Children's Reports of Asthma Education Received from Healthcare Provider

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Table of Contents

List of Figures

Abstract: Children are assuming responsibility for their asthma management at younger ages. It was reported that 20% of 7 year olds, 50% of 11 year olds and 75% of 15 year olds are responsible for their daily controller medication use (Orrell-Valente et al., 2011). Although children have developmental differences due to age, experts suggest they want to be stakeholders in their health care. When children feel a part of the decision-making process they may be more likely to adhere to the management plan. This project evaluated asthma education received from the healthcare provider and identified gaps in their asthma treatment plans to improve self-management. A primary analysis of de-identified data from 16 school-aged children at a West Coast asthma clinic was conducted. The questionnaire consisted of 21 questions. Seventeen items assessed children's receipt of asthma education and were scored based on how thoroughly the information had been discussed (0= *had not been discussed*; 1= *had been briefly discussed*; or 2= *had been discussed fully*). Higher average scores indicated greater engagement. Statistical analysis revealed a mean=1.47 (*SD*=0.52), indicating room for improvement in educating adolescents on asthma self-management. Four open-ended questions assessed what children want in their asthma management education and how they want the information delivered. All children expressed a desire to receive text messages with helpful asthma information and reminders either daily or monthly. Additional feedback included a desire for asthma information to be explained at their level, treatment reminders, peak flow meter use instructions and multi-language asthma education tools. These results indicate that important components of asthma self-management were only briefly discussed with children. As healthcare professionals strive to provide patient-centered care and children assume more responsibility for asthma management, it is critical that children be involved in the clinical encounter so tailored asthma education and management plans can be developed, resulting in improved outcomes.

Chapter I: Statement of the Problem

Introduction: Asthma is a chronic condition, and while there is no cure, symptoms can be managed when the proper treatment plan is recommended, understood and followed by patients with an asthma diagnosis. Patient adherence to a treatment plan is highly influenced by the patient's involvement in the treatment plan, and their ability to understand the importance of the treatment plan through education measures. Pediatric patients are often overlooked in the asthma education process, as healthcare providers solely educate parents and caregivers in the clinical setting most often. Since children and adults learn differently, it can be difficult for a child to understand his or her asthma and treatment plan based on the information given to his or her caregiver or guardian. For this reason, it is important to consider the child when providing asthma education to families, including the individualized learning needs of the child.

A study by Orrell-Valente et al. shows that by age 7, 20% of children are responsible for managing their own asthma. By age 11, the percentage rises to 50%, by age 15, 75%, and by age 19, 100% (Orrell-Valente et al., 2011). The statistics demonstrate that many children are self-managing their asthma, however, we as healthcare providers do not accurately recognize this and engage them to the fullest potential. By ignoring the issue and not teaching children how to optimally self-manage their asthma, in a way that will work for each child individually, there is a risk for increased poorly controlled asthma, which may potentially contribute to a greater number of preventable asthma-related ED visits and hospitalizations. Under the Affordable Care Act, these visits will have many financial consequences for hospitals, but luckily, these issues are preventable through individualized asthma education plans that aim to directly educate children, rather than their parents or guardians.

Background of the Problem: According to the Centers for Disease Control and Prevention (CDC), the prevalence of childhood asthma has increased from 2015 to 2017. The data reveals that in 2015, 6,188 children were diagnosed with asthma (approximately 8.4%). By 2017, approximately 6.3 million children have asthma (approximately 8.6%) (Centers for Disease Control and Prevention, 2017). Additionally, the number of children presenting to the Emergency Department with a primary diagnosis of asthma has remained consistent at 1.6 million from 2015 to 2017. The number of childhood deaths related to asthma has also increased from 2015 to 2017 from 3,615 deaths to 3,651 deaths (Centers for Disease Control and Prevention, 2017). This data indicates a need for improvement in preventative care measures, such as individualized pediatric asthma education (Centers for Disease Control and Prevention, 2017).

