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The role of health literacy and communication habits on previous colorectal cancer screening among low-income and uninsured patients

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ABSTRACT

Objective. To determine the association between health literacy, communication habits and colorectal cancer (CRC) screening among low-income patients.

Methods. Survey responses of patients who received financial assistance for colonoscopy between 2011 and 2014 at a family medicine residency clinic were analyzed using multivariate logistic regression ($n = 456$). There were two dependent variables: (1) previous CRC screening and (2) CRC screening adherence. Our independent variables of interest were health literacy and communication habits.

Results. Over two-thirds (67.13%) of respondents had not been previously screened for CRC. Multivariate analysis showed a decreased likelihood of previous CRC screening among those who had marginal (OR = 0.52; 95% CI = 0.29–0.92) or inadequate health literacy (OR = 0.49; 95% CI = 0.27–0.87) compared to those with adequate health literacy. Controlling for health literacy, the significant association between educational attainment and previous CRC screening was eliminated. Thus, health literacy mediated the relationship between educational attainment and previous CRC screening. There was no significant association between communication habits and previous CRC screening. There was no significant association between screening guideline adherence, and health literacy or communication.

Conclusion. Limited health literacy is a potential barrier to CRC screening. Suboptimal CRC screening rates reported among those with lower educational attainment may be mediated by limited health literacy.

Introduction

Colorectal cancer (CRC) can be prevented through routine screening and early detection with removal of pre-malignant lesions (Townsend et al., 2012; Centers for Disease Control). The preventable nature of this cancer and the peak incidence occurring after age 50 (Townsend et al., 2012) has resulted in age-based recommendations for routine screening (U.S. Preventive Services Task Force, 2008). Despite these recommendations (U.S. Preventive Services Task Force, 2008), about 28 million individuals in the United States are not up-to-date with CRC screening guidelines (Centers for Disease Control). Lack of health insurance has been consistently associated with suboptimal CRC screening (Anderson et al., 2013; Guessous et al., 2014; James et al., 2006; Meissner et al., 2006); however, 24% of Americans who have health insurance have not been screened for CRC (Centers for Disease Control and Prevention (CDC), 2013). Furthermore, even when free or subsidized CRC screening tests are provided, screening rates are still suboptimal (Anderson et al., 2011; Kobayashi et al., 2014). These findings suggest a need to identify other factors that could be contributory to inadequate screening rates.

Limited health literacy is one factor that has been associated with suboptimal CRC screening (Arnold et al., 2012), even when equal access exists (Kobayashi et al., 2014). Health literacy is defined as "the capacity to obtain, process, and understand basic health information and services to make appropriate decisions" (Institute of Medicine, 2004). About 88% of U.S. adults have marginal or inadequate health literacy (Kutner et al., 2000), limiting their ability to comprehend and utilize health information (Institute of Medicine, 2004). Lower educational attainment is often associated with suboptimal health literacy (Kutner et al., 2000; van der Heide et al., 2013; Guerra et al., 2005; Halverson et al., 2013; Sentell et al., 2013); however, those who have higher educational attainment may still have low health literacy (Institute of Medicine, 2004).

Although limited health literacy has been reported to adversely affect CRC screening (Kobayashi et al., 2014; Arnold et al., 2012; Kutner et al., 2000; Sentell et al., 2013; Morris et al., 2013; Peterson

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et al., 2007), these findings are inconclusive (Ferreira et al., 2005), with some studies reporting no association (Halverson et al., 2013; Khankari et al., 2007; Harrington et al., 2004) while another study reported that the association exists only among individuals age 65 and above (Oldach and Katz, 2014). Limited health literacy has also been associated with inadequate CRC knowledge (Arnold et al., 2012; Kutner et al., 2000) and identification of more barriers to CRC screening (Khankari et al., 2007). Improving health care providers' communication skills (Miller et al., 2007; White et al., 2008) and frequency of CRC screening recommendations (Miller et al., 2007) has been explored as a means of improving CRC screening among patients who have limited health literacy. However, patient communication habits also influence medical outcomes; interactive patients have been reported to be more likely to adhere to treatment recommendations (Modiri et al., 2013). A study reported that during consultations where CRC screening was discussed, patients were more likely to initiate the conversations and request clarifications (Katz et al., 2012a). Since patients who discuss CRC screening are more likely to receive a recommendation (Katz et al., 2012b), less communicative patients could be at increased risk for inadequate CRC screening recommendations and, consequently, inadequate CRC screening. Patients who have limited health literacy are less likely to engage in seeking information related to CRC (von Wagner et al., 2009); this could further decrease CRC screening rates among this population. However, few studies have examined the effect of limited health literacy and communication habits on previous colorectal cancer screening.

