Health Coaching Has Differential Effects on Veterans with Limited Health Literacy and Numeracy: a Secondary Analysis of ACTIVATE

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ABSTRACT:

BACKGROUND: Health coaching is an effective behavior change strategy. Understanding if there is a differential impact of health coaching on patients with low health literacy has not been well investigated.

OBJECTIVE: To determine whether a telephone coaching intervention would result in similar improvements in enrollment in prevention programs and patient activation among Veterans with low versus high health literacy (specifically, reading literacy and numeracy).

DESIGN: Secondary analysis of a randomized controlled trial.

PARTICIPANTS: Four hundred seventeen Veterans with at least one modifiable risk factor: current smoker, BMI ≥ 30, or < 150 min of moderate physical activity weekly.

METHODS: A single-item assessment of health literacy and a subjective numeracy scale were assessed at baseline. A logistic regression and general linear longitudinal models were used to examine the differential impact of the intervention compared to control on enrollment in prevention programs and changes in patient activation measures (PAM) scores among patients with low versus high health literacy.

RESULTS: The coaching intervention resulted in higher enrollment in prevention programs and improvements in PAM scores compared to usual care regardless of baseline health literacy. The coaching intervention had a greater effect on the probability of enrollment in prevention programs for patients with low numeracy (intervention vs control difference of 0.31, 95% CI 0.18, 0.45) as compared to those with high numeracy (0.13, 95% CI − 0.01, 0.27); the low compared to high differential effect was clinically, but not statistically significant (0.18, 95% CI − 0.01, 0.38; $p = 0.07$). Among patients with high numeracy, the intervention group had greater increases in PAM as compared to the control group at 6 months (mean difference in improvement 4.8; 95% CI 1.7, 7.9; $p = 0.003$). This led to a clinically and statistically significant differential intervention effect for low vs high numeracy (− 4.6; 95% CI − 9.1, − 0.15; $p = 0.04$).

CONCLUSIONS: We suggest that health coaching may be particularly beneficial in behavior change strategies in populations with low numeracy when interpretation of health risk information is part of the intervention.

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KEY WORDS: telephone coaching; health risk assessment; health literacy; health numeracy.

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INTRODUCTION

Health risk assessment and health coaching can be important elements of health promotion, a goal of which is to increase patient activation and participation in programs designed to improve health behaviors.[1–3] Patients who score higher on measures of activation have been shown to have improved health outcomes, as well as increased positive behavior change.[2, 4, 5] Health coaching, which combines education and motivational interviewing with problem-solving strategies and psychosocial support, has been shown to be effective as a behavior change strategy in a variety of settings, including primary care.[3, 6–10]

Many social and health-related factors are associated with lower levels of activation and lower levels of engaging patients in healthy behaviors.[11–13] Health literacy is one such factor that is critical to patient activation and patient self-advocacy.[14–17] Health literacy is defined by the Institute of Medicine as "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions".[18] This includes a range of literacy skills, including not only reading, but also writing, speaking and listening, and numeracy. Nearly half of American adults have limited health

literacy, lacking the skills needed to consistently and accurately use health information.[18–22]

Low health literacy is more prevalent among older, minority, low socioeconomic status, and immigrant populations and has been associated with poor health outcomes, such as increased hospitalizations and use of emergency care, decreased use of preventive services, poor self-management of chronic diseases, and higher all-cause mortality.[18, 23] These findings persist even after controlling for potential confounders, such as sociodemographic factors and baseline physical and mental health.[24] Low health numeracy specifically has been implicated in difficulties with risk communication, interpretation of health information, and decision-making.[23, 25] Interestingly, health literacy has been demonstrated to mediate both racial and age-related disparities for a variety of health outcomes,[23, 26, 27] and based on more recent research has emerged as an important independent predictor of health disparities.[28–30] The differential impact of certain behavior change intervention strategies, including health coaching, on patients with low versus adequate health literacy has not been fully investigated.

