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Examination of the uses, needs, and preferences for health technology use in adolescents with asthma

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ABSTRACT

Objective: To examine the health technology uses and preferences of adolescents with asthma using a qualitative descriptive individual interview approach. **Methods:** Twenty adolescents were recruited from regularly scheduled asthma clinic appointments from February to July 2016. Patients were interviewed about their technology use and ways in which health technology could improve their asthma management using an open-ended semi-structured interview format. Interviews were audio recorded, transcribed, and coded into themes. **Results:** Social media (e.g. Snapchat, Instagram) and general communication (e.g. messaging) were the most common uses of technology while medical reminders (e.g. appointment, refill, medication) were the most common use of health technology. Adolescents identified ways in which health technology could improve their asthma management including (1) tracking symptoms and medication, (2) medical reminders, and (3) asthma and self-management knowledge specifically related to medications and individual action plans. Other themes that emerged included a desire to customize health technology to fit with individual schedules and medical routines and use of health technology data with medical providers. **Conclusions:** Adolescents and parents experience a number of challenges related to managing asthma, and health technology interventions should focus on ways to improve adherence and self-management. Future research considerations and potential interventions including ways to integrate adolescent preferences with evidence-based interventions are discussed.

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Control/management; management/control; pediatrics; quality of life; therapy

Background

Many adolescents with asthma have inadequate control of their disease, leading to exacerbations, healthcare utilization, missed school/work days, and difficulties engaging in typical activities [1,2]. Adolescents struggle with effective disease management including adhering to and refilling prescribed medications, self-monitoring symptom progression, following a personalized asthma action plan, attending medical appointments, and communicating with caregivers and providers about symptoms and treatments [3,4].

Adolescence is a particularly challenging developmental period for self-management, as youth begin to establish independence and assume greater responsibility for their asthma management [5]. Poor adherence and ineffective self-management are common

among adolescents with asthma and it is estimated that adolescents take only 40–50% of their controller medication doses, although at least 80% adherence is required to prevent asthma exacerbations [1,6,7].

There is evidence to support the effectiveness of face-to-face self-management interventions in improving adherence, disease management, and health outcomes among adolescents with asthma [8]. However, providing this support in standard clinical care is challenging due to insufficient resources, inadequate training, and time constraints. Additionally, these interventions are less effective and more difficult to implement among adolescents with difficult-to-treat (DTT) asthma and these children struggle to sustain self-management behaviors between visits and post-intervention [9]. Studies demonstrate that self-management interventions delivered via

telehealth may improve patient adherence and health outcomes while increasing patient access to self-management support [10–12]. Various forms of health technology have also been used to offer patients accessible, cost-effective approaches to enhancing self-management such as smartphone apps that offer assistance with taking medication and tracking symptoms via automated reminders and graphical feedback. Medication inhaler sensors and mobile spirometers enable automatic adherence and symptom monitoring and provide feedback to patients and providers to facilitate collaborative asthma management [13]. Moreover, self-management interventions for several disease groups have also been adapted for web and mobile platforms, with evidence for improved symptom control and decreased health care utilization [12,14].

An important gap in this research is understanding adolescents' experiences with health technology to support self-management. As the types of self-management technologies continue to grow, it is crucial for providers and developers to understand the technologies adolescents are most likely to engage with and how adolescents would like to use these technologies to support their asthma care. The purpose of this study was to obtain a deeper understanding of adolescents' general and health technology uses and their perceptions of how health technology may be beneficial in improving asthma self-management and outcomes utilizing a qualitative descriptive individual interview approach.

Methods

Participants

Adolescent patients were recruited from an asthma clinic at Cincinnati Children's Hospital Medical Center, a large Midwestern children's hospital that serves a large urban core population. Patients were eligible if they (1) were between the ages of 13 and 18,

