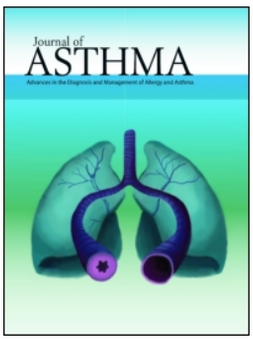

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A consumer designed smartphone app for young people with asthma: pilot of engagement and acceptability

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ABSTRACT

Objective: This pilot aimed to test the engagement, acceptability, and usefulness of a goal-setting smartphone app, Kiss myAsthma, in young people with asthma.

Methods: Young people aged 15–24 years old were invited to trial a smartphone app for asthma management. A mixed-methods approach combined quantitative analysis of self-report questionnaires and app usage log data with qualitative thematic analysis of open-ended questions at baseline and six weeks after downloading the app. App log data (pages visited, frequency of use and content of participants interaction, e.g.goals set, symptoms recorded) were analyzed.

Results: Nine of 12 participants completed both baseline and six-week questionnaires. Participants reported high satisfaction with app content and usability (median score 5 out of 6 [range 4–6]) and rated the app highly on "having easier discussions with my doctor about asthma" and "feeling confident in my ability to manage my asthma." At six weeks there was a clinically significant change in asthma quality of life (e.g. Emotional Function domain score baseline: 4.7 [2.7–6.3], follow-up: 5.7 [4.7–6.7]; $p = 0.043$). Participants logged information about asthma severity, flare-ups and mood and tracked their symptoms with the app's History functionality. Five participants (42%) nominated goals and strategies and 3 participants (25%) entered data in the Inspiration section, a tool to support intrinsic motivation to manage asthma. Qualitative data aligned with quantitative results.

Conclusions: This six-week pilot of the Kiss myAsthma app showed its potential to support self-management, quality of life and health behavior change in young people with asthma.

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Introduction

Adolescents have poorer asthma control than adults and are less likely to engage in the variety of tasks required to optimize self-management such as avoiding asthma symptom triggers, attending asthma review appointments and regularly taking prescribed medication (1). Moreover, adolescent motivations for adherence and engagement with technology will likely be influenced by their stage of development—for example, by a desire for social approval, for increased independence, or the development of a positive self-concept (2). Since adoption and engagement are core to the success of any intervention, it is important to develop digital tools, such as smartphone apps, to match end-user needs and motivations. A particular challenge for adolescents is prioritizing asthma management in the context of other competing life goals such as education and employment, relationships and recreation.

Goal-setting is a patient-centred, skill-based and teachable process with a sound theoretical basis (3) which can be used to facilitate skills in the self-management of chronic conditions. Studies in adults with asthma and hay fever show that patients can identify and achieve their own lifestyle and health goals and that goal-setting is associated with improved symptoms and quality of life (4,5).

Smartphone apps are increasingly being utilized as self-management tools for patients with chronic

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diseases such as asthma. Young people have an interest in apps that support health-related behavior change, particularly those that record and track behavior and goals (6). Asthma apps have been used to promote use of action plans, track use of reliever medicines, as reminders to take medicines, to promote recording of symptoms, provide education, communicate with clinicians, and avoid triggers (7–12). However most apps, whether for asthma or other chronic diseases, have not been co-designed with consumers, have not included goal-setting features, nor have they been tested for end-user acceptance (e.g. how a tool such as an app is perceived to handle tasks in real-world scenarios), engagement or effectiveness.

We previously reported on a process for co-designing and developing a smartphone app for asthma where 20 young people aged between 15 and 24 years were key collaborators in the design process (13). The goal-setting asthma app, which end-users named "Kiss myAsthma," was developed and tested in three phases. In the first phase, comprising analysis and design, app user needs were generated through participants' input in workshops and workbooks on their identity as a young person with asthma; their life goals; ideation of app content and features and creation of screen designs. In the second phase a prototype app was designed and developed including clinician feedback on the appropriateness of medical information provided in the app. The third phase included end-user feedback from nine of the Phase 1 participants on, and evaluation of, the resulting goal-setting asthma app. Moreover, in the app, the theory-driven "Goals" section, created by the research team and finessed by the young co-designers, included goal-setting support and "virtual goal-setting coaches" which were presented in the form of appealing monster avatars to add novelty and increase user-engagement (Figure 1).

