



Digital Health Passport

Service Evaluation Final Report

September 2024

Table of contents

Acknowledgements	2
Executive summary of findings	3
Background.....	5
Digital Health Passport	5
UCLPartners involvement.....	5
Purpose of this report	6
What is included.....	6
What is excluded.....	7
Methods	8
DHP user survey.....	8
Adoption strategies.....	11
DHP user and parent/carer interviews.....	12
Health economic analysis.....	13
Findings.....	16
DHP user survey.....	16
Adoption strategies.....	20
Health economic analysis.....	28
Patient interviews	32
Review of findings.....	39
Interpretation of findings against KEQs	39
Interpretation against key objectives for the DHP	44
Limitations	46
References	48
Appendix A: Partners In Health Scale	50
Appendix B: Asthma Control Test	54
Appendix C1: Interview protocol and topic guide for DHP user interview.....	55
Appendix C2: Interview protocol and topic guide for DHP parent/carer interview.....	58
Appendix D: Clinician survey	61

Acknowledgements

This report, and the analysis contained herein, was written by Kate Cheema, Dr Sarah Houston and Osahon Ohenhen at UCLPartners.

It was supported by Dr Shashi Hirani, at City, University of London and Dr Greg Burch, Dom Burch and Matt Bourne at Tiny Medical Apps.

The authors would like to thank all individuals who supported this evaluation by completing surveys, participating in interviews, administering and synthesising data source and undertaking data extracts for analysis.

This project would not have been possible without support from our ICB partners, Rotherham Respiratory who provided training materials, and the Small Business Research Initiative for funding support.



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Executive summary of findings

Has the Digital Health Passport achieved its objectives in current form?

There is promising data on the impact of the Digital Health Passport (DHP) on Asthma Control Tests (ACT) and on patient activation. As well as being validated clinical and behavioural predictors of improved asthma outcomes in terms of reliever medication use, emergency care use and asthma exacerbations, the statistically significant shift in these measures over a short period of time could indicate potential for sustained long-term impact. This evidence of a positive change in terms of asthma control drives an economic forecast model from the NHS system perspective that is promising at a system level, on the assumption that the cost of asthma management decreases as level of asthma control increases. This model predicts a return on investment of around £9.28 per £1 spent over three years.

However, the predicted improvement in asthma exacerbations, reliever medication use and general quality of life is not evident in the DHP users included in the analysis at this time. Whether this is because it will take time for the predicted impact to manifest, or the means of data collection is not as robust, or objective, as it could be, is unclear but at this point of analysis the expected outcome changes predicted by the positive improvement seen in ACT results and patient activation cannot be seen in the data available.

In addition, the social media focused adoption strategies discussed in this report suggest the reach and uptake is in the intended target population; deprived, and ethnically diverse young people. Early data, with a relatively small sample size, demonstrates that the user base is skewed towards more deprived quintiles and that the social media adoption strategy was most successful in the 13-17 age group, as intended. Other adoption strategies were hard to quantify in terms of conversion to DHP uptake but are discussed in the context of reducing inequity and the clinician role in utilising the DHP with higher need patients.

Benefits summary

- Patient activation as measured by the Partners In Health scale shows a statistically significant overall improvement and specific improvements in dimensions related to knowledge and skills, which in turn has been shown to predict improvement in asthma outcomes such as admissions and exacerbations.
- Results from the clinically validated ACT taken by 12+ years olds shows a statistically significant improvement and, in the cohort with poorly controlled asthma at baseline, a positive change in line with the minimum clinically important difference. This also has been shown to predict improvement in asthma outcomes, including over reliance on reliever medication, admissions and exacerbations.
- The improvements in the clinically validated ACT enabled modelling of potential economic impact at NHS system level on the basis, evidenced in literature, that improved asthma control leads to lower asthma management costs, balanced against the implementation and maintenance costs of the DHP. Results were positive, suggesting an ROI of £9.28 for every £1 spent.

Challenges summary

- The positive findings in relation to ACT and patient activation do not follow through to measurable reductions in asthma exacerbations and urgent and emergency care use in this dataset; thus, the economic benefit is modelled on the *predicted* changes in system

use and costs of management accompanying improvement in asthma control evidenced in literature rather than actual outcomes from the sample population.

- Confidence in talking about asthma with health professionals and family did not show a statistically significant improvement; confidence is a key facet of patient activation alongside knowledge and skills and therefore there may be a risk that DHP improves patient activation in a selective way.
- Evidence for younger DHP users, particularly in the context of the paediatric Asthma Control Test (pACT) and patient activation measures was not as conclusive as that for 12+ years olds. The greater focus on quality of life rather than clinical symptom management in the pACT also means that there is a paucity of evidence to support modelling cost impact for this group; therefore, it was excluded from the health economic analysis.
- Some specific outcomes on asthma exacerbations and urgent and emergency care use are reliant on retrospective self-reported measures which may be unreliable. Consideration of more objective longitudinal analysis using primary and secondary care records may be more reliable and have the additional advantage of being easier to include in economic models.
- Data quality has proven a challenge in a number of areas; incomplete demographic information and issues with transposition of some data into incorrect fields has given rise to the need to exclude some records to ensure data completion. A lack of validation on some 'open' fields has resulted in some extreme outliers which have been 'trimmed'. Inclusion of mandatory fields and basic validation would improve the data quality and ensure that all DHP users completing the survey are captured and their data usable.

Background

Digital Health Passport

The UK has the worst asthma mortality in Europe for the 10-24 year old age group (Nuffield Trust, 2019¹), accompanied by one of the highest prevalence and emergency admission rates (RCPCH, 2020²). It is estimated that there are one million children and young people in the UK receiving treatment for asthma, fewer than 25% of whom have a personalised asthma action plan in place.

The Digital Health Passport (DHP) is an asthma/allergy self-management app designed for teenagers, young adults, and the parents/carers of pre-teens. It has been co-designed to make patient-facing aspects of the care pathway smart and effective. DHP focuses on achieving better asthma outcomes at scale (and low cost) by optimising the delivery of the key elements of the asthma care pathway, specifically for children and young people:

- Making asthma plans smarter with signposting from symptom trackers
- Improving medication adherence by ordering repeat prescriptions within the app, with automated medication reminders, inhaler videos and tracking diaries
- Avoiding triggers with air quality alerts and personalised allergy education
- Improving education by focusing on seven core learning modules and regular reinforcement
- Personalised content

DHP supports the asthma review as an adjunct to ensure the key educational elements are covered and the asthma plan is retained on the patient's phone. By improving asthma control, it is anticipated that fewer face to face annual reviews and fewer out of hours and emergency appointments are required for people who are utilising DHP.

DHP roll out is currently at 'Level 1', a solution consisting of the DHP app tailored with resources and links to regional services, but not interoperable with other NHS digital services (e.g. NHS app, local shared care records, or individual practice systems).

UCLPartners involvement

UCLPartners is acting as the evaluation partner for the implementation of DHP through to May 2024. UCLPartners' role is to independently assess the impact, effectiveness and value of the DHP through delivering:

- Evaluation design, incorporating best practice for real world evidence generation including specialist advice
- Utilising mixed methods data collection approaches to provide a holistic and robust data set
- Analysis of qualitative and quantitative data, including health economic analysis
- Interpretation of analytical findings to inform the answers to key evaluation questions (see p.6)

Delivery of this evaluative work has been undertaken with the support of City University, London's Department of Health Services Research and Management, who are providing specialist expertise in patient activation measures and academic input.