(2) spoke English, (3) had a current asthma diagnosis, and (4) had a prescription for a daily controller inhaler. Exclusion criteria included the presence of a significant cognitive deficit (e.g. intellectual disability, severe autism spectrum disorder, Down syndrome), severe mental health diagnosis (e.g. schizophrenia), or no regular interaction with a smartphone. The presence of significant cognitive deficits or mental health concerns was determined by chart review and consultation with medical providers. The mild and moderate persistent asthma was based on National Asthma Education Prevention Program (NAEPP) guidelines [15] and the classification of difficult-to-treat (DTT)/severe persistent asthma was based on modified ATS/ERS severe asthma guidelines [16] that are searchable by electronic medical record. DTT/severe persistent asthma was defined in a participant that required at least one of the following major characteristics: (1) treatment with continuous or near continuous ($\geq 50\%$ of year) oral corticosteroids OR (2) requirement for treatment with high-dose inhaled corticosteroids and at least two minor characteristics (see Table 1). All procedures were approved by the Institutional Review Board. Eligible adolescents were identified through medical chart review. Twenty-eight adolescents were approached during a routine outpatient asthma clinic visit. All participants were provided with an informational letter explaining interview procedures and were notified that they could stop at any time without impact on their care.

Twenty adolescents completed a semi-structured interview and a demographic questionnaire directly following their clinic appointment. Of those who chose not to participate, seven adolescents indicated they did not have time while one adolescent was uncomfortable providing information required for reimbursement. Chart reviews were conducted to obtain disease severity data. Participants were compensated for their participation.

Table 1. DTT criteria^a: classification as DTT asthma requires at least one major characteristic and two minor characteristics.

Major characteristics

- Treatment with continuous or near continuous ($\geq 50\%$ of year) oral corticosteroids
- Requirement for treatment with high-dose inhaled corticosteroids

Minor characteristics

- Requirement for daily treatment with a controller medication in addition to inhaled corticosteroids, e.g. long-acting β -agonist, leukotriene modifier, or theophylline
- Asthma symptoms requiring short-acting β -agonist use on a daily or near daily basis
- Persistent airway obstruction ($FEV_1 < 80\%$ predicted or diurnal PEF variability $> 20\%$)
- One or more urgent care visits for asthma per year (includes ED, admissions, urgent care)
- Two or more oral steroid "bursts" per year
- History of a near fatal asthma event (intubation)

^aModified from Proceedings of the ATS workshop on refractory asthma: current understanding, recommendations, and unanswered questions. Am J Res Crit Care Med. 2000;162(6):2341–2351.

Individual interview design

Individual interviews were utilized to gain a deeper understanding of adolescents' current health technology uses and their perceptions of how health technology may be beneficial in improving asthma self-management. This format was used to maximize patient perspectives and prevent consensus effects on data integrity. Adolescents with asthma and their parents were interviewed together to encourage identification and discussion of different perspectives. While this method has many strengths, it allows adolescents to potentially defer responses and opinions to their parents. When this occurred, patients were asked to voice their thoughts about the issue being discussed.

The semi-structured interview guide was developed by the authors based on the literature, interview guides, and expert consensus. The authorship team composed of experts in asthma, health technology, and adolescent development (i.e. clinical pediatric psychologists, pediatric pulmonologist) created and modified the interview guide to include constructs relevant to the unique developmental period of adolescence (i.e. transition to independent management of illness, engagement with popular technology) that may impact use of health technology. The resulting semi-structured interview guide included questions related to the following topics: (1) uses of general technology (e.g. "What types of things do you do on your smart phone?") and health technology (e.g. "Do you use medication reminders, wearables, etc.?"), (2) preferences for health technology related to asthma management (e.g. "How do you think technology could be more helpful in managing your asthma?"), and (3) the integration of health technology into medical care (e.g. "What do you think about information gathered through health technology being shared with your doctor or healthcare team?"). It is available from the authors upon request.

Procedures

Two study team members conducted the interviews using the semi-structured guide to ensure that the same potential topics were covered for all adolescents while still allowing for the introduction of new relevant constructs. Consistent with the aim of grounded theory [17], follow-up prompts were used to encourage the adolescents to describe the relevance of each health technology and to discuss how this might support asthma management. As the study progressed, study team members continued to ask original interview questions but also followed up with more

specific questions based on previously collected data. All interviews were recorded, transcribed verbatim, and checked by a second study member for accuracy.

Analysis

Descriptive statistics were used to summarize the clinical and demographic characteristics of the sample. NVivo 10 software [18] was used for data coding and analyses. Codes for questions related to adolescents' use of general and health technology were summarized by calculating the percentage of adolescents who referenced a particular usage function. Next, line-by-line open coding was employed to define the actions and events in each line of data [19,20]. Line-by-line coding ensures that themes are built inductively and limits the imposition of investigator beliefs/theories on the interpretation of the data [19]. Upon completion of initial coding, the raters met to discuss individual codes and compare differences. The preliminary response categories were refined into a coding scheme and authors utilized the coding scheme to independently code the transcripts. Discrepancies between the raters were resolved via discussion of reclassification or modification of an existing theme until 100% agreement was reached.

