

A health care navigation tool assesses asthma self-management and health literacy



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Background: Self-management of moderate-to-severe asthma depends on the patient's ability to (1) navigate (access health care to obtain diagnoses and treatment), (2) use inhaled corticosteroids (ICSs) properly, and (3) understand ICS function.

Objective: We sought to test whether navigation skills (medication recall, knowledge of copay requirements, and ability to provide information needed for a medical visit about a persistent cough unresponsive to medication) are related to other self-management skills and health literacy.

Methods: A 21-item Navigating Ability (NAV2) questionnaire was developed, validated, and then read to adults with moderate-to-severe asthma. ICS technique was evaluated by using scales derived from instructions in national guidelines; knowledge of ICS function was evaluated by using a validated 10-item questionnaire. Spearman correlation was computed between NAV2 score and these questionnaires and with numeracy (Asthma Numeracy Questionnaire) and print literacy (Short Test of Functional Health Literacy in Adults).

Results: Two hundred fifty adults participated: age, 51 ± 13 years; 72% female; 65% African American; 10% Latino; 50% with household income of less than \$30,000/y; 47% with no more than a 12th-grade education; and 29% experienced hospitalizations for asthma in the prior year. A higher NAV2 score was associated with correct ICS technique ($\rho = 0.24$, $P = .0002$),

knowledge of ICSs ($\rho = 0.35$, $P < .001$), better print literacy ($\rho = 0.44$, $P < .001$), and numeracy ($\rho = 0.41$, $P < .001$).

Conclusions: Patients with poor navigational ability are likely to have poor inhaler technique and limited understanding of ICS function, as well as limited numeracy and print literacy.

Clinicians should consider these elements of self-management for their effect on asthma care and as a marker of more general health literacy deficits. (J Allergy Clin Immunol 2016;138:1593-9.)

Key words: Adults, asthma, health disparities, health literacy, inhaled corticosteroids, minority groups, numeracy, print literacy, self-management

Self-management of moderate-to-severe asthma depends on the patient's ability to access health care or navigate. Navigation, a concept first introduced in cancer management, is the facilitation of activities that allow early diagnosis and treatment.¹⁻³ The growing body of evidence supporting navigation as an effective intervention to improve screening and access to care in oncology has more recently been applied to chronic diseases, such as diabetes,⁴ hypertension,⁵ and depression.⁶ Navigation has not yet been investigated in patients with asthma. Navigation tasks can include successful medication recall, understanding copay and insurance requirements for medical visits, and knowing how to organize and respond to provider recommendations. Navigation and other self-management skills, such as proper use of inhaled corticosteroids (ICSs) and understanding their function, depend on health literacy.

Half of US adults have no more than basic reading and numerical skills.⁷ Patients who have limited literacy skills have greater difficulty accessing health care and navigating complex health systems and associated clinical practices.^{8,9} Low health literacy, which includes reading comprehension (or print literacy) in the health context, is associated with poor self-management of chronic diseases, including asthma.^{10,11}

Another health literacy component that contributes to self-management is numeracy, which includes basic arithmetic skills, in addition to health management tasks, such as timing medications and scheduling appointments.^{12,13} Numeracy also includes higher-level concepts, such as estimation, probability, problem solving, understanding variability and error in measurement, and risk assessment.^{12,14-16} All of these numeric skills are used in asthma management to understand the risk of uncontrolled disease compared with its management and to navigate health care resources by patients.^{15,17} Limited numeric skills were found to be associated with increased asthma-related hospitalizations and emergency department visits, lower asthma-related quality of life, and reduced asthma control.^{12,13,18}

Thus identifying patients with low literacy and developing effective interventions are needed. However, screening patients in

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Abbreviations used

ANQ: Asthma Numeracy Questionnaire
 DPI: Dry powder inhaler
 ICS: Inhaled corticosteroid
 MDI: Metered-dose inhaler
 NAV2: Navigating Ability 2
 S-TOFHLA: Short Test of Functional Health Literacy in Adults

a medical encounter for low print literacy or numeracy can be anxiety provoking, embarrassing, and deter patient-provider communication.¹⁹⁻²¹ If questions about navigating or accessing health care are also associated with validated health literacy tools, these navigation questions can serve as proxies for measuring print literacy and numeracy without embarrassing the patient while also evaluating essential patient navigation skills. Asthma care questions can also be more readily integrated into the flow of conversation between a provider and patient in a clinic visit than administration of a literacy tool.⁸ Patients identified as at risk for low health literacy could prompt the use of simpler language in clinical interviews and the “teach-back” technique, asking patients to repeat instructions to confirm understanding.²² By correlating different self-management skills, such as navigation or knowledge of essential functions of ICSs or proper use of a corticosteroid-containing inhaler, the assessment of one can inform the likelihood of difficulty with other skills.

In the current study we report the (1) development and validation of a questionnaire called Navigating Ability 2 (NAV2) that focuses on assessing asthma navigation skills, (2) examination of the association of navigation scores with other essential self-management tasks (patients’ knowledge of the function of ICSs and ability to correctly use their corticosteroid-containing inhaler), and (3) comparison of results from these self-management assessments with numeracy and print literacy scores. We hypothesize that navigation scores will be positively associated with the patient’s knowledge of the function of ICSs and ability to correctly use these inhalers and that better self-management assessments will be positively associated with higher health literacy.