The aim of the current study was to understand the user-experience and test the acceptance, engagement and effectiveness of the "Kiss myAsthma" goal-setting app for improving asthma self-management in a group of young people who piloted it for six weeks in their everyday life.

Figure 1. Monster avatars.

Methods

Participants

Eligible young people were aged 15–25 years old with doctor-diagnosed asthma, no prior experience of the Kiss myAsthma app and no involvement in any of the previous research phases. They were invited to participate in the study either by professional referral (e.g. by their asthma educator or personal referral having seen an advertisement within the Asthma app project newsletter, on the Young People with Asthma Facebook page, or on noticeboards. The digital or paper flyers sought expressions of interest in testing an asthma app and allowed for scanning of a QR code, which automatically sent an email containing the words "app test" from the potential participant to a member of the study team to follow up. Passive

snowballing was also used for participant invitation; a member of the research team contacted previous study participants to invite them to pass on study information to new participants.

Young people who expressed interest in testing the app were sent a Participant Information Statement and a Participant Consent Form. A Parental Information Statement and Consent Form were also provided to those aged less than 18 years. After receiving signed consent, a member of the study team screened each participant for eligibility and collected demographic information, such as age and study/work status. They then provided each participant with a link to the app to download to their Android smartphone or iPhone.

Ethics

Ethics approval was received from the University of Sydney ethics committee [HREC 2014/933]. Written informed consent was obtained from all participants and from parents of those under 18 years before participation.

Data collection

Study questionnaires

Study questionnaires were provided to participants for completion at study entry (baseline) and after six weeks of app use (follow-up). The baseline questionnaire comprised six questions that explored perceived confidence in setting health goals, level of asthma control using Asthma Control Questionnaire [ACQ] (14,15) and asthma quality of life using the Mini Asthma Quality of Life Questionnaire [Mini AQLQ] (16). The follow-up questionnaire asked additional questions about perceived usefulness, satisfaction and acceptability of the app (17), and on self-regulation of asthma management (18). Table 1 provides a summary of the two questionnaires.

Table 1. Baseline and follow-up questionnaire content.

Questionnaire components	Baseline	Six weeks
Goal-setting attitude scale consisting of two questions[a] on confidence in and perceived importance of setting health goals and scored 1–6 (1 = lowest confidence, 6 = highest confidence)	✓	✓
Asthma control [Asthma Control Questionnaire (14)] consisting of six questions designed to estimate a person's asthma control in the previous week and scored 0 best and 6 worst; <0.75 well controlled; >1.5 poorly controlled[b]	✓	✓
Mini asthma quality of life (16) questionnaire consisting of 15 items covering 4 domains: symptoms, activity limitation, emotional function and environmental stimuli (scored 1–7 for both overall score and individual domains)	✓	✓
App satisfaction scale[c] consisting of 13 questions on the usefulness, satisfaction and acceptability of the app and scored 1–6, 1 = low and 6 = high usefulness, satisfaction or acceptability (7 = "not applicable")	×	✓
Ratings of self-regulation of asthma management. This modified scale[d] measures participants' perceptions of the contribution of the app to their asthma self-management with questions concerning the regulation of a particular behavior or class of behaviors in relation to app use. It is scored 1–6, 1 = least favorable; 6 = most favorable score	×	✓
Free text questions on what participants liked most, least, what they found useful and what problems or difficulties they experienced with the app	×	✓

[a]Questions were "How confident are you in setting goals for your heath?" and " How important is it for you to set health goals?"
[b]Reference: Juniper (15).
[c]Adapted from a published usability questionnaire (17) to which asthma-specific questions were added.
[d]See Levesque et al. (18).

App usage statistics

Kiss myAsthma contained eight main sections (Figure 2) where users could interact with the app: Profile; Asthma History (including asthma severity, mood, asthma symptoms and exacerbations); Goals; Inspirations; Reminders (for medication-taking or other activities); Connect (i.e.to evidence-based website links); Information About Asthma; and Emergency Support (for provision of support during an asthma exacerbation).

App log data from participants' use were drawn on to analyze goal-setting success, goal difficulties, symptom reporting, asthma exacerbations (type, duration, and severity) and app engagement (such as types of pages visited and frequency). Usage data were gathered in the following sequence: Python script was used to connect to a backend database. The backend database used Mongo DB running on an Amazon Web Server to store user-related, de-identified data. A Secure Shell connection was used to access the Web server and run a Python script to export data as .csv files which were then downloaded onto a local computer.