When using a grounded theory approach to data analysis, enrollment is ended when saturation is reached, or all "new data fit into the categories already devised" [19]. The 7th and 8th interviews did not result in any new themes suggesting that saturation may have been reached. One important contribution of this qualitative data, however, is the detailed suggestions that arose within the themes and the importance of customization for adolescents with asthma. Therefore, we continued conducting interviews until complete saturation was noted with the 17th interview and confirmed when the 18th, 19th, and 20th interviews also did not provide new ideas [21].

Results

Study patients included 10 males and 10 females with a mean age of 15.4 years (SD = 1.6 years). The sample was 45% Caucasian, 50% African American, and 5% Hispanic. This sample included patients with intermittent (5%), mild (10%), moderate (15%) and severe DTT asthma (70%). All but one patient had been diagnosed with asthma for at least 5 years (range: 3–16 years with an asthma diagnosis). Additional demographic and clinical characteristics are presented

Table 2. Participant characteristics ($n = 20$).

Factor	<i>M</i>	<i>SD</i>
Child age (years)	15.4	1.6
	<i>n</i>	%
Child sex		
Male	10	50
Female	10	50
Child race		
White	9	45
Black	10	50
Hispanic	1	5
Child asthma severity		
Severe	14	70
Moderate	3	15
Mild	2	10
Intermittent	1	5
Child inhaled corticosteroid		
Breo Ellipta	8	40
Dulera	6	30
Advair	3	15
Asmanex	2	10
None	1	5
Mobile Device		
Android	7	35
iPhone	12	60
None	1	5
Family Insurance Status		
Private	13	65
Public	7	35

in Table 2. Patients did not decline to answer any of the questions.

General use of technology

Nearly all of the adolescents with asthma had a personal smartphone ($n = 95\%$) and all patients had access to a smartphone or tablet. The most common smartphone activities were communication, social media, general media, and education. Ninety-five percent of adolescents indicated that they use their phone as a communication tool, primarily for messaging. In addition, 90% of adolescents indicated that they use social media, with Snapchat being the most frequently endorsed. Adolescents also reported using media apps (e.g. YouTube) to watch videos/movies and to listen to music, educational apps for school, and entertainment apps (e.g. games). See Table 3 for information regarding specific apps/feature utilization for adolescents.

Health technology use

When asked about use of health technology, 100% of adolescents indicated that they have utilized at least one type of health technology. Eighty-five percent of adolescents indicated they have utilized their phones for medical reminders (e.g. appointment, medication) and 80% had used an app or wearable to track their

Table 3. General technology use ($n = 20$).

Factor	<i>n</i>	%
Have a personal smartphone	19	95
iPhone	12	60
Android (LG)	4	20
Other Android	3	15
Social media	20	100
Snapchat	15	75
Instagram	14	70
Facebook	13	65
Twitter	3	15
Communication	17	85
Messaging (e.g. standard text, Kik)	19	95
Standard call	5	25
FaceTime	5	25
Media (videos, music, movies)	18	90
YouTube	13	65
Netflix	8	40
Pandora	5	25
Spotify	5	25
Soundcloud	4	20
Apple Music/iTunes	3	15
Educational	11	55
Google classroom	3	15
Quizlet	3	15
Other Apps		
Entertainment (e.g. games, streaming)	14	70
Built-in apps (calculator, clock, etc.)	13	35
Shopping/lifestyle	6	30

Note: Only most popular specific apps are listed.

Table 4. Health technology use.

Factor	<i>n</i>	%
Use of Health Technology		
Medical reminders	17	85
Exercise tracking/wearables	16	80
Food/water/sleep tracking	9	45
Health/disease specific	8	40
Pharmacy/hospital apps	8	40
Medication tracking	4	20

exercise. See Table 4 for more information. Overall, patients had used health technology and drew from their favorable and unfavorable experiences to describe new technologies that might be helpful for managing their asthma in the future.