Purpose of this report

What is included

This document sets out to report UCLPartners findings from evaluative activities UCLPartners and City University undertook to date in answer the following key evaluation questions (KEQs):

- **KEQ:** Has the use of the DHP impacted on patient activation?
Rationale for inclusion: Improved patient activation has been shown to be beneficial to patient confidence in managing a long-term condition and has longer term effects on the utilisation of urgent and emergency care and GP services (Health Foundation, 2018³).
- **KEQ:** Have people using the DHP demonstrated changed asthma control, according to results from remote ACTs?
Rationale for inclusion: The ACT provides a clinically validated measure of asthma control; a significant change in ACT score may indicate the clinical impact of the DHP. Furthermore, undertaking and recording remote ACTs can help to reduce demand on primary care through the ability to prioritise patients according to their reported level of control.
- **KEQ:** Have people using the DHP demonstrated changes in self-reported quality of life?
Rationale for inclusion: Evaluating changes in self-reported quality of life provides a comprehensive and user-centric approach to assessing the impact of a product, ensuring that the focus remains on enhancing users' well-being and satisfaction. In addition, this KEQ can contribute to an understanding of cost effectiveness.
- **KEQ:** Have people using the DHP reported a change in NHS service usage, including prescribing?
Rationale for inclusion: In a constrained system under pressure, it is critical to understand the impact from a system demand perspective. In addition, this KEQ can contribute to an understanding of cost effectiveness.
- **KEQ:** Is the DHP cost effective from a health system perspective?
Rationale for inclusion: If the DHP is to be a successful innovation in the digital healthcare space it must demonstrate cost effectiveness alongside other service user and system benefits.
- **KEQ:** Which of three scalable adoption strategies has been most successful?
Rationale for inclusion: Understanding which approaches to adoption are most successful in terms of ensuring people are downloading the DHP in the first place is an important part of a long-term strategy for spread and adoption.
- **KEQ:** Which adoption strategy best promotes inclusion and diversity of DHP users?
Rationale for inclusion: Evidenced issues is children and young people's asthma care often disproportionately impact specific communities; therefore, to support equity of impact, understanding which adoption strategies can be best used to affect this inequality is important part of a long-term strategy for spread and adoption.
- **KEQ:** To what extent is the DHP acceptable to users and which elements of the DHP are particularly useful to the individuals using the product?

Rationale for inclusion: Understanding acceptability is essential for obtaining comprehensive insights into user satisfaction and experience. It also helps DHP's developers make informed decisions on where to improve the product and better cater to the needs and expectations of their target audience.

- **KEQ:** Do people using the DHP intend to continue usage?
Rationale for inclusion: One of the most significant challenges in the large-scale adoption of digital health products is user attrition; a measure of intention to continue use is an important indicator for sustainability, user satisfaction and the ability of the DHP to meet ongoing and evolving user needs effectively.

Findings are preceded by a detailed methods section which outlines the approach taken for each component of the analysis, including the analysis of costs derived from the data collected.

Following an outline of findings, a synthesis of data collected as part of each of the evaluative components is undertaken and interpreted in the context of the evaluation questions and limitations to the approach outlined. A review of these findings is then contextualised using the lenses of NICE technology standards, NHSE National Bundle of Care and the NASSS framework.

For readers short of time to read the full report, note that a summary of the benefits and challenges identified is provided on page 28.

What is excluded

This document is focused on the implementation of DHP at 'level 1' only. No data is available at this time to assess the distinct impact of 'level 2' (connected) or 'level 3' implementation.

Methods

The data collection and analysis required for this work was undertaken across four work packages. The methodology associated with each of these is outlined in this section, prior to discussion of findings.

DHP user survey

Users of the DHP were surveyed in-app at two time points. Time 1 (T1) was at point of registration and time 2 (T2) was after three months of use. Participation in both surveys was incentivised with a £5 Amazon gift voucher, rising to £10 in November 2023 to encourage greater response rates, specifically at T2.

The four components of the survey and the approach to sampling and analysis are described below.

Activation

Patient activation was measured using the Partners in Health Activation Scale⁵, a 14-item instrument designed to measure individuals' engagement in their health management.

Developed by Partners in Health, the instrument assesses respondents across four levels of activation, gauging their knowledge, skills, and confidence in taking an active role in their care. Level 1 represents a basic understanding, while Level 4 indicates a high level of activation and self-efficacy. The scale was chosen for its adaptability to the asthma context and because of the flexibility it provided in terms of allowing versions suitable for both individuals and parents/carers to complete. No license was required to use the Partners in Health Activation Scale.

Each question on the scale is scored 0-8 where a higher score is always more positive. This provides an overall maximum score of 112. No thresholds are associated with the Partners in Health Activation Scale; a higher score indicates greater activation and engagement with health management.

Versions of the Adult Partners in Health Activation Scale for individuals and for parents/carers can be found in appendix A.

Asthma control test

The Asthma Control Test^{TM, 6} (ACT) is a validated test that provides a snapshot of how well a DHP user's asthma has been controlled over the last four weeks. The ACT is available in both an adult version, for 12+ years of age, and a child version for those aged 8-11 years.

The adult ACT asks the user to respond to five questions, each with five options to select each with an associated score, where 5 is always the most desirable. These questions ask the user to consider their asthma over the past four weeks and its impact on:

- Everyday activities
- Shortness of breath
- Night or early wakefulness
- Use of inhalers/nebulisers
- Self-report of asthma control

The adult test provides a simple score out of 25; a score of 20 or more indicates asthma is at least reasonably well controlled. Scores less than 20 may indicate asthma has not been controlled and there is a need for an asthma action plan.

The child ACT has two components, one for the child to answer which asks more general questions about how their asthma is, whether its problem when they run or play sports, whether it makes them cough or wake up in the night. The second component is for a parent/carer to answer and asks about daytime asthma symptoms, wheezing and night wakefulness in the most recent four weeks. A higher score is always more desirable.

The child-completed component is scored out of 3 for each of four questions, the parent/carer component out of 5 for three questions. The child ACT is therefore scored out of 27; a score of 20 indicates well-controlled asthma. Scores below 20 may indicate a need for an asthma action plan.

The ACT element of the DHP user survey was made available to users based on the declared age of the asthma patient, so parents/carers could complete for children aged 8-11 years. Versions of the Adult ACT and Child ACT used in the DHP can be found in appendix B and were utilised under license from Quality Metrics™.

The data entered by users for T1 and T2 survey was captured in-app and stored securely on TMA servers. Summary data is made available via an online dashboard with secured role-based access; this also makes available a download facility for selected users of anonymised raw data for analysis purposes.

Quality of life

Quality of life was measured using EuroQol-5-Dimension -5-Level (EQ-5D-5L) for adults and EuroQol-5-Dimension-3-Level (EQ-5D-3L) for children⁴.

The descriptive system for EQ-5D-5L comprises five dimensions:

- **Mobility:** The individual's ability to walk about
- **Self-Care:** The individual's ability to wash or dress themselves
- **Usual Activities:** The individual's ability to perform their usual activities (e.g., work, study, housework, family or leisure activities)
- **Pain/Discomfort:** The level of pain or discomfort experienced by the individual
- **Anxiety/Depression:** The individual's experience of anxiety or depression

Each dimension has five levels: no problems, slight problems, moderate problems, severe problems and extreme problems. In the case of the EQ-5D-3L, the same dimensions are applied but with just 3 levels for each dimension: no problems, some problems, lots of problems.

The user, or parent/carer, is asked to indicate their (or their child's/person they care for) health state by ticking the box next to the most appropriate statement in each of the five dimensions. This decision results in a one-digit number that expresses the level selected for that dimension. A higher number is always indicative of a greater severity of problem; for example, on the mobility dimension, a score of 1 indicates no problems walking about whilst a score of 5 indicates the user is unable to walk about.

Responses from each of the five dimensions form a 5-digit health state code. For example, a response of 2 for mobility, 1 for self-care, 3 for usual activities, 2 for pain/discomfort, and 1 for anxiety/depression would form the health state 21321.

The health state code is converted into an index value using a country-specific value set. Value sets are derived from population studies and provide utility values (index values) for each health state. The index value is usually a number between 0 and 1 (with 1 representing perfect health, 0 representing a health state equivalent to death, and negative values representing states worse than death) and can be compared across time periods to assess change.

