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Assessing Children's Readiness to Carry and Use Quick-Relief Inhalers

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To the Editor:

Asthma self-management is critical to minimize adverse consequences and depends partly on access to inhalers, including independent carry and use of inhalers by children at school ("self-carry").(1) Traditionally, parents decide when children are ready to self-carry. However, parents often overestimate their child's self-management skills.(2) Further, many children have limited asthma knowledge and misuse inhalers.(3) One study concluded 38% of students (kindergarten-10th grade) have the ability to self-carry.(4) This study aimed to identify factors associated with children's readiness to self-carry inhalers using an objective tool and to determine how this tool aligns with traditionally utilized subjective readiness measures.

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This cross-sectional study was conducted in 2016–2017 among 3rd-8th grade children with physician-diagnosed asthma, their parents, and school nurses from four Chicago schools (97% African-American; 82% low-income). Asthma educators administered American Lung Association's expert-developed Student Readiness Assessment Tool (SRAT) to objectively measure children's level of readiness to self-carry (not ready=<70 points; almost ready=70–105 points; ready=106–130 points; Table E1). Children, parents, and nurses independently rated confidence in children's self-carry ability (Likert-scale; parents/nurses-10-point; children-4-point) and completed questionnaires (validated when available) about asthma control, impact, quality of life, care, documentation, and morbidity.

To evaluate factors associated with self-carry readiness, the primary analysis utilized multinomial logistic regression (SRAT=categorical) and sensitivity analysis used multivariate linear regression (SRAT=continuous); independent variables in Table E2. To examine concordance between objective and subjective readiness measures, McNemar's test was used. Statistical significance was defined by two-tailed p-value<.05. Analysis was done with STATA version14. University of Chicago's Institutional Review Board approved the study.

Among 64 children enrolled, mean age was 10.7 years (SD=1.66), 89.1% were Black/African-American (n=57/64), and 45.3% were female (n=29/64). Most parents were female (84.4%, n=54/64). Asthma characteristics are noted in Table I. Nearly 60% of children (n=38/64) self-carry inhalers at school. Objectively, 19% of children (n=12/64) were ready to self-carry, 58% (n=37/64) almost ready, and 23% (n=15/64) not ready. Twenty-four percent of those who self-carry (n=9/38) were ready. Approximately 90% of children (n=56/61) and parents (n=57/64) were confident in the child's self-carry skills; nurses were confident for 30% of children (n=19/64).

Higher level of self-carry readiness was associated with older age (p<.001), higher grade level (p=.01), and parent familiarity with asthma policy (p=.01). There was no association between self-carry readiness and other independent variables. Results were unchanged after adjusting for independent variables. In the sensitivity analysis, results remained significant (age-p<.001; grade-p<.001; familiarity with policy-p=.006); children's confidence in self-carry skills was also associated with higher readiness level (p=.02).

Compared to the objective tool, parents and children were significantly more likely to subjectively deem children ready to self-carry; parents were 46.00 times and children 42.09 times more likely (both p<.001). In contrast, school nurses were 2.33 times more likely than the SRAT to consider students ready; however, this difference was not statistically significant (p=.13).

This study is the first to assess children's readiness to self-carry objectively, determine factors associated with readiness, and compare objective and subjective readiness measures.

Only one-quarter of children who self-carry inhalers at school were objectively ready; these findings raise concerns about ability to self-manage among the other three-quarters who self-carry. Readiness to self-carry was associated with age, grade, and parental familiarity with school asthma policy but not with disease control, impact, morbidity, and documentation.

These results mirror literature showing age is associated with medication use(5) and self-carry readiness;(4) however this study shows readiness above 11 years, versus 8–11 years in prior studies.(1,6) Further, parental awareness of school policy may facilitate children's readiness to self-carry, potentially because awareness may lead to asthma teaching that contributes to children's readiness or because children's readiness prompts parents to become familiar with school policy. Efforts by schools and healthcare professionals to educate parents about self-carry may promote readiness. Notably, this study did not assess prior education about inhaler knowledge or skills, which could impact self-carry readiness since asthma education may be associated with improved outcomes.(3) Future studies should explore conceptual models linking variables impacting inhaler self-carry readiness.

This study also re-demonstrates that most children and parents are highly confident in the child's self-management skills, in this case inhaler self-carry.(6–8) However, this study shows children and parents overestimate self-carry readiness. Although children and parents perceived nearly all students were ready to self-carry, only one-third of children were ready based on nurse perceptions and one-quarter by objective measures. These findings mirror studies describing children lack knowledge and skills for self-carry even when they carried inhalers(4) and parents misjudge children's ability to self-medicate.(3) School nurses were least likely to subjectively recommend children to self-carry, potentially from greater awareness of knowledge, skills, and maturity required for self-management or hesitancy to recommend self-carry for children they do not know well, as these nurses are not present full-time.

