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A mixed-methods study examining inhaler carry and use among children at school

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Abstract

Objective—Asthma self-management depends partly on access to inhalers; for children, this includes independent inhaler carry and use at school (“self-carry”). Although laws and policies support self-carry, little is known about practices within schools. This study aimed to identify factors associated with inhaler self-carry among children and examine barriers and facilitators to self-carry.

Methods—This mixed-methods observational study included child-parent dyads and nurses from four Chicago schools. Children and parents answered questions about asthma care and morbidity, confidence in self-carry skills, and facilitators and barriers to self-carry. Nurses reported asthma documentation on file and their confidence in children’s self-carry skills. Analysis utilized logistic regression. Thematic analysis was performed for open-ended questions.

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Declaration of Interest Statement

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

Results—Of 65 children enrolled (mean=10.66 years), 45 (69.2%) reported having quick-relief medication at school, primarily inhalers, and 35 (53.8%) reported self-carry. Inhaler self-carry was associated with controller medication use and parent confidence in child's self-carry skills. Children and parents identified several facilitators to self-carry: child's asthma knowledge, inhaler characteristics, and need for easy inhaler access. Barriers included child's limited understanding of asthma and inhalers, perception that inhaler is not needed, and limited inhaler access. Children also emphasized social relationships as facilitators and barriers, while parents described children's responsibility as a facilitator and inconsistent policy implementation as a barrier.

Conclusions—Efforts to improve inhaler self-carry at school should focus on educating children about asthma and inhaler use, creating supportive environments for self-carry among peers and teachers, and fostering consistent implementation and communication about asthma policy among schools and families.

Keywords

asthma; children; inhalers; self-administration; self-carry; self-management; school

Introduction

Asthma affects over six million United States children⁽¹⁾ and can be effectively managed with symptom monitoring, medication use, and environmental control.⁽²⁾ Self-management is associated with better outcomes, including improved control, better quality of life, greater self-efficacy, and decreased hospitalizations and school absenteeism.^(2–4)

One key component of self-management is the use of quick-relief inhalers for asthma symptoms, potentially in a life-saving manner. Because symptoms may occur anytime and asthma-related emergencies are common,^(5,6) it is critically important that children have easy access to quick-relief inhalers at school, where they spend more than half their waking hours. By independently carrying and administering inhalers at school ("self-carry"), children have immediate access to medications to prevent or treat symptoms. Inhaler self-carry obviates the need for children to travel to access medications and decreases classroom disruptions.

To support self-management, national laws and guidelines recommend that schools ensure students have easy, immediate access to quick-relief medications.^(2,7,8) Every state mandates schools to allow inhaler self-carry, with most requiring approval from parents and physicians as well as children's demonstration of inhaler technique; no distinctions are made based on children's age or grade level.⁽⁹⁾ Local school district policies also support self-carry. For instance, in Chicago schools, the Asthma Management Policy allows students to self-carry and administer asthma medication with written parent consent and a prescription on file.⁽¹⁰⁾ Despite broad support for inhaler self-carry, a divide exists between policy and implementation⁽¹¹⁾ and little is known about self-carry practices in schools.

Literature about inhaler self-carry practices is primarily based on surveys of school nurses about school-wide practices and policy.⁽⁶⁾ At the child-level, one study in Alabama elementary schools found that few students self-carry despite supportive school policies.⁽¹²⁾

Facilitators and barriers to inhaler self-carry have not been specifically explored, although studies have identified barriers to inhaler availability in schools, including difficulty obtaining necessary documentation or additional inhalers.(12–15) Further, no study to date has evaluated which children self-carry inhalers and what practices support or hinder self-carry. Thus, this study examined the inhaler self-carry practices at school among children with asthma, including who carries inhalers, factors associated with self-carry, and facilitators and barriers to self-carry.

Methods

This observational study was conducted within an academic-community partnership between a university and four Chicago schools that serve predominantly African-American, low-income children. The schools follow Chicago's local school policy on inhaler self-carry. (10) University of Chicago's Institutional Review Board approved this study.

The study included children with physician-diagnosed asthma based on school-based screening.(16,17) It focused on 3rd-8th grade students, because literature suggests they are developmentally most affected by decisions to self-carry inhalers.(18) Questionnaires asked about medication use and inhaler self-carry at school and were developed by a multidisciplinary team, because no validated measures exist to assess self-carry. The team, consisting of a pediatrician, health services researcher, health psychologist, asthma coalition leader, asthma educators, and school nurses, met to generate an initial set of questions targeting study outcomes. These initial questions were reviewed by the team and questions were chosen for children, parents, and nurses based on face validity. Selected questions were then reviewed by an asthma coalition's community advisory board for clarity and comprehension, resulting in minor revisions. The final questionnaires included a combination of multiple-choice, Likert-scale, and open-ended questions. Table 1 details question topics, types, and analyses.

