ORIGINAL RESEARCH

What Patients Call Their Inhalers Is Associated with "Asthma Attacks"

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Background: **Clinician-patient miscommunication contributes to worse asthma outcomes. What patients call their asthma inhalers and its relationship with asthma morbidity are unknown.**

Methods: **Inhaler names were ascertained from Black and Latinx adults with moderate-severe asthma and categorized as "standard" if based on brand/generic name or inhaler type (i.e., controller vs. rescue) or "non-standard" for other terms (i.e., color, device type, e.g., "puffer," or unique names). Clinical characteristics and asthma morbidity measures were evaluated at baseline: self-reported asthma exacerbations one year before enrollment (i.e., systemic corticosteroid bursts, emergency department (ED)/urgent care (UC) visits, or hospitalizations), and asthma control and quality of life. Multivariable regression models tested the relationship between non-standard names and asthma morbidity measures, with adjustments.**

Results: **Forty-four percent (502/1150) of participants used non-standard inhaler names. These participants were more likely to be Black (p=0.006), from the Southeast (p<0.001), and have fewer years with asthma (p=0.012) relative to those who used standard names. Non-standard inhaler names was associated with an incidence rate ratio (IRR) of 1.29 (95% confidence interval [CI], 1.11-1.50, p=0.001; 1.8 vs. 1.5 events) for corticosteroid bursts for asthma, an IRR=1.43 (95% CI, 1.21-1.69, p<0.001; 1.9 vs. 1.4 events) for ED/UC visits for asthma, and an odds ratio=1.57 (95% CI, 1.12-2.18, p=0.008; 0.5 vs. 0.3 events) for asthma hospitalizations after adjustment.**

Conclusions: **Patients who use non-standard names for asthma inhalers experience increased asthma morbidity. Ascertaining what patients call their inhalers may be a quick method to identify those at higher risk of poor outcomes. (J Am Board Fam Med 2023;36:650–661.)**

Keywords: **Asthma, Health Literacy, Inhalers, Outcomes Assessment, Physician-Patient Relations**

Introduction

Effective clinician-patient communication is fundamental to optimal asthma management.[1–3] Patients' perceptions of how well they communicate with their clinician is associated with their understanding of asthma self-management and

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medication adherence,[3] an association mediated by trust and motivation.[3] Clinicians need to elicit their patients' notions of asthma treatment and build a shared clinical reality.[4,5] Miscommunication can occur when clinicians ineffectively recommend treatment and when patients misunderstand these recommendations,[6] and can prevent clinicians from identifying patients at greater risk of asthma morbidity because many risk factors (eg, spirometric readouts, biochemical assays, adverse socioeconomic conditions, allergens, pollution, etc.) may not be easily apparent.[7] Both clinicians seen as poor communicators[8,9] and patients who inadequately understand health information[10] are associated with worse asthma outcomes[11–14] and health care disparities for minorities with asthma.[15] Clinician-patient *terminology* mismatches can lead to miscommunication. For example, whereas clinicians typically use the term "asthma exacerbations," fewer than 25% of patients recognize the term[16] and instead tend to use "asthma attacks."[17,18] One study found that only 46% of parents could accurately name their children's asthma medications.[19] We know of no study that has investigated the relationship between terminology important in clinical asthma encounters and asthma morbidity outcomes.

Inhalers are the centerpiece of asthma management. Use of inhalers aims at quickly alleviating asthma symptoms with "rescue" inhalers or preventing them from occurring with "controller" therapy inhalers. Concerningly, however, no study has been conducted to identify the names that adult patients use for their asthma inhalers, whether these coincide with those used by their clinicians, and whether the names that patients use for their inhalers associate with asthma morbidity. The Patient-Centered Outcomes Research Institute (PCORI)-funded PeRson EmPowered Asthma RElief (PREPARE) Study was an open-label, multi-site, pragmatic clinical trial of inhaled corticosteroid (ICS) supplementation to rescue therapy in Black and Latinx adults with moderate-severe persistent asthma.[20] Asthma is a common chronic airway disease affecting 10.9% of Black adults and 6.9% of Latinx adults, populations who bear a disproportionate burden of disease from asthma.[21,22] During the PREPARE pilot study,[23] we learned that many participants did not use the terms "rescue" or "controller" for their asthma medications and had trouble answering study questions with these terms. To improve patients' ability to answer study questions, we collected the names that participants used for both rescue and controller therapy inhalers and inserted those personalized names into our surveys using an electronic data collection system.

