

Covariates. For multivariable models, control variables included: Age (continuous 18-75), sex (male or female, as relevant), education (less than high school, high school graduate, college graduate, more than college), poverty ($\leq$100%, of poverty vs. not), living in a rural area (vs. not), current insurance (vs. none), being born in the US (vs. elsewhere), and marital status (married vs. other). These variables are associated with health literacy, limited English proficiency and/or cancer screening in other studies (43). As insurance coverage does not necessarily guarantee health care access, we also included the dichotomous item (yes=1 or no=0) for "Visited a doctor in the past 12 months?"[1]

Language Concordance. Based on previous research (44), we also examined the role of patient-provider language concordance in compliance with cancer screening guidelines specifically among those with limited English proficiency. The patient-provider language concordance variable had two groups: (1) other-language concordant (patients and providers spoke the same non-English language) or (2) language discordant (patient did not share a language with their provider) (19, 45). For Chinese Americans with LEP, we first considered

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[1]We tested other potential control variables, including language of interview (English vs. Cantonese or Mandarin) and years in the US (<5 years, 5-10 years, 15+ years) for those born outside the US. However, these were not included in final models because of collinearity with LEP and birthplace variables.

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whether the language concordance variable had a significant relationship with each type of cancer screening in bivariate models. Then, for screening types in which a significant relationship was found for language concordance, language concordance was included in final multivariable models.

Samples. This study included three samples as different age groups and gender combinations are targeted by a distinct set of screening guidelines. Following the USPSTF guidelines (24-26), the cervical cancer sample included women ages 21-65, the breast cancer sample included women ages 50-74, and the colorectal cancer sample included men or women ages 50-75. All samples excluded individuals with missing health literacy measures and/or missing information regarding the screening outcome of interest. The unweighted sample sizes are as follows: cervical: 632; colorectal: 488; and breast: 326.

Statistical Methods. The 2007 CHIS public-use data file was used for all analyses. All data were analyzed in STATA 10.0 (46) using appropriate weighting methods to both correct for the complex sample design and to provide population-level estimates using the CHIS variables provided for this purpose in the public-use data file (47). Population-total weighting information is derived using data from the California Department of Finance's 2007 Population Estimates and 2007 Population Projections across 11 demographic, geographic, household composition, and socio-economic factors (47).

We first report descriptive statistics and cancer screening by low health literacy, compared using chi-square analyses. We then ran multivariable logistic regression models predicting cancer screening for each sample by low health literacy with LEP including control variables (US nativity, age, sex, marital status, insurance, education, living in a rural area, poverty, and recent doctor visit). All tests of statistical significance were two sided.

We then ran the same models including the four LEP and low health literacy combination groupings to examine and quantify the combined low health literacy and LEP burdens on cancer screening. Having neither low health literacy nor LEP was the reference group.

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This study was deemed exempt by the University of Hawaii IRB.

Results

As seen in Table 1, 85.5% met breast cancer screening guidelines, 77.8% met cervical screening guidelines, and 50.9% met colorectal screening guidelines (47.9% for women and 54.2% for men). Low health literacy was almost 30% or higher among all samples. LEP was above 40% in the breast cancer and CRC cancer screening samples, and almost 30% in the cervical cancer group. Many individuals had both LEP and low health literacy: 29% in the breast screening sample; 17% in the cervical sample, and 27% in the CRC sample. Of interest, 84% or more of each sample was born outside of the USA, 45-60% of each sample had a college degree (although perhaps from another country), 12-16% were living at or under 100% of the federal poverty level, and about 8-15% were uninsured. Across all samples, a little more than 80% had visited a doctor in the past year.

As seen in Table 2, in adjusted models including low health literacy and LEP separately, a recent physician's visit was highly associated with up-to-date cancer screening in all three samples with an odds ratio greater than 2 in all three models. Independent of a recent physician's visit, low health literacy was significantly (p<0.05) associated with lower odds of meeting breast cancer screening guidelines (OR: 0.41; 95% CI:0.20-0.82), was marginally associated with meeting cervical cancer screening guidelines (OR: 0.46; 95% CI:0.21-1.02; p=0.55), and was not significantly associated with meeting colorectal cancer screening guidelines (OR: 0.70; 95% CI:0.38-1.30). No other variables were significantly associated with mammography or CRC screening in the multivariable models. Age (older) and marital status (married) predicted screening in the cervical cancer sample.