The Evaluation of A Coaching by Telephone Intervention for Veterans and Care Team Engagement (ACTIVATE) trial assessed rates of enrollment in prevention programs and changes in behavioral activation in Veterans participating in a telephone coaching intervention. The coaching intervention tested in ACTIVATE resulted in a greater than twofold rate of enrollment in prevention services compared to controls.[31] In this secondary analysis, we hypothesized that the intervention effect would be stronger among Veterans with low health literacy (specifically, reading and numeric literacy) as compared to those with high health literacy.

METHODS

The ACTIVATE Trial

The ACTIVATE trial was a randomized controlled trial evaluating enrollment in prevention programs and changes in behavioral activation in Veterans receiving a comprehensive health risk assessment and telephone coaching intervention compared to Veterans receiving health risk assessment and usual care.[32] The study was conducted in three Veterans Health Administration (VHA) primary care clinics in Ann Arbor, Michigan, Durham, North Carolina, and Greenville, North Carolina; the Ann Arbor and Durham VA Medical Centers are academically-affiliated, and the Greenville VA is affiliated with the Durham VA. Eligible Veterans included those who were enrolled in primary care and had at least one modifiable risk factor: BMI ≥ 30, current smoker, and/or less than 150 min of moderate/vigorous physical activity per week. Veterans were excluded if they were diagnosed with dementia, active psychosis, serious personality disorder, current uncontrolled substance use disorder, severely impaired hearing or speech, terminal illness (with referral to hospice or palliative care); other exclusion criteria were inability to speak English, lack of access to a telephone, residence in a nursing home, or having participated in a prevention program or another VA study in the previous 6 months.

All enrolled Veterans ($n = 417$) completed the HealtheLiving Assessment at baseline, which is the VHA's web-based health risk assessment (HRA).[33] The HRA, publicly available via the patient web-portal "MyHealtheVet," uses statistical risk modeling to provide patients with "health age" based on lifestyle choices, family risk, and biological values, as well as information about the degree to which lifestyle changes can lower their "health age." The intervention group received two telephone calls from a trained health coach, whereas those in the usual care control group received no telephone coaching. The first telephone call occurred 1 week after the baseline interview; during this call, health coaches worked with participants to set goals to enroll in a prevention program. The second telephone call occurred 1 month after the initial call, with the primary purpose of reviewing whether the participant had made progress towards their goal; if the participant had not yet enrolled in a prevention program, the coach worked on problem-solving and setting a new goal for enrollment. The usual care group received a printed copy of their HRA output and were encouraged to discuss questions with their primary care team; primary care teams were also notified of their patients' participation in the study via a note in the electronic medical record.

The primary outcomes were self-reported enrollment in a structured prevention program (assessed at 1 month and 6 months after baseline) and Veteran activation as measured by the Patient Activation Measure (PAM) (measured at baseline, 1 month, and 6 months after baseline). The PAM is a 13-item measure that evaluates individuals' knowledge, skills, beliefs, and confidence for managing their health, and has demonstrated high construct validity.[1, 34] A 4–6 point difference on the 100-point scale has been identified as clinically meaningful.[35] Results of ACTIVATE showed higher rates of enrollment in prevention programs (51 vs 29%, OR = 2.5; 95% CI 1.7, 3.9; $p < 0.0001$) and greater mean increase in patient activation measure (PAM) scores at 6 months (mean difference 2.5; 95% CI 0.2, 4.7; $p = 0.03$) in the intervention group compared to the usual care group.[31]

Literacy and Numeracy Measures

For the purposes of this study, we will use the term "literacy" to refer specifically to reading health literacy and "numeracy" to refer to numeric health literacy.