Future health technology to improve self-management

Theme 1: Tracking asthma symptoms and treatment

An initial theme was the desire to have health technology that can track asthma symptoms and treatments using mobile devices. Six adolescents described a desire to log their symptoms using their mobile device so that they could be more aware of their symptoms and provide a more accurate report of symptom frequency and severity to their physician. Patients and parents suggested actively tracking symptoms through written tracking (e.g. writing down symptoms, check boxes for symptoms), weekly

quizzes, or verbal recording and passively tracking by allowing the devices to collect symptom data (e.g. “having a mobile phone microphone that picks up on coughing and tracks how long and how often you coughed”). One patient explained, “we could pull that [mobile symptom report] up... and I wouldn’t have to just try to remember when I do the table [clinic symptom questionnaire] – I don’t ever remember.” Others mentioned benefits of symptom tracking, including having a “symptom tracker to tell you the last time you had a specific set of symptoms and what you did to feel better” and having the technology “send an alert to a parent or doctor about any abnormal symptoms.” One parent said, “Having technology that could alarm my phone to let me know he is having symptoms and he might need to call the doctor... would bridge the gap of communication between me, him, and maybe the doctor also.”

Consistent with the theme of tracking to improve asthma management, 55% of patients and families also indicated that having health technology that monitors and provides feedback regarding medication taking (i.e. adherence) would be beneficial. For example, four patients and families described an app with a “counter” that “will add it up (the number of times you have taken your medication) for you.” Patients noted that tracking systems would be best if they do not require a lot of input and that “passive tracking (e.g. electronic monitor on inhaler rather than being required to manually log doses taken) would be great so that I don’t have to remember to do it.” Another option provided by the patients was to use video conferencing or a scanner that can count pills to demonstrate adherence to caregivers and/or medical providers. Patients and parents mentioned the ability to track usage of both the rescue and controller inhalers would be beneficial because “sometimes he is not aware of how much he is using it or not using it.” Patients also suggested treatment strategies utilizing this tracking data (e.g. setting a limit for the number of times they will use their rescue inhaler before reaching out to their medical team, passively monitoring environmental triggers when they are frequently using rescue medication).

Theme 2: Reminders

Adolescents also reported that “reminders could help with forgetting” as this is a major barrier to their asthma management. They endorsed a desire for reminders to (1) take inhalers and medications ($n = 16$), (2) bring inhalers with them when they leave home ($n = 1$), (3) schedule and attend medical

appointments ($n = 4$), and (4) obtain refills ($n = 8$). Adolescents expressed interest in an “app that talks to you and tells you ‘time to take your medicine’ or plays music like your favorite song to let you know it is time.” Although the preferred modality of the reminders varied, 16 adolescents and 10 parents indicated a desire to have reminders for engaging in asthma self-management tasks.

Adolescents also stressed the importance of having the technology follow up with them to determine if they had taken their medication. For example, an alarm with a “snooze option” that allows the reminder to be delayed would be beneficial because adolescents are often busy, do not have their medications with them, or simply do not feel like taking their medication at the moment the alarm rings. Said one patient, “having a snooze option would allow it to be annoying to remind me until I take it because sometimes I need multiple reminders.” Three patients also suggested having a reminder system with “notification alarms that call you if you ignore the (original) alarm.” Patients and parents also mentioned that it would be helpful for parents to be included in the medication reminder system, specifically that parents could be alerted once the adolescent has been notified and missed a dose of medication (i.e. a progressive reminder system). The timing preference of the alarms varied based on the purpose of the alarm. For example, “It should remind you next week you are going to run out so you get a refill” or “alert me to schedule an appointment months in advance.”

Theme 3: Asthma and self-management knowledge

An additional theme that emerged was that patients preferred to have information specific to their own asthma digitally available to inform their self-management. Four patients and parents described how they were uncertain about when they were supposed to take specific medications and the purpose of each medication. Additionally, parents noted that adolescents and alternate caregivers are often unaware of when care should be stepped up (e.g. to yellow zone care). One parent explained, “I think he needs an app that tells him his action plan, like what to do in certain situations. I think the app should be able to describe his medicines to him and what they do for him.” Further, four patients and parents indicated that they would like a “digital asthma action plan that provides management instructions based on current, reported symptoms.”

Three patients also expressed a desire to obtain general asthma knowledge, including asthma-related

news and symptom management tips, via videos or social media posts. Health technology should “use social media sites such as a YouTube subscription, social media notification, Snapchat, or Instagram, for asthma-related news” and offer “tips on how to manage asthma symptoms.”