Data analysis

Quantitative analysis included descriptive statistics for demographic and questionnaire data and frequency analysis for use of app features and downloaded data. This was performed using SPSS version 22 (IBM Corp., NY) (19). We also carried out qualitative thematic analysis on the free text questionnaire responses.

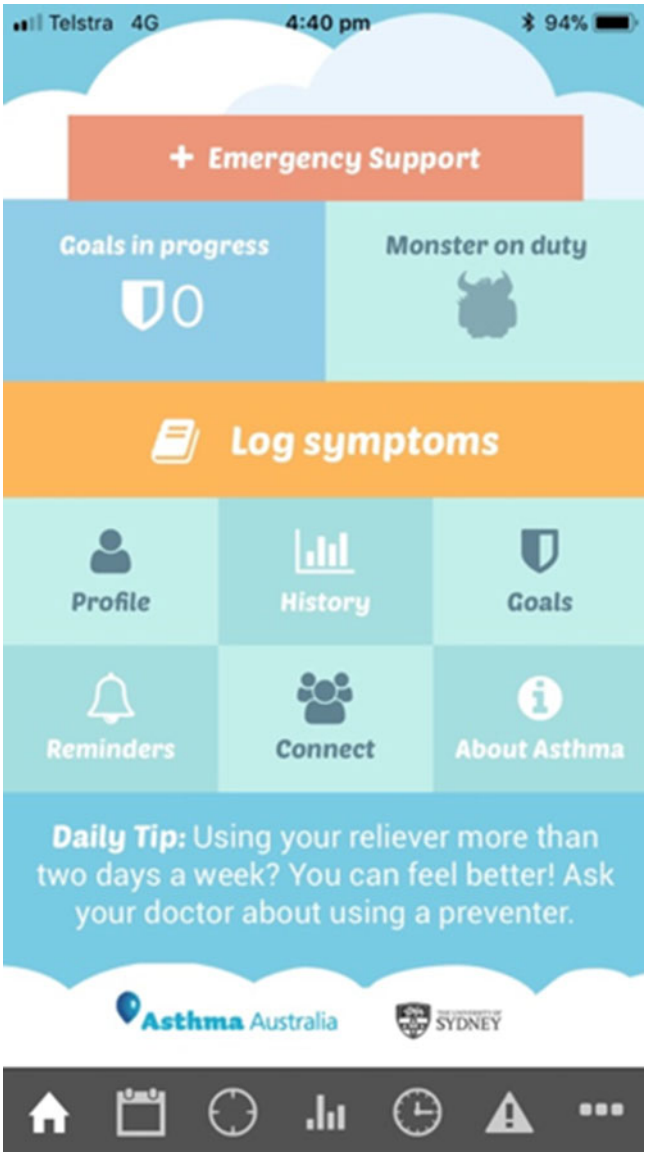

Figure 2. Kiss myAsthma main screen.

Results

Participants

Twelve young people were screened for eligibility, provided consent, completed a baseline questionnaire and downloaded the app. Half were recruited through referral from peers (3) or asthma educators (3), with the rest through the project newsletter (1), noticeboards (2) and the Young People with Asthma Facebook page (3). Participants (mean age 19.5 years [range: 15–24], 58% male) were either currently in secondary ($n = 3$) or tertiary ($n = 4$) education or working ($n = 5$) and lived in various geographic locations.

After six weeks, nine participants completed the follow-up questionnaire. The scores reported below are for the nine individuals who completed both baseline and follow-up questionnaires, with the exception of the app interaction logs, which included all 12 participants. Demographic characteristics and questionnaire baseline scores did not differ between those who did or did not complete the follow up questionnaire.

App interaction logs

Logs of six-week use of Kiss myAsthma functionality were analyzed for all 12 participants; zero interactions with the app were recorded for three participants. Over 6 weeks, without follow up appointments, telephone calls or reminders from the research staff, four participants used the app one-five times, three participants used it six-ten times and two participants used it more than ten times. The data show that one user was still active well after the 6-week trial period, but analysis of long-term use was not the focus of this study. The sections visited were Asthma History, Goals and Inspirations (Figure 3).