For recruitment, two asthma educators called parents of eligible children and invited one parent and their child to participate in a study about inhaler use.(19) An asthma educator met with each child-parent dyad for 45–60 minutes at the school or a public library. Following consent/assent, the child and parent independently completed questionnaires about the child's asthma, morbidity (i.e. emergency department visits, hospitalizations, missed school days), medication use, and confidence in inhaler self-carry. Both child and parent questionnaires included open-ended questions about facilitators and barriers to self-carry. Validated questionnaires were also utilized to assess asthma control,(20–22) impact,(23,24) and caregiver quality of life (QOL).(25) The asthma educator assisted children with reading and directly recording responses as needed.

Also, the two school nurses who serve these four schools were both approached and recruited to participate in this study. For each child, their school nurse completed a questionnaire that reported the nurse's confidence in the child's inhaler self-carry skills. The nurse also indicated whether the child had asthma documentation on file at school, including parent approval for medication self-administration form, asthma action plan, and Section

504 plan. The 504 plan outlines legally protected accommodations in school that support the academic success of children identified to have a disability, including asthma.

Data analysis

Quantitative analysis included descriptive statistics (mean, median, standard deviation, interquartile range) and logistic regressions. For validated questionnaires, established cutoffs were applied to develop binary variables; confidence was also analyzed as binary variables (Table 1). Simple logistic regressions were utilized to test for differences between students who self-carry inhalers at school and those who do not. Multiple logistic regression was used to determine if differences remained significant after adjusting for independent variables. Due to sample size and power, independent variables were included if relevant to asthma care and inhaler self-carry or if the factors were statistically significant in the univariate analysis; non-significant co-variables were removed. Significance was defined as two-tailed p -value $<.05$. Analysis utilized STATA version 14 (StataCorp).

Qualitative analysis was conducted for the open-ended questions about facilitators and barriers to inhaler self-carry utilizing an iterative process based on grounded theory principles.(26,27) Two research team members (GS, AV) reviewed children and parents' responses and developed codes independently. Codes were refined through discussion until themes were established and agreed upon. Themes and codes were then reviewed with the entire research team and revised based on feedback.

Results

Demographics (Table 2)

Of 189 eligible children, 118 parents were reached and 65 child-parent dyads (55.1%) enrolled in the study over one year (2016–2017). Children's mean age was 10.66 years (SD=1.68). Nearly all participants were Black/African-American, consistent with the schools' demographics. Approximately half the children were female (46.2%, $n=30/65$). Two sibling pairs enrolled in the study. Among the 63 unique parents who participated in the study, most were female (87.3%, $n=55/63$); one did not report their gender. The two school nurses who serve these four schools were both enrolled.

Asthma disease characteristics (Table 3)

More than half of children (56.9%, $n=37/65$) had persistent asthma, based on controller medication use. The majority of children had good control (64.6%, $n=42/65$) and low impact (55.4%, $n=36/65$) of their asthma. Over the prior 12 months, 40.0% ($n=26/65$) missed school, 40.0% ($n=26/65$) visited an emergency department, and 9.2% ($n=6/65$) were hospitalized due to asthma. Most parents had high caregiver QOL (66.2%, $n=43/65$). While 40.0% of parents ($n=26/65$) were familiar with school asthma policy, less than one-third of children had an asthma action plan (32.3%, $n=21/65$), 504 plan (32.3%, $n=21/65$), or parent approval for medication self-administration form (29.2%, $n=19/65$) on file at school.

Inhaler availability and self-carry at school (Table 3)

Among the 65 children, 45 (69.2%) reported they had quick-relief medication at school. Most students had inhalers (97.8%, n=44/45) (one had nebulizer; another had both). Thirty-five students (53.8%) reported self-carry of inhalers and 13 (20.0%) kept inhalers in the office (main office or nurse's office based on school); of these, four (6.2%) did both.

Most children identified they were confident with inhaler self-carry (91.8%, n=56/65). Similarly, most parents indicated confidence in their child's self-carry skills (n=89.1%, n=57/65). In contrast, school nurses reported confidence in the self-carry skills of less than one-third of children (29.2%, n=19/65).