EQ-5D instruments were chosen as they provide a comprehensive and internationally accepted framework for assessing health outcomes across diverse populations. EQ-5D's ability to generate a single index facilitates quantitative comparisons across different groups, and provides a holistic perspective on a DHP user's broader health status.

The EQ-5D index is also invaluable for economic evaluations and cost-utility analyses and the widespread use of EQ-5D in clinical trials, health surveys, and outcome assessments enhances the comparability of findings across other studies of digital health tools.

Asthma check in

The asthma check in consists of four questions where the user is asked to estimate the number of the following items that occurred in the most recent three months:

- **Asthma Attacks:** Number of asthma attacks
- **Days off:** Number of days off school / work
- **Steroids:** Number of steroid prescriptions
- **Emergency Care:** Number of A&E visits, or unscheduled GP appointments

This is designed to be a simple, self-reported estimate of key outcome indicators that speak to the general, and economic, impact of asthma on individuals as a long-term condition. Users simply enter a valid integer in response. No validation was incorporated into this aspect of the survey.

Sampling and analysis

The DHP user survey was available to all users who downloaded and registered with the DHP, but was not a mandatory element either during initial registration and onboarding, or at the point of three months of usage. There was no specific sampling frame applied to the incentivised recruitment of the DHP users to complete the user survey, meaning that no randomisation or systematic approach was applied. In essence a sample of convenience was employed for its practicality and accessibility in the context of constraint on time, resources and logistics.

While this method offers convenience, it may introduce biases, as the sample is unlikely to be representative of the broader population of children and young people with asthma. Consequently, findings derived from this sample should be interpreted and generalised cautiously, although it may be noted that as this project constitutes a service evaluation rather than more formal research, generalisability may be of less concern.

In addition, the incentivisation of survey completion may boost participation rates and data quality, but may also attract individuals who are solely interested in incentives, potentially skewing responses. Striking a balance is crucial to ensure genuine engagement and reliable data while managing potential bias introduced by the incentive structure. The analysis of the survey data will include a comparison of demographics from the surveyed sample with those of the user base as whole to assess whether there are any systemic differences to consider in the final analysis.

Only DHP users who stated they completed the survey on behalf of themselves or someone they care for were included in the analysis.

Given that the quality of life measure and the ACT test are both age specific, records where the age was not completed were excluded from analysis as it was not possible to be certain that the correct, age appropriate survey items had been completed.

Otherwise, no other exclusions were made. Where missing data was evidence for specific data items, the record was excluded for analysis of that data item, but not from the whole analysis.

For analysis purposes the focus is on responses where *both* T1 and T2 surveys have been completed to ensure controlled comparison. To determine whether there is a statistically significant difference between the means of T1 and T2 responses (i.e. paired observations) at $\alpha = 0.05$ level, paired t-tests will be undertaken on relevant dimensions of the survey. This assumes normal distribution of the differences between pairs and the independence of observations within each pair. T-tests are accompanied by estimates of effect size using Cohen's d; Cohen suggested that $d = 0.2$ be considered a 'small' effect size, 0.5 represents a 'medium' effect size and 0.8 a 'large' effect size. This means that if the difference between two groups' means is less than 0.2 standard deviations, the difference is negligible, even if it is statistically significant²⁰.

All analysis of the DHP user survey data was carried out using R Statistical Software (v4.3.1)²⁴ and MSEXcel. Index value calculation for EQ-5D measures was undertaken using the 'eq5d' package²³ for R and all other R-based data shaping and management used the 'Dplyr' package²⁵.

Adoption strategies

Asthma care in the UK needs a step change that can help millions of people, so it is not enough to develop self-management tools. They must get to the people who need them most. One of the goals of this project is to evaluate the relative effectiveness of three on-boarding strategies in the context of their ability to successfully recruit users to the DHP and their ability to increase the diversity of the user base, directly addressing the inequalities in children and young people's asthma care that are well documented¹.

The three scalable adoption strategies (and their cost-effectiveness) that will be assessed are:

- Social media campaigns that can reach underserved groups - for example, campaigns, on TikTok and Instagram
- 'Normal' NHS communication at scale - for example, posters in pharmacies, schools, GPs, clinics, and awareness campaigns for staff
- Upskilling of practice nurses in asthma care, which will include a module on digital self-management tools

The data for the social media campaign was undertaken by a third party supplier, Nonsensical, a UK based TikTok marketing agency. Nonsensical worked with two TikTok influencers, creating TikTok content relevant to the DHP, and undertook a TikTok based campaign aimed at a target audience of 13-25 year olds between May to October 2023.

Data generated from the campaign was summarised to provide stratified insights into success, in terms of conversation rates and cost per acquisition, on a number of dimensions including:

- Age group
- Device (iOS or Android)
- Target geography vs national

Additional insight from the social media approach once its management was taken in house was provided in summary by Tiny Medical Apps and is included in the findings and discussion.

Assessment of the NHS communications adoption strategy (e.g, posters, stickers and other materials) was undertaken through interviews with high volume users of these communication materials. This was undertaken in the form of a small focus group, held virtually, with semi-structured interview questions seeking insight on the following areas:

- Awareness of staff and patients about the DHP
- Feedback on communication materials
- Engagement with communication materials

In addition to these interviews, a survey was also conducted seeking views and feedback from clinicians who are known to have utilised the app (see appendix D). For those clinicians who attended a one hour training session in 'Digital Tools for Asthma Self-Management', additional questions were included regarding the efficacy and effectiveness of the training. The survey was administered via Qualtrics, open for a period of three weeks. Respondent who answered 'No' to question 10 on the survey, were exempted from answering question 11-14 pertinent to the self-management specific training modules.

DHP user and parent/carers interviews

Provision of qualitative data and insight in acceptability, usability, user satisfaction and intention to continue was undertaken via telephone based interviews. Users were incentivised to take part in interviews with a £20 Amazon gift voucher. Invitations to interview were sent out by Tiny Medical Apps and participants were asked to book themselves into a convenient slot using Calendly.

Structured telephone interviews, lasting around 10-20 minutes were undertaken by UCLPartners interviewers between December 2023 and May 2024. For reference, the interview protocols and topic guides are available in Appendices C1 (DHP users) and C2 (parents/carers).

The initial intent was to recruit and interview children and young people using the DHP for themselves, and parents or carers using the DHP on behalf of a child or young person with asthma. However, during recruitment it became apparent that DHP users from older age groups had also been using the DHP for themselves. These users represented a significant cohort and as such were included in the analysis. In addition to people with asthma and their parents/carers, three asthma nurses who had been using the app as a demonstrator and to support with patient education were also included in the invitation. Nurse participants were still interviewed but their responses were analysed separately and incorporated into staff feedback.

Interviews were transcribed, anonymised and thematically coded using the continuous use model (see figure 1). This theoretical model is adapted from Song et al (2021)²¹ who tested it in the context of hypertension self-management, in turn built upon the information systems success model (DeLone & McLean, 1992)²². The continuous use model presents a framework for understanding the factors influencing the sustained use of technology or digital platforms beyond initial adoption. This model emphasises the dynamic and ongoing interaction between users and technology, highlighting that continued use is not just a function of the technology's initial appeal but also of how well it integrates into the users' daily lives and meets their changing needs over time, a factor that is particularly important in the context of a long term condition such as asthma.