Because poor patient-clinician communication is a risk factor for worse asthma outcomes, we hypothesized that (1) the use of inhaler names that *did not* coincide with those regularly used by clinicians (ie, "*nonstandard names*") would be associated with educational level attained, health literacy, or beliefs about asthma medications, and (2) worse asthma morbidity outcomes relative to use of "*standard inhaler names.*" This article describes the way patients referred to their inhalers and the associations between nonstandard inhaler names with patient clinical characteristics and asthma morbidity measures among participants from the PREPARE study.

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Conflict of interest: Ms. Forth reports receiving honoraria from Takeda for work in advisory boards for Alpha 1 antitrypsin and severe COPD. Dr. Cardet reports receiving honoraria from AstraZeneca, Genentech, and GSK for work in advisory boards and educational lectures on asthma. Dr. Fuhlbrigge is an unpaid consultant to AstraZeneca for the development of outcome measures for asthma and COPD clinical trials and a consultant to Novartis on epidemiologic analyses related to asthma control. Dr. Pace has received research grants from and is a consultant for Boehringer Ingelheim and a research grant from AstraZeneca. Dr. Phipatanakul received grants from Genentech, Regeneron, Novartis, Sanofi, Merck, and GSK; consulting fees from Regeneron, Sanofi, GSK, Genentech, and Novartis; and honoraria for educational events from Genentech, Sanofi, Regeneron, and GSK. Dr. Mosnaim received research grant support from AstraZeneca, Alk-Abello and Genentech and receives research grant support from GlaxoSmithKline, Novartis, Sanofi-Regeneron, and TEVA. Dr. Israel received in-kind medications or devices for NIH or PCORI-sponsored studies from Teva, Circassia, royalties from UpToDate, and consulting fees from AB Science, Allergy and Asthma Network, Amgen, Arrowhead Pharmaceuticals, AstraZeneca, Avillion, Biometry, Equillium, Genentech, GlaxoSmithKline, Merck, NHLBI, Novartis, Pneuma Respiratory, PPS Health, Regeneron, Sanofi Genzyme, Sienna Biopharmaceuticals, TEVA, and

Methods

Data Source

Black and Latinx adults with moderate-severe asthma were recruited for the PREPARE study from 19 clinical organizations throughout the continental United States and Puerto Rico from November 2017 through March 2020. To be eligible for the PREPARE study, participants self-identified as Black or Latinx, required a physician's diagnosis of asthma for more than 1 year before enrollment, and either had had 1 or more self-reported asthma exacerbations requiring systemic corticosteroids during the year before enrollment or uncontrolled asthma defined as an Asthma Control Test (ACT)[24] score <= 19 points. ACT scores range from 5 to 25, and a minimal clinically important difference of 3 points; scores of 20 to 25 indicate well-controlled asthma, 16 to 19 indicate not well-controlled asthma, and 5 to 15 indicate very poorly controlled asthma. Participants self-identified in the baseline questionnaire to the terms "Black" and "Latino." The terms "Black" and "Latinx" were decided on in consultation with the PREPARE trial Patient Partners during the conduct of the trial and were also used for recruitment (eg, in flyers, social media advertisements, etc.). Additional details on the PREPARE study population, aims, methods, and data collected can be seen in the published methodology[20] and primary trial result[25] articles.

The data used for this ancillary study consisted of quantitative baseline questionnaire data. Demographic data that were collected through questionnaires included age, gender, ethnicity, preferred spoken language, and region. Race and ethnicity were self-reported. "Caribbean Latinx" individuals were those who self-identified to be Latinx and either were born or trace their heritage to Puerto Rico, Dominican Republic, or Cuba. "Other Latinx" individuals were those who self-identified to be Latinx and either were born or trace their heritage to Mexico, Central or South America, or Spain. Because the term "Latinx" refers to an ethnicity with shared language and not a race,[26] individuals who self-reported to be both Latinx and Black were considered Latinx in the PREPARE study.