Factors associated with inhaler self-carry (Table 3)

When comparing children who self-carry inhalers versus those who do not, there was no difference in age, grade, or gender. There was no difference in asthma control, impact, and morbidity between the two groups. Children who self-carry were more likely to use controller medications, compared to those who do not (71.4% versus 40.0%, p=0.01). This association remained significant in multivariate analysis (p=0.02), after adjusting for age, gender, and parent confidence.

Caregiver QOL, parent familiarity with school policy, or documentation at school did not differ between the two groups. Child and nurse confidence were also not associated with self-carry (p=.90 and p=.67, respectively). In contrast, parents were more likely to be confident in their child's self-carry skills among students who self-carry, compared to those who do not (97.1% versus 79.3%, p=0.02). This association remained significant in multivariate analysis (p=0.02), after adjusting for age, gender, and controller medication use.

Facilitators to inhaler self-carry (Table 4)

Children and parents described similar facilitators to inhaler self-carry, including child's asthma knowledge, inhaler characteristics, and need for easy inhaler access. Parents also reported responsibility of the child as a facilitator to self-carry, while children identified social support from peers and teachers as facilitators.

Child's asthma knowledge—Children and parents described knowledge about asthma and its impact as a facilitator to inhaler self-carry. Both stated asthma education taught children about the logistics of inhaler use and the importance of having it to treat and prevent symptoms. A 10-year-old girl described feeling comfortable with self-carry at school "because I have been taught and I know how to use [the inhaler]." Parents echoed this perspective, with one parent of an 11-year-old female explaining, "She knows how important it is to have [the inhaler] so she can breathe better." Asthma knowledge also came from practical self-management experiences. One parent stated their 13-year-old daughter carries her inhaler because "we have worked with her since she was diagnosed...she has had years of experience by now."

Inhaler characteristics—Students and parents explained that inhaler characteristics foster portability and facilitate self-carry. Several children described the inhaler as "small",

“lightweight,” and “easy to carry”, enabling transport in their pocket, bookbag, or purse. Parents similarly stated that the inhaler is “small [and] can fit in [a] pocket or bookbag” (parent of 11-year-old male) or can be stored in “a special compartment on/in bookbag to make it easy to find” (parent of 10-year-old male).

Need for easy inhaler access—Students and parents described a need for immediate inhaler access to minimize disruptions and ensure prompt treatment as a motivation for children to self-carry. Many students mentioned they self-carry to store their inhaler in an easily accessible place and lessen interruptions from classes or activities. A 10-year-old male explained self-carry ensures that “I can use my inhaler quickly and get it out of my bookbag.” Similarly, parents described self-carry decreases the time needed to obtain medication; a parent of an 8-year-old male stated: “I believe it is quicker if he has [the inhaler] on him versus running down to the office. So that’s why we decided to have him carry it.” Further, parents highlighted that self-carry ensures children can easily access inhalers if medical staff is absent, as shown by one parent who places their 10-year-old son’s inhaler in “his bookbag in case the nurse is not in school.”

Responsibility of child—Parents described that their children’s responsibility was a facilitator to inhaler self-carry. In fact, parents associated responsibility with appropriate use of the inhaler. A parent of a 10-year-old male stated, “He has been responsible enough to know how to use [the inhaler] only when needed and can have easy access to his treatment.” Notably, children did not cite responsibility as a factor impacting self-carry.

Social support from peers—Several children explained that peers facilitate inhaler self-carry at school. One way that peers offered support was reminders to carry inhalers. A 9-year-old female described, “My friends ask me over and over again, ‘Do you have your inhaler on you?’” Other children spoke about the support friends offered when asthma symptoms arise. An 11-year-old female stated: “[My peers] know if my asthma gets out of control they can tell me to calm down and use my medicine.” Notably, no parent discussed the role of peers in inhaler self-carry.

Social support from teachers—Several students indicated teachers facilitate self-carry by supporting children’s efforts in asthma care. A 7-year-old female described teachers’ important role in preventing symptoms: “They know [I have asthma], and they tell me ‘don’t forget your asthma pump, because we have gym tomorrow.’” Children also described that teachers support inhaler use when symptoms occur. A 9-year-old male commented: “My teachers understand I have trouble breathing and they help me.” In contrast to children, no parents discussed the role of teachers in inhaler self-carry.

Barriers to inhaler self-carry (Table 4)

Both students and parents identified several barriers to self-carry, including child’s limited understanding about asthma and inhalers, perception that inhaler is not needed, and limited inhaler access. In addition, children identified embarrassment within social groups as another barrier to inhaler self-carry, whereas parents focused on inconsistent policy implementation in schools.