Unmanaged pediatric asthma not only yields negative patient outcomes, as it is also costly. According to the Asthma and Allergy Foundation, the annual cost of asthma in the United States is approximately $56 billion. Approximately $50.1 billion are attributed to direct care costs, while $5.9 billion are attributed to indirect costs such as loss in productivity or pay due to illness or death (Asthma Facts and Figures, 2015). As asthma morbidity increases, the amount of money spent on asthma is also likely to increase.

Purpose of the Study: Primary data were collected at a pediatric asthma and immunology clinic on the West Coast in order to identify gaps in asthma knowledge, identify child needs and wants, determine preferences for education delivery and increase pediatric asthma knowledge to improve self-management. Through asking children questions regarding how they best learn and how they would like asthma information presented to them, there is a higher probability that children will adhere to the asthma treatment plan.

Significance of the Study: According to a study performed in 2011 by Trollvik et. al, asthma can severely effect a child's quality of life due to fear of asthma exacerbation (as cited in Trollvik, 2013). Asthma education programs have been demonstrated to help with these fears, leading to better health outcomes and quality of life (Trollvik, 2013). The primary data collected proves that children prefer technological education interventions over traditional methods that are often used in the hospital setting. By catering to these requests made by pediatric patients with asthma for children with asthma, we can help improve child interest in learning about his or her asthma, leading to better outcomes for the child and placing less burden on hospital systems, as there will be fewer asthma exacerbations when asthma education is understood and treatment plans are followed. This yields a mutual benefit for pediatric patients, caregivers, hospital staff and hospital systems.

Theoretical Framework: Orem's Self-Care Deficit Nursing Theory (SCDNT) serves as the theoretical framework for this project. It posits that self-care is a necessary regulatory process to sustain life, physical and psychosocial functioning, and integrity of performance and development. In this theory, Orem states that "self-care must be learned and it must be deliberately performed continuously" (as cited in Lawson, 2014). The ideology of the theory is that a patient's capabilities related to self-care are determined by the patient's maturity level. Therefore, the theory helps explain how the level of nursing care necessary for each patient is determined, and explains limitations that may serve as a barrier to performing self-care measures (as cited in Lawson, 2014). This theory illustrates the importance of developing education plans individualized for children, as their maturity level and ability for self-care varies greatly to that of an adult.

Research Questions: Aim #1: To assess children's reports of education received from their healthcare provider about their asthma. Research Question (RQ) #1: What do children know and not know about their asthma? Aim #2: To determine what children indicate they need in order to better self-manage their asthma. RQ#2: What methods do children suggest healthcare providers utilize in order to educate them about their asthma? Aim #3: To identify features of an asthma app that would help children increase their asthma knowledge and assist with their self-management. RQ#3: What types of games and features would children be willing to use on a regular basis in order to better understand their asthma diagnosis and improve adherence to their asthma treatment plan?

Chapter II: Review of the Literature

Asthma is a common chronic illness among the pediatric population, affecting approximately 8.3% of children between the ages of 5-17 years living in the United States today (Centers for Disease Control and Prevention, 2015). Prevention of asthma attacks and exacerbations is essential in managing pediatric asthma throughout the United States, and this prevention starts with effective education provided by healthcare professionals. Many children are now self-managing their asthma, therefore, a child's understanding of their asthma and asthma management plan is crucial.

To begin the literature search process, I utilized the terms asthma, education, children and self-management on the PubMed search engine. After receiving over one thousand results, I narrowed my search further. To include articles regarding children's self-management education, and their general educational history regarding asthma and self-management knowledge, both key phrases were also included. The search was filtered to selectively include

peer reviewed articles only. Search engines PUBMED, Cochrane and CINAHL were used to find articles, and PUBMED proved to be most helpful for this particular search.