Measures

Socioeconomic data included highest level of education, total yearly household income, and health literacy (ascertained through the Brief Health Literacy Screen [BHLS]).[27] The BHLS consists of 3 items on a 5-point response scale with higher scores indicating higher subjective health literacy. Clinical data included body mass index (BMI), medical comorbidities (including heart disease, cancer [excluding nonmelanoma skin], stroke, diabetes, chronic kidney disease, COPD, HIV/AIDS, depression, and/or sleep disorders), smoking environment, age diagnosed with asthma, years with asthma diagnosis, use of nebulizers for rescue therapy, baseline asthma controller therapy regimen, their beliefs about their asthma medical regimen (ascertained through the Beliefs about Medicines Questionnaire [BMQ]),[28] and self-reported adherence to their asthma medication regimen (ascertained through the Medication Adherence Report Scale-5 (MARS-5).[29]

Participants were required to bring their inhalers to the trial's single (enrollment) visit. At that time, they were asked their preferred names for their inhalers. Using content analysis[30,31] we qualitatively coded the preferred names of inhalers and collapsed them into 5 categories: brand or generic name (eg, Proair or albuterol), inhaler type (ie, rescue or controller), color (eg, red, brown), delivery device (eg, puffer, pump, disk), and unique name (eg, Bob, friend). Names based on brand or generic names or inhaler type, which allow clinicians to distinguish inhalers within standard asthma management regimens, were categorized as "standard." All other names were categorized as "nonstandard." A participant was considered to use nonstandard inhalers names if he or she used a nonstandard name *for either a controller or rescue therapy inhaler or for both*; a participant was considered to use standard inhalers names if he/she used standard names *for both* controller and rescue therapy inhalers (Table 1).

Outcomes

Asthma morbidity measurements included self-reported asthma exacerbations requiring systemic corticosteroids ("corticosteroid bursts"), self-reported emergency department (ED)/urgent care (UC) visits, or hospitalizations (0 versus >1) in the year before enrollment, asthma control (ascertained

Cowen. The other authors have no conflicts of interest to disclose.

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Table 1. Definitions of Non-Standard and Standard Inhaler Names*

All Inhalers (Both Controller and rescue therapy inhalers)			
Non-Standard Inhaler Names (n = 502) (*44% of participants used non-standard names for either controller or rescue inhalers or for both)*		Standard Inhaler Names (n = 648) (*56% of participants used standard names for both controller and rescue inhalers)*	
Controller therapy inhalers			
Non-Standard Controller Inhaler Names (n = 335) (*29% of participants used non-standard names for controller inhalers)*		Standard Controller Inhaler Names (n = 815) (*71% of participants used standard names for both controller and rescue inhalers)*	
Color	174	Brand or generic name	654
Delivery device type (e.g., puffer, disc, "pompa," etc.)	117		
Unique name (e.g., "Get it," "Friend," etc.)**	44	Inhaler type (i.e., "controller")	161
Rescue therapy inhalers			
Non-Standard Rescue Inhaler Names (n = 407) (*35% of participants used non-standard names for controller inhalers)*		Standard Controller Rescue Names (n = 743) (*65% of participants used standard names for both controller and rescue inhalers)*	
Color	144	Brand or generic name	528
Delivery device type (e.g., puffer, disc, "pompa," etc.)	234		
Unique name (e.g., "Bob," "Lifeline," etc.)#	29	Inhaler type (i.e., "rescue")	215

Notes: *A participant was considered to use non-standard inhalers names if he/she used a non-standard name *for either a controller or rescue therapy inhaler or for both*; a participant was considered to use standard inhalers names if he/she used standard names *for both* controller and rescue therapy inhalers. **Other unique controller inhaler names included "Buddy," "El de la casa," "The Q," "Relaxing" and "Savior." #Other unique rescue inhaler names included "Breath of life," "Helper," "Keep me alive," "Mi salvación," and "My baby."

through the ACT and asthma Activities, Persistent, triGgers, Asthma medications, Response to therapy [APGAR][32] scores) and asthma-related quality of life (ascertained through the Asthma Symptom Utility Index [ASUI]).[33] The asthma APGAR score ranges from 0 to 6, where a total score >2 represents uncontrolled asthma. The ASUI scores range from 0 (worst symptoms) to 1 (no symptoms) with minimal clinically important difference of 0.09 points.

