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ARE CHILDREN WITH ASTHMA OVERCONFIDENT THAT THEY ARE USING THEIR INHALERS CORRECTLY?

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Abstract

Objective—The objectives of this study were to quantify the extent to which children with asthma are overconfident that they are using their inhalers correctly and determine whether demographic and clinical characteristics are associated with children being overconfident.

Methods—Children (n=91) ages 7-17 with persistent asthma were recruited at two pediatric practices in North Carolina and demonstrated their inhaler technique for metered dose inhalers during an office visit. Children were dichotomized into two groups based on how confident they were that they were using their inhalers correctly: ‘completely confident’ or ‘not completely confident.’ The mean number of inhaler steps (out of 8) children performed incorrectly was examined. We applied linear regression models for children in the ‘completely confident’ group to determine whether demographic and clinical factors predicted their overconfidence, defined as the number of inhaler steps performed incorrectly.

Results—Children were primarily male (56%) and non-Hispanic White (60%). Sixty-eight (75%) children were ‘completely confident’ that they were using their inhalers correctly. The

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Declaration of interest

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'completely confident' group missed an average of 1.5 steps. In the 'completely confident' group, males ($p < 0.04$) missed significantly more steps than females. The two most common errors were forgetting to shake the inhaler and holding their breath for 10 seconds.

Conclusion—Regardless of their confidence level, children in our sample missed an average of 1 to 2 steps on an inhaler technique assessment. Findings from this study provide new evidence that it is insufficient to ask children if they are using their inhalers correctly. Therefore, it is vital that providers ask children to demonstrate their inhaler technique during health encounters.

Keywords

asthma; asthma control; children; inhaler technique; self-efficacy

INTRODUCTION

In the United States, asthma affects nearly 7.1 million children under the age of 18 [1] accounting for 200,000 hospitalizations, 640,000 emergency department visits, and 14.4 million school absences per year [2-3]. Within population subgroups asthma prevalence is higher among female children, individuals who are African American, Hispanic, or multiracial, and individuals with a low socioeconomic status[2, 4]. The economic costs associated with asthma are estimated at $56 billion per year including lost wages, medical costs, missed work and school days, and premature death[5]. In addition to financial burden, asthma negatively impacts a child physically, emotionally, and socially by diminishing their quality of life[6-8].

Inadequate management of asthma is life-threatening to children because it may increase the frequency and severity of asthma attacks [9-10]. Prior research has found that approximately 32% - 64% of children have poorly controlled asthma (i.e., chronic symptoms and episodic exacerbations) with a higher risk for physical activity limitations[11-12]. In contrast, well-controlled asthma is associated with a higher quality of life and lower healthcare utilization [8, 13]. Engaging and sustaining asthma management behaviors such as assessing and monitoring symptoms, reducing asthma triggers, and taking medications correctly could contribute to well-controlled asthma [14-17].

Some researchers have observed that children with asthma have significant inhaler technique deficiencies[18-20]. Suboptimal inhaler technique is correlated with an increase in healthcare utilization[2], inadequate asthma control [21], and deaths[22]. National guidelines recommend that clinicians provide inhaler technique education (i.e., providing verbal and written instructions, providers demonstrating correct technique, and asking the patient to demonstrate correct technique) at each healthcare encounter[23]. Yet, factors such as lack of knowledge, inadequate time, and limited access to inhaler devices may prevent healthcare providers from following these guidelines [18, 24]. For these reasons, providers may ask children how confident they are in using their inhalers correctly rather than engaging in technique demonstrations. Prior research has revealed that 97% and 96% of physicians did not assess child inhaler technique or demonstrate proper use of metered dose inhalers, respectively, during pediatric asthma visits[19].

Studies on asthma self-management suggest self-efficacy beliefs are a motivational influence to controlling asthma. However, self-efficacy beliefs may not be an accurate reflection of individual skill in asthma self-management[25-27]. To our knowledge, no previous studies have attempted to quantify the extent to which children's inhaler self-efficacy, or their belief that they can use their inhalers correctly, is an accurate indicator of their inhaler technique. The aim of this study is to quantify the extent to which children with asthma are overconfident that they are using their inhalers correctly. This is defined as the number of steps they incorrectly performed on an inhaler technique assessment, even though they were completely confident they were using their inhalers correctly. The second aim of this study is to determine whether demographic and clinical characteristics are associated with children being overconfident in their ability to use their inhalers correctly.