Identifying children's asthma illness beliefs and barriers to the use of daily controller medications combined with teaching children about medication adherence, peak expiratory flow monitoring, environmental control of asthma triggers and proper inhaler usage are vital components of an asthma education plan. This knowledge can help prevent asthma attacks, which could potentially decrease the number of ED visits a child experiences. Standard asthma education programs, however, ignore illness beliefs and barriers and focus more heavily on trigger control and proper inhaler technique. Generalized education itself, however, is not enough to prevent asthma complications unless the plans are individualized and specific, catering to the unique needs of each child. One way to individualize asthma education plans is through behavioral strategies, such as utilizing positive reinforcement and incentives for children performing expected behaviors to improve asthma management. Burkhart & Dunbar-Jacob argue that on average, there was a 25% adherence improvement to recommended treatment programs when behavioral strategies were utilized along with education tactics (as cited in Burkhart, 2007). A randomized, controlled clinical trial found that to improve child adherence to treatment plans, a multiple-component behavioral approach was more effective than a single behavioral strategy, emphasizing the importance of tailoring pediatric asthma treatment and education plans to the specific needs of every child (Burkhart, Rayens, Oakley, Abshire, & Zhang, 2007).

Effective education must be holistic, indicating that a child should be reminded about his or her asthma treatment regimen and educated through in-patient services, at home and even at school. School-based asthma programs can serve as another effective way to educate children,

with the reduced risk of directing the education towards parents or guardians. A systematic review of school-based education programs for children aged 4 to 17 years old shows school-based programs improved asthma knowledge in 7 out of 10 studies, self-efficacy in 6 out of 8 studies, and self-management behaviors in 7 of 8 studies (Coffman, Cabana, Halpin, & Yelin, 2008). In 2005 and 2006, a retrospective, descriptive study was used to determine the number of children with asthma or parents of children with asthma who received thorough asthma education before discharge from New England Children's Hospital. Four hundred fifty-two records were reviewed in 2005 (mean age of children 7 years), and 561 records were reviewed in 2006 (mean of children 7.2 years). It was found that 70 charts (15%) in 2005 and 235 charts (42%) in 2006 contained record of inclusive asthma education completed prior to discharge. In the 2006 cohort, 181 families attended a hospital-based group education program out of the 242 families referred (Tolomeo, 2008). Approximately 287 participants evaluated the program, and when asked, "Do you feel this class will help you to manage asthma better at home?" 169 participants responded "yes." These results show that many were receptive to asthma education when it was offered to them (Tolomeo, 2008).

Consideration of the home environment and controlling asthma triggers are also important factors in asthma education. A study performed in Taiwan found that house dust allergens are a major cause of childhood asthma and must be controlled. Thirty-eight children (ages 6-14 years old) and parents of the experimental group participated in a 12-week patient-centered asthma education program conducted by a well-trained asthma nurse, while thirty-seven children (ages 6-14 years) and parents in the comparison group received routine asthma education. The study found parents in the experimental group to have significantly greater dust control and improved cleaning methods contrasted with those in the comparison group. The

results also showed that the children who had moderate to severe asthma in the experimental group presented with fewer asthma signs and symptoms and demonstrated improved lung functioning compared to the children in the comparison group (Tzeng, Chiang, Hsueh, Ma, & Fu, 2010).

While it is important to consider education methods within the major settings of a child's life (i.e. school, clinic/hospital, home), these methods must cater to the child's interest and needs in order to be effective. Researchers from the University of California, Berkeley designed a randomized control trial to study the effectiveness of computer-based asthma education programs versus handwritten asthma education interventions. Monitoring asthma symptoms and functional status with the "Health Buddy", a computer-based self-management asthma education program, increased self-management skills and resulted in better asthma outcomes for child participants in comparison to the asthma diary (Guendelman, Meade, Benson, Chen, & Samuels, 2002). Another study performed in Queensland, Australia with eighty children (ages 2-5 years old) found that children who received asthma education via video tape or picture book learning acquired more asthma-related knowledge than children who did not have access to these educational resources, and children exposed to both interventions demonstrated the largest knowledge increase (Holzheimer, Mohay, & Masters, 1998). Another study conducted in San Francisco and San Jose, California, with a sample of 119 children aged 5-12 years old determined that an educational multi-component asthma video game including behavioral and medical interventions targeted at inner-city children with asthma whom are considered high-risk can improve asthma knowledge and quality of life (Shames et al., 2004). In a technologically advanced society, evidence shows that children engage more frequently with games, computerized programs and other forms of technology-based education, which is useful

information to consider when developing pediatric asthma education programs. Utilizing technology is another advantageous way to individualize asthma education by catering to the interest of the child and overcoming the literacy issues that may be present with printed materials.