Data Analysis

Demographic, socioeconomic, and clinical characteristics were compared by inhaler name category (standard versus nonstandard) using Chi-square or Student's *t* test, as appropriate. Characteristics significantly different at $P < .10$ were entered as adjustment covariates in multivariable regression models. Age, gender, ethnicity, and BMI were entered into multivariable models a priori as standard adjustment covariates. Final models were also adjusted by region, smoking environment, years diagnosed with asthma, and asthma controller regimen. Negative binomial regression was used to examine corticosteroid bursts and ED/UC visits for asthma, logistic regression was used to examine asthma hospitalizations, and linear regression was used to examine asthma control (ACT and asthma APGAR) and quality of life (ASUI) measures. Heterogeneity of effects of asthma inhaler names on asthma exacerbations requiring corticosteroid bursts, ED/UC visits for asthma, and asthma hospitalizations was investigated using interaction terms between significant baseline characteristics and asthma inhaler names and stratified analyses.

Before the start of data collection, the PREPARE study was reviewed and approved by the institutional review board of Partners HealthCare and local institutional review boards of each participating organization.

Results

Preferred names for asthma controller and rescue inhalers were collected from 1150 participants: 580 Black participants and 570 Latinx participants. Inhaler names were unable to be coded on 51 of the 1201 PREPARE study participants (eg, name was missing or participants entered "I do not know"). Nonstandard names were used by 502 (44%). There were 45 unique names given to controller therapy inhalers and 29 unique names for rescue. Examples of unique names include "*My morning puff*," "*The sour stuff*," and "*Sustainer*" *for* controller therapy inhalers, and "*Life saver*," *Help aid*," and

Table 2. Characteristics of Participants by Standard vs Non-Standard Names

Characteristics	Overall (n = 1150)	Inhaler Names		
		Non-Standard Names (n = 502)	Standard Names (n = 648)	*p*-Value
Demographic				
Age	48.2 (13.8)	48.3 (13.1)	48.1 (14.3)	0.853
Gender				
Women	83.6%	83.1%	84.0%	0.689
Ethnicity and race*				
Non-Latinx Black	50.4%	55.8% (280)	46.3% (300)	0.006
Caribbean Latinx	38.1%	34.5% (173)	40.9% (265)	
Other Latinx	11.5%	9.8% (49)	12.8% (83)	
Language				
Spanish	21.9%	24.1%	20.2%	0.114
Region**				
Northeast	40.3%	28.7%	49.2%	<0.001
Ohio Valley Central	14.5%	16.3%	13.1%	
Puerto Rico	8.5%	10.4%	7.1%	
Southeast	30.9%	38.4%	25.0%	
Southwest	5.8%	6.2%	5.6%	
Socioeconomic				
Highest Education level				
Less than high school	13.9%	15.2%	12.8%	0.306
High school, some college or tech school	55.6%	54.2%	56.8%	
College or graduate school	30.5%	30.7%	30.4%	
Total yearly household income?				
Less than $10,000	25.8%	29.3%	23.1%	0.076
$10,000 to $40,000	36.3%	36.9%	35.9%	
>$40,000	19.9%	19.0%	20.5%	
Prefer not to answer	18.1%	14.9%	20.5%	
Health Literacy (BHLS)				
High	83.0%	83.9%	82.3%	0.471
Clinical				
BMI	35.0 (9.2)	35.1 (9.3)	34.9 (9.2)	0.758
Comorbidities#				
0	29.4%	30.7%	28.4%	0.230
1+	69.7%	69.0%	70.0%	
Missing	1.0%	0.2%	1.5%	
Lives in smoking environment	22.1%	24.9%	19.9%	0.043
Age diagnosed with asthma				
Less than 12 years	41.4%	41.6%	41.4%	0.547
12 years or more	49.4%	49.0%	49.9%	
Missing	9.0%	9.4%	8.8%	
Years with asthma				
0 to 10 years	22.0%	25.5%	19.5%	0.012
More than 10 years	69.7%	65.3%	73.0%	
Missing	8.3%	9.2%	7.6%	