METHODS

Participants

The data from this study come from the baseline visit of a randomized controlled trial, which tested whether 3-minute videos could be used to improve children's inhaler technique[20]. Study participants were recruited at two pediatric practices in a medium metropolitan county (population ~171,000) in North Carolina[28]. Children were eligible if they: (a) were 7-17 years old, (b) spoke English or Spanish, (c) read the assent form, (d) were present at the visit with an adult (>18 years old) caregiver (parent or legal guardian) who spoke English or Spanish, (e) missed or incorrectly performed at least one step on an inhaler technique assessment, and (f) had mild, moderate, or severe persistent asthma[23, 29]. The study was approved by the University of North Carolina Institutional Review Board and was registered with clinicaltrials.gov. (NCT01641211).

Each clinic received $500 per month to help pay for clinic staff who referred interested families to a bilingual research assistant (RA). The RA assessed children's inhaler technique as part of the eligibility screening process. Ineligible families were given a $5 cash incentive for their time. If the child and caregiver were eligible, the RA explained the study and obtained written caregiver informed consent and child assent. Caregivers then completed a brief demographic questionnaire before the child's regularly-scheduled office visit. All consent/assent forms and data collection instruments were available in English and Spanish.

After the child's office visit, the RA reconvened with the family in a private room and children were randomized to watch either an inhaler technique video (intervention) or a nutrition video (control) in their choice of English or Spanish. While children watched the video, caregivers completed a brief questionnaire. The child received a $15 cash incentive after the visit.

Measures

Inhaler technique

Metered dose inhaler (MDI) technique was measured as the number of steps (out of 8) that the child performed correctly at baseline (Table 1)[20]. The RA used a validated inhaler technique checklist[30-31] to document whether each step was performed correctly. If a child

indicated that he/she used a MDI both with and without a spacer, then he/she was asked to demonstrate technique with and without a spacer. Additional methods of the parent study have previously been published elsewhere[19].

Child inhaler self-efficacy

Child inhaler self-efficacy was measured using one item from the Bursch et al.[32] asthma management self-efficacy measure, "How sure are you that you can use your inhaler correctly?" Response options included: 1= 'not at all sure,' 2= 'a little bit sure,' 3= 'fairly sure,' 4= 'quite sure,' and 5= 'completely sure.' Prior studies have used this self-efficacy item measure [19, 26-28]. We dichotomized children into two groups based on their response to this question. The first group, referred to as the 'not completely confident' group, was comprised of all children who responded with a 1-4. The second group consisted of all children who responded with a 5, indicating they were 'completely confident' they could use their inhaler correctly.

Demographic and other measures

We also measured: (a) child age (in years), gender (male and female), race (Non-Hispanic White, Non-Hispanic Black, and Other), asthma severity (mild persistent and moderate/severe persistent), duration of asthma (in years), whether child was taking a control MDI medication, and (b) caregiver educational level (in years).

Statistical Analyses

Analyses were conducted using SPSS, version 22.0. The steps children in each group missed are descriptively summarized. T-tests and chi-square tests were conducted at the 0.05 significance level for comparing groups on demographic and clinical factors. A linear regression model using only baseline data for children in the 'completely confident' group was used to assess whether demographic and clinical factors predicted their overconfidence, defined as the number of inhaler steps they performed incorrectly.

RESULTS

Sample characteristics

Table 2 presents the demographic characteristics of children in the 'completely confident' and 'not completely confident' groups. The groups were not significantly different on any demographic characteristics. Approximately half of the children in the sample were male with an average age of 11 years. Most children self-identified as White and slightly more had mild persistent than moderate/severe persistent asthma. Children reported living with asthma for roughly three years, on average. The majority of the sample were taking an asthma controller medication. Only three children used their MDI both with and without a spacer.

Level of confidence

Table 3 presents the number of children who were 'completely confident' and 'not completely confident' they could use their inhalers correctly. Children in the 'completely

confident' group performed 1.5 steps incorrectly, whereas children in the 'not completely confident' group missed 1.8 steps. The difference in the number of steps missed between the 'completely confident' and 'not completely confident' group was statistically insignificant ($t_{(87)}$ =1.26. p=0.21).