Data on compliance with screening guidelines by the four low health literacy-LEP combination groups are shown graphically in Figure 1. For breast cancer, 69.2% of those with both LEP and low health literacy met screening guidelines, while the other three groups had

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over 88% screening rates (Figure 1). For CRC screening, only 39% of those with both LEP and low health literacy met screening guidelines, compared to 61% of those with neither LEP nor low health literacy. However, for cervical cancer screening, the LEP and low health literacy group was not the group with the lowest percent reaching screening guidelines. Instead, the group with lowest percent reaching screening guidelines was those with low health literacy only.

Findings from the multivariable logistic models considering the four low health literacy-LEP combination groups (adjusted for control variables) for each screening type are provided in Table 3. In adjusted models, following the patterns in Figure 1, those with both LEP and low health literacy were significantly less likely to meet breast cancer screening guidelines (OR: 0.21; 95% CI:0.08-0.54) and colorectal cancer screening (OR: 0.49; 95% CI: 0.25-0.97) than those with neither LEP nor low health literacy (Table 3). Visiting a doctor in the past year was again highly predictive of screening in all three models.

Considering language concordance, in descriptive analyses among those with LEP (not shown in table), not having a language concordance provider was significantly associated with poorer screening for mammography specifically (61% with no concordant provider vs 86% with a concordant provider, p=0.01). Thus, language concordance was included in the multivariable models for mammography. However, this factor was not significant in multivariable models. Language concordance was not associated with Pap or CRC screening in descriptive analyses and was not included in multivariable models for those outcomes.

Discussion

Our study shows that health literacy is an important factor to consider for understanding low cancer screening rates among Chinese Americans. Low health literacy alone was associated with lower odds of meeting breast cancer screening guidelines and those with both LEP and low health literacy appear to be at particularly high risk for not meeting colorectal and breast cancer screening guidelines. Even after considering having a recent visit with a

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physician, having low health literacy and limited English proficiency together was an

independent predictor of screening for two out of three cancer screening types. <mark>Visiting a doctor

in the past year was also highly predictive of all three types of cancer screening. This highlights

the importance of health care system access above and beyond insurance coverage in ensuring

receipt of needed preventive care. We also note that English proficiency and health literacy

appear to have distinct relationships with the three types of cancer screening.</mark>

Our findings suggest that for breast cancer interventions in particular, strategies to

improve health literacy (such as simplifying health information) or to increase the health-literate

nature of the health care organization (such as confirming understanding at all points of patient

contact) (48-49) may increase screening in Chinese Americans, particularly in concert with other

proven strategies (50-51). It also suggests that including health literacy in multivariable studies

of factors associated with Chinese American cancer screening may be important to understand

all significant contributors to screening behavior in this group.

We also find that Chinese Americans with the combined barriers of LEP and limited

health literacy are a particularly vulnerable population for colorectal and breast cancer

screening. This supports previously findings of linguistic barriers to care and low cancer

screening rates among Chinese Americans with LEP (52-54) with further insight about the

additional burden of low health literacy. Of relevance, in a previous study of LEP and low health

literacy with CHIS data, Chinese reported the highest rates of both low health literacy and LEP

compared to other racial/ethnic groups (38).

Those with both LEP and low health literacy may fall outside many existing pathways of

health communication as both English or adapted Chinese language print materials may not be

accessible. Promising research has found that multifaceted, culturally and linguistically

appropriate interventions, including health educators in the primary care setting, can improve

cancer screening in Chinese American populations (55-56). Such interventions may be critically

important for those with LEP and low health literacy in order to illuminate screening access

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opportunities and to combat misconceptions about screening (such as whether women who are

not sexually active should be screened) (55-56).

Our findings also reveal the critical importance of regular access to a physician. Previous

studies have shown that this access factor is associated with higher rates of preventive care

and early detection of disease, but that regular visits to a doctor are less common among

minority racial/ethnic groups, especially those with LEP (57-58). The powerful role of this

variable in our study reveals the particular importance of this factor for Chinese Americans in

general, and as a way to potentially overcome the impacts of health communication barriers of

LEP and low health literacy specifically. This finding has critical current policy relevance in light

of the expanded insurance coverage under the Affordable Care Act. Our study emphasizes that

insurance alone is only the first step to receiving needed preventing care; an actual connection

with the health care system is also critical.