The purpose of this study was to examine the associations between limited health literacy, patient communication habits, and ever having had a CRC screening or being adherent to screening guidelines, among low-income uninsured patients in a primary care setting. We hypothesized that patients who had suboptimal health literacy levels and/or communication habits would be less likely to report ever having CRC screening or being adherent to screening guidelines. We also hypothesized that although lower educational attainment would be associated with decreased likelihood of both outcome variables, these associations would cease to exist when health literacy is included in the model.

Methods

Patients seeking financial assistance for colonoscopy at a family medicine residency clinic completed a form to determine eligibility for free or subsidized CRC screening based on income level and household size. Approximately 2 weeks before the procedure, eligible patients participated in a preparatory (prep) visit with a clinic-based community health worker (CHW). Surveys were administered during the prep visit to collect information on demographics, communication habits, health literacy, and whether or not the individual had a previous CRC screening. Surveys were administered in Spanish or English by bilingual CHWs. Patients were consented for the colonoscopy as part of usual care procedures at the clinic. All patient data were de-identified by the clinic's data analyst prior to data analysis, as approved by the organization's Institutional Review Board.

Based on screening guidelines, respondents who were less than 51 years of age were excluded from the analyses ($n = 232$). Because of insufficient numbers, those who did not self-report their race/ethnicity as white, black, or Hispanic were also excluded ($n = 51$). Those who responded "do not know" for "ever had colorectal cancer screening" ($n = 25$), last time of CRC screening (n = 15), family history of polyps or CRC (n = 30), and missing values ($n = 61$) were also excluded. A total of 414 observation were excluded from the analyses. Final sample size was 456.

Measures

We had two outcome variables of interest: (1) whether the respondent had ever had CRC screening using any of the recommended screening tests: fecal occult blood test, sigmoidoscopy or colonoscopy (coded as 1 = yes, 0 = no); and (2) whether the respondent was adherent to screening guidelines (coded as 1 = yes, 0 = no). The question used to determine previous colorectal cancer screening was "Have you ever had any of the following colorectal cancer screening procedures? Options provided were Fecal Stool Blood Test (FOBT, FIT, DNA), barium enema, CT colonography, flexible sigmoidoscopy, and colonoscopy; the response options were "Yes/No/Unknown." To ascertain screening guideline adherence, the respondents were asked to identify the last time they were screened using any of the procedures they had indicated; the response options were "Less than 1 year ago/1–3 years/3–5 years/5–10 years/More than 10 years." The questions were determined based on types of tests used for CRC screening and their recommended intervals. We limited our analyses to the modalities recommended by the United States Preventive Service Task Force, namely, FOBT/FIT, sigmoidoscopy, and colonoscopy (U.S. Preventive Services Task Force, 2008). Individuals were considered as being adherent to screening guidelines if they reported having an FOBT/FIT within the past year, sigmoidoscopy within the past 5 years, or colonoscopy within the past 10 years.

There were two independent variables of interest: respondents' health literacy and patient communication habits, measured using previously validated scales (Chew et al., 2008; Stanford Patient Education Research Center). Health literacy was measured with the question "How confident are you filling out medical forms by yourself without assistance?" For the purpose of analysis, the original five-point Likert-type scale (1—never to 5—always) responses for the health literacy variable were condensed and reversed to a three-point scale: 1 (always/often), 2 (sometimes), and 3 (rarely/never). Those who indicated "always/often" responses were regarded as having adequate health literacy; a response of "sometimes" was regarded as marginal, while "rarely/never" was regarded as inadequate. Patient communication habit was assessed using three questions: "When you visit your doctor, how often do you do the following? (1) Prepare a list of questions for your doctor, (2) ask questions about the things you want to know and things you do not understand about your treatment, and (3) discuss any personal problem that may be related to your illness." A composite score was generated from the three communication questions (Stanford Patient Education Research Center).