Table 4 presents the specific steps both groups were most likely to miss. Children in both the 'completely confident' and 'not completely confident' groups were most likely to forget to shake their inhalers and hold their breath for 10 seconds.

Linear regression

Table 5 presents the regression model at baseline for children who were 'completely confident'. Clinical characteristics were not significantly associated with the number of steps children in the 'completely confident' group performed incorrectly. However, overconfident boys (p= 0.04) were more likely to miss more steps than overconfident girls.

DISCUSSION

This is the first study to assess the extent to which children are overconfident that they are using their asthma inhalers correctly. In addition, the inclusion of both English and Spanish speaking families and having bilingual study staff member were strengths of the study. Although 75% of the children in this sample were overconfident (i.e. they reported completed confidence in their ability to use their inhalers correctly) they missed 1.5 steps on average. Overconfident males (p<0.04) missed significantly more steps, on average, than overconfident females.

The most common inhaler technique errors children made were not shaking the inhaler and not holding their breath for 10 seconds. An additional study found that children commonly forgot to shake their inhalers and hold their breath[19], while others have found that the most common error was either inhaling too early or late [33-36]. This step was not assessed among current study participants. The possible reasons for missed steps could be that the participants were not adequately trained when they first received their inhalers or inhaler technique has not been periodically monitored by healthcare providers.[19] Of note, even though we did not seek to examine differences in technique between children who used and did not use a spacer, we found that the "continue to inhale 3-4 seconds" step was performed correctly by 84% of 'completely confident' children who used a spacer but only 63% of completely confident children who did not use a spacer. This finding suggests that spacers were helpful for improving technique for children in our sample. Although the children in this sample only missed 1.5-1.8 steps on average, each step is important for inhaler technique, providers should strive to have their patients achieve 100% correct technique.

National guidelines [23] recommend that providers review children's inhaler technique at each healthcare encounter. Findings from this study provide new evidence that it is insufficient to ask children if they are sure that they can use their inhaler correctly, as child self-report of confidence in using an inhaler is not a good proxy of correct inhaler technique. It is vital for providers to review children's inhaler technique to ensure children are correctly self-administering their inhaled medications. Additionally, as providers work with children to

help improve their inhaler technique, findings from this study emphasize the importance of being cognizant of the inhaler technique steps that children miss most frequently (i.e., shaking the inhaler and holding breath for 10 seconds).

This study has several limitations. First, although our study sample was diverse, we enrolled from only two study locations. As such, our results may not be generalizable to children in other clinical settings. Future studies should examine inhaler technique overconfidence in larger samples. Second, participation was voluntary; therefore, those who participated in the study may have been more overconfident than individuals who decided not to participate. Third, all study participants had to miss at least one step to be eligible; however, no child in this study was excluded due to perfect technique. All children who were screened for the study missed at least one step. Yet, children may have experienced the Hawthorne effect[44] because they were aware they were being observed for inhaler technique which may have resulted in better performance. If observed using their inhalers when they did not know they were being watched children may have skipped more steps. On average, children missed 1.5-1.8 steps. Fourth, we did not investigate whether missing inhaler technique steps were differentially related to medication effectiveness. Fifth, frequency of doctor visits was not assessed in the study. Future studies should include and control for this variable.

CONCLUSIONS

In this study, children with asthma who were completely confident in their ability to use their asthma inhaler correctly still missed steps such as shaking their inhaler and holding their breath for ten seconds. This incorrect technique could compromise delivery of their medications to their lungs, which could lead to poorly controlled asthma. Thus, healthcare providers (i.e., physicians, nurses, and pharmacists) asking children about their inhaler technique is insufficient. During each health encounter, healthcare providers should work closely with children to ensure they are using their asthma inhalers correctly.

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Table 1

Inhaler technique steps for a Metered Dose Inhaler (MDI) with and without a spacer at baseline

Step	MDI with spacer	MDI without a spacer
1	Remove cap from inhaler	Remove cap from inhaler
2	Attach inhaler mouthpiece into holding chamber	Shake inhaler 4-6 times
3	Shake inhaler 4-6 times	Exhale normally
4	Exhale normally	Tilt head back slightly, place mouthpiece between lips or 1-2 inches in front of a wide open mouth
5	Tilt head back slightly, place holding chamber mouthpiece between lips, holding inhaler upright	Begin a slow, deep breath
6	Press inhaler canister once to place dose in holding chamber	Press inhaler canister once at beginning of breath
7	Begin a slow, deep inhalation immediately after placing dose in holding chamber (3-4 seconds)	Continue to inhale for 3-4 seconds
8	Hold breath for 10 seconds	Hold breath for 10 seconds