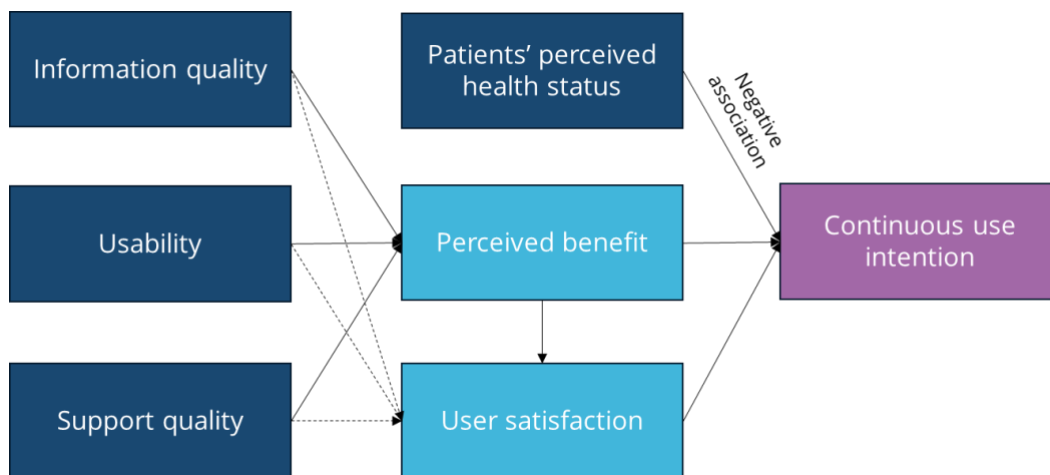


Figure 1: Continuous use model for self-management of chronic conditions (adapted from Song et al., 2021)

At its core, the continuous use model suggests that sustained engagement with technology is driven by a combination of intrinsic and extrinsic motivations. Intrinsic motivations include factors such as enjoyment, personal interest, and the inherent satisfaction derived from using the technology. Extrinsic motivations encompass practical benefits such as efficiency, utility, the fulfillment of specific goals or tasks and avoiding negative consequences.

The continuous use model also incorporates the importance of user experience, suggesting that positive interactions and satisfaction with the technology significantly enhance continuous use. This involves aspects like ease of use, reliability, and the ability to provide consistent value. Additionally, the social context and peer influence play a role, where recommendations and shared experiences within a community can reinforce ongoing use. The continuous use model also integrates the concept of feedback loops, where user experiences and outcomes feed back into their perceptions and expectations, thereby influencing future use, a cyclical process suggests that reinforces the need for technology developers to continually innovate and adapt to maintain user engagement.

The continuous use model provides a comprehensive lens through which to analyse user experience, perception of benefit and usefulness, and satisfaction in the context of ongoing use. This model is the agreed framework for assessment against the key evaluation questions to understand user's intention to continue within DHP, and so has formed the basis of interviews and thematic analysis.

As survey participants were recruited via the app, there is a risk of bias as those who took part in interviews would be more digitally literate, more likely to engage with the app and more likely to respond to interview invitations in English. These results do not capture the experiences of those who could not use the app or could not engage with phone interviews.

Health economic analysis

Health economic analysis is a systematic approach used to assess the efficiency of an intervention or project in achieving its outcomes relative to the costs incurred in implementing it. This analysis seeks to evaluate the costs of realising health gains, as defined by the aims of the project, the economic benefit of realising those gains and can be used to guide decisions on resource allocation, budgeting, and project prioritisation.

Any health economic analysis requires a clear definition of the perspective from which the costs and outcomes are analysed; in this case the analysis will be undertaken from the perspective of the healthcare system, as opposed to the individual user or GP practice (for example).

All cost analysis for this report has been undertaken on DHP survey data extracted on the 30th June 2024.

The approach for the health economic analysis for this project are described as follows:

- **Identifying relevant costs:** These will primarily include licensing costs (ie the costs charged to the healthcare system by Tiny Medical Apps, the vendor of DHP, for use of the platform) and implementation costs which in turn may include clinical time, project management or administration time and any technical input required. These have been estimated for a 'typical' ICB implementation in terms of time and cost using PSSRU Unit Costs of Health and Care 2022⁷ adjusted for inflation where required.

These implementation costs are offset against cost of care provided to the DHP user; this can be estimated *either* through the asthma check in data which includes self report of urgent and emergency care usage, GP attendances and steroid prescriptions, all of which are costed using the relevant tariff or PSSRU Unit Costs of Health and Care 2022⁷, adjusted for inflation where required, or an alternative approach utilising Asthma Control Test scores.

The alternative approach, utilised here, to estimating care costs is modelled based on research data. The annual costs of managing asthma for a range of adult ACT scores have been estimated across seven European countries⁸. These estimated costs have been converted to GBP using xe.com (accessed 29th January 2024) and uplifted for inflation. This provides an estimated annual cost of asthma management per patient for patients with severely uncontrolled asthma (ACT < 15), moderately uncontrolled asthma (ACT score 15-19) and controlled asthma (ACT ≥ 20). The change in numbers of patients in each category at baseline and at three month follow up is calculated and the cost differential shown. This is then modelled forward for up to three years, assuming the same shift in ACT scores occurs across all patients who use DHP, with all other asthma patients maintaining the same mix of controlled and uncontrolled as at baseline. The uptake of DHP is modelled using 'best estimates' and is assumed to increase year on year to a maximum of 40%. Note that results from the under 12 age group are excluded; the greater focus on quality of life rather than clinical symptom management in the pACT means that there is a paucity of evidence to support modelling cost impact for this group.

Total costs are presented assuming implementation costs occur on a one-off basis, with annual maintenance and license costs occurring annually and inflation stable at 3%. An estimate of possible forecast cost reductions on this basis is given separately.

- **Quantifying outcomes:** There are a range of outcomes available within this project to include in a health economic analysis. For this project, the change in ACT score for adults (12+ years) will be used. This has been chosen for two reasons:
 1. Whilst it is common for EQ-5D as a measure of quality of life (QoL) to be used for this purpose, the EQ-5D measures used in this project do not currently have a UK-specific scoring system. ACT is clinically validated in the UK and is a sensitive,

asthma specific, indicator of outcome of the DHP tested across the target demographic range.

2. ACT is a better predictor of long-term benefit, in terms of care costs, in the context of childhood asthma than a measure of QoL.
- **Identify comparative scenarios:** This is the identification of two scenarios to compare, one with the relevant intervention, in this case the DHP, the other the alternative which is this case is 'normal' care. For the purposes of this project the 'alternative' scenario is defined as cost and outcomes measured at baseline. The intervention scenario is the cost and outcomes at three months post on-boarding.

Findings

DHP user survey

Demographics

A total of 1,294 DHP users who completed the survey on or before the 30th June 2024 on behalf of themselves or someone they care for were in the primary data set. As noted above, records where the age was not completed were excluded from this analysis as it was not possible to be certain that the correct, age appropriate, survey items had been completed. This reduced the analysis set to 1,106 DHP users who had completed the DHP user survey at least one time.

Of these 1,106 users 235 (21.2%) were aged under 13 years, 871 (78.8%) aged 13+ years. The majority (75.0%) were completing the survey for themselves. The overall sample was majority female (65.3%), although the gender balance varied by age group; 45.5% of under 13s were female, compared with 70.6% in the 13+ years age group.

Ethnicity breakdown (figure 2) was majority White (76.4%) and had broadly the same profile in both the under 13 and 13+ years age groups. Overall, this is generally representative of the ethnic profile of England, based on the 2021 census.