This study also identifies significant discordance in self-carry readiness with the objective tool categorizing far fewer children as ready compared to traditionally utilized measures of confidence. These findings may reflect that the objective tool is based solely on student knowledge and skills, while parent and child confidence incorporate holistic factors (e.g. child's maturity, self-efficacy, applied knowledge demonstrated by day-to-day behaviors; school environment). Future studies should clarify best approaches to assess self-carry readiness to ensure children have optimal asthma care at school.

Limitations include generalizability as the study included African-American students in four Chicago schools. Further, the study may have limited power to detect small differences due to sample size. Recruitment may have been biased toward children who use inhalers at school or families who are more engaged, given the high proportion of self-carry versus prior studies.(9) Lastly, social desirability bias may be present as children answered questions face-to-face with educators; parents completed paper questionnaires and nurses online, thus diminishing this bias.

In conclusion, this study highlights the need for objective self-carry readiness measures to facilitate appropriate, timely, and effective access to critical medications for children with asthma. Also, because many children are not prepared to self-carry inhalers, clinicians should regularly incorporate education about the knowledge and skills required for self-carry, including inhaler technique. Future studies should examine inhaler self-carry practices, integration of self-carry readiness assessments in schools, and interventions to improve readiness among diverse pediatric populations to support asthma self-management.

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Clinical Implications box

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Children's and parents' subjective confidence in self-carry skills overestimate children's abilities; thus objective measures should be used to assess readiness to self-carry. Age, grade, and parental knowledge about school asthma policies are associated with children's readiness to self-carry.

Table I:

Association between readiness to self-carry inhalers, based on American Lung Association Student Readiness Assessment Tool, and demographics, severity/control/impact, care at school, morbidity, and confidence (n=64)

	AllStudents(n=64)n (%)	Not Ready(n=15)n (%)	AlmostReady (n=37)n (%)	Ready(n=12)n (%)	P-value
Demographics					
Age, mean (SD)	10.70 (1.66)	9.4 (1.55)	10.97 (1.52)	11.15 (1.38)	**<.001**
Grade, mean (SD)	5.30 (1.66)	4.27 (1.62)	5.49 (1.57)	6.00 (1.48)	**.01**
Female gender	29 (45.3)	4 (26.7)	19 (51.3)	6 (50.0)	.24
Severity, control, impact					
Daily use of controller inhaler	37 (57.8)	10 (66.7)	19 (51.4)	8 (66.7)	.47
Good asthma control,based on ACT/cACTscore≥20	41 (64.1)	10 (66.7)	21 (56.8)	10 (83.3)	.22
Low asthma impact,based on PAIS<11	28 (43.8)	4 (26.7)	18 (48.7)	6 (50.0)	.30
Good caregiver qualityof life, based on PACQLQ score≥81	43 (67.2)	9 (60.0)	24 (64.9)	10 (83.3)	.36
Morbidity					
Hospitalizations					.17
0	58 (90.6)	14 (93.3)	35 (94.6)	9 (75.0)	
1	4 (6.3)	0	2 (5.4)	2 (16.7)	
2	2 (3.1)	1 (6.7)	0	1 (8.3)	
Emergency department visits					.77
0	38 (59.4)	9 (60.0)	23 (62.2)	6 (50.0)	
1	9 (14.1)	2 (13.3)	5 (13.5)	2 (16.7)	
2–4	17 (26.6)	4 (26.7)	9 (24.3)	4 (33.3)	
School days missed by student					.91
0	38 (59.4)	9 (60.0)	23 (62.2)	6 (50.0)	
1	6 (9.4)	2 (13.3)	2 (5.4)	2 (16.7)	
2–5	16 (25.0)	3 (20.0)	10 (27.0)	3 (25.0)	
6–10	3 (4.7)	1 (6.7)	1 (2.70)	1 (8.3)	
11+	1 (1.6)	0	1 (2.70)	0	
Work days missed by caregiver					.54
0	42 (65.6)	9 (60.0)	27 (73.0)	6 (50.0)	
1	5 (7.8)	2 (13.3)	1 (2.8)	2 (16.7)	
2–5	13 (20.3)	3 (20.0)	7 (18.9)	3 (25.0)	
6–10	2 (3.1)	1 (6.7)	1 (2.7)	1 (8.3)	
11+	2 (3.1)	0	1 (2.7)	0	
Care at school					

	AllStudents(n=64)n (%)	Not Ready(n=15)n (%)	AlmostReady (n=37)n (%)	Ready(n=12)n (%)	P-value
Self-carry of inhaler at school	38 (59.4)	10 (66.7)	19 (51.4)	9 (75.0)	.27
Parent familiar with school's asthma policy	26 (40.6)	2 (13.3)	16 (43.2)	8 (66.7)	**.01**
Parent approval for medication self-administration on file	17 (26.6)	5 (33.3)	8 (21.6)	4 (33.3)	.58
Asthma action plan on File	21 (32.8)	4 (26.7)	11 (29.7)	6 (50.0)	.38
504 Plan on file	19 (29.7)	5 (33.3)	8 (21.6)	6 (50.0)	.18
Confidence in child's ability to self-carry inhaler at school					
Child confident	56 (91.8) * (n=61)	11 (78.6) * (n=14)	39 (97.1) * (n=35)	11 (91.7)	.13
Parent confident	57 (89.1)	13 (86.7)	32 (86.5)	12 (100)	.21
Nurse confident	19 (29.7)	2 (13.3)	12 (32.4)	5 (41.7)	.21

Abbreviations: ACT=Asthma Control Test; cACT=Childhood Asthma Control Test; PACQLQ=Pediatric Asthma Caregiver's Quality of Life; PAIS=Pediatric Asthma Impact Scale

* Three children (one child in not ready group and two children in almost ready group) did not complete the questions about confidence.