Our research found distinct relationships for low health literacy and LEP by screening

type. This may be related to differential health literacy and health communication demands by

screening type. The three cancer screening types vary in procedural complexity, direct patient

involvement, and/or the number of contact or communication points needed to complete the

screening. For cervical cancer screening with a Pap test, the procedure is often completed in a

single medical visit with minimal preparation by the patient. Our results showed that visiting a

doctor in the last year was particularly critical for receiving this procedure specifically and

neither of our health communication variables was significant in the cervical cancer models

when this factor was included. For mammography, the complexity of screening completion is

higher, as it can require navigating (and potentially scheduling) a separate visit often at a

different location than the doctor's office. Our findings showed that low health literacy has an

independent association with low mammography screening and that the combined burdens from

both low health literacy and LEP exacerbate the barriers for obtaining mammography. CRC

screening is the most complex of our tested screening procedures, involving multiple contact

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points and including pre-visit preparations (such as stool collection and handling for Fecal Occult Blood Test or Fecal Immunochemical Test, or dietary preparations prior to colonoscopy). These screening procedures demand literacy skills to comprehend and implement instructions. Among Chinese Americans, CRC screening had the lowest adherence rate among the three cancers studied, and the combined burdens of low health literacy and LEP were associated with lower rates of up-to-date CRC screening in this population.

Both culturally and linguistically appropriate services are likely needed to reduce health care disparities (59). While having a recent doctor visit was highly predictive of receipt of cancer screening, health communication variables were also important. Health care systems and providers able to effectively address Chinese specific cultural concerns around cancer screening are needed (55-56), especially for those with limited understanding of the U.S. medical system (for which LEP and/or low health literacy may be proxy measures).

This study has many strengths, such as a population-based data set with significant numbers of Chinese Americans, including those with LEP. However, some issues should be considered during interpretation. The health literacy items have been used in a number of previous studies (19, 37-38) and were taken from the Commonwealth Fund's 2006 Quality of Care Survey (60), but they are self-reported and only focus on some aspects of health literacy. Also, to our knowledge, such self-reported health literacy items have been validated in English speakers (39) and studied in Asian groups outside the US (61), but have not been validated in Chinese Americans specifically. It would be useful to consider differences in self-reporting health literacy challenges across Asian groups in the US, due to known cultural differences in responses to questionnaires, including gender differences (61). It would also be useful to see how other health literacy domains, such as the ability not just to understand, but also to communicate, are described by Chinese Americans and how these might be impacted by LEP. Our CHIS data lack some variables, including cultural and health belief-related factors, associated with cancer screening in Chinese Americans (62-63). We also lacked the sample

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Cancer screening among Chinese Americans also varies by geographic location. For instance, in Hawaii, Chinese Americans have higher cancer screening compliance than many other racial/ethnic groups, and higher rates of screening than are seen in these data from California (64). It would be helpful to see if the role of health literacy and/or LEP also varies, or if other factors are at play. These areas also have distinct patterns of immigration and differential percentages of Chinese relative to the larger population that may also be important in explaining these findings (2).

Conclusions

This study provides important new information about the role of low health literacy and limited English proficiency in cancer screening guideline adherence among Chinese Americans. Health literacy is increasingly recognized as an important factor in health care access and cancer screening in particular and is distinct from, but associated with, limited English proficiency. Efforts to promote screening in Chinese American communities should consider the health communication barriers of low health literacy and LEP separately and in combination to improve screening rates in these populations. Physician access barriers should also be considered as these appear critically important to cancer screening among Chinese Americans.

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Contributorship Statement

TS conceived and designed the study, obtained the funding, and drafted the manuscript. JT helped to draft the manuscript, interpret analyses, and contextualize study findings. TD participated in the study design and coordination and helped to draft the manuscript. JD participated in the design of the study, performed the statistical analysis, and helped to draft the manuscript. KB participated in the study design and coordination, and helped to draft the manuscript. All authors read and approved the final manuscript.

Competing Interests Statement

The authors have no competing interests to report.

Data Sharing

The 2007 CHIS public use data files used in this study can be downloaded at no cost from http://healthpolicy.ucla.edu/chis/data/Pages/overview.aspx. For any additional questions about specific study analyses and data (e.g., variable specification), please email tsentell@hawaii.edu.