Control variables were based on past literature and included marital status (married, single, divorced/separated, widowed), gender (female, male), education (more than high school education, some high school education, less than high school education), race/ethnicity (White, Black/African American, Hispanic/Latino), a personal/family history of adenomatous polyps or CRC (1—yes, 0—no), and age in categories (less or equal to 60 years, greater than 60 years). Although age 65 years has been used as the cutoff for younger and older individuals in the literature (Meissner et al., 2006), we used age 60 because of inadequate numbers. We also controlled for residence which was measured by self-reported zip code; rural/urban classification was achieved by merging the data set with the Rural Urban Commuting Area Codes Data for the state of Texas (RUCA Rural Health Research Center). Four classifications of residence were used: urban, large rural, small rural and isolated rural.

Statistical analysis

Contingency tables of select demographic variables by previous CRC screening were calculated using chi-square tests. Multivariate analyses using logistic regression were used to estimate odds ratios and 95% confidence intervals. All statistical tests were two-sided, and findings were considered statistically significant at $p < 0.05$. All analyses were conducted using Stata 13.1 (StataCorp, 2013).

We used four models to test our hypotheses for both outcome variables. First, we constructed a baseline model that included only the control variables (model 1). We then controlled for the two

independent variables of interest using separate models: model 2 controlled for health literacy; model 3 controlled for patient communication habits; and the final model (model 4) comprised of all of the control and independent variables.

Results

Descriptive statistics for control variables by previous CRC screening are presented in Table 1. Over two-thirds (67.13%) of respondents had not been previously screened for CRC using any of the three screening modalities. Those who had achieved more than a high school education were more likely to report having prior CRC screening compared to those who had some high school or less than high school education (46.51%% vs. 36.73% vs. 25.69%; $p = 0.005$). The older group (60 years and above) had a greater proportion of individuals who had a previous CRC screening compared to respondents below age 60 years (48.25% vs. 30.70%; $p = 0.001$). A greater proportion of those who did not have a family history of polyps or CRC had not been previously screened for CRC compared to their counterparts (73.98% vs. 43.80%; $p = <0.0001$).

Table 2 displays results from the multivariate logistic regression for ever having a CRC screening. In model 1, those with less than a high school education had a decreased likelihood of ever having a CRC screening compared to those who had more than a high school education (OR = 0.41; 95% CI = 0.19–0.87). Younger (≤60 years) individuals also had a decreased likelihood of having a previous CRC screening compared to their counterparts (OR = 0.44; 95% CI = 0.27–0.71). There was an increased likelihood of ever having CRC screening among individuals who had a personal or family history of adenomatous polyps or CRC (OR = 3.63; 95% CI = 2.29–5.76) compared to their counterparts.

Upon addition of health literacy into the model (model 2), educational attainment was no longer statistically significant. Younger individuals continued to have a decreased likelihood of previous CRC screening compared to their counterparts (OR = 0.46; 95% CI = 0.29–0.75). Those who had a positive family or personal history still had increased likelihood of reporting a previous CRC compared to their counterparts (OR = 3.57; 95% CI = 2.24–5.70). There was a decreased likelihood of having a previous CRC screening among individuals with marginal (OR = 0.52; 95% CI = 0.29–0.92) or inadequate health literacy (OR = 0.49; 95% CI = 0.27–0.87).

Patient communication was not associated with previous CRC screening (Model 3). However, with health literacy not included in the model, once again having less than a high school education was associated with a decreased likelihood of CRC screening (OR = 0.42; 95% CI = 0.19–0.90). Younger (age ≤ 60) individuals remained less likely (OR = 0.45; 95% CI = 0.28–0.72) to report previous CRC screening while those with a positive family history still had an increased likelihood (OR = 3.63; 95% CI = 2.29–5.76) of reporting previous CRC screening.