Note: MDI= metered dose inhaler

Table 2

Baseline characteristics of children who were ‘completely confident’ or ‘not completely confident’ that they were using their asthma inhalers correctly (n=91)

	Completely confident (N=68)	Not completely confident (N=23)	p-value
Child characteristics			
Age, years, mean (SD)	11.1 (2.6)	10.2 (3.1)	0.28
(range)	(0-17)	(0-17)	
Gender, n (%)			
Male	37 (54%)	12 (52%)	0.85
Female	31 (46%)	11 (48%)	
Race, n (%)			
Non-Hispanic White	29 (43%)	8 (35%)	0.48
Non-Hispanic Black	16 (23%)	4 (17%)	
Other	23 (34%)	11 (48%)	
Asthma severity, n (%)			
Mild persistent	34 (51%)	12 (52%)	0.96
Moderate/severe persistent	32 (49%)	11 (48%)	
Years living with asthma, mean (SD)	3.5 (3.7)	3.9 (2.8)	0.15
(range)	(0-17)	(0-17)	
Taking a control MDI medication, n (%)	43 (63%)	19 (83%)	0.09

Note: MDI= metered dose inhaler

Table 3

Number of inhaler steps performed incorrectly for children who were ‘completely confident’ or ‘not completely confident’ they were using their inhaler correctly at baseline

	N (%) of children in each group	Mean # of steps children performed incorrectly	SD	Median # of steps performed incorrectly	Maximum # of steps performed incorrectly (n=8)
Completely confident using inhaler correctly	68 (75%)	1.5	1.04	1.0	4.0
Not completely confident using inhaler correctly	23 (25%)	1.8	0.98	2.0	4.0

Table 4

Children in the ‘completely confident’ and ‘not completely confident’ groups who performed each MDI step with and without spacer correctly at baseline

	Completely confident (n=19) N(%)	**Not completely confident (n=7) N(%)**
MDI with spacer (n=26)		
1. Remove cap from inhaler	19(100.0)	7 (100.0)
2. Attach inhaler mouthpiece into holding chamber	19 (100.0)	7 (100.0)
3. Shake inhaler 4-6 times	7 (36.8)	1 (14.3)
4. Exhale normally	17 (89.5)	6 (85.7)
5. Tilt head back slightly, place mouthpiece between lips or 1-2 inches in front of a wide open mouth	19 (100.0)	7 (100.0)
6. Press inhaler canister once at beginning of breath	18 (94.7)	7 (100.0)
7. Begin a slow, deep breath	16 (84.2)	4 (57.1)
8. Hold breath for 10 seconds	1 (5.3)	0 (0.0)
	Completely confident (n=49)	**Not completely confident (n=19)**
MDI without spacer (n=68)		
1. Remove cap from inhaler	42 (85.7)	18 (94.7)
2. Shake inhaler 4-6 times	22 (44.9)	7 (36.8)
3. Exhale normally	43 (87.8)	14 (73.7)
4. Tilt head back slightly, place mouthpiece between lips or 1-2 inches in front of a wide open mouth	49 (100.0)	19 (100.0)
5. Begin a slow, deep breath	47 (95.9)	17 (89.5)
6. Press inhaler canister once at beginning of breath	48 (98.0)	19 (100.0)
7. Continue to inhale for 3-4 seconds	31 (63.3)	13 (68.4)
8. Hold breath for 10 seconds	4 (8.2)	0 (0.0)

Note: MDI=metered dose inhaler

* ‘Not completely confident’ column adds to 26 children because 3 children demonstrated technique with and without spacer.

Table 5

Regression model predicting overconfidence (# of steps missed) for children who were completely confident (n=68)

Variables	B (Standard Error)	p-value	Adjusted R^2
			.036
Child's race (reference: White)	0.08 (0.16)	0.61	
Child's sex (reference: Male)	−0.53 (0.26)	0.04	
Child's age (in years)	0.10 (0.06)	0.10	
Disease duration (in years)	−0.06 (0.03)	0.10	
Caregiver's education (in years)	−0.03 (0.05)	0.59	