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Table 1: Descriptive Data for Cancer Screening Samples data in 2007 CHIS for Chinese Respondents

Samples	Breast Cancer Screening	Cervical Cancer Screening	CRC Screening
Inclusions	Females, age 50-74	Females, age 21-65	Females and Males, age 50-75
Unweighted N	326	632	488
	%	%	%
Met Screening Guidelines	85.5	77.8	50.9
Low Health Literacy (LHL)	36.3	29.7	37.6
Limited English Proficiency (LEP)	46.9	28.7	41.1
LHL and LEP combinations			
Both LHL and LEP	29.0	17.4	27.0
LHL-only	17.9	11.2	14.1
LEP-only	7.2	12.3	10.6
Neither LHL and LEP	45.9	59.1	48.3
Education			
Less than HS	20.7	9.0	13.4
High School Grad	34.1	30.1	32.8
College Grad	26.5	33.9	28.4
More than College Degree	18.9	27.0	25.5
Age Group			
Young (18-24)	--	11.0	--
Middle (25-64)	70.4	87.0	67.0
Older (65+)	29.6	1.9	33.0
Control Variables			
Born in USA	10.0	16.5	11.0
$\leq$100% Fed Poverty Level	16.1	11.7	14.8
Rural Residency	2.1	4.9	1.90
Married	81.1	66.8	86.1
Female	100	100	52.5
Insured	89.9	84.7	91.6
Visited Doctor in Past Year	84.8	80.4	82.4
Language Discordant Provider	16.9	16.4	15.4

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Table 2: Logistic Models Predicting met the US Preventive Service Task Force Cancer Screening Guidelines for Breast, Cervical and Colorectal Cancer (CRC) by Health Literacy in 2007 California Health Interview Survey among Chinese Respondents[1]

	Breast Cancer Screening OR (95% CI)	Cervical Cancer Screening OR (95% CI)	CRC Screening OR (95% CI)
Low Health Literacy	0.41 (0.20-0.82) *	0.46 (0.21-1.02)	0.70 (0.38-1.30)
Limited English Proficiency	0.49 (0.20-1.22)	0.78 (0.28-2.22)	0.66 (0.35-1.22)
Education			
Less than HS	1.37 (0.33-5.61)	1.01 (0.26-3.98)	0.51 (0.14-1.88)
High School Grad	1.19 (0.39-3.59)	1.30 (0.40-4.17)	1.02 (0.46-2.27)
College Grad	0.50 (0.17-1.52)	1.13 (0.40-3.22)	0.79 (0.34-1.81)
More than College Degree	ref	ref	ref
Control Variables			
Born in USA	0.64 (0.13-3.02)	0.96 (0.32-2.88)	0.88 (0.42-1.84)
Age	1.01 (0.96-1.07)	1.07 (1.03-1.10)*	1.04 (1.00-1.08)
Female	--	--	0.88 (0.49-1.57)
≤100% Fed Poverty Level	1.44 (0.44-4.71)	0.93 (0.29-3.04)	1.00 (0.36-2.79)
Rural Residency	1.25 (0.19-8.19)	0.42 (0.08-2.20)	1.21 (0.22-6.58)
Married	0.61 (0.20-1.86)	2.37 (1.13-5.00)*	0.74 (0.26-2.12)
Insured	1.02 (0.26-3.97)	1.27 (0.42-3.80)	2.27 (0.82-6.31)
Visited Doctor in Past Year	4.68 (1.57-13.98)*	2.62 (1.35-5.11)*	2.10 (1.07-4.11)*
Language Discordant Provider	0.55 (0.20-1.54)	--	--

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[1] Factors significant p<.05 are noted with an asterisk.

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Table 3: Logistic Models Predicting met the US Preventive Service Task Force Cancer Screening Guidelines for Breast, Cervical and Colorectal Cancer (CRC) by Low Health Literacy (LHL) and Limited English Proficiency (LEP) combinations in 2007 California Health Interview Survey among Chinese Respondents[1]