The full model (model 4) showed that once more, with health literacy included in the model, educational attainment had no significant association with ever having had a CRC screening. Those with marginal (OR = 0.51; 95% CI = 0.29–0.92) or inadequate health literacy (OR = 0.48; 95% CI = 0.27–0.87) levels were less likely to have had a previous CRC screening compared to those with adequate health literacy. There remained a decreased likelihood of previous CRC screening among those who were younger (OR = 0.46; 95% CI = 0.29–0.75), and an increased likelihood among those who had a positive family history of adenomatous polyps or CRC (OR = 3.57; 95% CI = 2.24–5.70). There was no statistically significant association between communication and previous CRC screening.

There was no statistically significant association between being within screening guideline recommendations and health literacy or communication with physicians (Table 3). A positive family history was consistently associated with increased likelihood of screening guideline adherence across the four models.

Table 1
Select characteristics of respondents who received free or subsidized colonoscopy between 2011 and 2014 by previous colorectal cancer (CRC) screening.

	Previous colorectal cancer screening				
	No (*n*)	%	Yes (*n*)	%	*P* value
Gender					0.769
Female	207	64.490	114	35.510	
Male	89	65.930	46	34.070	
Race/ethnicity					0.127
White	92	62.160	56	37.840	
Black/African America	59	59.000	41	41.000	
Hispanic/latino	145	69.710	63	30.290	
Residence					0.712
Urban	169	64.260	94	35.740	
Large rural	25	65.790	13	34.210	
Small rural	54	70.130	23	29.870	
Isolated rural	48	61.540	30	38.460	
Educational attainment					**0.005**
More than high school	46	53.490	40	46.510	
High school	143	63.270	83	36.730	
Less than high school	107	74.310	37	25.690	
Marital status					0.458
Married	138	66.670	69	33.330	
Single	66	61.110	42	38.890	
Separated/divorced	64	62.140	39	37.860	
Widowed	28	73.680	10	26.320	
Age					**0.001**
>60 years	59	51.750	55	48.250	
≤60 years	237	69.300	105	30.700	
Family history of CRC/polyps					**<0.0001**
No	236	73.980	83	26.020	
Yes	60	43.800	77	56.200	

Bold indicates that the p value is significant.

Discussion

In this study, we explored the associations between health literacy and patient communication habits and ever having had a CRC screening or being within screening guidelines. We found that although lower educational attainment was associated with decreased likelihood of having a previous CRC screening, this association was eliminated when health literacy was included in the model. This finding is in contrast to another study, which found that educational attainment and health literacy were both independent predictors of colorectal cancer screening (Kobayashi et al., 2014); this difference could be because our study participants were predominantly uninsured and potentially, less diverse than the former study. In agreement with a previous study (Arnold et al., 2012), we found that respondents who had marginal or limited health literacy were less likely to have ever had a CRC screening. However, in agreement with other studies (Kutner et al., 2000; Khankari et al., 2007), we found no statistically significant association between health literacy and up-to-date screening. These findings suggest that programs which seek to improve CRC screening rates among uninsured individuals should consider developing and implementing strategies aimed at improving health literacy levels among their target populations. Since limited health literacy has been found to also adversely affect utilization of health services and adherence to health care provider instructions (Institute of Medicine, 2004), such strategies could have an added benefit of improving health seeking behavior, and thus health outcomes of such individuals. Developing educational materials aimed at individuals with low health literacy, as well as training health care providers on how to effectively communicate with individuals with limited literacy, should also be explored. Patients who have limited health literacy could particularly benefit from such interventions because these individuals have been found to be less likely to receive CRC screening recommendations from a health care provider (Guerra et al., 2005), a strong predictor of colorectal cancer screening (Wolf et al., 2006; Wong et al., 2013; Laiyemo et al., 2014; Underhill and Kiviniemi, 2012).

Table 2
Multivariate analysis: Influence of health literacy and communication habits on ever having colorectal cancer (CRC) screening, respondents received free or subsidized colonoscopy between 2011 and 2014 ($n = 456$).