Another important component of an asthma education program is to include information that is not readily known by the participating child, such as concepts like usage of peak flow meter, controller medications and symptom monitoring. A study conducted among a sample of 3,953 children found that being taught to use an inhaler (78.6%), being taught episode response (86.3%), and being taught episode signs and symptoms (82.0%) are three asthma education components most frequently reported (Zahran, Person, Bailey, & Moorman, 2012). While this information is helpful, there is no evidence to support that a child will fully understand and utilize the information he or she is taught in an asthma education program, and this approach does not consider personal beliefs, preferences, and barriers. Therefore, the only effective way to ensure asthma education plans are individualized and cater to the needs of children is to ask the children what they feel they are missing in their asthma treatment plans, and what they feel they need to better self-manage their asthma. While the literature shows that programs where children actively participate in asthma self-management education programs are lacking, an exploratory descriptive study collected data by monitoring child and healthcare professional interactions through observation or tape recording to determine how children best comprehend asthma education (Trollvik, Ringsberg, & Silén, 2013). The asthma education program was presented in four themes: children learned from each other, through interaction with educational material, through interaction with healthcare personnel and vice versa, and through discussion and expression of their understanding of asthma. This program is unique as it was developed

based on contributions from the children, in order to address their concerns and help them better understand the asthma scenarios and psychosocial encounters they experience daily (Trollvik, Ringsberg, & Silén, 2013).

Overall, the evidence demonstrates that pediatric asthma education helps with adherence to asthma treatment plans, children's understanding of their chronic illness, and improved health outcomes; especially when the programs are tailored to a child's individual interests and learning styles or preferences. The focus of our project will be to gather information directly from children regarding what they feel they need, and what they are missing, to better self-manage their asthma. We will then take this information to create an asthma education program tailored to the interests of children (i.e. Smartphone application, games, etc.) in order to increase asthma knowledge, self-management skills and health outcomes.

Chapter III: Methodology

Research Design: Primary data collection occurred from August 2015 through February 2016 as part of a quality improvement project and needs assessment, and thus, IRB review was not required. A Human Subjects Research Assessment Form was utilized. A questionnaire was distributed to 16 school-aged children with asthma at a clinic on the West Coast. The purpose was to determine what children know and do not know about their asthma and the intended treatment plan based on education they received from their healthcare provider. The questionnaire consisted of 21 questions, 17 which assessed children's receipt of their asthma education, and 4 open-ended questions to assess children's needs and desires to determine what components they would like to see implemented into their asthma treatment plan. Analysis was conducted from the de-identified data set.

Population and Sample Design: An asthma and immunology clinic on the West Coast was chosen as the site for this study. The intention behind choosing this site was to recruit pediatric patients with asthma of diverse backgrounds to determine commonalities and differences in asthma knowledge and treatment suggestions based on culture. The clinic site served patients from various ethnic and cultural backgrounds, making it an ideal site for data collection. English and Spanish-speaking patients were accommodated. The clinic is staffed with physicians, nurse practitioners, nurse aids, respiratory therapists and respiratory techs to provide general medical care and cater to the needs and treatment plans of pediatric patients with asthma and other patients experiencing chronic conditions.

Data Collection Procedures: To be eligible for questionnaire distribution, the child must have met the following criteria: a) The child must be of school-age and have the ability to read the questionnaire independently without parental, guardian or provider assistance 2) had a diagnosis of asthma, per information obtained from the healthcare provider treating the child at the clinic 3) able to read and comprehend English or Spanish. No sociodemographic or protected health information was collected. Interaction with the healthcare providers was utilized to identify eligible participants. I collected half of the questionnaires while working an internship on the West Coast. Jenny Partida, a respiratory technician at the clinic, collected the other half of the questionnaires.