Child's limited understanding of asthma and inhalers—Both children and parents identified the child's limited understanding of asthma and inhalers as a barrier to self-carry. Several parents highlighted their child's lack of understanding of when or how to use an inhaler as a barrier. For instance, a parent of a 9-year-old female stated: "My child does not fully understand how to breathe in." Echoing parents' concerns, children expressed discomfort with self-carry when they had difficulty with proper inhaler use. For example, an 11-year-old male commented he did not self-carry because "it is hard to connect spacer and inhaler." Children also stated they forgot how to use the inhaler properly, creating a barrier to inhaler self-carry. A 9-year-old female said she does not self-carry "because sometimes I might forget what I am supposed to do."

Perception that inhaler is not needed—Several children described a belief that they do not need their inhaler, leading them to not self-carry; some parents expressed similar beliefs. One 14-year-old male stated, "I don't feel like I need [the inhaler]." His parents explained, "Because he do not have any symptoms, he still needs to have a rescue inhaler... he does not think he needs it until he has a difficult time breathing." Another parent described their 8-year-old son does not self-carry an inhaler because his "asthma really does not bother him." Despite expressing that inhalers are not needed, these children each described times when having inhalers with them at school would have been beneficial. For example, children recalled experiencing symptoms during gym, recess, or afterschool that required them to stop activities, seek help, and sometimes leave school for medical care.

Limited inhaler access—Children and parents explained that a barrier to self-carry was limited access to inhalers, resulting from forgetting, losing, or not having functional inhalers. Several children and parents described forgetting inhalers at home, as demonstrated by an 11-year-old female who commented she "forgets to bring [the inhaler]"; her parent concurred: "We mistakenly leave it at home." Children and parents also reported loss of inhalers; a parent of a 13-year-old female described: "I wish she would keep and maintain it on her person instead of losing it." In some cases, parents did not allow self-carry because the child "might lose her spacer and inhaler" (parent of 8-year-old female). In addition to forgetting or losing inhalers, children and parents reported limited access due to the lack of functional inhalers. Some children reported having a "broken" inhaler (11-year-old female), while others stated their inhaler ran out of medicine, as one 13-year-old male explained: "I did not have [the inhaler] with me because I did not tell my mom I did not have any more medicine." Further, one parent cited an inability to obtain inhalers due to lack of access to medical care and insurance.

Embarrassment about asthma within social groups—While some children reported comfort talking about their asthma with peers, several students described embarrassment about asthma management as a barrier to inhaler self-carry. A 10-year-old male described discomfort with carrying his inhaler in school "because of what class may say. [It] caused me to be a little embarrassed." Similarly, an 11-year-old female expressed using the inhaler "makes me feel different." Other children described incidences of teasing by peers about inhaler use, which limited their self-carry. An 11-year-old male carried his inhaler but was reluctant to use it, stating: "Sometimes I don't like pull it out because some kids may make

fun of me.” Notably, parents did not mention embarrassment as a barrier to inhaler self-carry.

Inconsistent policy implementation in schools—Parents described inconsistent policy implementation in schools as a barrier to inhaler self-carry and expressed varied understanding about what was permitted at school. Highlighting discrepancies in asthma management practices versus policy, a parent of a 13-year-old female stated, “this school has such strict rules...I am concerned that [my child] may think she can wait until class is over to take her medicine.” Several parents also reported standards differed between classes and teachers in the same school, creating confusion. The parent of an 11-year-old female who carried an inhaler in her purse stated: “Certain teachers have restrictions for girls carrying purses in their classrooms.” Further, some parents expressed concern that children would not have adequate support for self-carry, such as assistance from teachers or staff.

Discussion

This study is the first in-depth examination of children’s inhaler self-carry practices at school. We show over half of students self-carry inhalers and that self-carry is associated with controller medication use and parent confidence in the child’s skills. Further, we identify actionable self-carry facilitators and barriers for families, schools, and healthcare professionals to support asthma self-management.