Theme 4: Importance of customization

Patients and families expressed varying preferences for features of asthma-management health technology, thereby highlighting the importance of having customization and individualization systematically built into the intervention. Adolescents described reminders utilizing audible cues (e.g. vocal prompts, music) while other patients and families suggested use of push notifications or text messages. In fact, a patient stated, “voices are annoying, a text reminder ... that is nice”; two patients indicated that they often shut off notifications. In addition to the modality of the reminder, patients reported a desire to individualize the frequency and timing of reminders based on their treatment regimen and personal schedule. For example, an app that “does not remind me during school hours because I do not take medications at school.” Similarly, various modalities (i.e. touchscreen, vocal, text message) were proposed for inputting data for tracking medication and symptoms.

In addition to the customization of desired health technology, patients and families also expressed a strong desire for health technology that includes their specific health data and asthma action plans and then aids in self-management decision-making. Specifically, parents would like a digital version of their adolescent’s individualized asthma action plan to be available on their smart phone and to instruct adolescents in next management steps based on current symptoms. Overall, they suggested that health technology collect symptom data and respond in a way that helps them to identify their zone and decide which medications to take based on their asthma action plan.

Three patients and families described opportunities for incorporating the adolescent’s interests into the intervention. For instance, patients proposed playing the user’s favorite song or celebrity voice for medication reminders while others discussed use of different tones assigned to medications. It was also suggested that it would be helpful if the app’s design was related to the adolescent’s interests (e.g. sports, music).

Theme 5: Use of data with medical providers

All of the patients indicated a desire for their medical providers to have access to the health data that is

collected through asthma-management technology. The majority (75%) of the patient–parent dyads were comfortable with the healthcare team having full access to all data and reaching out to patients if concerns arose. For those who expressed reservations, the concerns included: “only asthma doctors ... should see (data),” “only want the doctor to see my information in preparation for my appointment,” and “I want to be very certain of exactly what they can see.” Patients explained that the increased exchange of patient data with the medical teams could assist with patient–provider communication, improved treatment planning, earlier interventions, and better health outcomes. “It would be great if [the medical team] could reach out if they see something abnormal,” stated one patient. Others anticipated that the medical team’s remote monitoring of symptoms could potentially prevent visits to the emergency department. Two patients suggested that clinic visits may be more productive from the added information (e.g. the medical team “could know ahead of time and ask for an update”). With regard to getting feedback about their health data, only one parent reported that getting feedback should be optional because “it might get annoying.” Overall, patients were excited about the possibility of their health care team having access to their recorded health data.

Discussion

Results of this study revealed that adolescents have access to mobile devices, use technology as communication and social media tools, and have a strong desire to utilize mobile interventions to improve their asthma management. Patient responses regarding how technology could aid in asthma management resulted in three specific intervention themes: (1) tracking asthma symptoms and medication, (2) reminders, and (3) asthma knowledge. Other themes that emerged included a desire to customize technology to fit patient preferences and a desire to share collected data with medical providers. This study provides a deeper understanding of adolescents’ technology uses and ways in which adolescents believe health technology can be beneficial in improving asthma self-management. The ultimate purpose for obtaining this information is to guide the development of a self-management system for these adolescents.

Despite the inductive nature of theme development, themes are consistent with traditional, evidenced-based self-management interventions. Consistent with the tracking theme, youth with asthma demonstrate

improved lung function, fewer activity limitations, and increased awareness of elevated symptoms when systematically monitoring [22–24]. Similarly, passive and active medication monitoring has resulted in a positive impact on adherence, self-management, and asthma outcomes [22,23] particularly when paired with feedback [25–27]. Of note, adolescents in the current study stressed the importance of tracking that takes minimal effort and time, suggesting that passive medication monitoring and minimally invasive symptom monitoring protocols should be utilized. To promote adolescent engagement, future research should examine the ease of tracking, necessary frequency of gathering symptom data and the most succinct way to provide feedback.