Baseline information was obtained from Veterans during a face to face meeting with a research assistant. Literacy was assessed using a single-item question developed by Chew et al.: "Do you usually ask someone to help you read materials you receive from the hospital?".[36] The answers were in the form of a 5-item ordinal response scale. For this study, we placed Veterans into two groups according to their responses: Veterans who reported "never" requiring assistance were classified as "high literacy" and Veterans who listed any other

response ("rarely," "sometimes," "often," or "always") were classified as "low literacy." This measure has been validated in a large outpatient VA population against the S-TOFHLA and REALM[37] and has a sensitivity of > 90% to detect low literacy when using the cutoff point in the ordinal response scale used in this analysis.[38]

We used a modification of the Subjective Numeracy Scale (SNS) to assess numeracy.[39, 40] The modified version uses 3 of the original 8 items from the measure to evaluate numeracy: self-reported skill working with fractions, skill working with percentages, and frequency of usefulness of numerical information. The 3-item SNS has been independently validated in several large cohorts of adult patients (including Veterans) and has been demonstrated to correlate well with the full 8-item SNS (median ρ 0.91) and other numeracy measures.[41] The mean of the scores for the three questions was calculated and patients were split into two groups ("high numeracy" versus "low numeracy") based on their median summary scores (minimum = 1, maximum = 6, mean = 4.6, median = 4.67). Scores that were on the median were included in the "low numeracy" group.

Statistical Analysis

Two separate logistic regression models were used to examine the intervention effect on enrollment in a prevention program for literacy and numeracy subgroups; one model examined the differential intervention effect for high and low literacy, and the other model examined the differential intervention effect for high and low numeracy. The outcome variable in both models was whether or not the patient enrolled in a prevention program by 6 months. Each model included indicator variables for intervention group, high literacy/numeracy, the interaction between intervention and literacy/numeracy. Finally, we used a single logistic model which included indicators for both literacy and numeracy and their interaction to investigate the possibility of an interaction effect. PROC GLM in SAS (version 9.4) was used to fit the models and generate estimated probabilities, risk differences, and corresponding 95% confidence intervals and p values.

Two separate repeated measures general linear models (PROC MIXED in SAS, version 9.4) were used to estimate mean PAM scores over time; one model examined the differential intervention effect for high and low literacy, and the other model examined the differential intervention effect for high and low numeracy. For each, the final model parameters included a common intercept for patients with limited literacy or numeracy, a common intercept for patients with adequate literacy or numeracy, dummy-coded time, an intervention arm indicator variable interacted with each follow-up time-point, and each of these terms interacted with literacy and numeracy subgroups. Again, we also used a single repeated measured model with indicators for both literacy and numeracy and their interaction to investigate the possibility of an interaction effect of the two domains on PAM scores over time. PROC MIXED in SAS (version 9.4) was used to fit the models and test for PAM differences at 6 weeks and 6 months. An unstructured covariance was included to account for patients' repeated measurements over time.

RESULTS

Tables 1 and 2 show baseline characteristics of the study subjects according to those with high and low literacy (Table 1) and high and low numeracy (Table 2). Notably, a higher proportion of individuals were less likely to be employed and less likely to have an adequate income in the low literacy and low numeracy groups. There is also a higher proportion of African-American individuals in the low numeracy group compared to the high numeracy group.

Enrollment in Prevention Programs

We hypothesized that the intervention effect would be stronger among Veterans with low literacy and numeracy as compared to those with high literacy and numeracy. Model results of enrollment in prevention programs provide some evidence that the intervention had a differential effect among high versus low numeracy Veterans (interaction term $p = 0.05$), but not among high versus low literacy Veterans (interaction term $p = 0.3$). As shown in Table 3, rates of enrollment were about 50% for all intervention patients, regardless of numeracy status. However, usual care enrollment rates were only 21% (95% CI 0.14–0.30) in the low numeracy subgroup versus 36% (95% CI 0.28–0.46) in the high numeracy subgroup, leading to the intervention having a greater effect on probability of enrollment in prevention programs for patients with low numeracy as compared to those with high numeracy (0.18, 95% CI − 0.01, 0.38; $p = 0.07$). There was no evidence of a significant interaction of literacy and numeracy upon enrollment in a prevention program ($p = 0.60$). The estimated probabilities show that the intervention has a significant effect upon enrollment for patients with low numeracy, regardless of literacy level.