The History function allowed participants to select and record their perceived asthma severity (ranging from 0 "no bother" to 4 "extremely bothersome"); symptoms; attacks (date experienced and notes about what was happening then) as well as mood (0 = awful, 4 = great).

The Goal function enabled participants to select a pre-populated goal(s) or create unique personal goals. Five participants (42%) nominated one or more goals and associated strategies (Table 2). Of the 12 goals overall chosen by these five people, ten (82%) were from the Kiss myAsthma goal menu (82%). Two participants created their own goals.

Three participants made entries in the Inspiration section, which provided a tool to support users' intrinsic motivation to manage their asthma. Motivations selected by participants included optimizing fitness (to run cross country more easily; go horse riding) managing comorbidity (battle hay fever and educate others to do same); optimizing medication taking (use short acting beta agonist medication for symptom relief less regularly, and only when absolutely required); and reducing future risk of asthma (have improved long-term lung health/function).

Questionnaire responses

Attitudes towards goal setting (scored 1–6 where 1= lowest and 6= highest importance or confidence)

Regarding the importance of setting goals, the baseline median score was 5.0 (range 2–6). After six weeks the

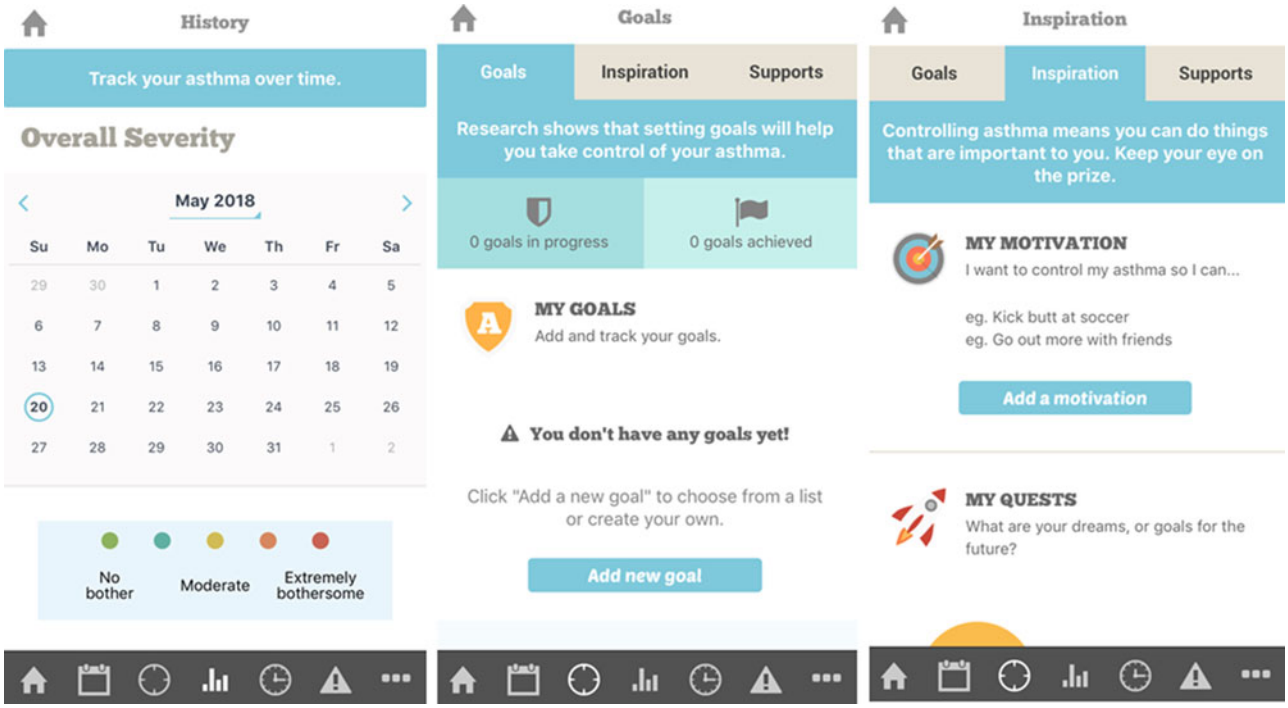

Figure 3. App screens for history, goals and inspiration sections.

Table 2. Goals and strategies.