	Model 1, odds ratio (95% CI)	Model 2, odds ratio (95% CI)	Model 3, odds ratio (95% CI)	Model 4, odds ratio (95% CI)
Marital status				
Married				
Single	1.05 (0.61–1.80)	1.11 (0.64–1.92)	1.07 (0.62–1.85)	1.10 (0.63–1.92)
Separated/divorced	0.98 (0.57–1.69)	1.03 (0.59–1.79)	0.98 (0.57–1.70)	1.03 (0.59–1.79)
Widowed	0.50 (0.21–1.17)	0.54 (0.23–1.27)	0.50 (0.21–1.16)	0.54 (0.23–1.27)
Gender				
Female				
Male	0.87 (0.55–1.38)	0.94 (0.59–1.50)	0.87 (0.55–1.38)	0.94 (0.59–1.50)
Educational attainment				
More than high school				
High school	0.60 (0.34–1.05)	0.71 (0.40–1.28)	0.60 (0.34–1.06)	0.71 (0.40–1.28)
less than high school	0.41 (0.19–0.87)	0.55 (0.25–1.21)	0.42 (0.19–0.90)	0.55 (0.25–1.20)
Race/ethnicity				
White				
Black/African American	1.53 (0.84–2.76)	1.50 (0.82–2.72)	1.52 (0.84–2.75)	1.50 (0.82–2.73)
Hispanic/Latino	1.62 (0.86–3.04)	1.70 (0.90–3.24)	1.65 (0.87–3.11)	1.70 (0.89–3.23)
Age				
>60 years				
≤60 years	0.44 (0.27–0.71)	0.46 (0.29–0.75)	0.45 (0.28–0.72)	0.46 (0.29–0.75)
Residence				
Urban				
Large rural	0.86 (0.39–1.89)	0.99 (0.44–2.20)	0.87 (0.39–1.92)	0.99 (0.44–2.20)
Small rural	0.66 (0.36–1.20)	0.64 (0.35–1.16)	0.66 (0.36–1.20)	0.64 (0.35–1.16)
Isolated rural	1.11 (0.62–1.99)	1.14 (0.63–2.07)	1.10 (0.61–1.98)	1.14 (0.63–2.07)
Family history of CRC/polyp				
No				
Yes	3.63 (2.29–5.76)	3.57 (2.24–5.70)	3.63 (2.29–5.76)	3.57 (2.24–5.70)
Health literacy				
Adequate				
Marginal		0.52 (0.29–0.92)		0.51 (0.29–0.92)
Inadequate		0.49 (0.27–0.87)		0.48 (0.27–0.87)
Communication				
			1.02 (0.95–1.09)	1.00 (0.93–1.07)

Table 3
Multivariate analysis: Influence of health literacy and communication habits on colorectal cancer screening guidelines adherence, respondents received free or subsidized colonoscopy between 2011 and 2014 ($n = 456$).

	Model 1, odds ratio (95% CI)	Model 2, odds ratio (95% CI)	Model 3, odds ratio (95% CI)	Model 4, odds ratio (95% CI)
Marital status				
Married				
Single	0.65 (0.34–1.24)	0.66 (0.35–1.26)	0.69 (0.36–1.32)	0.69 (0.36–1.33)
Separated/divorced	0.69 (0.36–1.32)	0.71 (0.37–1.36)	0.70 (0.37–1.35)	0.71 (0.37–1.37)
Widowed	0.56 (0.21–1.51)	0.59 (0.22–1.61)	0.55 (0.20–1.49)	0.58 (0.21–1.57)
Gender				
Female				
Male	1.06 (0.62–1.80)	1.12 (0.65–1.92)	1.06 (0.62–1.81)	1.11 (0.65–1.91)
Educational attainment				
More than high school				
High school	1.13 (0.58–2.23)	1.28 (0.64–2.57)	1.17 (0.59–2.32)	1.29 (0.64–2.60)
Less than high school	0.87 (0.35–2.14)	1.07 (0.42–2.70)	0.96 (0.38–2.39)	1.11 (0.43–2.83)
Race/ethnicity				
White				
Black/African American	1.38 (0.69–2.73)	1.35 (0.68–2.69)	1.36 (0.68–2.71)	1.34 (0.67–2.68)
Hispanic/Latino	1.44 (0.70–2.97)	1.49 (0.72–3.10)	1.51 (0.73–3.15)	1.54 (0.74–3.22)
Age				
>60 years				
≤60 years	0.56 (0.33–0.96)	0.59 (0.34–1.01)	0.58 (0.34–0.99)	0.60 (0.35–1.03)
Residence				
Urban				
Large rural	0.89 (0.37–2.16)	0.98 (0.40–2.41)	0.93 (0.38–2.26)	1.00 (0.41–2.45)
Small rural	0.64 (0.31–1.32)	0.62 (0.30–1.29)	0.64 (0.31–1.33)	0.62 (0.30–1.30)
Isolated rural	1.12 (0.58–2.19)	1.16 (0.59–2.28)	1.11 (0.57–2.18)	1.14 (0.58–2.25)
Family history of CRC/polyp				
No				
Yes	3.93 (2.33–6.62)	3.87 (2.29–6.54)	3.95 (2.34–6.67)	3.90 (2.30–6.60)
Health literacy				
Adequate				
Marginal		0.64 (0.33–1.27)		0.68 (0.34–1.35)
Inadequate		0.63 (0.31–1.25)		0.68 (0.33–1.38)
Communication				
			1.06 (0.98–1.15)	1.04 (0.96–1.14)