METHODS**Study design and questionnaire development**

We used an exploratory mixed-methods approach, including questionnaire development²³ and a cross-sectional analysis of baseline data that is nested within an ongoing randomized controlled trial: A Patient Advocate to Improve Real-world Asthma Management for Adults Living in the Inner-city (NCT01972308, R18 HL116285). The parent study compares an individualized patient advocate intervention with currently practiced, guideline-based usual care in adults with moderate or severe asthma. Approval for research was obtained from the Institutional Review Board of the University of Pennsylvania.

Participants

Patients 18 years and older with a physician’s diagnosis of asthma and prescribed an ICS were identified by using the electronic health records of participating practices. The practices included outpatient primary care and asthma specialty practices within the University of Pennsylvania Health System, a federally qualified health center, and a primary care practice serving mainly Spanish-speaking patients.

Identified patients were invited for screening for evidence of reversible airflow obstruction: an FEV₁ of less than 80% of predicted value at the time of

screening or within the 3 years before this screening and improvement with bronchodilator. For the parent study, participants were randomized to work with a patient advocate or to receive usual care. Exclusion criteria included inability to complete study tasks because of severe psychiatric or cognitive issues, difficulty understanding and providing informed consent, or inability to communicate in English or Spanish.

Procedures

After providing informed consent, participants completed questionnaires about their asthma history, current asthma status, quality of life, sociodemographics, health literacy, and navigation ability. Spirometry was performed according to American Thoracic Society guidelines.²⁴

Navigation ability questionnaire development

To develop a questionnaire to measure patient navigation ability, we followed procedures described by Streiner and Norman,²⁵ Collingridge,²⁶ and McKinley et al.²⁷ First, we reviewed the oncology navigation literature, which included well-established categories of navigation, such as insurance, referrals, community resources, and transportation access.^{25,26} Next, we convened focus groups of patients and providers to inform the design of the ongoing patient advocate study. Participants in both groups were diverse in terms of race/ethnicity and sex. Patients also were diverse with respect to asthma severity, comorbidities, and social support. Health care providers were diverse according to practice (primary care vs asthma specialty) and years in practice. Focus group discussions generated items for a draft of a navigation questionnaire.²⁸ Then we piloted these questions about accessing health care for an outpatient appointment.^{28,29} These pilot participants were also diverse in terms of race/ethnicity, age, sex, asthma severity, comorbidities, and household income. The group was enriched for patients with the highest asthma morbidity: female low-income adults. Based on these experiences, we refined the questionnaire and used it in the ongoing patient advocate study (Table I). Many other factors likely influence navigation ability, including personal factors, such as empowerment, and system factors, such as ease of access and cultural factors. This study was not designed to look at these influences, but future research is warranted on these potential influences.

The NAV2 questionnaire is comprised of 21 questions, which ask about medication recall, copay requirements, access to health insurance, and information needed in preparation for an outpatient visit. Each item has an individual score based on whether the response was correct. A total NAV2 score was the sum of correct items (range, 0-21; Table I). A statistical analysis to validate the NAV2 questionnaire is presented, followed by a cross-sectional analysis examining the association between numeracy and print literacy and self-management skills for the chronic disease of asthma, examining participants at baseline of the parent study.

Other self-management measures

ICS knowledge. ICSs are essential medications for all but intermittent asthma. We measured knowledge of ICS function using a previously validated 8-item questionnaire with a 5-point response scale.^{30,31} Two additional items were added to this questionnaire. The scale is calculated by using a total score from the sum of the items, reversing items where needed so that a higher score indicates having more knowledge of the function of inhaled steroids. It has a range of 10 to 50 (see Table E1 in this article’s Online Repository at www.jacionline.org).

ICS technique. Trained research coordinators observed and graded ICS inhaler technique using a 7-point scale for metered-dose inhalers (MDIs) and a 6-point scale for dry powder inhalers (DPIs). The scales were derived from instructions in national guidelines (see Table E2 in this article’s Online Repository at www.jacionline.org).³²

Patient-perceived asthma control

Asthma-related quality of life was measured with the Mini-Asthma Quality of Life Questionnaire.³³⁻³⁵ Asthma control was assessed by using the 7-item