Participant	Goal/strategies	Strategy	Goal unique to participant or assisted by App
1 (male)	Finish a game with no symptoms	• Warm-up before every game • Use my reliever 10 minutes before the game • Take my preventer morning and night • Build physical stamina by running once a week	Unique to Participant
2 (female)	Get active	• Do 30 day fitness challenge every morning	App
	Healthy diet	• Eat 2 serves of fruit every day	App
	Reduce stress	• Do a short workout every day after school (will need to be linked to an app)	App
	Take my preventer medicine everyday	• Make it a habit to take my preventer when I brush my teeth	App
	Identify my triggers	• Keep a diary of my symptoms and when they occur to figure out what's triggering them	App
3 (male)	Get active	Run every Saturday morning	App
	Take my preventer medicine everyday	• Leave my preventer out where it's visible • Make it a habit to take my preventer when I brush my teeth • Set an Asthma reminder to take my preventer morning and night • Make sure I have multiple spacers available	App
	Find out which triggers should be avoided	Some triggers such as exercise and laughing should not be avoided; some should be avoided- see the Asthma Australia triggers brochure for	
	Get adequate sleep at night		Unique to Participant
4 female	Get active	Run every Saturday morning	App
5 female	Take my preventer medicine everyday	• Leave my preventer out where it's visible • Make it a habit to take my preventer when I brush my teeth • Set an Asthma reminder to take my preventer morning and night • Keep a preventer in all homes that I spend time in regularly	App

median score was also 5.0 but with a range from 4–6 ($p = 0.253$), suggesting some participants saw greater importance in setting goals following app usage (Table 3). Median scores for confidence around setting goals did not change after six weeks of use.

Usefulness, satisfaction and acceptability of the app (scored 0–6 where 0= strongly disagree and 6 strongly agree)

Participants' responses generally revealed high satisfaction with app features (median total score 5 [range

Table 3. Questionnaire scale scores ($n = 9$).

	Baseline	Follow-up	p value[a]
Asthma control, median[b] (range)	1.7 (0.2–2.3)	1.5 (0.16–2.0)	0.204 (ns)
Quality of life (mini AQLQ)[c]	4.9 (3.2–6.2)	5.6 (4.5–6.3)	0.68 (ns)
Overall: median (range)			
Quality of life (mini AQLQ)[c]			
Domains: median (range)			
Symptoms	4.8 (2.8–6.0)	5.2 (4.6–6.4)	0.176 (ns)
Activity limitations	5.8 (2.8–6.5)	6.0 (2.8–6.0)	0.906 (ns)
Emotional function	4.7 (2.7–6.3)	5.7 (4.7–6.7)	0.043 ($p < 0.05$)
Environmental stimuli	4.7 (2.3–6.3)	5.3 (3.3–6.7)	0.125 (ns)
Attitudes to goal setting			
Confidence	5.0 (2–6)	4.0 (2–6)	1.0 (ns)
Importance	5.0 (2–6)	5.0 (4–6)	0.253 (ns)

[a]Wilcoxon signed rank test.
[b]0 = totally controlled; 6 = severely uncontrolled; ACQ often reported as mean, however this population was not normally distributed.
[c]7 = no impairment; 1 = severe impairment.

Table 4. User satisfaction scores for Kiss myAsthma app.

Questionnaire item	Item score median (range)
It was simple to use this app	6 (4–6)
After making a mistake it was easy to continue using the app.	6 (4–6)
The information in the app (e.g. about asthma) was easy to understand.	6 (4–6)
The information was organized clearly on the screen.	5 (4–6)
The information in the app could help me take care of my asthma.	4 (2–6)
The look and feel of the app is appealing.	5 (4–6)
The language used in the app is engaging (interests me).	5 (4–6)
It was easy to use the interface (e.g. moving between screens, location of buttons).	5 (3–6)
This app does all the things I expected it to do.	5 (2–6)
This app would make it easier to talk with my doctor about my asthma.	6 (4–6)
I like the name of the app.	6 (4–6)
Overall, I am satisfied with the app.	5 (2–6)
I would recommend this app to a friend with asthma.	6 (3–6)
Total score (median all item scores)	**5** (4–6)

4–6], as shown in Table 4. The highest scores related to the app's benefit for having easier discussions with the doctor about asthma, intention to recommend the app to a friend with asthma, and simplicity of use the app or information provided by the app. However for one participant some functionality elements scored 2, such as "This app does all the things I expected it to do" and "Overall, I am satisfied with the app," indicating low satisfaction. This participant reported what she described as a glitch in the app operations; specifically that whenever she updated her daily log of asthma symptoms it would change for every other daily log recording.