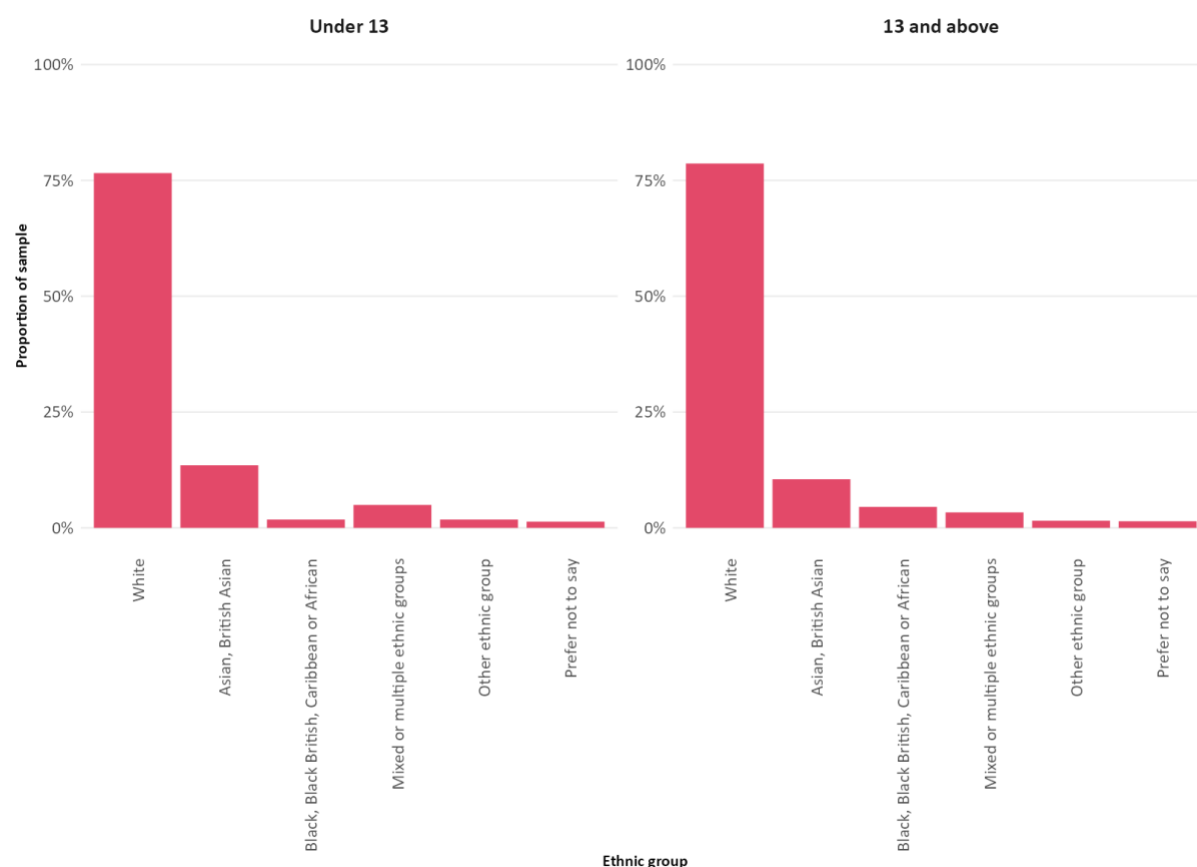


Figure 2: Ethnicity breakdown of included DHP users completing at least one DHP user survey

The socioeconomic makeup of the sample skews slightly towards more deprived quintiles. Approximately 54.3% of DHP users included in the analysis, where the IMD quintile was known,

are from IMD quintile 1 and 2. The remaining DHP users in the sample are evenly distributed across the quintiles 3-5. 319 DHP users (28.8%) had an unknown IMD quintile.

The demographics of those included in this service evaluation were very similar as the demographics of the wider DHP user base, over 5,000 in number at the time of writing. Figure 3 below shows the comparison between the evaluation participants and the 5,000+ DHP users across all NHS regions in England. The primary difference between the evaluation sample and the overall DHP user base is in age group; the vast majority of all DHP users are under 25, whereas less than 50% was in this age group in terms of the evaluation sample. This may reflect a greater willingness in older age groups to take part in surveys and other evaluation activities, compared to younger age groups.

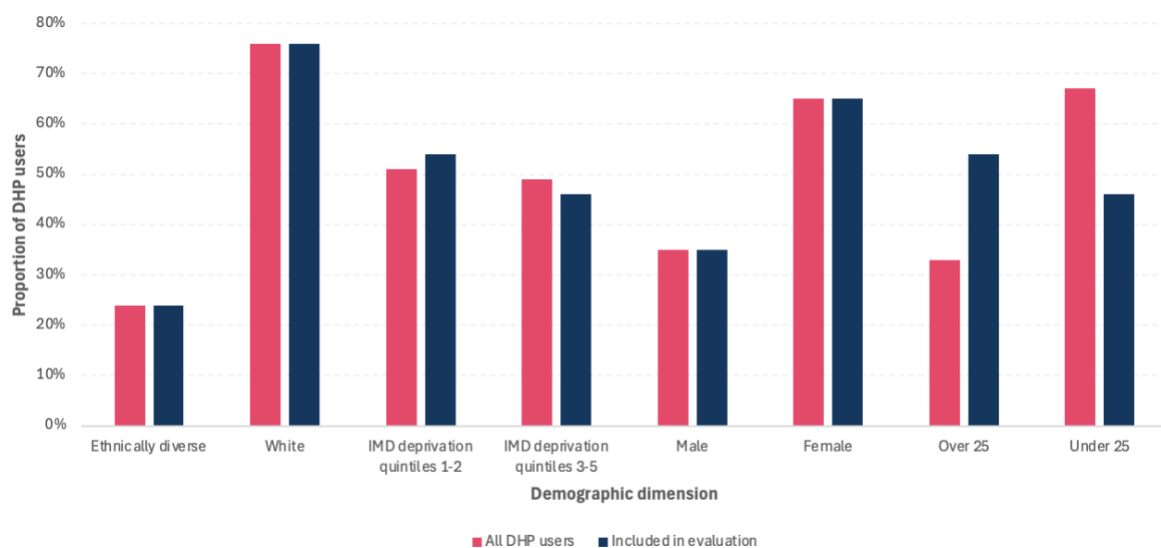


Figure 3: comparison of demographics between service evaluation sample and wider DHP users

Activation

A total of 137 DHP users completed the Partners in Health scale at both T1 and T2. 75.9% of these were completing on behalf of themselves, the remainder on behalf of someone they cared for.

Across the entire sample, the 12 item Partners in Health scale showed a statistically significant change between T1 and T2 ($\bar{x}_{t1} = 72.4$, $\bar{x}_{t2} = 77.9$, $t = -4.32$, $p < 0.05$). The effect size was estimated at around 0.4, considered a small to moderate effect (Cohen's $d = 0.35$).

However, stratifying the analysis into 'self' and 'carer' respondents showed a difference between these two groups. Those DHP users completing for themselves, still demonstrated statistically significantly different change in overall Partners in Health score ($\bar{x}_{t1} = 69.79$, $\bar{x}_{t2} = 76.0$, $t = -3.8$, $p < 0.05$) with a small to moderate effect size ($d = 0.38$). The 'carer' cohort did not demonstrate the same significance ($\bar{x}_{t1} = 81.9$, $\bar{x}_{t2} = 84.6$, $t = -1.74$, $p = 0.09$) and showed only a small effect size ($d = 0.24$). As 'self' and 'carer' conditions are a reasonable proxy for age group (under 13s being largely represented by carers) it is not surprising to see the same effect when the data is split by age group. In under 13s there is no statistical significance ($\bar{x}_{t1} = 80.2$, $\bar{x}_{t2} = 82.1$, $t = -1.29$, $p = 0.21$) and effect size is small ($d = 0.16$). In 13+ age group there is a statistically significant change ($\bar{x}_{t1} = 70.5$, $\bar{x}_{t2} = 76.9$, $t = -4.16$, $p < 0.05$) and a small to moderate effect size ($d = 0.40$).

Examining in more detail the changes in mean scores for each dimension of the Partners in Health across the whole sample reveals that, on average, there was an improvement in 11 of the 12 the dimensions, nine of which were statistically significant marked with an asterisk in Figure 4. However, the validity of analysing single dimensions of a composite measurement instrument such as Partners in Health is far from certain and should be interpreted with caution.