TABLE I. NAV2 questionnaire*

	No. of participants with correct response (n = 250)
1. Patient lists all asthma medication names correctly.	195 (78%)
2. Patient correctly recites number of times a day required to take inhaled steroid.	222 (89%)
3. Patient correctly recites number of puffs of inhaled steroid per unit of time.	215 (86%)
4. Patient can correctly name which of their medications is a controller and which is a reliever.	182 (73%)
5. Patient can recite action plan.	78 (31%)
<i>The sum of "Yes" responses will be the score. Score range is 0-5.</i>	
Score: _____	
6. Ask patient: "What is a copay?"	143 (57%)
<i>Correct answer: A copay is the portion I pay for a medical visit or medication that insurance doesn't cover. (Participant must indicate: I pay; not covered by insurance; for medical visit or medication or procedure)</i>	
<i>Correct answer: score 1. Incorrect or no answer: score 0.</i>	
Score: _____	
7. Ask patient: "If you were unsure of the amount of your copay, what is the best way to find out how much it is?"	
Read choices and ask patient to choose the best response.	
a. Call the insurance company	167 (67%)
b. Ask the receptionist	
c. Ask the doctor	
d. Ask a friend	
e. Other	
<i>Correct answer: a. Call the insurance company: score 1. Incorrect or no answer: score 0.</i>	
Score: _____	
8. Ask patient: "If your doctor prescribes a medicine that your health insurance does not cover, what would you do?"	
Read choices and ask patient to choose the best response.	
a. Call the doctor's office	197 (79%)
b. Wait until next visit, scheduled in a month	
c. Borrow from a friend or family member	
d. Do nothing	
e. Substitute another medicine	
<i>Correct answer: a. Call the doctor's office: score 1. Incorrect or no answer: score 0.</i>	
Score: _____	
9. Ask patient: "You are accompanying a friend to his/her first visit to a new primary care provider. Your friend was recently hospitalized. What would he/she need to bring to that visit?"	
Do not read options.	
a. Insurance card	148 (59%)
b. ID	105 (42%)
c. Medications/list of medications	127 (51%)
d. Records and/or test results	138 (55%)
<i>The sum of "yes" responses will be the score. Score range is 0-4.</i>	
Score: _____	
10a. Ask patient: You were seen by the doctor for a cough. You were given a medication for the cough. The cough does not go away. You are going to a follow-up visit for the cough. What could you do to prepare for the visit?	
Do not read options.	
1. Write down or prepare questions	21 (8%)
2. Make a list of symptoms	54 (22%)
3. Know medications taken	65 (26%)
4. List problems with medications	51 (20%)
5. Other reasonable option (eg, bring any tests or records since you had the initial visit)	11 (4%)
<i>The sum of "yes" responses will be the score. Score range is 0-5.</i>	
Score: _____	
10b. Ask patient: "What could you do to remember the details of the visit?"	
Do not read options.	
1. Take notes at the visit	158 (63%)
2. Ask questions at the end of the visit	14 (6%)
3. Look at the visit summary	80 (32%)
4. Bring a family member or a friend	10 (4%)
<i>The sum of "yes" responses will be the score. Score range is 0-4.</i>	
Score: _____	
Summary score (the sum from all questions): _____	

*The questionnaire is displayed in the left-hand column. Scoring of each item is indicated in the italicized areas. The numbers of participants with correct response are presented in the right-hand column. For items 1 to 5 and 9 to 10, the response is as follows: ☐₁ Yes ☐₀ No. The sum of the "yes" responses where "yes" is counted as 1 and "no" as 0 is the score.

version of the Asthma Control Questionnaire, which asks about symptoms over the past week.³⁶⁻³⁸

Health literacy variables

The health literacy questionnaires used are available in English and Spanish. To assess asthma-related numeric skills, the Asthma Numeracy Questionnaire (ANQ) was read to participants in their primary language, while a written copy was available to view.¹² The ANQ is a validated 4-item questionnaire that tests numeric concepts, such as arithmetic and percentages, adapted from standard asthma education. The score is the number of correct answers, with a range of 0 to 4.¹²

Reading comprehension was tested by using the Short Test of Functional Health Literacy in Adults (S-TOFHLA), which consists of 36 modified Cloze procedure items.³⁹ The score is the number of items correct; however, the authors recommend treating the score as a categorical variable, which has functional relevance, as follows: inadequate (raw score, ≤ 16), marginal (raw score, 17-22), and adequate (raw score, 23-36).^{40,41}

Other participant characteristics

The study sample was summarized according to self-reported demographic characteristics associated with literacy and asthma morbidity, including age, race, ethnicity, educational attainment, household income, insurance status, and comorbidities.^{8,42} Self-reported comorbidities were verified in the electronic health record in 10% of the sample.

Statistical analysis

Descriptive statistics and data analyses were performed with Stata 14.1 software (StataCorp, College Station, Tex) and SAS 9.4 software (SAS Institute, Cary, NC). The analysis proceeded in 3 phases. First, the internal consistency of the items and the reliability of the Navigating Ability scale were evaluated by using Cronbach α . In addition, the scale unidimensionality and item-person reliability was examined by using a Rasch model, and goodness of fit was assessed.²⁶

Second, Wilcoxon rank sum tests were used to compare literacy (ANQ and S-TOFHLA scores) to each item of the navigation ability scale. A false discovery rate approach was used to account for multiple testing.

Finally, we examined the associations between literacy, self-management skills, and navigation ability. For navigation ability, we used the sum of items correct. Specifically, we assessed the association of literacy and self-management skills with navigation ability using Spearman correlation coefficients as the distributions of literacy, inhaler technique, and numeracy violated the assumption of normality. We confirmed the strength of the associations after adjusting for participants' characteristics (educational attainment, household income, and race) with linear regression.