Katz and colleagues found that providing patients with CRC-related information, encouraging them to ask their providers about CRC screening, and counseling patients on identified barriers resulted in increased CRC discussion, screening recommendations, and test completion among patients including low-income, uninsured, and limited health literacy individuals (Katz et al., 2012b). Another study, comprised of predominantly minority and low-income patients, found that in physician visits where CRC discussions occurred, patients who had been activated to discuss CRC screening were more likely to initiate these discussions (Katz et al., 2012a). Encouraging patients to initiate CRC screening discussions during physician visits has also been associated with increased CRC-related discussion and increased likelihood of receiving a CRC screening recommendation (Christy et al., 2013). These findings indicate that communicative patients could have an advantage over non-communicative patients with regards to CRC screening (Modiri et al., 2013). However, we found no association between previous CRC screening or adherence to CRC screening guidelines, and communication habits among our study population.

Study limitations

This study has several limitations. Since respondents were uninsured or low-income (less than 250% Federal Poverty Level), it might have been beneficial to compare results to an insured population; however, that is beyond the scope of this study because the grant funding the CRC screenings was directed to uninsured and/or underinsured populations. Second, the data were based on self-report and might therefore have been subject to certain bias such as social desirability or recall bias. The retrospective nature of this study also limits our ability to verify possible changes in health literacy. The exclusion of other racial/ethnic groups based on insufficient numbers and the focus on uninsured or low-income patients in one primary care setting could also limit the generalizability of our study findings. Finally, the questions used to assess communication were not necessarily specific to communication domains related to CRC screening. This could have influenced our finding of no association between communication habits and previous CRC screening. Despite these limitations, our study findings could guide the implementation of programs aimed at improving CRC screening among underserved populations.

In conclusion, health literacy could account for the suboptimal CRC screening rates reported among individuals with lower educational attainment. Individuals who have limited health literacy might be at a higher risk for suboptimal CRC screening and, potentially, CRC. It is therefore pertinent that strategies to improve CRC screening among low-income or uninsured patients include the development of educational interventions tailored to meet the needs of those with limited health literacy. Strategies to improve health literacy levels should also be explored.

Conflict of interest

The authors declare that there are no conflicts of interest.

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References

Anderson, J.C., Fortinsky, R.H., Kleppinger, A., Merz-Beyus, A.B., Huntington 3rd, C.G., Lagarde, S., 2011. Predictors of compliance with free endoscopic colorectal cancer screening in uninsured adults. J. Gen. Intern. Med. 26 (8), 875–880.

Anderson, A.E., Henry, K.A., Samadder, N.J., Merrill, R.M., Kinney, A.Y., 2013. Rural vs urban residence affects risk-appropriate colorectal cancer screening. Clin. Gastroenterol. Hepatol. 11 (5), 526–533.

Arnold, C.L., Rademaker, A., Bailey, S.C., Esparza, J.M., Reynolds, C., Liu, D., Platt, D., Davis, T.C., 2012. Literacy barriers to colorectal cancer screening in community clinics. J. Health Commun. 17 (Suppl. 3), 252–264.