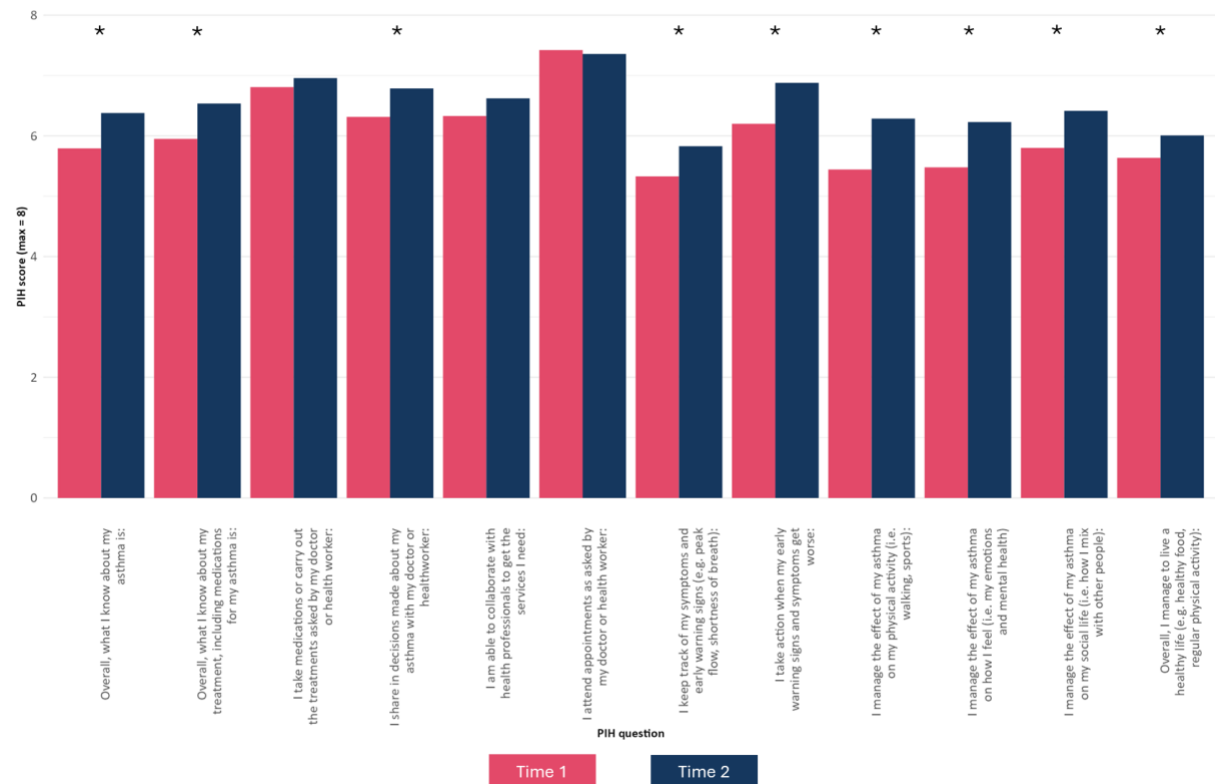


Figure 4: Mean scores at T1 and T2 for each PIH dimension. * = statistically significant difference

The Partners in Health was appended for this survey with two additional questions relating to the confidence of DHP users in talking to their healthcare professional and their family about their asthma. These two questions combined did not show any significant change between T1 and T2 ($\bar{x}_{t1} = 13.47$, $\bar{x}_{t2} = 14.0$, $t = -1.94$, $p = 0.05$) in the overall sample, which was also the case for the under 13 age group. However, confidence did appear to be statistically significantly different in the 13+ years age group ($\bar{x}_{t1} = 13.18$, $\bar{x}_{t2} = 13.9$, $t = -2.10$, $p < 0.05$), although the effect size was small ($d = 0.21$).

Asthma control test

A total of 200 DHP users completed an age-appropriate ACT at T1 and T2; 177 of these were the adult test for 12+ age group, 23 completed the pACT.

Across the entire sample, the adult ACT scale showed a statistically significant change between T1 and T2 ($\bar{x}_{t1} = 15.9$, $\bar{x}_{t2} = 17.4$, $t = -5.03$, $p < 0.01$) (see table 1). The effect size was between a small and moderate effect (Cohen's $d = 0.3$).

Results for the change in pACT between T1 and T2 were not statistically significant ($\bar{x}_{t1} = 18.5$, $\bar{x}_{t2} = 18.4$, $t = -0.21$, $p = 0.84$) and the effect size is considered almost non-existent ($d = 0.04$).

Table 1: Descriptive statistics and paired t-test results for overall ACT and pACT measures

ACT type	T1		T2		t-stat	P-value
	Mean	SD	Mean	SD		
Adult (12+ years)	15.9	5.32	17.4	4.63	-5.03	<0.01
Child (8-12 years)	18.5	3.26	18.4	2.32	-0.20	-0.84

Stratifying the analysis into 'self' and 'carer' respondents for the adult ACT showed a slight difference between these two groups. Those DHP users completing for themselves, still demonstrated statistically significantly different change in ACT score ($\bar{x}_{t1} = 15.53$, $\bar{x}_{t2} = 17.04$, $t = -4.77$, $p < 0.01$) with a small to moderate effect size ($d = -0.31$). The 'carer' cohort did not demonstrate the same statistical significance ($\bar{x}_{t1} = 17.53$, $\bar{x}_{t2} = 18.73$, $t = -3.23$, $p = 0.23$) and but did show a small effect size ($d = 0.27$). The lack of statistical significance is likely therefore to be a result of a small sample size of 'carers' undertaking adult ACT ($n = 15$).

Drilling further into the sample, of those with T1 and T2 adult ACT responses who had an ACT score below 20 at T1 ($n = 130$) and were therefore defined as having uncontrolled asthma as baseline, there was a statistically significant difference ($\bar{x}_{t1} = 13.58$, $\bar{x}_{t2} = 15.82$, $t = -6.34$, $p < 0.01$) and a moderate effect size ($d = 0.54$).