RESULTS

Recruitment

More than 80,000 records were reviewed, and approximately 10,045 patients were identified who had an upcoming appointment, were at least 18 years old with a physician's diagnosis of asthma, and had an ICS prescription. After eliminating multiple appointments for any 1 patient, inadequate response to bronchodilator, and filtering for any severe psychiatric or cognitive problems and lung diseases, such as pulmonary hypertension, cystic fibrosis, and lung cancer, 2265 patients were eligible. We made 534 attempts to contact potential participants by telephone or in person and successfully reached 347. Two hundred fifty patients agreed to participate and

TABLE II. Characteristics of 250 adults with moderate or severe asthma

Characteristics	Total (n = 250)
Sociodemographics	
Age (y)*	51 $\pm$ 13
Female sex	181 (72%)
Race	
Black/African American	162 (65%)
White	62 (25%)
Asian	3 (1%)
No response or declined to answer	22 (9%)
Ethnicity: Hispanic/Latino	24 (10%)
Household income per year	
<\$30,000	125 (50%)
\$30,000-\$49,999	35 (14%)
\$50,000-\$99,999	35 (14%)
\$100,000 or more	23 (9%)
No response or declined to answer	32 (13%)
Educational attainment (highest level achieved)	
Eighth grade or less	3 (1%)
Some high school	31 (12%)
High school graduate	84 (34%)
Some college or trade school	61 (24%)
College graduate	71 (28%)
Health insurance	
Medicaid	88 (35%)
Medicare only	58 (23%)
Self-pay (none)	3 (1%)
Commercial with or without Medicare	100 (40%)
No response or declined to answer	1 (1%)
Asthma severity	
FEV ₁ at enrollment (percent predicted)*	68 $\pm$ 19
No. with ≥ 1 emergency department visit for asthma in past year	104 (42%)
No. with ≥ 1 hospitalization for asthma in past year	73 (29%)
Asthma-related quality of life*†	4.0 $\pm$ 1.5
Asthma control*‡	2.3 $\pm$ 1.2
Literacy	
Numeracy*§	2.0 $\pm$ 1.3
Reading comprehension (median [IQR])	34 (25-35)
Comorbidities (no.)	
Hypertension	130 (52%)
Diabetes	53 (21%)
Body mass index*¶	33.9 $\pm$ 8.9
Current smoker	44 (18%)
Ever smoked	128 (51%)

IQR, Interquartile range.

*Mean $\pm$ SD.

†Asthma-related quality of life was measured with the Mini-Asthma Quality of Life Questionnaire. It is a 15-item questionnaire reflecting well-being over the past 2 weeks. It has a 7-point response scale for each item, ranging from 1 (maximum impairment) to 7 (no impairment). The average of the items' scores yields the mean summary score.³³⁻³⁵

‡Asthma control was assessed by using the 7-item version of the Asthma Control Questionnaire.³⁶⁻³⁸ The score is the mean of all responses (0, total control; 6, extremely uncontrolled). A score of greater than 1.5 is considered inadequate control.⁴³

§Numeracy was measured with the ANQ.¹²

||Reading comprehension was measured by using the S-TOFHLA.³⁹ This distribution is highly skewed. We report medians and interquartile ranges. Thirty-five (14%) participants had inadequate literacy, 18 (7%) had marginal literacy, 194 (78%) had adequate literacy, and 3 (1%) were missing on this measure.

¶Normal body mass index is 18.5 to 24.9 kg/m² (overweight, 25.0-29.9 kg/m²; obese, ≥ 30 kg/m²).

TABLE III. Correlations of asthma numeracy (measured by the ANQ score) and print literacy (measured by the S-TOFHLA score) with navigation ability items among 250 patients with moderate or severe asthma (eg, a patient who does not know the names of asthma medications is more likely to have low numeracy and low reading comprehension)