Eligible children were asked to participate through face-to-face invitation with caregiver permission. Invitations were given at the end of the appointment with the healthcare provider. Once the provider indicated the appointment with the patient was complete, the researcher conducting the data collection would enter the room and introduce herself and the questionnaire. The patient and caregiver were given an explanation of what the questionnaire would entail, how

long it would take to complete, and the compensation (a $5 Jamba Juice gift card) that would be provided for participating in the questionnaire. Parents and/or guardians were present at the time instruction was given, and were asked not to assist the child in any way with the questionnaire. Parents and guardians acknowledged understanding of this requirement. Participants and guardians were informed of the following information: a) they were being asked to participate in a project regarding the thoroughness and effectiveness of asthma education for children in the hospital setting, and were asked to take part in this project if he or she was a child with asthma who had seen a health care provider recently; b) the purpose of the project, which was to determine what most children do and do not know about managing their asthma, with the goal being to improve asthma education methods so that children are better able to self-manage their asthma; c) that taking part in the project was completely voluntary, and they could skip over any question they did not want to answer; d) they could choose to withdraw participation at any time without penalty; and e) no information would be collected or included in the project making it possible to identify the participant. Each child was assigned a unique identification number and only this number appeared on the questionnaire. Children were asked to fill out the questionnaire at their own pace, though the questionnaire was created with intent to be completed in approximately ten minutes. Contact information for myself and research mentor, Kimberly Arcoleo (PhD, MPH), was provided to each participant should he or she have questions after leaving the clinic.

Data Collection Instrument: The data collection instrument, a pediatric asthma questionnaire, consisted of 21 questions. Seventeen items assessed children's receipt of asthma education and were scored based on how thoroughly the information had been discussed with them by their healthcare provider (0= *had not been discussed*; 1= *had been briefly discussed*; or 2= *had been*

discussed fully). Higher average scores indicated greater engagement in discussion. These questions inquired about the patients' knowledge regarding prevalent asthma topics such as peak flow meter use, importance of controller medication use and management, and proper utilization of emergency services. Four open-ended questions assessed what children want implemented into their asthma management education and content that they feel they are missing, in order to better self-manage their asthma. Children were also asked about methods for how they want the information delivered and the frequency of information delivery.

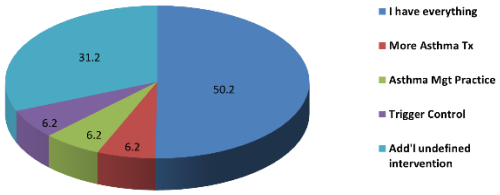
Chapter Summary: The data collected from this needs assessment is valuable, as it gauges the opinions and desires of children who are frequently left out of conversations during healthcare encounters around asthma education. Engaging children in developing the asthma education plan is beneficial, as it allows them to feel empowered through providing opinions regarding their healthcare. This information also serves to guide future pediatric asthma studies, as we are now aware of what children with asthma identify needing in order to better self-manage their asthma.

Chapter IV: Results

Questionnaire data were analyzed using SPSS (Version 22). The average total score was 1.51 (*SD*=0.51). Results from the open-ended questions 18-21 examined what children indicate they need, that they were currently missing, in order to better self-manage their asthma (Figure 1). Half of children stated they had no needs related to their asthma education. Half of children indicated a need for interventions related to the following topics: asthma treatment education, asthma management practice and trigger control. Statistical analysis revealed that 6.2% of children indicated a need for more information regarding asthma treatments, 6.2% indicated a

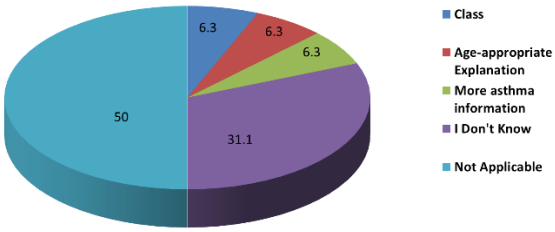
greater need for more asthma management practice and 6.2% indicated a need for further education regarding trigger control. An additional 31.2% of participants indicated a need for some form of additional intervention in order to better self-manage their asthma, however, did not specify or suggest a particular intervention.