Patient Activation Scores

Table 4 shows the estimated mean PAM scores with 95% confidence intervals at 1-month and 6-month assessments for participants with high versus low numeracy and literacy. Participants with low numeracy exhibited the same changes in PAM scores regardless of intervention status with no differences in scores at 6 months (mean difference in improvement 0.15; 95% CI − 3.1, 3.4). However, among patients with high numeracy, the intervention group had greater increases in PAM as compared to the control group at 6 months (mean difference in improvement 4.8; 95% CI 1.7, 7.9; $p = 0.003$), leading to a differential effect of the intervention for patients with low vs high numeracy (− 4.6; 95% CI − 9.1, − 0.15; $p =$ 0.04). There was no differential effect of the intervention on

Table 1 Baseline Characteristics of Study Subjects for High Versus Low Literacy

	Overall ($n = 417$)	High reading literacy		Low reading literacy	
		Intervention ($n = 148$)	Usual care ($n = 144$)	Intervention ($n = 60$)	Usual care ($n = 65$)
Age, mean (SD)	55.8 (12.2)	54.2 (13.2)	55.1 (12.8)	57.9 (11.1)	58.9 (8.2)
Race, %					
African American	169 (40.5)	62 (41.9)	53 (36.8)	28 (46.7)	26 (40.0)
Caucasian	209 (50.1)	71 (48.0)	77 (53.5)	28 (46.7)	33 (50.8)
Other	39 (9.4)	15 (10.1)	14 (9.7)	4 (6.7)	6 (9.2)
Ethnicity					
Hispanic or Latino	13 (3.1)	6 (4.1)	5 (3.5)	1 (1.7)	1 (1.5)
Married, %	213 (51.1)	60 (40.5)	80 (55.6)	36 (60.0)	37 (56.9)
Employed part/full time, %	153 (36.7)	62 (41.9)	54 (37.5)	17 (28.3)	20 (30.8)
Inadequate income, %	111 (26.6)	38 (25.7)	35 (24.3)	19 (31.7)	19 (29.2)
General health excellent/very good, %	121 (29.0)	46 (31.1)	44 (30.6)	10 (16.7)	21 (32.3)
Study inclusion criteria met					
BMI ≥ 30, %	332 (79.6)	116 (78.4)	117 (81.3)	45 (75.0)	54 (83.1)
Physical activity < 150 min per week, %	209 (50.1)	71 (48.0)	74 (51.4)	28 (46.7)	36 (55.4)
Current cigarette smoker, %	163 (39.1)	62 (41.9)	53 (36.8)	26 (43.3)	22 (33.8)

PAM scores in Veterans with low versus high literacy (see Table 4). Results of the three-way interaction model approached statistical significance ($p = 0.06$), indicating that among patients with high numeracy and low literacy, PAM scores are significantly greater at 6 months for Veterans in the intervention group compared to Veterans in the control group (mean difference = 8.8, 95% CI 3.0, 14.7).

DISCUSSION

In this secondary analysis of the ACTIVATE trial, we examined whether a health risk assessment and health coaching intervention resulted in similar increased enrollments in prevention programs and in patient activation among Veterans with low versus high literacy or numeracy.

Our results show that the intervention had a similar effect on enrollment in prevention programs regardless of baseline literacy. However, while not statistically significant, there was a clinically meaningful differential treatment effect in the low versus high numeracy groups, suggesting a larger effect of the intervention in the low numeracy group. What was particularly notable was the very low enrollment rate for patients with low numeracy in the control group, 21%, when compared to all other groups. The most likely explanation for this finding is that by facilitating plain-language discussion of Veterans' health risks, the health coaching intervention relieved the burden of having to interpret numerical risk as presented by the HRA results.[43] Interacting with a coach may have helped to put numeric values generated by the HRA into context and help make these values more meaningful. There is limited and inconsistent knowledge about the relationship between numeracy and the treatment decision-making process (e.g., choosing to enroll in a prevention program).[44]