NAV2 items	ANQ†			S-TOFHLA‡		
	Median (IQR) for NAV2 items: answered correctly	Median (IQR) for NAV2 items: answered incorrectly	Unadjusted <i>P</i> value	Median (IQR) for NAV2 items: answered correctly	Median (IQR) for NAV2 items: answered incorrectly	Unadjusted <i>P</i> value
Medication and action plan recall						
1: Asthma medication names	2.0 (1.0-3.0)	1.0 (1.0-2.0)	.001*	35 (30-35)	26 (17-35)	.001*
2: Frequency of ICSs	2.0 (1.0-3.0)	2.0 (1.0-2.0)	.016*	35 (25-35)	33 (21-35)	.074
3: Number of ICS puffs	2.0 (1.0-3.0)	1.0 (1.0-2.0)	.009*	35 (26-35)	34 (17-35)	.073
4: Controller vs reliever	2.0 (1.0-3.0)	1.0 (1.0-2.0)	<.001*	35 (32-36)	26 (14-35)	<.001*
5: Asthma action plan	2.0 (1.0-3.0)	2.0 (1.0-3.0)	.069	35 (32-36)	34 (23-35)	.017*
Health insurance requirements						
6: Copay requirements	2.0 (2.0-3.0)	1.5 (1.0-3.0)	<.001*	35 (33-36)	32 (19-35)	<.001*
7: Copay amount	2.0 (1.0-3.0)	2.0 (1.0-3.0)	.061	35 (29-36)	33 (19-35)	.003*
8: No insurance coverage	2.0 (1.0-3.0)	1.5 (1.0-3.0)	.059	35 (24-35)	34 (26-35)	.197
Initial medical visit preparation						
9a: Insurance card	2.0 (1.0-3.0)	2.0 (1.0-3.0)	.199	35 (29-35)	34 (20-35)	.053
9b: ID	2.0 (1.0-3.0)	2.0 (1.0-3.0)	.168	35 (28-35)	34 (23-35)	.132
9c: List of medications	2.0 (1.0-3.0)	2.0 (1.0-3.0)	.003*	35 (28-35)	34 (25-35)	.195
9d: Records and/or test results	2.0 (2.0-3.0)	1.0 (1.0-3.0)	<.001*	35 (33-36)	32 (20-35)	<.001*
Follow-up medical visit preparation						
10a (1): Questions	3.0 (2.0-4.0)	2.0 (1.0-3.0)	.004*	35 (33-36)	34 (25-35)	.093
10a (2): List of symptoms	3.0 (2.0-3.0)	2.0 (1.0-3.0)	.001*	35 (34-36)	34 (21-35)	<.001*
10a (3): Know medications taken	2.0 (1.0-3.5)	2.0 (1.0-3.0)	.053	35 (34-36)	34 (20-35)	.002*
10a (4): List problems with medications	2.0 (1.0-3.0)	2.0 (1.0-3.0)	.122	34 (28-35)	34 (25-35)	.199
10a (5): Other reasonable option	2.0 (1.0-3.0)	2.0 (1.0-3.0)	.199	35 (24-36)	34 (25-35)	.060
Follow-up medical visit: Remember details						
10b (1): Take notes at the visit	2.0 (1.0-3.0)	2.0 (1.0-3.0)	.003*	35 (31-36)	33 (18-35)	<.001*
10b (2): Ask questions at the end of the visit	1.0 (1.0-3.0)	2.0 (1.0-3.0)	.109	34 (21-36)	34 (25-35)	.199
10b (3): Look at the visit summary	2.0 (1.0-3.0)	2.0 (1.0-3.0)	.070	35 (31-35)	34 (23-35)	.131
10b (4): Bring a family member or friend	4.0 (2.0-4.0)	2.0 (1.0-3.0)	.012*	36 (35-36)	34 (25-35)	.045

IQR, Interquartile range.

*Statistically significant at the .05 level after false discovery rate adjustment of Wilcoxon rank sum *P* values.†ANQ score: range, 0-4.¹²‡S-TOFHLA score: range, 0-36.³⁹

completed baseline surveys used in this analysis. Ninety-seven patients declined and gave the following reasons: 15 did not believe the parent study would be beneficial for them or others, 5 were concerned about research process and privacy issues, 19 had difficulty with travel time to get to appointments, 50 were too busy to participate, 3 had providers who believed the study to be not beneficial, and 5 stated they did not have asthma.

Participants' characteristics

The 250 participant ranged in age from 19 to 85 years. Participants were mostly female and black/African American (Table II).^{12,33-39,43} Almost half of the cohort had at least 1 asthma-related emergency department visit, and almost one third had been hospitalized for asthma in the past year. Mini-Asthma Quality of Life Questionnaire scores were low and more variable than in the population of symptomatic asthmatic patients in which this measure was validated (4.0 ± 1.5 compared with 5.4 ± 0.8).^{33,34} Asthma control scores tended to be in the uncontrolled range. Comorbidities were prevalent. The mean ICS knowledge score was 35 ± 6.7 , indicating low knowledge. For inhaler technique, 147 used an MDI only, 95 used a DPI only, and 7 used both. The mean MDI score for the 7-point questionnaire was 6.1 ± 1.0 , and the DPI score was 5.6 ± 0.6 for the 6-point questionnaire.

NAV2 validation

The navigation ability scale achieved moderate internal consistency with a Cronbach α value of 0.54 (item-specific range, 0.49-0.56). One- and 2-parameter logistic Rasch models were fit to the navigation ability scale. The 2-parameter model yielded significant improvement in the fit (likelihood ratio χ^2 [$df = 20$] = 116.47, $P < .001$), suggesting that the items have varying levels of discrimination. The overall goodness-of-fit test of the 2-parameter Rasch model versus the saturated model found no evidence that the Rasch model does not hold ($P > .99$). However, a model allowing multiple dimensions (Akaike information criterion = 5188.08) yielded a better fit compared with the unidimensional Rasch model (Akaike information criterion = 5245.84), suggesting the scale might be composed of more than 1 factor.

Item-level analysis

More than two thirds of participants answered correctly all medication recall items (items 1-4 of the NAV2 questionnaire), and more than half answered correctly the copay requirement items (item 6 and 7, Table I). The follow-up medical visit question (item 10a) had the worst results, with 8% providing the correct "prepares questions" response, and 4% correctly responding

“bring a family member or friend.” There were significant associations between ANQ scores and scores on 11 of 21 NAV2 items and S-TOFHLA and 9 of 21 NAV2 items after accounting for multiple testing, as shown in Table III.¹² Participants who answered the NAV2 items correctly had higher levels of literacy, as measured by median ANQ and S-TOFHLA scores, compared with participants with incorrect responses to NAV2 items.