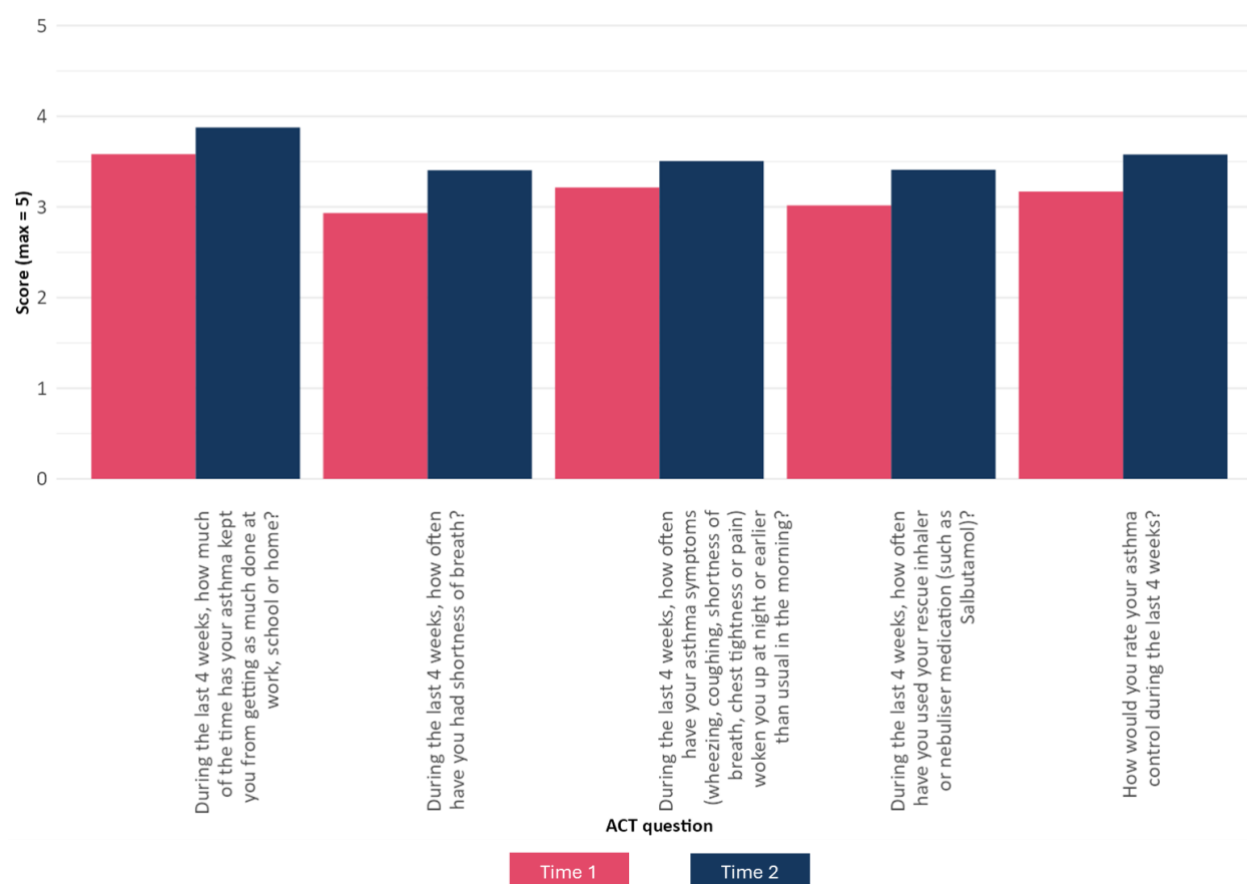


Figure 5: Mean score at T1 and T2 for each adult ACT dimension.

Examining in more detail the changes in mean scores for each dimension of the adult ACT only across the whole sample reveals that, on average, there was an improvement in all the dimensions (see figure 5). However, the validity of analysing single dimensions of a composite measurement instrument such as ACT is far from certain and should be interpreted with caution.

Quality of life

EQ-5D-3L had a low number of completion (n=10). EQ-5D-5L was completed by a greater number of DHP users (n= 157). There was no statistically significant improvement in either the EQ-5D-3L ($\bar{x}_{t1} = 0.83$, $\bar{x}_{t2} = 0.87$, $t = -0.98$, $p = 0.35$) or in the EQ-5D-5L ($\bar{x}_{t1} = 0.69$, $\bar{x}_{t2} = 0.69$, $t = -0.15$, $p = 0.88$) as shown in table 2.

Table 2: Descriptive statistics and paired t-test results for quality of life measures

Quality of life measure	T1		T2		t-stat	P-value
	Mean	SD	Mean	SD		
EQ-5D-3L index reverse crosswalk - UK Devlin value set	0.83	0.14	0.87	0.16	-0.98	0.35
EQ-5D-5L US crosswalk - EQ-5D-5L Shaw value set V1.1	0.69	0.26	0.69	0.28	-0.15	0.88

Looking at each of the individual dimensions of the EQ-5D-5L there are none that stand out as being significantly changed compared to the others.

Asthma check in

The four asthma check in questions were completed by 203 DHP users with valid records at both T1 and T2. Of these, 18.2% were in the under 13s age group and 64% were female.

Looking at each of the four questions individually there was no significant evidence of change in either direction (see table 3).

Table 3: Descriptive statistics and paired t-test results for asthma check questions

Asthma check question	T1		T2		t-stat	P-value
	Mean	SD	Mean	SD		
No. Asthma attacks	1.02	1.61	0.93	1.51	0.71	0.48
No. Days off school/work	2.23	5.79	1.77	4.02	1.06	0.29
No. Steroid Rx	0.76	1.39	0.92	1.83	-1.20	0.23
No. Urgent & emergency care visits	0.47	1.05	0.45	0.94	-0.20	0.84

There is a large degree of variance in the question relating to days off school or work, evidenced by the large SD for this measure. Others are less widely distributed.

Post-hoc tests looking at specific age groups so not give an indication of any significant change in any of the measures included in the asthma check section of the DHP user survey.

Adoption strategies

Traditional NHS adoption approaches

Tint Medical Apps make 'traditional' communication and promotional tools available to NHS staff to support the adoption of the DHP in a variety of clinical settings. Materials include:

- A4 posters
- Roller banners
- Stickers
- A5 flyers

The content of these materials are adapted for specific settings, for example the 'hospital' poster will differ from the 'community' flyer. Since September 2023 materials have been sent to 10 ICB areas and been distributed at hospitals, community settings, GP surgeries, pharmacies, schools and at events. An estimated 10,100 stickers, 10,000 flyers, almost 800 posters and 30 roller banners have been provided, at an estimated cost of around £4,750 (including postage), an average regional spend of around £475. In terms of volume of materials, hospitals and pharmacies were the biggest users of the communication materials in general with stickers and A4 posters being especially popular in these settings. GP settings utilised all the materials on offer but generally at a lower volume.

Feedback from recipients of the communication materials, where received, has been positive and included indications that children and carers were also engaging with the materials.

In a focus group held with high volume users of the 'traditional' communication materials designed for the NHS, senior and CYP asthma nurse practitioners from North East London shared their experiences with the DHP and the associated communications materials. They first learned about the platform through clinical networks and have since introduced it to their patients, particularly those needing significant support for asthma control, or who have not received much engagement previously.

Communication materials, such as flyers, posters, and stickers with QR codes, were generally well-received but required additional explanation for effective use. The nurse practitioners noted that while the materials were suitable for older children with smartphones, they might not appeal to younger children. The need for varied and more engaging materials, especially for younger audiences, was highlighted. The nurse practitioners suggested the development of more targeted promotional materials, particularly for very young children transitioning to secondary school, a particularly important, and often vulnerable, time in learning to self-manage their condition.

Regarding the effectiveness of the communication materials, the nurse practitioners observed that stickers were particularly successful in A&E departments and pharmacies due to their ease of use, which was reflected in the analysis of which materials were most used in which setting. However, they did not have direct follow-up data to assess which materials led to the most patient engagement.

It was also noted that the communication materials were often beneficial for older children in non-English-speaking families as those children tended to have good spoken English and could actually use the DHP to support and educate the wider family group. It was also noted that videos, or links to videos, may be more beneficial to those patients or carers with limited English.

The nurse practitioner acknowledged limitations in reaching some groups, both in terms of utilising some of the communications materials such as QR codes. This included those without

smartphones or with no access to mobile data. Some communities do not use digital devices (e.g. some Orthodox Jewish communities in North East London).

In terms of reflection on the DHP itself, there was a reflection that the DHP has been useful in reinforcing communications heard in clinic for those with neurodiversity. The nurse practitioners also noted that they have observed whole families engage with the app together, perhaps due to genetic nature of condition and in non-English speaking families, older children with better English language skills using the DHP to increase health literacy with their parents. It was also noted that the app has been used to help lead conversations in clinic, for example by completing the symptom tracker together.

Whilst the traditional NHS adoption strategies appear to be broadly successful insofar as the materials are acceptable to the clinicians who are most likely to promote the DHP, and that these clinicians are also accepting of the app itself, it is not really possible to assess whether the spend on adoption in this area is cost effective. The translation of communications materials and promotion with clinical teams into DHP downloads and usage cannot be assessed as the data to enable that does not exist. However, clinical recommendation of the DHP app is likely to have a high impact on patients and carers given the high trust relationship. Also, it is patients with more complex or uncontrolled asthma who are more likely to be seeing asthma nurses or other clinicians more often; this is the group who appear to derive the most benefit from DHP use.

Across the ICB areas covered by the dissemination of 'traditional' materials the under 25 population is estimated at 4.9m people, with around 450,000 likely to have asthma in some form. This figure then provides the maximum 'reach' for the 'traditional' NHS materials but is obviously further limited in that very young children are not a target audience and also that, outside of the schools campaign in Cambridgeshire and Peterborough, the materials have been disseminated in healthcare settings where young people are unlikely to be unless they are unwell or attending an annual review.