Centers for Disease Control, l. Colorectal (Colon cancer). (Accessed on 7/31/2014). http://www.cdc.gov/cancer/colorectal/basic_info/index.htm.

Centers for Disease Control and Prevention (CDC), 2013. Vital signs: colorectal cancer screening test use—United States, 2012. MMWR Morb. Mortal. Wkly Rep. 62 (44), 881–888.

Chew, L.D., Griffin, J.M., Partin, M.R., Noorbaloochi, S., Grill, J.P., Snyder, A., Bradley, K.A., Nugent, S.M., Baines, A.D., Vanryn, M., 2008. Validation of screening questions for limited health literacy in a large VA outpatient population. J. Gen. Intern. Med. 23 (5), 561–566.

Christy, S.M., Perkins, S.M., Tong, Y., Krier, C., Champion, V.L., Skinner, C.S., Springston, J.K., Imperiale, T.F., Rawl, S.M., 2013. Promoting colorectal cancer screening discussion: a randomized controlled trial. Am. J. Prev. Med. 44 (4), 325–329.

Ferreira, M.R., Dolan, N.C., Fitzgibbon, M.L., Davis, T.C., Gorby, N., Ladewski, L., Liu, D., Rademaker, A.W., Medio, F., Schmitt, B.P., Bennett, C.L., 2005. Health care provider-directed intervention to increase colorectal cancer screening among veterans: results of a randomized controlled trial. J. Clin. Oncol. 23 (7), 1548–1554.

Guerra, C.E., Dominguez, F., Shea, J.A., 2005. Literacy and knowledge, attitudes, and behavior about colorectal cancer screening. J. Health Commun. 10 (7), 651–663.

Guessous, I., Dash, C., Lapin, P., et al., 2014. Colorectal cancer screening barriers and facilitators in older persons. Prev. Med. 50 (1–2), 3–10.

Halverson, J., Martinez-Donate, A., Trentham-Dietz, A., Walsh, M.C., Strickland, J.S., Palta, M., Smith, P.D., Cleary, J., 2013. Health literacy and urbanicity among cancer patients. J. Rural. Health 29 (4), 392–402.

Harrington, J., Noble, L.M., Newman, S.P., 2004. Improving patients' communication with doctors: a systematic review of intervention studies. Patient Educ. Couns. 52 (1), 7–16.

Institute of Medicine, 2004. Health Literacy: A Prescription to End Confusion. The National Academies Press, Washington, D.C.

James, T.M., Greiner, K.A., Ellerbeck, E.F., et al., 2006. Disparities in colorectal cancer screening: a guideline-based analysis of adherence. Ethn. Dis. 16 (1), 228–233.

Katz, M.L., Broder-Oldach, B., Fisher, J.L., King, J., Eubanks, K., Fleming, K., Paskett, E.D., 2012a. Patient-provider discussions about colorectal cancer screening: who initiates elements of informed decision making? J. Gen. Intern. Med. 27 (9), 1135–1141.

Katz, M.L., Fisher, J.L., Fleming, K., Paskett, E.D., 2012b. Patient activation increases colorectal cancer screening rates: a randomized trial among low-income minority patients. Cancer Epidemiol. Biomarkers Prev. 21 (1), 45–52.

Khankari, K., Eder, M., Osborn, C.Y., Makoul, G., Clayman, M., Skripkauskas, S., Diamond-Shapiro, L., Makundan, D., Wolf, M.S., 2007. Improving colorectal cancer screening among the medically underserved: a pilot study within a federally qualified health center. J. Gen. Intern. Med. 22 (10), 1410–1414.

Kobayashi, L.C., Wardle, J., von Wagner, C., 2014. Limited health literacy is a barrier to colorectal cancer screening in England: evidence from the English Longitudinal Study of Ageing. Prev. Med. 61, 100–105.

Kutner, M., Greenberg, E., Jin, Y., Paulsen, C., 2000. The Health Literacy of America's Adults: Results From the 2003 National Assessment of Adult Literacy (NCES 2006–483). U.S. Department of Education. National Center for Education Statistics, Washington, DC.