NAV2 score association with literacy and other self-management questionnaires

NAV2 scores are positively associated with numeracy (Spearman $\rho = 0.41$, $P < .001$), as measured by using the ANQ, and reading comprehension ($\rho = 0.44$, $P < .001$), as measured by using the S-TOFHLA. NAV2 scores were associated with other asthma self-management questionnaires: correct technique for using a corticosteroid-containing inhaler ($\rho = 0.24$, $P = .0002$) and ICS knowledge ($\rho = 0.35$, $P < .001$). All associations remained statistically significant after adjusting for educational attainment, household income, and race.

DISCUSSION

We report the validation of a health care navigation ability tool, the NAV2, which is associated with health literacy measures of print and numeracy and also associated with other asthma self-management assessments. This association is important for patient care because it tells us that the navigation items, which are routine questions for asthma assessment, can be used as indicators of the literacy skills of the patient and also of knowledge of other essential concepts of self-management, without embarrassing patients or disrupting the flow of an office visit with a literacy screening questionnaire. Poor response to any of the navigation items associated with low literacy (Table III) should prompt providers to spend more time educating the patient, simplifying information, or seeking additional resources to assist the patient. In addition, this knowledge can influence the number of follow-up tasks (behavior changes, medication changes, diagnostic testing, and follow-up appointments) asked of patients. Prioritizing and limiting the number of such tasks might improve successful completion.

Potentially, 3 of the highest-performing items (naming asthma medications, asking whether a medication is a controller or a reliever, and asking what is a copay) could be used quickly by a provider in an office visit to assess literacy and navigation skills. Further research is needed to see whether these 3 items together could serve as an effective brief screen for low literacy and poor navigation skills. This has potential implications for management of other chronic diseases, given the significant comorbidities in this population. Further research also is warranted to determine whether modification of the quick screen could be used to identify patients with low literacy or poor navigation skills who have other chronic diseases, such as hypertension or diabetes. It is noteworthy that our asthma study is important for being one of a very few studies that considers patients with prevalent comorbidities.

Our study has several limitations. First, this is not a longitudinal study and does not demonstrate that an intervention to improve navigation improves subsequent health outcomes. Such a longitudinal study is an important next step. Nevertheless, the finding of reduced asthma control and asthma-related quality of

life in our cohort tells us that populations with low health care navigation ability tend to be those with high asthma morbidity who need further intervention to achieve better control. Improving navigation ability or simplifying the navigations required of patients by practices needs evaluation.

Second, our population is mostly from 1 health system, and generalizability to other patient groups in other settings must be studied. However, this study draws patients from a number of diverse practices: family practice, general internal medicine, pulmonary, and allergy-immunology. In addition, the patients are generally from a group with the highest asthma morbidity: minority women from low-income households. Even patients with high literacy have trouble navigating and remembering instructions in a stressful medical environment.¹⁷ Although the generalizability would also improve if the NAV2 were modified for other chronic diseases, this could be done by modifying items 1 to 5.

In summary, simple navigation questions or questions about knowledge or proper use of ICSs also provide information about patient literacy and the need to match information to patient literacy needs.

Clinical implications: Patients' health care navigation ability predicts patients' asthma self-management skills and, more generally, their health literacy. Attention to navigation might allow providers to tailor information and ultimately improve patient-provider communication.

REFERENCES

- Freeman HP. Patient navigation: a community centered approach to reducing cancer mortality. *J Cancer Educ* 2006;21(suppl):S11-4.
- Freeman HP. The origin, evolution, and principles of patient navigation. *Cancer Epidemiol Biomarkers Prev* 2012;21:1614-7.
- Ko NY, Snyder FR, Raich PC, Paskett ED, Dudley DJ, Lee JH, et al. Racial and ethnic differences in patient navigation: results from the Patient Navigation Research Program. *Cancer* 2016;122:2715-22.
- Loskutova NY, Tsai AG, Fisher EB, LaCruz DM, Cherrington AL, Harrington TM, et al. Patient navigators connecting patients to community resources to improve diabetes outcomes. *J Am Board Fam Med* 2016;29:78-89.
- Wang ML, Gallivan L, Lemon SC, Borg A, Ramirez J, Figueroa B, et al. Navigating to health: evaluation of a community health center patient navigation program. *Prev Med Rep* 2015;2:664-8.
- Diaz-Linhart Y, Silverstein M, Grote N, Cadena L, Feinberg E, Ruth BJ, et al. Patient navigation for mothers with depression who have children in Head Start: a pilot study. *Soc Work Public Health* 2016;31:504-10.
- Kutner M, Greenberg E, Jin Y, Paulsen C. The health literacy of America's adults: results from the 2003 National Assessment of adult literacy (NCES 2006-483). Washington, DC: National Center for Education Statistics; 2006.
- Nielsen-Bohlman L, Panzer A, Kindig D. Health literacy: a prescription to end confusion. Washington, DC: National Academies Press; 2003.
- Healthy People 2010: health communication. 2010. Available at: <http://www.healthypeople.gov/document/html/volume1/11healthcom.htm>. Accessed August 17, 2010.
- Matsuoka S, Tsuchihashi-Makaya M, Kayane T, Yamada M, Wakabayashi R, Kato NP, et al. Health literacy is independently associated with self-care behavior in patients with heart failure. *Patient Educ Couns* 2016;99:1026-32.
- O'Connor R, Wolf MS, Smith SG, Martynenko M, Vicencio DP, Sano M, et al. Health literacy, cognitive function, proper use, and adherence to inhaled asthma controller medications among older adults with asthma. *Chest* 2015;147:1307-15.
- Apter AJ, Cheng J, Small D, Albert C, Fein D, Bennett IM, et al. Asthma numeracy skill and health literacy. *J Asthma* 2006;43:705-10.
- Apter AJ, Wang X, Bogen D, Bennett I, Jennings R, Garcia L, et al. Linking numeracy and asthma-related quality of life. *Patient Educ Couns* 2009;75:386-91.
- Rudd RE, Anderson JE, Oppenheimer S, Nath C. Health literacy: an update of medical and public health literature. In: Comings JP, Smith C, Garner B, editors. *Review of adult learning and literacy*. Vol 7. Mahwah, NJ: Lawrence Erlbaum Associates; 2007:175-204.