Continued

Table 2. Continued

Characteristics	Overall (n = 1150)	Inhaler Names: Non-Standard Names (n = 502)	Inhaler Names: Standard Names (n = 648)	*p*-Value
Use a nebulizer as rescue med?				
Yes	66.7%	67.9%	65.7%	0.435
Baseline controller therapy regimen				
ICS only	17.0%	17.3%	16.8%	0.033
ICS + 1+ controllers	80.0%	78.9%	80.8%	
Regimen includes biologic	3.0%	3.8%	2.3%	
BMQ Subgroup				
High necessity, high concern	35.1%	35.7%	34.7%	0.975
High necessity, low concern	54.4%	54.0%	54.8%	
Low necessity, high concern	1.7%	1.6%	1.9%	
Low necessity, low concern	8.7%	8.8%	8.6%	
Low self-reported adherence to asthma medications[%]	52.7%	52.6%	52.8%	0.95

Notes: Categorical data are presented as percentages, continuous data are presented as means (standard deviation). P-values correspond to the comparison between values for standard versus non-standard names using Student's *t* test or χ^2 test, as appropriate. *Since the term "Latinx" refers to an ethnicity with shared language and not a race,[26] individuals who self-reported to be both Latinx and Black were considered Latinx in the PREPARE study. "Caribbean Latinx" includes individuals who self-reported to be Puerto Rican, Dominican or Cuban; "Other Latinx" includes individuals who self-reported to be Mexican, Central or South American or Spaniard. **These regions are reflective of the location of the PREPARE study recruitment clinical sites and are not meant to encompass all possible regions of the US. [#]Medical comorbidities include heart disease, cancer [excluding non-melanoma skin], stroke, diabetes, chronic kidney disease, COPD, HIV/AIDS, depression, and/or sleep disorders.

[%]Based on the Medication Adherence Report Scale-5 (MARS-5) scale which measures participant-reported medication adherence, in reference to asthma medications in the context of the PREPARE trial. Mean scores are calculated from five items and range from 1 to 5, with higher scores indicating better adherence. Here low adherence was defined as scores <4.5 [Chan et al. Br J Clin Pharmacol 2020;86:1281-8].

Abbreviations: BHLS, Brief Health Literacy Screen[27]; BMI, body mass index; BMQ, Beliefs about Medicines Questionnaire[28]; ICS, inhaled corticosteroids.

"Get it" for rescue therapy inhalers, among others. Table 1 provides further detail on the frequency and descriptions of nonstandard and standard names used.

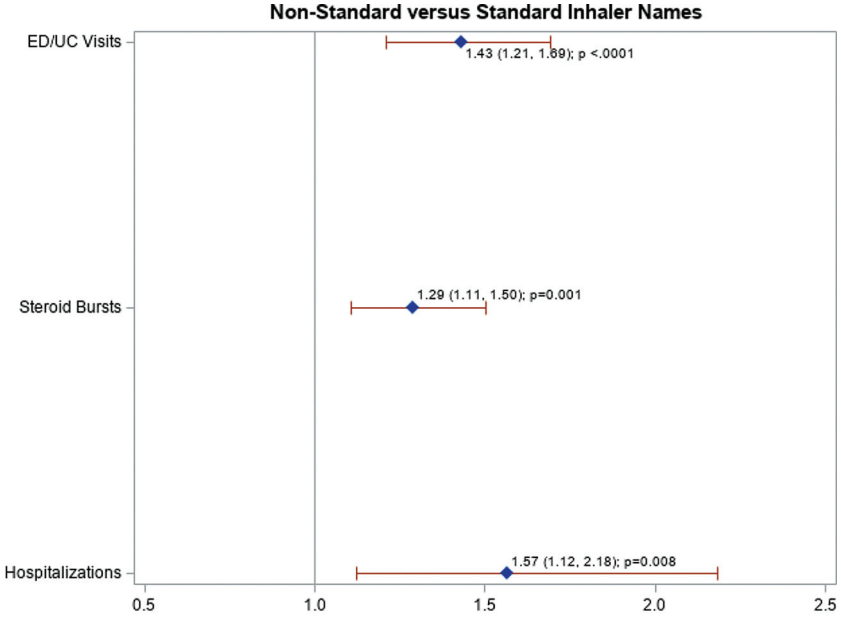
Hypothesis (1): nonstandard inhaler names are associated with educational level attained, health literacy, or beliefs about asthma medications:

Table 2 presents the demographic, socioeconomic, and clinical characteristics of the overall cohort and compares these by inhaler name category. Black participants were more likely than Latinx participants to use nonstandard inhaler names (48.3% versus 38.9%, respectively, *P* = *.002*). In addition, participants from the Southeast versus those from other regions (54.4% versus 38.9%, *P* < *.001*), those living in smoking versus nonsmoking environments (49.2% versus 42.1%, *P* = *.045*), and those diagnosed with asthma within the past 10 years versus those diagnosed for longer (50.4% versus 41.7%, *P* = *.015*) were more likely to use nonstandard inhaler names. Those with asthma therapy regimens including 2 or more controllers versus those with other controller regimens were less likely to use nonstandard inhaler names (39.0% versus 46.9%, *P* = *.001*). Notably, no significant differences in highest education level achieved, health literacy, income, medical comorbidities, medication beliefs, self-reported adherence to asthma medications, or any other characteristic were noted between participants who use nonstandard vs standard inhaler names (Table 2).

Hypothesis (2): nonstandard inhaler names are associated with worse asthma morbidity outcomes:

Figure 1 shows the results of the multivariable analysis of differences in corticosteroid bursts, ED/UC visits for asthma, and asthma hospitalizations. Use of nonstandard inhaler names was associated with an incidence rate ratio (IRR) of 1.29 (95% confidence interval [CI]

Figure 1. Forest plot comparing participants who use nonstandard versus standard asthma inhaler names using multivariable regression models and controlling for age, gender, ethnicity, BMI, region, smoking environment, years diagnosed with asthma, and asthma controller regimen. Incidence rate ratios (for ED/UC visits and steroid bursts) and odds ratios (for hospitalizations) (all outcomes denoted by the blue diamonds), their 95% confidence intervals (denoted by the red lines with whiskers) and p-values are shown for each outcome. Abbreviations: BMI, body mass index; ED, emergency department; UC, urgent care.



Notes: Values to the right of the vertical line mean greater incidence rate ratios and odds of outcomes for participants who use nonstandard asthma inhaler names. The models for ED/UC asthma visits and steroid bursts for asthma exacerbations use negative binomial regression, whereas the model for asthma hospitalizations uses logistic regression.

1.11-1.50, *P*=*.001*; 1.8 versus 1.5 events) for corticosteroid bursts for asthma, an IRR = 1.43 (95% CI 1.21-1.69, *P*<*.001*; 1.9 versus 1.4 events) for ED/UC visits for asthma, and an odds ratio (OR) =1.57 (95% CI 1.12-2.18, *P*=*.008*; 0.5 versus 0.3 events) for asthma hospitalizations after adjustment by age, gender, ethnicity, BMI, region, smoking environment, years diagnosed with asthma, and asthma controller regimen relative to use of standard names. We conducted interaction analyses to determine whether the association between nonstandard inhaler name use and corticosteroid bursts, ED/UC visits for asthma and asthma hospitalizations was different for baseline characteristics in Table 1 that are significantly associated with nonstandard name use (ie, race and ethnicity, region, smoking environment, duration of asthma, or controller therapy regimen). We found that none of these characteristics modified the association between nonstandard name use and any of the above 3 asthma morbidity measures (ie, all interaction p-values >0.05). Participants who use nonstandard inhaler names experience more asthma exacerbations regardless of race and ethnicity, region, asthma controller therapy regimen, smoking environment, and years diagnosed with asthma (ie, all effect measure ratios are >1 in stratified analyses regardless of baseline characteristic subgroup). Finally, use of nonstandard relative to standard inhaler names was associated with worse asthma control scores (mean ACT score was 0.58 points lower [95% CI, 0.04-1.12] and mean asthma APGAR score was 0.28 points higher [95% CI, 0.06 to 0.51]) and worse preference-based asthma-related quality of life scores (mean ASUI score was 0.04 points lower [95% CI, 0.01 to 0.07]) for those participants who used nonstandard vs standard inhaler names (Table 3)

Table 3. Asthma Control and Quality of Life Outcomes by Standard vs Nonstandard Inhaler Names

	Non-Standard versus standard Inhaler Name Use		
	Effect size	95% CI	*p*-Value
ACT	−0.58	−1.12 to −0.04	0.0372
ASUI	−0.04	−0.07 to −0.01	0.0022
APGAR	0.28	0.06 to 0.51	0.0142

Notes: Data shown compare asthma control and quality of life survey scores for participants who use non-standard inhaler names relative to those who use standard inhalers names. These are the results of multivariable linear regression models, controlling for age, gender, ethnicity, BMI, region, smoking environment, years diagnosed with asthma, and asthma controller regimen.