In this study, higher proportions of children reported inhaler availability (70%) and self-carry (54%) at school, compared to Gerald et al.’s study showing only 14% have inhalers available and few self-carry.(12) Methodologic differences between children’s self-report in this study versus actual assessment by Gerald et al. may partly explain this discrepancy, as children and parents over-report compliance with asthma management.(28,29) The divergent results may also arise from differences in practices across school districts, asthma policy implementation over the decade between studies, parent-child relationships that promote self-carry, or health literacy and resource access that affect self-management.(15,30) Further, children’s asthma history and experiences may impact whether they carry inhalers, although guidelines recommend all students with asthma have quick-relief inhalers available at school.(2,7)

One factor associated with inhaler self-carry was controller medication use. Children who require controller medications may gain asthma knowledge and inhaler skills, which supports self-carry in school. These children may also have more asthma-related healthcare interactions, increasing opportunities to discuss inhaler self-carry. Although controller medication use was associated with self-carry, asthma control, impact, and morbidity were not. This finding suggests that having controller medications, when used to appropriately manage asthma, does not imply worse asthma control, impact, or morbidity, especially in our study population who primarily had good control and low impact.

Parent confidence in the child’s self-carry skills was also associated with inhaler self-carry, while children’s and nurses’ confidence were not. The association between parent confidence and self-carry is logical, as parents are well-described as key decision-makers in

their children's medical care.(31,32) Children cannot self-carry without parental involvement;(33) if parents are not confident in their child's skills, they may not provide the supplies and documentation necessary for self-carry. In contrast, nurses may play an ancillary role in self-carry, particularly in Illinois where nurses are not present full-time in schools and self-carry does not require nurses approval.(9,34) Notably, no association was seen between self-carry and parent familiarity with school policies or asthma-related documentation on file, suggesting policy awareness and documentation are necessary but insufficient for self-carry.

Regarding facilitators and barriers to self-carry, children and parents highlighted similar themes and raised distinct topics. Both noted foundational asthma knowledge (e.g. triggers, symptoms) and practical skills (e.g. proper inhaler use) as facilitators to self-carry and, conversely, deficits in these areas or lack of appreciation of their importance as barriers. This finding aligns with literature connecting asthma knowledge and health literacy with self-management,(15,35,36) as well as the Children's Health Belief Model,(37) which proposes the strongest predictors of medication use are children's perceptions of their disease's severity and medications' benefit. For example, children who believe the inhaler is not necessary may not carry or use it, despite having an inhaler and knowing when and how to use it properly. This perception may stem from denial or misunderstanding of their diagnosis or its severity, consistent with studies describing children and parents' skepticism about the diagnosis and medication necessity.(32,38,39) Thus, repeated asthma education for children and parents across healthcare settings, schools, and homes may support inhaler self-carry.

Additionally, children and parents stressed that inhaler portability supports self-carry, suggesting pharmaceutical manufacturers can promote self-carry by prioritizing portability when designing quick-relief inhalers and spacers. Notably, lack of access to functional inhalers was an important barrier, consistent with previously described barriers to self-management.(15,32) Thus, efforts to ensure accessible, affordable medical care, prescriptions, and insurance coverage are crucial to provide children with sufficient functional inhalers to use at the multiple locations where they live and play.

Children emphasized social relationships positively and negatively impacted inhaler self-carry, aligning with studies describing the impact of social groups on asthma self-management(15,40–43) and the depression, anxiety, and rejection experienced by some children with asthma.(44,45) In contrast, parents did not identify the impact of social relationships on inhaler self-carry, diverging from studies describing that parents view social support as a key component in asthma management.(32,46) While prior studies specifically elicited perspectives on social support, this study broadly explored inhaler self-carry barriers and facilitators, potentially explaining this discrepancy. Alternatively, parents may perceive social support to be important in asthma self-management but not in self-carry. Our study suggests parents may benefit from education about the impact of social relationships and stigma on inhaler self-carry. Efforts should also increase asthma awareness among peers and staff to foster supportive school environments for self-carry.

In contrast to children, parents emphasized their child's responsibility facilitated inhaler self-carry, consistent with studies of asthma medication use.(47,48) This finding reinforces

parents' key role in inhaler self-carry and may partly explain the association between parent confidence and self-carry: parents who deem their child to be responsible may be more confident in their child's skills and thus allow self-carry. However, because parents may not reliably estimate proper inhaler use,(47) further studies are needed to better identify children who are appropriate candidates for self-carry.