15. Montori VM, Rothman RL. Weakness in numbers. The challenge of numeracy in health care. *J Gen Intern Med* 2005;20:1071-2.
16. Schwartz LM, Woloshin S, Black WC, Welch HG. The role of numeracy in understanding the benefit of screening mammography. *Ann Intern Med* 1997;127:966-72.
17. Apter AJ, Paasche-Orlow MK, Remillard JT, Bennett IM, Ben-Joseph EP. Numeracy and communication with patients: they are counting on us. *J Gen Intern Med* 2008;23:2117-24.
18. Apter AJ, Wan F, Reisine S, Bender B, Rand C, Bogen DK, et al. The association of health literacy with adherence and outcomes in moderate-severe asthma. *J Allergy Clin Immunol* 2013;132:321-7.
19. Davis TC, Williams MV, Marin E, Parker RM, Glass J. Health literacy and cancer communication. *CA Cancer J Clin* 2002;52:134-49.
20. Parikh NS, Parker RM, Nurss JR, Baker DW, Williams MV. Shame and health literacy: the unspoken connection. *Patient Educ Couns* 1996;27:33-9.
21. Wolf MS, Williams MV, Parker RM, Parikh NS, Nowlan AW, Baker DW. Patients' shame and attitudes toward discussing the results of literacy screening. *J Health Commun* 2007;12:721-32.
22. Paasche-Orlow MK, Riekert KA, Bilderback A, Chanmugam A, Hill P, Rand CS, et al. Tailored education may reduce health literacy disparities in asthma self-management. *Am J Respir Crit Care Med* 2005;172:980-6.
23. Loerbroeks A, Leucht V, Keuneke S, Apfelbacher CJ, Sheikh A, Angerer P. Patients' needs in asthma treatment: development and initial validation of the NEAT questionnaire. *J Asthma* 2016;53:427-37.
24. Standardization of spirometry, 1994 update. American Thoracic Society. *Am J Respir Crit Care Med* 1995;152:1107-36.
25. Streiner DL, Norman GR. Health measurement scales: a practical guide to their development and use. 2nd ed. Oxford: Oxford University Press; 1996.
26. Collingridge D. Validating a questionnaire. 2015. Available at: <http://www.methodspace.com/profiles/blogs/validating-a-questionnaire>. Accessed November 24, 2015.
27. McKinley RK, Manku-Scott T, Hastings AM, French DP, Baker R. Reliability and validity of a new measure of patient satisfaction with out of hours primary medical care in the United Kingdom: development of a patient questionnaire. *BMJ* 1997;314:193-8.
28. Black HL, Priolo C, Akinyemi D, Gonzalez R, Jackson DS, Garcia L, et al. Clearing clinical barriers: enhancing social support using a patient navigator for asthma care. *J Asthma* 2010;47:913-9.
29. Apter AJ, Wan F, Reisine S, Bogen DK, Rand CS, Bender BG, et al. Feasibility, acceptability and preliminary effectiveness of patient advocates for improving asthma outcomes in adults. *J Asthma* 2013;50:850-60.
30. Apter AJ, Reisine ST, Affleck G, Barrows E, ZuWallack RL. Adherence with twice-daily dosing of inhaled steroids. Socioeconomic and health-belief differences. *Am J Respir Crit Care Med* 1998;157:1810-7.
31. Apter AJ, Boston R, George M, Norfleet AL, Tenhave T, Coyne JC, et al. Modifiable barriers to adherence to inhaled steroids among adults with asthma: it's not just black and white. *J Allergy Clin Immunol* 2003;111:1219-26.
32. Expert Panel Report 3: guidelines for the diagnosis and management of asthma. Bethesda: National Institutes of Health/National Heart, Lung, and Blood Institute; 2007.
33. Juniper EF, Buist AS, Cox FM, Ferrie PJ, King DR. Validation of a standardized version of the Asthma Quality of Life Questionnaire. *Chest* 1999;115:1265-70.
34. Juniper EF, Guyatt GH, Cox FM, Ferrie PJ, King DR. Development and validation of the Mini Asthma Quality of Life Questionnaire. *Eur Respir J* 1999;14:32-8.
35. Juniper EF, Guyatt GH, Willan A, Griffith LE. Determining a minimal important change in a disease-specific quality of life Questionnaire. *J Clin Epidemiol* 1994;47:81-7.
36. Juniper EF, O'Byrne PM, Ferrie PJ, King DR, Roberts JN. Measuring asthma control. Clinic questionnaire or daily diary? *Am J Respir Crit Care Med* 2000;162:1330-4.
37. Juniper EF, O'Byrne PM, Guyatt GH, Ferrie PJ, King DR. Development and validation of a questionnaire to measure asthma control. *Eur Respir J* 1999;14:902-7.
38. Juniper EF, O'Byrne PM, Roberts JN. Measuring asthma control in group studies: do we need airway calibre and rescue beta2-agonist use? *Respir Med* 2001;95:319-23.
39. Baker DW, Williams MV, Parker RM, Gazmararian JA, Nurss J. Development of a brief test to measure functional health literacy. *Patient Educ Couns* 1999;38:33-42.
40. Parker RM, Baker DW, Williams MV, Nurss JR. The test of functional health literacy in adults: a new instrument for measuring patients' literacy skills. *J Gen Intern Med* 1995;10:537-41.
41. Nurss J, Parker R, Williams M, Baker D. Test of functional health literacy in adults. Robert Wood Johnson Foundation. Hartford (MI): Peppercorn Books and Press; 1995.
42. Akinbami LJ, Moorman JE, Liu X. Asthma prevalence, health care use, and mortality: United States, 2005-2009. *Natl Health Stat Rep* 2011;(32):1-14.
43. Juniper EF, Bousquet J, Abetz L, Bateman ED, Committee G. Identifying 'well-controlled' and 'not well-controlled' asthma using the Asthma Control Questionnaire. *Respir Med* 2006;100:616-21.