Another theme was the inclusion of reminders for asthma-related tasks, which addresses the major adherence barrier of forgetting [28]. In fact, medication reminders have resulted in significantly better adherence and asthma control [25,29]. Adolescents also discussed the importance of having the ability to customize reminders to their individual medication routine and personal schedule. One way to customize treatment-related reminders is to use a technology-based progressive reminder system in which the adolescent is alerted with a phone call if they do not respond to an initial text- or app-based reminder to take their medication. Caregivers have also been successfully incorporated into progressive reminder systems used in other patient populations by adding an additional parent call for added accountability and parental support [30].

Adolescents repeatedly indicated the importance of knowledge presentation and availability on mobile devices. The extant literature has demonstrated that knowledge is a necessary component of self-management interventions but is insufficient to improve and sustain treatment [8,31,32]. Teaching adolescents the skills to apply this knowledge is critical to improve self-management; therefore, interventions should include education and digitally available resources as one of several intervention components.

Our findings are largely consistent with previous research investigating adolescents' preferences for asthma mHealth apps, but also extend these findings by examining a more diverse sample (e.g. age range, asthma severity, socioeconomic status, race) and preferences broadly related to asthma-management health technology (versus specific apps). Similar to our study, parents and Australian adolescents/young adults have recommended or rated highly functions that allow for tracking of symptoms, triggers, activity, and

medications, use of reminders, general asthma information, visual feedback, interactive asthma action plans, and patient-provider communication tools [33–35]. The anticipated benefits of asthma-specific health technology described by our participants are also consistent with previous studies reporting perceived benefits to include visual symptom and adherence feedback, understanding individual asthma triggers, and improved awareness of self-management behaviors [24]. In contrast, however, adolescents and families in the present study provided fewer suggestions related to mental health management (e.g. mood diaries, social support from others) and behavioral incentives (e.g. earning rewards for completing asthma treatments, competing with other app users) [33] and more interest in medication reminders compared with previous studies [35]. While similarities in health technology preferences across studies provide a strong basis for the foundation of asthma-specific health technology interventions, disparities in these findings are likely due to differences in sample characteristics such as patient age, asthma severity, socioeconomic and cultural differences, and previous experiences with health technology.

Although the themes within this study have been formed inductively and are supported by the literature, the findings should be interpreted within the context of methodological limitations. First, despite the richness and diversity of qualitative data obtained, the sample size was fairly modest; however, we found no new themes were emerging by the 16th interview, and consistency across participants suggests sufficient sampling. Second, parents and adolescents were interviewed together, which may have inhibited participants' responses. Overall, the patient-parent dyads in our study exhibited a comfortable interactional style, even when sharing differing opinions. In the few instances in which the adolescent appeared uncomfortable sharing a disparate preference from their parent (e.g. disliking the idea of allowing parents to access adherence information within the app) our intervention to specifically elicit more responses from the adolescent appeared effective. Still, additional information might be gleaned from individual interviews or parent/child-specific focus groups in future studies. Third, this was a single site study conducted in an urban, asthma-specific clinic with a high proportion of DTT patients. As such, patients and families in this study may have been more receptive to intensive health technology interventions due to a higher burden of disease. However, there were no discernible differences on health technology preferences

between patients with DTT asthma and less severe asthma, with participants in both groups expressing an interest in using technology to support medication and symptom tracking, reminders, and communication with providers. Further research is needed to generalize findings to families of all ethnicities, those living outside urban areas, and patients with less severe forms of asthma.

The similarities between adolescent desires for mobile asthma management tools and existing interventions supported in the literature are promising. Future studies must focus on how to integrate these desires with traditional, evidenced-based interventions into an engaging mobile-based platform. When designing these systems, it is also important to consider customization and use of data by medical providers such as a technology-assisted stepped-care model that would provide varying levels of self-management support based on the need of the adolescent. For example, adolescents may first receive a low level of support, such as automated reminders. If this low-intensity, low-effort intervention is unsuccessful at a systematically scheduled checkpoint, then adolescents could receive a more intense intervention.

Conclusions/key findings

Adolescents with asthma frequently use technology and have a desire to use health technologies such as digital monitoring, reminders, and knowledge to help them to better manage their asthma. Adolescents prefer health technology to be customizable to their individual schedule and medication regimen and to be shared with their medical team. In the development of self-management interventions specific to adolescents with asthma, it is important to recognize that adolescents require a different approach than children and older adults and that technology is an important vehicle for intervention delivery for adolescents. Developing technology-based strategies will be critical to the success and health of adolescents with asthma.

Disclosure statement

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