Pathways linking health literacy, health beliefs, and cognition to medication adherence in older adults with asthma

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Background: Limited health literacy is associated with low adherence to asthma controller medications among older adults.
Objective: We sought to describe the causal pathway linking health literacy to medication adherence by modeling asthma illness and medication beliefs as mediators.
Methods: We recruited adults aged 60 years and older with asthma from hospital and community practices in New York, New York, and Chicago, Illinois. We measured health literacy and medication adherence using the Short Test of Functional Health Literacy in Adults and the Medication Adherence Rating Scale, respectively. We used validated instruments to assess asthma illness and medication beliefs. We assessed cognition using a cognitive battery. Using structural equation modeling, we modeled illness and medication beliefs as mediators of the relationship between health literacy and adherence while controlling for cognition.
Results: Our study included 433 patients with a mean age of 67 ± 6.8 years. The sample had 84% women, 31% non-Hispanic blacks, and 39% Hispanics. The 36% of patients with limited health literacy were more likely to have misconceptions about asthma ($P < .001$) and asthma medications ($P < .001$). Health literacy had a direct effect ($\beta = 0.089$; $P < .001$) as well as an indirect effect on adherence mediated by medications concerns ($\beta = 0.033$; $P = .002$). Neither medication necessity ($\beta = 0.044$; $P = .138$) nor illness beliefs ($\beta = 0.007$; $P = .143$) demonstrated a mediational role between health literacy and adherence.
Conclusions: Interventions designed to improve asthma controller medication adherence in older adults may be enhanced by addressing concerns about medications in addition to using communication strategies appropriate for populations with limited health literacy and cognitive impairments. (J Allergy Clin Immunol 2017;139:804-9.)

Key words: Asthma, elderly, health literacy, adherence, medication beliefs, illness beliefs, cognition

Although the prevalence of asthma in older adults is similar to that in the young and middle-aged, older adults bear a disproportionate burden of asthma morbidity and mortality.[1-3] In 2009, older adults represented only 12% of all patients with asthma in the United States,[4] yet more than half of all deaths from asthma occurred among adults older than 65 years.[2] Similarly, asthma hospitalization rates were more than 3 times as high among those older than 65 years (25.5 per 10,000) compared with 15- to 44-year-olds (7.2 per 10,000).[2]

Low rates of adherence to asthma controller medications may contribute to the poor outcomes observed among older adults with asthma.[5,6] Inhaled corticosteroids, the mainstay of asthma controller medications and asthma management, decrease asthma symptoms and reduce emergency room visits, hospitalizations, and death,[7] yet less than 50% of older adults with asthma use them as prescribed.[8,9] There are various factors associated with underuse of asthma controller medications ranging from barriers to the specific treatment, including complex and costly regimens,[10] patient/provider-level barriers, such as provider perceptions about the time required to complete patient counseling[11,12] and a poor patient-provider relationship,[13] to patient-level barriers including polypharmacy from a combination of chronic conditions[14] and a lack of motivation to manage chronic illnesses.[13] A growing body of research highlights the impact of 3 additional patient-level factors: (1) limitations in health literacy, 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,"[15] (2) misconceptions about asthma and the medications used to treat it,[16] and (3) impairments in cognition.[17]

We have demonstrated that limited health literacy, as measured using the Short Test of Functional Health Literacy in Adults (S-TOFHLA), is associated with inaccurate illness beliefs, namely, that asthma is present only when there are symptoms, that asthma is not a chronic condition, and that asthma is curable.[18] Limited health literacy was also associated with having

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Abbreviations used

B-IPQ:	Brief Illness Perceptions Questionnaire
BMQ:	Beliefs about Medications Questionnaire
MARS:	Medication Adherence Rating Scale
S-TOFHLA:	Short Test of Functional Health Literacy in Adults
WMS-immediate:	Wechsler Memory Scale Story A
Trails B:	Trail Making Test Part B

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more concerns about medications on the Beliefs about Medications Questionnaire (BMQ), including that medications were addictive and greater concerns about medication side effects.[19-21] Similarly, limitations in health literacy and cognition are independently associated with lower medication adherence among patients with asthma.[17,22,23]

Although it is well established that limited health literacy impacts medication adherence, the mechanisms by which this happens are uncertain. One potential mechanism is that health literacy influences beliefs about asthma and the medications used to treat it through its impact on information acquisition, which subsequently impacts medication adherence. To test illness and medication beliefs as mediators on the pathway linking health literacy and medications adherence, we performed structural equation modeling with data from a cohort of older adults with asthma.