Laiyemo, A.O., Adebogun, A.O., Doubeni, C.A., Ricks-Santi, L., McDonald-Pinkett, S., Young, P.E., Cash, B.D., Klabunde, C.N., 2014. Influence of provider discussion and specific recommendation on colorectal cancer screening uptake among U.S. adults. Prev. Med. 23 (67C), 1–5.

Meissner, H.I., Breen, N., Klabunde, C.N., Vernon, S.W., 2006. Patterns of colorectal cancer screening uptake among men and women in the United States. Cancer Epidemiol. Biomarkers Prev. 15, 389–394.

Miller Jr., D.P., Brownlee, C.D., McCoy, T.P., Pignone, M.P., 2007. The effect of health literacy on knowledge and receipt of colorectal cancer screening: a survey study. BMC Fam. Pract. 3 (8), 16.

Modiri, A., Makipour, K., Gomez, J., Friedenberg, F., 2013. Predictors of colorectal cancer testing using the California Health Inventory Survey. World J. Gastroenterol. 19 (8), 1247–1255.

Morris, N.S., Field, T.S., Wagner, J.L., Cutrona, S.L., Roblin, D.W., Gaglio, B., Williams, A.E., Han, P.J., Costanza, M.E., Mazor, K.M., 2013. The association between health literacy and cancer-related attitudes, behaviors, and knowledge. J. Health Commun. 18 (Suppl. 1), 223–241.

Oldach, B.R., Katz, M.L., 2014. Health literacy and cancer screening: a systematic review. Patient Educ. Couns. 94 (2), 149–157.

Peterson, N.B., Dwyer, K.A., Mulvaney, S.A., Dietrich, M.S., Rothman, R.L., 2007. The influence of health literacy on colorectal cancer screening knowledge, beliefs and behavior. J. Natl. Med. Assoc. 99 (10), 1105–1112.

RUCA Rural Health Research Center, r. RUCA Data. (Accessed on 11/19/2014). http://depts.washington.edu/uwruca/ruca-download.php.

Sentell, T., Braun, K.L., Davis, J., Davis, T., 2013. Colorectal cancer screening: low health literacy and limited English proficiency among Asians and Whites in California. J. Health Commun. 18 (Suppl. 1), 242–255.

Stanford Patient Education Research Center., r. Communication with Physicians. (Accessed on 11/19/2014). http://patienteducation.stanford.edu/research/communprov.html.

StataCorp, 2013. Stata Statistical Software: Release 13. StataCorp LP, College Station, TX.

Sabiston Textbook of Surgery. In: Townsend Jr., C.M., Beauchamp, R.D., Evers, B.M., Mattox, K.L. (Eds.), The Biological Basis of Modern Surgical Practice. Elsevier, Philadelphia, PA.

U.S. Preventive Services Task Force, 2008. Screening for colorectal cancer: U.S. Preventive Services Task Force recommendation statement. Ann. Intern. Med. 149 (9), 627–637.

Underhill, M.L., Kiviniemi, M.T., 2012. The association of perceived provider-patient communication and relationship quality with colorectal cancer screening. Health Educ. Behav. 39 (5), 555.
van der Heide, I., Rademakers, J., Schipper, M., Droomers, M., Sørensen, K., Uiters, E., 2013. Health literacy of Dutch adults: a cross sectional survey. BMC Publ. Health 27 (13), 179.
von Wagner, C., Semmler, C., Good, A., Wardle, J., 2009. Health literacy and self-efficacy for participating in colorectal cancer screening: the role of information processing. Patient Educ. Couns. 75 (3), 352–357.
White, S., Chen, J., Atchison, R., 2008. Relationship of preventive health practices and health literacy: a national study. Am. J. Health Behav. 32 (3), 227–242.
Wolf, M.S., Satterlee, M., Calhoun, E.A., Skripkauskas, S., Fulwiler, D., Diamond-Shapiro, L., Alvarez, H., Eder, M., Mukundan, P., 2006. Colorectal cancer screening among the medically underserved. J. Health Care Poor Underserved 17 (1), 47–54.
Wong, C.R., Bloomfield, E.R., Crookes, D.M., et al., 2013. Barriers and facilitators to adherence to screening colonoscopy among African-Americans: a mixed-methods analysis. J. Cancer Educ. 28 (4), 722–728 (Dec).