Abbreviations: ACT, Asthma Control Test®[24]; APGAR, asthma Activities, Persistent triGgers, Asthma medications and Response to therapy)[32]; ASUI, Asthma Symptom Utility Index[33]; BMI, body mass index; CI, confidence interval. The ACT is a self-administered survey that assesses asthma control levels, with total score ranging from 5 to 25, and a minimal clinically important difference of 3 points; scores of 20–25 indicate well-controlled asthma, 16–19 not well-controlled asthma, and 5–15 very poorly controlled asthma. The ASUI is a self-administered survey that assesses preference-based quality of life, with minimal clinically important difference of 0.09 points, and scores ranging from 0 (worst symptoms) to 1 (no symptoms). The asthma APGAR has 3 questions related to activity limitations and daytime and nighttime asthma symptoms, with total score ranging from 0 to 6, where a total score >2 represents uncontrolled asthma.

after adjustment with the same set of covariates listed above.

Discussion

To our knowledge, this ancillary study is the first to report that patients' use of nonstandard names for asthma inhalers among Black and Latinx adult patients is common, with nearly half (44%) of our sample using nonstandard names, and associates with increased odds of corticosteroid bursts for asthma, asthma ED/UC visits, and hospitalizations. The magnitude of these associations is not substantially changed after adjustment for age, gender, ethnicity, BMI, region, smoking environment, years diagnosed with asthma, and asthma controller regimen relative to use of standard names.

Prior studies have documented that patients frequently do not use asthma-related terminology that clinicians use; for example, "asthma attacks" instead of "asthma exacerbations."[17] Black and Latinx patients have been found to have less understanding of asthma self-management (including knowledge of inhaler use and medications) compared with Whites.[3] We have now documented that more than 40% of a large cohort of Black and Latinx adults with moderate-severe asthma uses nonstandard asthma inhaler names that cannot be readily interpreted by their clinician to identify the inhaler or its role within an asthma medical regimen (eg, inhaler colors, inhaler descriptors like "puffer," and unique names like "Friend" do not reveal the identity or purpose of the inhaler to a clinician). This large proportion suggests that nonstandard inhaler name use might be widespread in Black and Latinx communities. We found that nonstandard name use was more frequent among participants with certain baseline characteristics. For example, Black participants were more likely to use nonstandard names than Latinx, and participants from the Southeast were more likely to use nonstandard names than those from other regions. There likely is regional variation in what clinicians call asthma inhalers as well, and we speculate that the use of nonstandard inhaler names relates to regional variation in attitudes toward health care, but this possibility would need to be verified in future studies. Regardless, our heterogeneity of effects analysis shows that the use of nonstandard inhaler names relates to worse asthma morbidity outcome independently of baseline characteristic subgroup; that is, nonstandard inhaler names associate with worse asthma morbidity regardless of our participants being Black or Latinx or from the Southeast or elsewhere. Using nonstandard inhaler names as a marker for worse asthma morbidity does not seem to be restricted to specific baseline participant characteristics, as assessed in our cohort.

We also sought to understand why participants' use of nonstandard inhaler names would associate with worse asthma morbidity. We hypothesized that nonstandard inhaler name use would associate with lower educational level attained, lower health literacy, or beliefs about asthma medications, but *none* of these characteristics were associated. Low

self-reported adherence to asthma medications was also not associated with the use of nonstandard inhaler names. However, we did observe associations between participant characteristics (ie, ethnicity, region, smoking environment, years diagnosed with asthma, and asthma controller regimen) and nonstandard inhaler name use, but the inclusion of these characteristics as adjustment covariates in our multivariable model addresses potential confounding of our results showing associations between nonstandard inhaler name use and worse asthma morbidity measures; however, unmeasured confounding may still underlie these associations. Patients are commonly forced to change their inhalers based on changes in insurance policy coverage, loss of insurance, or unavailability of prescribed inhalers, which we speculate might be especially problematic among patients who use nonstandard inhaler names.[34] Our results should thus inform policy makers that formulary changes in inhaler coverage should be brought about with robust patient education of these changes and of proper inhaler usage.