The intervention also had a differential effect on patient activation scores between the low and high numeracy groups, but interestingly favored the high numeracy group

Table 2 Baseline Characteristics of Study Subjects for High Versus Low Numeracy

	Overall ($n = 417$)	High numeric literacy		Low numeric literacy	
		Intervention ($n = 103$)	Usual care ($n = 103$)	Intervention ($n = 105$)	Usual care ($n = 106$)
Age, mean (SD)	55.8 (12.2)	56.3 (13.1)	57.5 (12.6)	54.2 (12.3)	55.1 (10.8)
Race, %					
African American	169 (40.5)	36 (35.0)	38 (36.9)	54 (51.4)	41 (38.7)
Caucasian	209 (50.1)	57 (55.3)	54 (52.4)	42 (40.0)	56 (52.8)
Other	39 (9.4)	10 (9.7)	11 (10.7)	9 (8.6)	9 (8.5)
Ethnicity, %					
Hispanic or Latino	13 (3.1)	4 (3.9)	3 (2.9)	3 (2.9)	3 (2.8)
Married, %	213 (51.1)	48 (46.6)	58 (56.3)	48 (45.7)	59 (55.7)
Employed part/full time, %	153 (36.7)	43 (41.7)	44 (42.7)	36 (34.3)	30 (28.3)
Inadequate income, %	111 (26.6)	21 (20.4)	24 (23.3)	36 (34.3)	30 (28.3)
General health excellent/very good, %	121 (29.0)	32 (31.0)	33 (32.0)	24 (22.9)	32 (30.2)
Study inclusion criteria met					
BMI ≥ 30, %	332 (79.6)	82 (79.6)	86 (83.5)	79 (75.2)	85 (80.2)
Physical activity < 150 min per week, %	209 (50.1)	43 (41.7)	51 (49.5)	56 (53.3)	59 (55.7)
Current cigarette smoker, %	163 (39.1)	39 (37.9)	35 (34.0)	49 (46.7)	40 (37.7)

Table 3 Predicted Probability of Enrollment in Prevention Programs for Participants According to Baseline Numeric and Reading Literacy Classification ($n = 373$)

Group	Intervention probability of enrollment (95% CI)	Usual care probability of enrollment (95% CI)	Difference, intervention vs usual care (95% CI)	Differential effect of intervention (low vs high); p value
Numeracy				
Low	0.52 (0.42, 0.63)	0.21 (0.14, 0.30)	0.31 (0.18, 0.45)	0.18 (−0.01, 0.38); $p = 0.07$
High	0.50 (0.39, 0.60)	0.36 (0.28, 0.46)	0.13 (−0.01, 0.27)	
Literacy				
Low	0.53 (0.39, 0.65)	0.23 (0.15, 0.35)	0.29 (0.12, 0.46)	0.11 (−0.10, 0.31); $p = 0.30$
High	0.50 (0.41, 0.59)	0.32 (0.24, 0.40)	0.18 (0.07, 0.30)	

rather than the low numeracy group; and, in particular, the combined group of high numeracy and low literacy. There was no differential effect between the low versus high reading literacy groups alone. The exact reason for this is unclear. While reading and numeric literacy are known to be associated with patient activation, and health coaching has been shown to increase patient activation, there are no prior studies that specifically examine differential effects of health coaching on low reading or numeric literacy populations.[14, 15, 31, 45] There is some data suggesting that patients with high numeric literacy are more likely and willing to engage in shared decision-making—it is possible then that the telephone calls with the coaches resulted in increased patient activation in this group.[46]

Nevertheless, the discrepancy noted between the results of enrollment in prevention programs and PAM scores raises the question of which factors aside from patient activation are contributing to the differential effects of health coaching on enrollment in patients with low numeracy. These factors may include changes in attitudes, knowledge, and patient-provider relationships and communication resulting from the health coaching intervention. Additionally, the subgroups included in this secondary analysis did have variability between them, including most notably, a lower rate of employment and adequate income in both the low literacy and low numeracy groups, and a higher proportion of African Americans in the low numeracy group.