Parents also emphasized the impact of school procedures on inhaler self-carry. Although school policy allows children to self-carry, parents described varied experiences with inhaler use at school, assorted rules by teachers that sometimes contradict school policy, and concern about adequate assistance for their child. These findings illustrate that consistent, appropriate asthma care at school necessitates both policy development and implementation. Effective policies should detail processes to identify students who can appropriately self-carry and metrics to evaluate efficacy and safety. Further, successful policy implementation requires broad dissemination and clear communication among school staff, parents, and children, as emphasized in prior studies.(32,35,49)

Parents' comments also raise a critical question: who is ultimately responsible for children's inhaler use at school? While parents are key decision-makers, children must determine when and how to utilize their inhaler under varying supervision at school. Interventions to improve school asthma management should clarify the roles of staff, parents, and children in inhaler self-carry and ensure tailored support based on children's self-management skills and schools' resources.

Study limitations include generalizability because participants were predominantly African-American from four Chicago schools. Different populations and schools may have varied experiences with inhaler use at school. Further, this study has limited power to detect small differences in factors associated with self-carry due to small sample size. Given the high proportion of children found to self-carry versus prior studies,(12) selection bias may be present toward children who have medications at school and families with higher health literacy, suggesting gaps between policy and implementation may be larger than described here. Also, participants may over-report inhaler availability at school; thus, future studies should explore validation. Finally, social desirability bias may lead children and parents to minimize barriers to inhaler self-carry, such as financial hardship or social stigma.

Conclusion

Because inhaler self-carry is critical for self-management, interventions to improve asthma care should educate children and parents about asthma and inhaler use, enable access to affordable inhalers, and foster supportive school environments. Although school policies allow self-carry, efforts to improve policy implementation and promote communication between schools and families hold potential to improve pediatric asthma care and outcomes.

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Table 1:

Topics in study questionnaires of children, parents, and school nurses

Question topics	Question types	Analysis
<u>Children</u>		
Demographics	Multiple choice and fill in the blank	Binary and categorical
Medication availability and use at school	Yes/No and Multiple choice	Binary and categorical
Type of medication at school	Multiple choice (inhaler, nebulizer, both)	Categorical
Location of medication at school	Multiple choice (office, self-carry, other)	Binary, self-carry versus no self-carry
Comfort with inhaler self-carry ^a	Likert scale, 1=very uncomfortable to 4=very comfortable	Binary, not comfortable (1–2) versus comfortable (3–4)
Facilitators and barriers to inhaler self-carry at school	Open ended	Thematic
Asthma control	Asthma Control Test (ACT) 12 years or Childhood Asthma Control Test (cACT) for 4–11 years(20–22)	Binary, good control (20) versus lack of control (<20)
Asthma impact	Pediatric Asthma Impact Scale (PAIS) ^{17,18}	Binary, negative impact (11) versus minimal impact (<11)
<u>Parents</u>		
Demographics	Multiple choice and fill in the blank	Binary and categorical
Child's medication availability and use at school	Yes/No and Multiple choice	Binary and categorical
Child's use of controller medication	Multiple choice	Binary
Healthcare utilization and missed school days	Fill in the blank	Categorical
Overall confidence in their child's inhaler self-carry skills	Likert scale, 1=not at all confident to 10=extremely confident	Binary, not confident (1–5) versus confident (6–10)
Facilitators and barriers to inhaler self-carry by students	Open ended	Thematic
Asthma control	Asthma Control Test (ACT) 12 years or Childhood Asthma Control Test (cACT) for 4–11 years old(20–22)	Binary, good control (20) versus lack of control (<20)
Asthma impact	Pediatric Asthma Impact Scale (PAIS)(23,24)	Binary, negative impact (11) versus minimal impact (<11)
Caregiver quality of life	Pediatric Asthma Caregiver's Quality of Life Questionnaire (PACQLQ) (25)	Binary, high QOL (81) versus low QOL (<81)
<u>School nurses</u>		
Child's asthma documentation on file at school (asthma action plan, 504 plan, parent approval for medication self-administration)	Yes/No	Binary, yes versus no
Confidence in child's ability to self-carry their inhaler	Likert scale, 1=not confident to 10=extremely confident	Binary, not confident (1–5) versus confident (6–10)

The study's intention was to understand confidence to self-carry; however, after feedback from the multidisciplinary team and community advisory board, the child questionnaire used , to meet children's literacy and comprehension level.

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Table 2:

Demographics of participating children with asthma and their parents (n=65)

Demographics		n (%)
Child's gender	Female	30 (46.2)
Child's age	Age, mean (SD [*])	10.66 (1.7)
Child's grade	3 rd grade	15 (23.1)
	4 th grade	7 (10.8)
	5 th grade	13 (20.0)
	6 th grade	13 (20.0)
	7 th grade	10 (15.4)
	8 th grade	7 (10.8)
Child's race ^{**}	Black or African-American	58 (89.2)
	Two or more races	4 (6.2)
	No answer	3 (4.6)
Parent's gender	Female (n=63) ^{***}	55 (87.3)

^{*} SD = standard deviation

^{**} Other races listed, but not chosen, include American Indian / Alaska Native, Asian, Hispanic / Latino, Native Hawaiian / other Pacific Islander, White.