REFERENCES

- E1. Apter AJ, Reisine ST, Affleck G, Barrows E, ZuWallack RL. Adherence with twice-daily dosing of inhaled steroids. Socioeconomic and health-belief differences. *Am J Respir Crit Care Med* 1998;157: 1810-7.
- E2. Apter AJ, Boston R, George M, et al. Modifiable barriers to adherence to inhaled steroids among adults with asthma: it's not just black and white. *J Allergy Clin Immunol* 2003;111:1219-26.
- E3. Expert Panel Report 3: guidelines for the diagnosis and management of asthma. Bethesda (MD): National Institutes of Health/National Heart, Lung, and Blood Institute; 2007.

TABLE E1. ICS knowledge questionnaire^{E1,E2}

	Definitely true	Mostly true	Don't know	Mostly false	Definitely false
1. Inhaled steroids make airway muscles relax.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
2. Inhaled steroids work by fighting inflammation.	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
3. Inhaled steroids work by fighting infection.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
4. The full effect of inhaled steroids depends on regular use and may take days to work.	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
5. Inhaled steroids make you gain weight.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
6. When you use inhaled steroids, your wheeze or chest tightness gets better immediately.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
7. The full effect of inhaled steroids begins immediately.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
8. Even if I have no symptoms from asthma, I should take [say rescue/reliever inhaler they are prescribed] everyday so that I can stop asthma attacks from starting.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
9. Even if I have no symptoms from asthma, I should take [say ICS they are prescribed] everyday so that I can stop asthma attacks from starting.	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
10. [Say ICS they are prescribed] should be taken only when I have asthma symptoms.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

The sum of the 5-point Likert score for each item is calculated so that more knowledge on an item results in a higher score.

TABLE E2. Measurement of ICS technique^{E3}

MDI inhaler technique		
1. Canister shaken	☐ ₁ Yes	☐ ₀ No
2. Exhales before actuating inhaler	☐ ₁ Yes	☐ ₀ No
3. Actuates inhaler at the start or within 1 second of the start of inhalation	☐ ₁ Yes	☐ ₀ No
4. Actuates only once per inhalation	☐ ₁ Yes	☐ ₀ No
5. Inhalation takes place over 3-5 seconds	☐ ₁ Yes	☐ ₀ No
6. Position of inhaler appears adequate	☐ ₁ Yes	☐ ₀ No
7. Patient holds breath for 6-10 seconds	☐ ₁ Yes	☐ ₀ No
DPI inhaler technique		
1. Exposes mouthpiece	☐ ₁ Yes	☐ ₀ No
2. Cocks the triggers (activates the Diskus)	☐ ₁ Yes	☐ ₀ No
3. Holds Diskus horizontally while inhaling	☐ ₁ Yes	☐ ₀ No
4. Inhales deeply	☐ ₁ Yes	☐ ₀ No
5. Holds breath 6 seconds	☐ ₁ Yes	☐ ₀ No
6. Does not blow into Diskus	☐ ₁ Yes	☐ ₀ No

For each value, the score is the sum of the “yes” responses, so that a maximum score for MDI inhaler technique is 7 and that for DPI inhaler technique is 6.