Figure 1. Asthma Needs



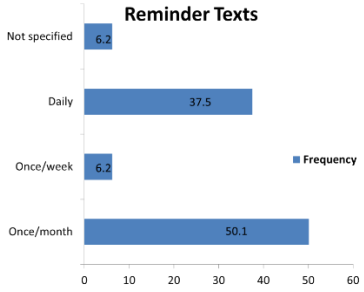
Data regarding pediatric patients' suggested strategies to meet asthma education needs were also analyzed (Figure 2). Analysis revealed that 6.3% of participants indicated that a child-centered asthma education class tailored to their language and development would be helpful. An additional 6.3% of children indicated a need for an increased amount of asthma education information and materials in multiple languages, while 6.3% of children indicated a need for more age appropriate explanation of their asthma and management plan. These data also revealed that 50% of participants indicated no need for additional asthma education strategies, and 31.1% indicated a need for some type of intervention in relation to strategies to meet asthma education needs, but did not specify a particular strategic intervention.

Figure 2. Strategies to Meet Needs



A third open-ended question inquired about a child's willingness to receive an asthma education reminder text, and if so, with what frequency (Figure 3). Participants indicated an interest in either receiving a daily (37.5%), weekly (6.2%) or monthly (50.1%) asthma reminder text.

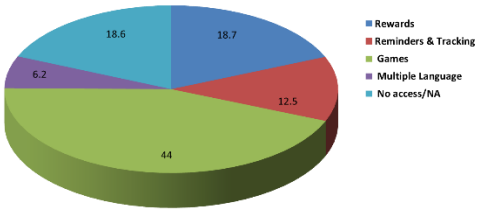
Figure 3. Frequency of Asthma Reminder Texts



Children were also asked about features they would like to see implemented into an asthma app (Figure 4). Among the responses were requests for games (44%); reminders and tracking (12.5%); rewards (18.7%); and multiple language components (6.2%) to the asthma app, particularly in Spanish. Some children did not indicate an interest in features of the asthma app, or expressed concerns with not having access to the technology to utilize an app (18.6%). From the data, we found that all children expressed a desire to receive text messages with helpful asthma information and reminders to some frequency. Additional feedback included a desire for

asthma information to be explained at a child-level, treatment reminders, peak flow meter use instructions and multi-language asthma education tools.

Figure 4. Features of Asthma App



Chapter V: Conclusions and Recommendations

Conclusions: Asthma is a chronic condition affecting both children and adults, but more commonly, children. Regardless of this fact, children are often overlooked when it comes to implementing preventative measures, such as effective education, to reduce poor health outcomes and healthcare costs related to asthma exacerbations. According to the CDC (2017), one in twelve people (8% or 25 million people) had asthma in 2009, compared to one in fourteen people (20 million or 7%) in 2001. Asthma costs Americans approximately $56 billion per year when medications, ED visits, hospital admissions and missed work and productivity are considered, indicating the issue is prevalent and costly, and preventative action must be taken (Asthma and Allergy Foundation of America, 2015). By teaching children how to manage their asthma from a young age, they will likely have an increased chance to develop healthy management tactics, leading to improved asthma control and better health outcomes in adolescence and adulthood.