^{***} Two sibling pairs participated in the study; thus a total of 63 unique parents participated in the study. One of the parents did not report their gender.

Table 3:

Comparison of demographics, asthma disease characteristics, and confidence in self-carry among children who independently carry and use their inhaler at school versus those who do not (n=65)

	All students (n=65) n (%)	Students who self-carry (n=35) n (%)	Students who do not self-carry (n=30) n (%)	Odds ratio (95% confidence interval)	P-value	Adjusted odds ratio (95% confidence interval)	P-value
Demographics							
Age, mean (SD)	10.66 (1.68)	10.83 (1.52)	10.47 (1.85)	0.13 (-0.16, 0.43)	.38		
Grade, median (IQR)	5 (4, 7)	5 (4, 7)	5 (3, 6)	0.16 (-0.14, 0.45)	.30		
Female gender	30 (46.2)	16 (45.7)	14 (46.7)	-0.04 (-1.02, 0.94)	.94		
Asthma severity, control, and impact							
Daily use of controller inhaler	37 (56.9)	25 (71.4)	12 (40.0)	1.32 (0.29, 2.36)	.01	1.27 (0.18, 2.37) *	.02
Good asthma control, based on Asthma Control Test score ²⁰	42 (64.6)	21 (60.0)	21 (70.0)	0.44 (-0.59, 1.47)	.40		
Minimal asthma impact, based on Pediatric Asthma Impact Scale score ^{<10}	36 (55.4)	22 (62.9)	14 (46.7)	0.66 (-0.33, 1.65)	.19		
Good caregiver quality of life, based on PACQLQ score ⁸¹	43 (66.2)	24 (68.6)	19 (63.3)	0.23 (-0.80, 1.26)	.66		
Asthma care at school							
Asthma action plan on file	21 (32.3)	12 (34.3)	9 (30.0)	0.20 (-0.85, 1.24)	.71		
504 Plan on file	19 (29.2)	10 (28.6)	9 (30.0)	-0.07 (-1.14, 1.00)	.90		
Parent approval for medication self-administration on file	17 (26.2)	10 (28.69)	7(23.3)	0.27 (-0.85, 1.39)	.63		
Parent familiar with school's asthma policy	26 (40.0)	16 (45.76)	10 (33.3)	0.52 (-0.49, 1.53)	.31		
Asthma morbidity							
Hospitalizations				0.70 (-0.71, 2.11)	.29		
0	59 (90.8)	30 (85.7)	29 (96.7)				

	All students (n=65) n (%)	Students who self-carry (n=35) n (%)	Students who do not self-carry (n=30) n (%)	Odds ratio (95% confidence interval)	P-value	Adjusted odds ratio (95% confidence interval)	P-value
1	4 (6.2)	4 (11.4)	0 (0)				
2	2 (3.1)	1 (2.9)	1 (3.3)				
Emergency department visits							
0	39 (60.0)	22 (62.9)	17 (56.7)				
1	9 (13.9)	3 (8.6)	6 (20.0)				
2-4	17 (26.2)	10 (28.6)	7 (23.3)				
School days missed by student							
0	39 (60.0)	19 (54.3)	20 (66.7)	0.15 (-0.30, 0.60)	.50		
1	6 (9.2)	4 (11.4)	2 (6.7)				
2-5	16 (24.6)	9 (25.7)	7 (23.3)				
6-10	3 (4.6)	3 (8.6)	0 (0)				
11+	1 (1.5)	0 (0)	1 (3.3)				
Work days missed by caregiver							
0	43 (66.2)	20 (57.1)	23 (76.7)	0.39 (-0.11, 0.88)	.11		
1	5 (7.7)	3 (8.6)	2 (6.7)				
2-5	13 (20.0)	9 (25.7)	4 (13.3)				
6-10	2 (3.1)	2 (5.7)	0				
11+	2 (3.1)	1 (2.9)	1 (3.3)				
Confidence in inhaler self-carry skills							
Child comfortable with inhaler self-carry at school	56 (91.8)	32 (91.4)	24 (92.3)	-0.12 (-1.98, 1.75)	.90		
Parent confident in child's ability to self-carry inhaler at school	57 (89.1)	34 (97.1)	23 (79.3)	2.18 (0.00-4.36)	.02	2.16 (-0.83-4.40)**	.02
Nurse confident in child's ability to self-carry inhaler at school	19 (29.2)	11 (31.4)	8 (26.7)	0.23 (-0.85, 1.31)	.67		