Contribution of the app to asthma self-management (scored 1–6, where 1 = least favorable and 6 is most favorable)

Participants reported highest scores within the Self-Regulation of Asthma Management questionnaire component for "The app helped me to feel confident in my ability to manage my asthma," "The app highlighted my ability to make personal changes" and "The app helped me to address issues that matter to me" (Table 5). Slightly lower scores (all 4 out of 6) were recorded for "The app helped me feel less alone in dealing with asthma" and "The app helped me to feel part of a community."

Attitudes toward the Kiss myAsthma app

Thematic content analysis of open-ended question responses from the follow-up questionnaire revealed three themes: positive app attributes, suggestions for improvement, and app usefulness.

Positive attributes included the visual appeal of the design; flexible functionality; and helpful tools for goal setting, monitoring and reminders. Screen icons, color and layout were also well received:

> The flexibility of the app, allowing you to monitor your asthma as closely as you want. I think it is well set up and easy to use. (CN male 18)

> Setting goals that incorporated the limitations of asthma; realistic/helpful goal setting. (HC female 21)

> The reminders to take my preventer were very helpful … (AD female 15)

Suggestions for improvement and participants' dislikes related to app design, missing functionality and superfluous features were also shared:

Table 5. Self-regulation of asthma management using Kiss myAsthma app.

Item	Median score (range)
I feel confident in my ability to manage my asthma	5 (5–6)
The app helped me to feel confident in my ability to manage my asthma	5 (4–6)
I feel like I have a say in choosing how my asthma is managed	5 (4–6)
The app helped me to feel I have options for managing my asthma	5 (4–6)
The app helped me to address issues that matter to me	5 (4–6)
The app highlighted my ability to make personal changes.	5 (4–6)
The app encouraged me to learn about my condition	5 (3–6)
The app allowed me to do things my way.	5 (3–6)
I feel like I share a common bond with other young people with asthma	4 (3–6)
I feel close to people who appreciate how difficult asthma can be	4 (3–6)
I feel like no one around me understands what it's like to have asthma.	5 (2–6)
The app helped me to feel part of a community	4 (2–6)
The app helped me feel less alone in dealing with asthma	4 (3–6)
Overall Median Score (range)	5 (4–5)

> Setting goals was confusing, as you could only achieve a goal once before it was deleted, even if the goal was a daily task (AD female 15)

> Too much focus on how you're feeling. Should give more tips e.g. how to correctly use an inhaler. (KB male 18)

Concerning app usefulness, participants indicated that the app assisted with GP visits. For example, logging useful information about their asthma enabled real-time feedback and better understanding by them of patterns of asthma symptoms that could be shared with their GP, as well as reminding them about medication taking:

> I like the idea of logging/tracking your asthma—makes GP visits easier and helps you see your change. (HC female 21)

Asthma control

The median ACQ score [well-controlled <0.75; not well-controlled 0.75–1.5, uncontrolled asthma >1.5] (15) was 1.7 (range 0.2 – 2.3) at baseline and 1.5 (range 0.16–2.0) at follow-up ($p = 0.204$); a difference less than the minimal clinically important difference of 0.5 (15).

Quality of life

The median total miniAQLQ score [1 = severe impairment, 7 = no impairment] was 4.9 (3.2–6.2) at baseline and 5.6 (4.5–6.3) at follow-up ($p = 0.68$), a difference exceeding the clinically minimal important difference of 0.5 (16). The emotional function and environmental stimuli subdomain scores also improved by the clinically minimal important difference at six weeks, and despite the small numbers involved, the change in subdomain "Emotional Function" was also statistically significant (4.7 (2.7–6.3) at baseline and 5.7 [4.7–6.7] at follow up; $p = 0.043$).