Table E1:

Student Readiness Assessment Tool Questions and Answers

Question	**Answer**
Section 1: Basic Understanding of Asthma	
What part of your body is affected by asthma? Can you show me? What is this part of the body called?	The lungs.
What do the lungs do?	They help you breathe. They move air in and out of the body.
What happens to your lungs when you're having symptoms?	It's hard to breathe; the muscles squeeze tight; the insides of the airways swell; the airways fill with mucus.
What can you do to keep from getting asthma symptoms?	Avoid or limit exposure to the things that bother your lungs; taking daily controller medicine as prescribed by doctor.
What does it mean to have asthma under control?	I would not have symptoms when I do the things I want to do; I could do anything that my friends without asthma can do.
Section 2: Understanding of Symptoms and Asthma Management	
What are the signs you have **before** your asthma symptoms begin?	Most people have early warning signs that may occur hours before symptoms appear, such as: feeling tired; needing to clear throat often; sore or itchy throat; dry mouth; fever; feeling nervous, grumpy, or upset; rapid heartbeat; stuffy nose or head; restlessness; rubbing chin or throat repeatedly.
What are your asthma symptoms?	Asthma symptoms vary from one person to the next but may include: coughing; wheezing; feeling of tightness in the chest.
What should you do if you are having asthma symptoms?	Response should include: notifying an adult; taking asthma medicine; resting; doing relaxation exercises.
*How do you measure your breathing with a peak flow meter?	Responses should include a series of steps. Refer to the How to Use a Peak Flow Meter video or download instructions.
Section 3: Using Asthma Medication	
Describe your asthma medications and how to use them.	Use this as an opportunity to verify that the student understands the different types of medicines to treat asthma [i.e. long-term control medicine v. quick-relief medicine]. Response should include: the names of the medicines they take to treat their asthma, how much to take, and when to take them. Refer to the student's asthma action plan for their individualized treatment plan.
Demonstrate how to use your quick-relief medication and after care. What does it mean if you use	Response should include a series of steps. Refer to the metered-dose inhaler video or download instructions. IT means my asthma is not in good control. I should tell my
your quick-relief medicine more than twice per week? Who should you tell and why?	parents and the school nurse, so we can tell the doctor and get the help I need to be active and healthy.
*Demonstrate how to use long-term control medication and after care.	Response should include aa series of steps. Refer to the American Lung Association's asthma medication page to identify the correct inhaler and coordinating instructions.
Section 4: Avoiding or Limiting Asthma Triggers	
Can you show me (by pointing to a trigger graphic)the things that make breathing difficult for you?	Asthma triggers vary from person to person but many include: respiratory infections such as a cold; exercise; irritants; allergens; smoke from tobacco, wood, or car exhaust; changesin weather; and/or strong emotions. Refer to lung.org/asthma triggers for more details.
What can you do about [trigger] to avoid it or limit your time near it?	Managing exposure to triggers can greatly reduce the need for asthma medicines. For example, if the trigger is cold air, an appropriate response may be wearing scarf over your nose and mouth to warm the air you breathe in. If the trigger is exercise, an appropriate response may be to take quick-relief medicine before exercise.

*Optional question

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Table E2:

Independent variables

Independent variables	Analysis
Age	Continuous
Grade	Continuous
Gender	Binary (female/male)
Inhaler self-carry	Binary (yes/no)
Controller medication use	Binary (yes/no)
Asthma control	Binary (good: ACT/cACT≥20 versus poor: ACT/cACT<20)
Asthma impact	Binary (low=PAIS<11 versus high=PAIS≥11)
Caregiver quality of life	Binary (good=PACQLQ≥81 versus poor=PACQLQ<81)
Hospitalizations	Categorical (0,1,2+)
Emergency department visits	Categorical (0,1,2+)
Missed school days	Categorical (0,1,2–5,6–10,11+)
Parent missed work days	Categorical (0,1,2–5,6–10,11+)
Parent familiarity with asthma policy	Binary (yes/no)
Parental approval to self-administer medications	Binary (yes/no)
Asthma action plan on file	Binary (yes/no)
504 plan on file	Binary (yes/no)
Child confidence in ability to self-carry	Binary (1–2=not confident versus 3–4=confident)
Parent confidence in child's ability to self-carry	Binary (1–5=not confident versus 6–10=confident)
Nurse confidence in child's ability to self-carry	Binary (1–5=not confident versus 6–10=confident)