This study has limitations. Our study was conducted in Veterans, and we have fewer female and Hispanic individuals than the general population. Additionally, the study was a secondary analysis. The original study was not designed to detect treatment differences in these subgroups, making these analyses underpowered to detect potentially clinically meaningful differences. Finally, the single-item assessment of literacy used in this study was shown to have a summary likelihood ratio of 2.9 (95% CI 2.3–3.7) for inadequate or marginal literacy for answers of "sometimes" and more frequently, while answering "rarely" had a LR of 1.0 (95% CI 0.8–1.3).[37] In this study, participants who answered "rarely" were included in the low literacy subgroup, potentially resulting in a subgroup that did not consist entirely of individuals with inaccurate literacy and therefore minimizing a possible differential treatment effect.

The results of our study suggest that health coaching may be particularly beneficial in behavior change strategies in populations with low numeracy when interpretation of health risk

Table 4 Estimated Mean PAM and 95% Confidence Intervals for Participants According to Baseline Numeric and Reading Literacy Classification ($n = 417$)

Time/group	Intervention (95% CI)	Usual care (95% CI)	Difference, intervention vs usual care (95% CI)	Differential effect of intervention (low vs high); p value
Numeracy				
Baseline*				
Low	59.2 (57.6, 60.9)	59.2 (57.6, 60.9)		
High	63.9 (62.2, 65.6)	63.9 (62.2, 65.6)		
Week 6				
Low	61.0 (58.6, 63.5)	60.9 (58.6, 63.3)	0.07 (−3.2, 3.3)	−2.8 (−7.3, 1.7); $p = 0.22$
High	65.4 (63.0, 67.8)	62.6 (60.2, 64.9)	2.9 (−0.3, 6.0)	
Month 6				
Low	63.9 (61.4, 66.4)	63.7 (61.4, 66.1)	0.15 (−3.1, 3.4)	−4.6 (−9.1, −0.15); $p = 0.04$
High	68.8 (66.4,71.2)	64.0 (61.6, 66.4)	4.8 (1.7, 7.9)	
Literacy				
Baseline*				
Low	57.4 (55.2, 59.5)	57.4 (55.2, 59.5)		
High	63.3 (61.9, 64.7)	63.3 (61.9, 64.7)		
Week 6				
Low	60.3 (57.2, 63.5)	58.6 (55.7, 61.5)	1.7 (−2.3, 5.8)	0.4 (−4.5,5.2); $p = 0.89$
High	64.5 (62.4, 66.6)	63.1 (61.2, 65.1)	1.4 (−1.4, 4.1)	
Month 6				
Low	63.6 (60.4, 66.8)	60.6 (57.7, 63.6)	3.0 (−1.1, 7.0)	0.7 (−4.1,5.5); $p = 0.78$
High	67.5 (65.5, 69.6)	65.3 (63.2, 67.3)	2.3 (−0.4, 5.0)	

**As recommended for the analysis of randomized trials[42] to improve efficiency, the longitudinal model constrained the intercept to be the same for intervention and usual care groups*

information is part of the intervention. The health coaching intervention resulted in overall higher rates of enrollment in prevention programs, regardless of health literacy level; however, the differential effect of health coaching on the low versus high numeracy subgroups highlights that health coaching may also reduce disparate effects of certain health behavior interventions on populations with low health literacy. Additionally, our findings that PAM scores improved significantly for patients with high numeracy underscores that this group may be more activated by a health coaching intervention grounded in motivational interviewing. These findings demonstrate the need for further examination of health coaching as a strategy for reducing inequities in health and in motivations for behavior change. Furthermore, coaching strategies that are tailored to populations with low health literacy—for example, using plain language and incorporating graphical methods of risk communication—may potentially result in more significant treatment effects. Our results also illustrate that the relationship between health literacy, patient activation, and behavior change is complex and likely requires multilevel interventions that consider interpersonal, community, and policy in addition to individual-level interventions such as health coaching.[47]

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