ACT=Asthma Control Test, IQR=interquartile range, PAIS=Pediatric Asthma Impact Scale, PACQLQ=Pediatric Asthma Caregiver's Quality of Life, SD=standard deviation

* Adjusted for age, gender, parent confidence

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Adjusted for age, gender, controller medication use
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Table 4:

Representative quotes from children and parents describing facilitators and barriers to inhaler self-carry and use in school

	Quotes by children	Quotes by parents
Facilitators		
Child's asthma knowledge	"I need [the inhaler] to keep me alive and healthy." (10-year-old female)	"He is pretty aware of his asthma and its triggers. Asthma education has helped a lot." (parent of 13-year-old male)
		"Thanks to our health care provider we are fully aware of the or most of the triggers and how to manage asthma." (parent of 10-year-old female)
Inhaler characteristics	"Because [the inhaler] is small, it is easy to carry." (10-year-old male)	"He can put [the inhaler] in his pocket." (parent of 11-year-old male)
	"[The inhaler] is small and it does not take up much space. I can take it in gym." (11-year-old female)	"...she carries [the inhaler] in her purse." (parent of 10-year-old female)
	"I keep [the inhaler] in my book bag and I can always go and get it. I always know where it is at." (10-year-old male)	
Need for easy inhaler access	"If I am running, I can take a break and use it instead of going back to the office." (10-year-old female)	"She is currently on the 3rd floor and the office is in the 1st floor. She needs quick access." (parent of 9-year-old female)
	"I carry my inhaler with me but also has one in the office just in case I forget mine and I need it. I can get to it quickly and I don't have to go home and get it." (10-year-old female)	Child carries inhaler so "he could continue his school work and be productive in school." (parent of 12-year-old male)
Social support from friends	"Because [my friends] can take me to go get my inhaler. I tell them so they will know why I may be sitting down." (11-year-old male)	<i>This theme did not arise from parent participants.</i>
	"[My friends] connect with me and tell me what to do during an asthma attack." (13-year-old female)	
Social support from teachers	"My teacher...gets my inhaler from my book bag and she calls my mom and my mom tells me to calm down." (9-year-old male)	<i>This theme did not arise from parent participants.</i>
Responsibility of child	<i>This theme did not arise from youth participants.</i>	"She is responsible and understands [the inhaler]'s necessity. She carries it in her purse." (parent of 11-year-old female)
Barriers		
Child's limited understanding of asthma and inhalers	"[I am] not sure how to use [the inhaler and spacer] properly." (9-year-old female)	"[He] doesn't know when to use [the inhaler]." (parent of 9-year-old male)
	"My mother usually shakes the inhaler and I may forget." (11-year-old male)	"I just want us to be knowledgeable about his asthma and know that it's serious and to always keep his inhaler with him and use it properly." (parent of a 9-year-old male)
	"I can't really put the spacer and inhaler together because I have a panic attack with my asthma attack." (11-year-old male)	
Perception that inhaler is not needed	"Never really need [the inhaler]." (13-year old male)	"He does not think he needs [the inhaler] until he has a difficult time breathing." (parent of 14-year-old male)
		"[He] refuses to carry [an inhaler]." (parent of 13-year-old male)
Limited inhaler access	"[I] forget to bring [my inhaler]." (11-year-old female)	"We mistakenly leave [the inhaler] at home. I will start to keep her medicine at school and on her." (parent of 11-year-old female)
	"[I don't] know where [my inhaler] is...I don't use it a lot." (8-year-old male)	

	Quotes by children	Quotes by parents
		"[She] might lose her spacer and inhaler. She won't carry her asthma spacer and inhaler to gym and therefore won't use it or have access to it, if needed." (parent of 8-year-old female)
Embarrassment about asthma within social groups	"I don't like to talk to [classmates] about medication, because a majority of the children like to tease people about medication." (11-year-old male)	<i>This theme did not arise from parent participants.</i>
	"Because I don't want to talk about [the inhaler]. I get nervous sometimes." (10 year-old male)	
Inconsistent policy implementation in schools	<i>This theme did not arise from youth participants.</i>	Self-carry is "being allowed to use [the inhaler] and being assisted by teachers and staff." (parent of 8-year-old female)