METHODS
Participants and setting

Data for this analysis came from the Asthma Beliefs and Literacy in the Elderly study, a prospective cohort of adults aged 60 years and older with asthma.[24] Briefly, patients were recruited from hospital- and community-based primary care and pulmonary practices in New York, New York, and Chicago, Illinois, between December 2009 and May 2012. Participants were eligible for the study if they were English or Spanish speaking, were 60 years or older, and had persistent moderate or severe asthma diagnosed by a clinician. Those who had chronic obstructive pulmonary disease, other chronic lung diseases, or more than 10 pack-year history of smoking were excluded. Once participants provided informed consent, they underwent a standardized, in-person interview in their preferred language (English or Spanish). Participants were excluded from this analysis if they did not complete the health literacy assessment. The study was approved by the institutional review boards at the Icahn School of Medicine at Mount Sinai and the Feinberg School of Medicine at Northwestern University.

Measures

Sociodemographic characteristics and potential variables along the causal pathway connecting health literacy to medication adherence were assessed: health literacy, illness and medication beliefs, cognition, and medication adherence.

Health literacy. Health literacy was measured using the S-TOFHLA.[25] The S-TOFHLA is a 36-item reading comprehension and 4-item numeracy exercise. The reading comprehension test has 2 health care–related passages with every fifth to seventh word deleted. Participants select words that best complete each sentence. The numeracy test assesses health care–related quantitative capacity, such as the ability to understand numerical information on prescription bottles. Individual items were summed for a total score of 0 to 100, where inadequate is 0 to 53, marginal is 54 to 66, and adequate is 67 to 100. The S-TOFHLA has been validated for use in English and Spanish.[25] Before conducting the analyses, we examined the distribution of scores and found that few patients were in the lowest categories. As a result, we dichotomized the health literacy scores as adequate (≥67) or limited (<67).

Illness and medication beliefs. Beliefs about asthma were assessed with the 8-item Brief Illness Perceptions Questionnaire (B-IPQ).[26] The B-IPQ is based on Leventhal's Common Sense Model of Self-Regulation and relies on the theory that patients' mental models, or representations of an illness, provide the framework through which they understand and manage their illnesses.[27,28] This model has served as a framework for understanding patients' experiences of symptoms, treatment adherence, and care seeking for a range of conditions, including cardiovascular diseases, diabetes, cancer, and asthma.[18] An overall B-IPQ score was computed by summing the items, with a total score ranging from 0 to 80; higher scores indicate a more negative or threatening view of the illness. We also reported specific beliefs from the B-IPQ that have been found to be strongly predictive of adherence to controller medications.[18,29] Beliefs about asthma controller medications were assessed using the BMQ, a 10-item scale that can be tailored to measure beliefs about medications for a specific chronic illness.[30] It is divided into 2 domains—concerns and necessity. Higher scores on the concerns subscale indicate greater concern about side effects and long-term dependence on asthma controller medications. Higher scores on the necessity subscale represent greater belief in the necessity of asthma controller medications for preserving one's health.

Cognition. Cognitive function was measured using a selection of tests from the Alzheimer's Disease Centers' Uniform Data Set with extensive normative data.[31] The neuropsychological battery was designed to assess immediate recall, executive function, verbal fluency, and processing speed. Assessment of immediate recall was done using the Wechsler Memory Scale Story A (WMS-immediate). The WMS-immediate requires participants to listen to a short story and immediately repeat as many details as possible.[32] Assessment of executive function was done through the Trail Making Test Part B (Trails B). The Trails B represents the time required to sequentially connect a series of alternating letters and numbers scattered across a page in alphanumeric order.[33] Verbal fluency was tested through animal naming whereby participants are given 1 minute to name as many animals as possible.[33] Last, working memory was assessed through the use of the Weschler Adult Intelligence Scale III Letter-Number Sequencing.[32] In this test, participants listen to a sequence of letters and numbers spoken by the interviewer, and then repeat them back in ascending number and alphabetical order.

Medication adherence. Adherence to asthma controller medications was measured using the 10-item Medication Adherence Rating Scale (MARS).[34] The MARS is composed of statements about medication use behaviors, including regular versus as-needed use and intentional versus unintentional nonadherence. Respondents are asked how often they exhibit each behavior, with 5 options ranging from "always" to "never." MARS has high interitem reliability (Cronbach $\alpha = 0.85$), good test-retest reliability ($r = 0.65$; $P < .001$), and correlates strongly with objective measurements of asthma controller medication adherence.[34] A mean MARS score between 1 and 5 was calculated from the answers to individual items; higher scores indicate better adherence. Participants with a mean MARS score of 4.5 or more were coded as having good adherence.[34,35]

Sociodemographic characteristics. Demographic variables, including age, sex, race/ethnicity, educational attainment, and income, were collected via self-report using validated items. We also collected data on the length of time since asthma diagnosis and whether participants had ever been intubated.

Statistical analysis

We tested associations between baseline demographic characteristics and health literacy using chi-square or ANOVA tests. We also used chi-square tests to conduct bivariate tests of association between (1) health literacy and each of illness and medication beliefs and cognition and (2) between the 3 factors —health literacy, illness and medication beliefs, and cognitive function—and medication adherence.

We used structural equation modeling to assess the indirect effect that health literacy has on medication adherence through illness beliefs, medication beliefs subscale items (concern and necessity), and cognition. Health literacy and medication adherence were entered into the model as