The fact that there is concordance between corticosteroid bursts for asthma, ED/UC visits for asthma, hospitalizations, ACT, ASUI, and asthma APGAR scores validates and further supports our findings. We found that relative to use of standard inhaler names, use of nonstandard names associated with -0.58 lower ACT scores. Whereas a change in ACT score of 3 is the minimal clinically important difference (MCID) for patients with asthma,[24] the MCID is a measure for minimum benefit to individuals;[35] our finding indicates that there is a significant population response on asthma control. Although the effect sizes for corticosteroid bursts, ED/UC visit, and hospitalizations (OR = 1.29, =1.43, and =1.57, respectively) are small using the Cohen's d statistical classification,[36] their clinical significance is substantial especially considering the high rates of asthma exacerbations and morbidity that Black and Latinx adults with asthma experience. Therefore, we have identified an easily identifiable *marker for worse asthma morbidity*. If prospectively validated, this marker could potentially be used as a very simple and quick way to identify patients at risk of greater asthma morbidity in clinical settings.

Our results should be interpreted in the context of the study's limitations and strengths. Our data on asthma exacerbations were retrospectively based on self-report, and therefore subject to recall bias. However, there is no reason to believe that patients using nonstandard inhaler names would self-report higher number of exacerbations. Although participants may not correctly differentiate between ED visits, UC visits, or hospitalizations, our results demonstrate consistency in their associations with worse morbidity for participants who use nonstandard names. Because we studied only Black and Latinx adults with poorly controlled asthma, our results may not be as generalizable to other racial and ethnic populations, children, and those with well-controlled asthma; these populations should be considered for future studies of nonstandard inhaler names. However, our heterogeneity analyses show comparable effects of nonstandard inhaler names with worse asthma morbidity regardless of race and ethnicity, region, and other significant baseline characteristics, which argues in favor of their generalizability.

Our findings suggest that patients use different names than clinicians for their asthma inhalers and that patients who do this are at higher risk for asthma morbidity. The mechanism by which nonstandard inhaler names associates with worse asthma morbidity is unclear but may relate to several factors. One such factor could be the mistaken use of an inhaler of an incorrect drug class (eg, using a red bronchodilator only inhaler instead of a red anti-inflammatory inhaler, the underuse of which associates with poor asthma control).[1] Another potential mechanism is the identification of patients who may misunderstand asthma self-management instructions. The inability to use the standard inhaler names employed in those instructions may signify the inability to apply other important details in those instructions; nonstandard nomenclature may merely be a marker for other global issues in asthma care for the patient. Both these hypotheses would need to be prospectively verified. Characteristics such as ethnicity, language preference, educational level and health literacy do not necessarily identify which patients might use nonstandard names. Cultural differences between our study participants and their clinicians[4] may underlie our findings; future studies that capture such cultural differences or competence may confirm this possibility. Although additional unmeasured factors may underlie the association between nonstandard inhaler name use and asthma morbidity, that does not reduce the utility of using it as a tool for identifying patients at higher risk. In addition, the

cross-sectional study design of our ancillary study does not allow us to address temporality, which is the persistence of the association between nonstandard inhaler names and worse asthma morbidity over time. Future studies on nonstandard inhaler name use that prospectively follow participants would address this point.

Regardless of the cause of the association between nonstandard nomenclature and asthma morbidity there is a potentially significant clinical implication. Recognizing nonstandard inhaler name usage may allow clinicians to identify patients requiring additional asthma care and possible intensification of therapy due to the increase in the risk domain of their asthma. As a corollary, our findings suggest the possibility that keeping a consistent name despite formulary changes might be beneficial to patients and clinicians through these transitions, but this inferential leap would need to be prospectively demonstrated. A potential policy implication of our results is that ensuring the names are pronounceable in various languages and increasing the distinguishing features of each inhaler might improve asthma outcomes. With so many inhaler types, it can be quite confusing for patients,[37] especially those with multiple medical comorbidities and their attendant polypharmacy.

Considering the association of greater asthma morbidity with nonstandard inhaler name use, identifying use of nonstandard names for inhalers can be a method to quickly identify patients at higher risk of asthma morbidity. A research implication of our results is that future studies should prospectively evaluate whether asking patients of other populations to name their inhalers identifies patients at higher risk and examine whether intervening early with asthma therapy optimization may improve asthma morbidity measures.

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