Discussion

To our knowledge this is the first co-designed asthma app to be piloted in an everyday situation where the use of app features was simultaneously monitored over six weeks. Data downloads showed that participants were willing to set goals, the majority of which were guided by the Kiss myAsthma goal menu. Several participants set goals around adherence to preventer medicines, whilst acknowledging that help with remembering to take preventer medicine is required. Our findings are consistent with research by Carpenter et al. (11) in which 38% of adolescents cited medication reminders as the most used feature in an asthma app, and linked app features to increased self-observation. For our user cohort, exercise and improving sporting performance were logged under goals and motivations, which may indicate a target group of asthma app users for future research. Not all participants set goals, which indicates an opportunity for health professionals to initiate useful discussions with their young patients about the benefits of identifying personally meaningful goals and strategies.

There is scant literature about goal setting in young people with asthma. The addition of behavioral elements to mobile applications, such as the goal-setting support and virtual goal-setting coaches found in Kiss myAsthma, has been suggested to enhance medication adherence outcomes in adolescents (20,21). A pre-populated list of asthma goals from which adolescents can choose has also been recommended for asthma apps (11), which was confirmed in this study where participants preferentially utilized pre-set goals. The relatively high perceived confidence in setting health goals at baseline may explain why the scores were similar after the six-week period. In contrast, the perceived importance of setting goals improved for some young people (three of nine individuals had an increase of ≥0.5 in their importance score) after six

weeks of app use, suggesting the potential for the app to influence attitudes and behavior.

Usability scores for the app were generally high, implying that participants were largely satisfied with the app content and its value for supporting self-management. This is consistent with the results of our previous study in which participants used the app in a single session of less than one hour's duration (13). High scores were gained for the information provided in the app. Although no data logs for information pages such as About Asthma were available, other information sources such as asthma information messages which display when opening the main screen appear to have been well-received by participants.

Triangulation from several data sources in this study provided important evidence regarding participants' ability and willingness to self-manage their asthma with the aid of the app. After six weeks, the most highly ranked items in the Self-Regulation of Asthma Management questionnaire—confidence to manage asthma, ability to address issues, and ability to make changes—indicated perceived high levels of personal control and autonomy. These items are typically indicative of strong motivation to undertake health-related behaviors (3). While we cannot attribute these scores to the app itself given the lack of a comparison group, the potential benefit of the app is supported by motivations logged by participants, such as to decrease reliever use and achieve better control of hay fever. In turn, such motivations can be anticipated to support the improvements in quality of life observed, particularly the emotional function domain which includes patients' feelings of frustration, concern and fear around asthma and medication availability. Taken together, the responses from this pilot study suggest that motivation for health behavior change may be achievable with the support of the app. The items with the lowest scores—such as helping the participant to feel part of a community and less alone in dealing with asthma—may be explained by the fact that there was (intentionally) no discussion forum, chat, sharing, or other social features in the app, but rather, that it included evidence-based links to support and information. While social features were deemed potentially valuable by the development team and users, the resources for moderation required to ensure safe and healthy interaction among young people with chronic illness did not allow for inclusion of these features in a first iteration.

Emergent themes from the open-ended questions indicated generally positive attitudes towards the app by young people. Participants reported the value of being able to log and track their symptoms, which was confirmed by data downloads showing participants had interacted with the app's History functionality to log information about asthma severity, symptoms, exacerbations and mood. These features appear to support young people to self-monitor their asthma. An unexpected feature was that young people reported the value of this objective evidence in discussions with their healthcare professional.

This pilot raises the possibility that improvements in asthma control and quality of life can occur in as little as six weeks, with scores for the quality of life total score and sub-domains of emotional function and environmental stimuli all improved by clinically minimally important differences.

The Australian government has since committed to roll out the Kiss myAsthma app across all Australian schools through "The Asthma in School program."

A limitation of this study is the small number of young people who participated in the pilot, who due to selection bias may have been more motivated than other young people with asthma The relatively brief study period and the lack of a control group prevent attribution of change in asthma outcomes to the app, which could have resulted from increased engagement with asthma self-management due to wider aspects of participating in the study

Conclusions

These pilot data suggest that apps such as Kiss myAsthma have the potential to improve self-management, autonomy and confidence, and quality of life in young people with asthma at relatively low cost. A larger trial is needed to confirm these findings, including the longer term use of the app and opportunities to test the effect of customizing the app for different ages. We also recommend that future research includes an analysis of the Australian Government's impending roll-out of Kiss myAsthma in schools (supported by Asthma Australia).

The app is available for free download.

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Declaration of interest

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