In order to implement interventions that are useful and sustainable, children must be involved in the intervention formulation process. To determine what education methods pediatric patients with asthma want and need to more effectively self-manage their asthma, directed and open-ended questions must be asked in order to tailor intervention efforts to a child's specific needs. Directed questions should regard asthma attacks, peak flow meter use, potential management barriers and medication compliance. Open-ended questions allow patients the opportunity to share their opinions regarding interventions that healthcare providers may not have considered before, how they would like to receive information, and in what format. This information is valuable, as interventions will only effectively yield positive outcomes if the children are willing to utilize the created interventions. By involving the children in the design and content of the intervention, and empowering them to have a voice in their own care plan, relevant interventions can be tested. This will yield more positive results for a future research study, for the interventions we choose to study will be suggested by the children.

Limitations: We were unable to collect any socio-demographic information from participants. Questionnaires in Spanish were created and provided upon request halfway through the data collection process, which may have discouraged some children from participating in the beginning stages of the project due to language barrier issues.

Implications of the Study: Based on the data collected in this project, it is evident that there is a discrepancy between what children indicate they need implemented in their asthma education and how we provide that education in the healthcare and community setting. The average total score of pertinent asthma topics being discussed was 1.51, meaning healthcare providers are only briefly discussing pivotal asthma topics with our pediatric patients with asthma. This indicates the need to improve our asthma education strategies with pediatric patients, especially since

many children are now self-managing this chronic condition. Handouts and verbal instruction are commonly utilized when providing asthma education to pediatric patients and their caregivers, however, children indicate they would like to see technology implemented into their education sessions and content tailored to them. America's healthcare system strives to provide patient-centered, individualized care. To do this, we must listen to our patients and their suggestions. As many children are technology-oriented, utilizing these methods to educate them would likely be most effective, especially when these methods are recommended by pediatric patients themselves.

The information from this project suggests that there is a need for more primary intervention with pediatric patients with asthma, and this can be utilized by providers in the healthcare setting to tailor their education methods to the younger pediatric population. While this project represents a general analysis of the preferences of a small population of pediatric patients with asthma, individual needs should be considered for each patient in the healthcare setting. Above all else, our hope is that this project will serve as a reminder to engage patients, regardless of their age, in conversations regarding their care plan, including education needs and preferences.

Recommendations: This needs-assessment pilot study presents an opportunity for future research. This pilot study provided preliminary data, and we would like to build upon this information by conducting a larger study of more pediatric patients with asthma at clinics around the country, to collect data that is diverse and from children of various cultural, socioeconomic and geographic backgrounds. Future research plans also include collection of socio-demographic information from participants in order to categorize our findings by age group and to create interventions targeted towards pediatric patients of a specific age range.

Focus groups would also be a helpful strategy in future research. Questions one through seventeen on the questionnaire asked children to rate pertinent asthma topics based on how thoroughly each topic had been discussed with their healthcare providers. Low scoring topics (information children indicated had not been discussed with them by their healthcare provider) may have been rated poorly simply because the child did not understand the information when it was discussed with him or her, rather than the topic not being discussed with them at all. Focus groups would be helpful to determine why children indicated the information had not been discussed, and to gauge whether or not they understand the topic well enough when it is brought up with them in a discussion with their healthcare provider. Focus groups with healthcare providers at asthma clinics would also be helpful to determine current methods of asthma education delivery. Information gathered in focus groups could be utilized to create more individualized, targeted interventions.

After gathering more specific information from our targeted population, pediatric patients with asthma, development of a pediatric asthma app would be the next step in future research. The app would include interventions, games and education materials recommended by targeted pediatric patients with asthma. Creation and distribution of this app, then measurement of health outcomes and feedback from patients that utilized the app would serve as the final determination of whether the app was truly helpful. While some children did not specify a frequency, all participants indicated that they were interested in receiving an asthma reminder text with some frequency, meaning this could also be a helpful intervention worth testing.

Health outcomes could be determined by comparing changes in ED visits, hospital admissions and peak flow readings of the intervention group (children with asthma utilizing the asthma app) versus a control group (children with asthma not utilizing the asthma app).

Gathering feedback from pediatric app users and suggestions for improvement would also be important in order to further improve the effectiveness of our intervention. The ultimate goal would be to disseminate the asthma app in several languages, and encourage the use of the application in primary care and outpatient asthma clinics.

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