	Breast Cancer Screening OR (95% CI)	Cervical Cancer Screening OR (95% CI)	CRC Screening OR (95% CI)
LHL and LEP combinations			
LHL and LEP	0.21 (0.08-0.54)*	0.41 (0.15-1.13)	0.49 (0.25-0.97)*
LEP Only	0.85 (0.27-2.72)	0.60 (0.15-2.34)	0.50 (0.21-1.17)
LHL Only	0.92 (0.24-3.57)	0.37 (0.15-0.92)*	0.50 (0.23-1.08)
Neither	Ref	ref	ref
Education			
Less than HS	1.34 (0.32-5.73)	0.92 (0.23-3.73)	0.50 (0.14-1.82)
High School Grad	1.10 (0.34-3.45)	1.28 (0.40-4.10)	1.01 (0.46- 2.26)
College Grad	0.46 (0.16-1.37)	1.14 (0.40-3.28)	0.77 (0.33-1.77)
More than College Degree	Ref	ref	ref
Control Variables			
Born in USA	0.72 (0.16-3.26)	0.91 (0.30-2.75)	0.85 (0.41-1.80)
Age	1.02 (0.96-1.07)	1.06 (1.03-1.10)*	1.04 (0.99-1.08)
Female	--	--	0.89 (0.49-1.61)
≤100% Fed Poverty Level	1.50 (0.44-5.13)	0.95 (0.29-3.08)	0.96 (0.35- 2.64)
Rural Residency	1.01 (0.17-6.06)	0.45 (0.09-2.20)	1.23 (0.25-6.07)
Married	0.66 (0.23-1.89)	2.29 (1.06-4.94)*	0.76 (0.27-2.10)
Insured	0.92 (0.23-3.66)	1.31 (0.44-3.91)	2.32 (0.81-6.64)
Visited Doctor in Past Year	4.90 (1.67-14.36)*	2.57 (1.31-5.05)*	2.04 (1.06-3.93)*
Language Discordant Provider	0.59 (0.21-1.63)	--	--

[1] Factors significant p<.05 are noted with an asterisk.

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3 Figure 1: Percent That Met Cancer Screening Guidelines by Low Health Literacy (LHL) and Limited English Proficiency (LEP) among
4 Chinese respondents the 2007 CHIS[1]
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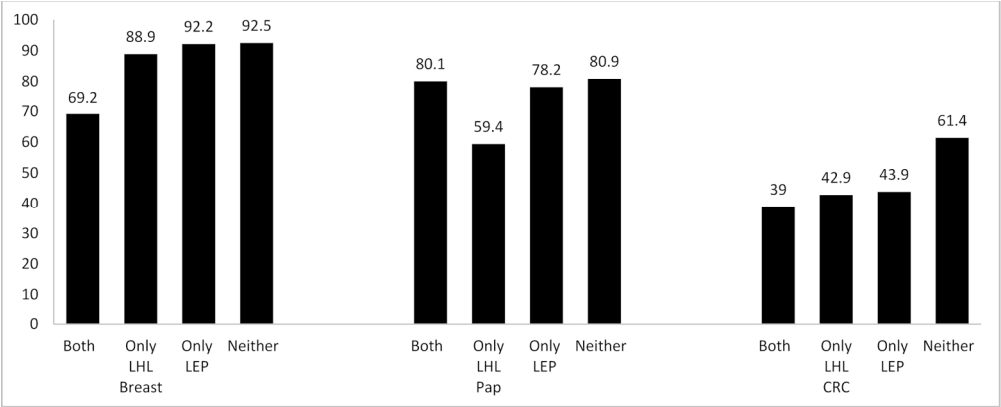39 [1] Unweighted sample sizes for the LEP/LHL combos by screening type. Breast: LHL+LEP: 75; LHL only: 32; LEP only: 40; Neither:
40 179; Pap: LHL+LEP: 101; LHL only: 79; LEP only: 61; Neither: 391; CRC: LHL+LEP: 103; LHL only: 61; LEP only: 52; Neither: 272
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	Item #		Confirmation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Y
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Y
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Y
Objectives	3	State specific objectives, including any prespecified hypotheses	Y
Methods			
Study design	4	Present key elements of study design early in the paper	Y
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Y
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Y
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Y
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Y
Bias	9	Describe any efforts to address potential sources of bias	Y
Study size	10	Explain how the study size was arrived at	Y
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Y
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Y

		(*b*) Describe any methods used to examine subgroups and interactions	Y
		(*c*) Explain how missing data were addressed	Y
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Y
		(*e*) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Y
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Y
		(b) Indicate number of participants with missing data for each variable of interest	Y
Outcome data	15*	Report numbers of outcome events or summary measures	Y
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Y
		(*b*) Report category boundaries when continuous variables were categorized	Y
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Y

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Y
Discussion			
Key results	18	Summarise key results with reference to study objectives	Y
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Y
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Y
Generalisability	21	Discuss the generalisability (external validity) of the study results	Y
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Y

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