There are opportunities for improvement in the materials underpinning the adoption approach, and the DHP itself from the clinician perspective. Thinking about materials to increase the adoption rate in younger children, especially as they move into primary school, and how the DHP could be utilised to further support children and young people whose first language is not English may be especially beneficial.

Staff training approach

A small sample of attendees at the 'Digital Tools for Asthma Self-Management' one-hour training module (n=2) suggested that the training was 'somewhat effective' in preparing them for using the DHP with patients, and 'somewhat confident' in their ability to support their patients with using the app as part of their asthma care. Despite being a very limited sample, this is suggestive of a positive impact of the training in terms of staff perception of 'upskilling' them to use digital tools as part of standard asthma care.

The staff who attended the training were also more likely to report that the app provided 'lots of potential for improvement' in relation to improving asthma education specifically compared to those staff that had not reported attending the training. These staff who attended the training were also more likely to identify the app as have at least 'some potential' for improving asthma self-management, improving patient/carer knowledge about the condition and improving asthma outcomes. Given these results, this suggests that the training module could be a factor in maximising staff awareness of the opportunities for improvement that the DHP has been designed to support.

Feedback from the survey with regards to individual experience of the DHP was limited as many respondents chose not to complete all questions. Those who responded to the relevant questions reported, in general, but not unanimously:

- that the app easy to use
- agreed it was up to date with latest clinical guidance
- felt it relevant to their needs as a clinician
- found at least some of the features useful, specifically air quality and pollen videos, correct inhaler usage videos, medication reminders, health coaching for asthma and recording triggers

ACT scores and interoperability with the NHS app were noted as opportunities for functional improvement.

Whilst this provides some, very limited evidence, that the staff training approach increases the awareness of the potential of the DHP to improve various aspects of asthma care, it is not possible to say whether this in turn influences uptake. Building on the discussion above, increasing clinician awareness of potential benefit and having them as 'partners' in the use of the DHP alongside their patients, could have a high impact for those individuals. It may also be hypothesised that those patients using the DHP alongside clinical teams are more likely to have less well controlled asthma and therefore benefit the most.

TikTok campaign

An initial TikTok campaign undertaken in 2023 generated 1,132 downloads of the DHP, through 2.24 million total impressions and 9,440 click throughs, an overall conversion rate of around 12%. These activity figures gave rise to a CPA* of £4.76 (95% CI = £1.28).

*Table 4: TikTok campaign performance metrics by month**

Month	Cost	CPC	CPM	Impressions	Clicks	Conversions	CPA	CVR
May	£1,228	£0.54	£2.02	606,830	2,262	202	£6.08	8.93%
June	£1,393	£0.56	£2.34	594,886	2,479	276	£5.05	11.13%
July	£406	£0.66	£2.28	178,539	616	94	£4.32	15.26%
August	£171	£0.56	£2.40	61,062	246	20	£8.55	8.13%
September	£1,164	£0.58	£3.14	371,317	2,008	303	£3.84	15.09%
October	£1,020	£0.56	£2.40	425,542	1,829	237	£4.30	12.96%
Total	£5,385	£0.57	£2.41	2,238,176	9,440	1,132	£4.76	11.99%

* CPC = cost per click, CPM = cost per 1,000 impressions (where an "impression" refers to when someone sees a campaign on social media, the search engines or another marketing platform), CPA = cost per acquisition (i.e. download) which is the total costs divided by the number of conversions, CVR = conversion rate which is the number of conversions divided by the number of clicks or click throughs.

Please note that costs reported in table 4 exclude the charges from the influencers who generated the campaign content. Taking this and agency costs into account, the overall CPA was £15.37.

This overall picture masks some significant variation. Looking at the results by month, impressions, clicks and conversions were all much lower in July and August compared with other months of the campaign. This relates directly to the amount spent on the campaign in these months; very little was spent in the August campaign and whilst the CPC was consistent with other months, this did not translate into conversions. Therefore, August had the lowest CVR. September was the best performing month, with the lowest CPA (£3.84, 20% lower than the overall CPA) and highest CVR (15.09%). The choice to spend less in the July and August period likely resulted in the lower performance in these months but reflects the anticipated drop in traffic that may occur over the UK school holiday period.

The vast majority of downloads (80%) were generated via iOS devices, potentially due to the differing demographics of iOS users who are more likely to be aged 16-24, at least in Western markets, compared to Android users⁹. The CPA for iOS was just £4.02 compared with £7.80 on Android. However, it should be noted that the campaign was restructured to allow more spend targeting iOS devices once it was appreciated it was performing well, and therefore the overall comparison will be skewed towards iOS.

Comparisons of running the campaign targeted regionally vs nationally, showed that national approaches generate lower CPA, an average of £4.68. Regional campaigns in the West Midlands, London and Manchester generated a CPA of, on average, £6.52, with London performing best out of the regions at a CPA of £5.48.

Some data was collected by age group but is incomplete as visibility of conversions, and therefore CPA and CVR, is not available split by age groups for iOS devices, which makes up 80% of the downloads. Figure 6 shows CPC and CPM only by age bracket. The 13-17 year old age bracket was the best performing at just £0.40 for CPC and £1.43 for CPM respectively compared with all the other age brackets with a CPC above £0.50 and CPM above £2.50. Given the clear relationship between clicks, impressions and conversions for this campaign, and the younger demographic on iOS devices, it is very possible, although not proven, that the 13-17 year old age bracket was the overall best performing age group.

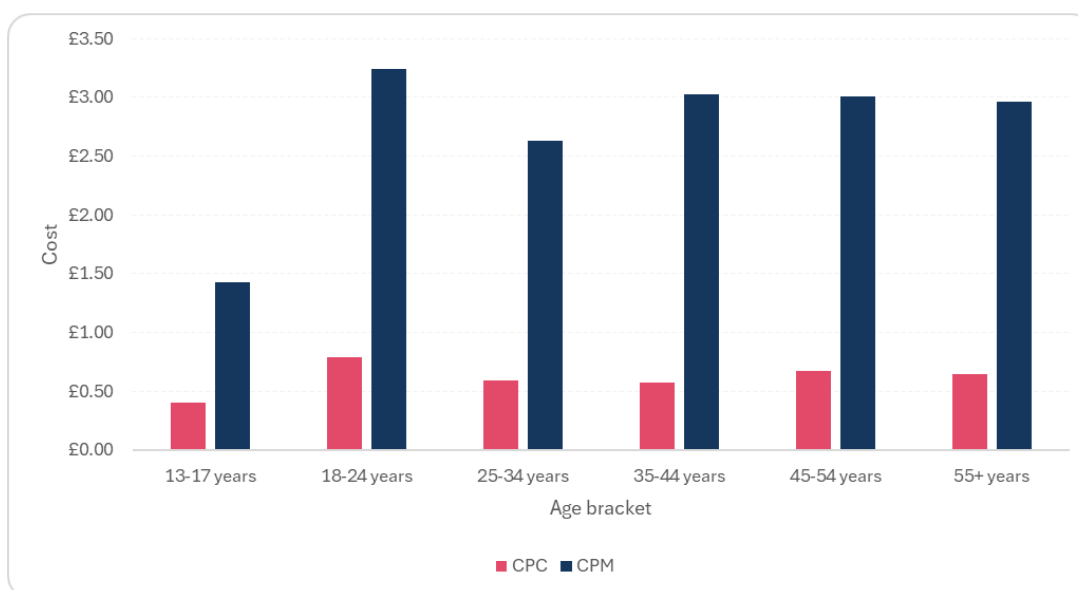


Figure 6: CPM and CPC by age bracket for all devices

However, the 25-34 years bracket was also better performing than other age bands (CPC = £0.59, CPM = £2.63); this is likely to be indicative of the 'Ask About Asthma' facet of the campaign which was focussed on the 25+ age group and could indicate that this element was most successful in the younger demographic.

Using this data to forecast potential conversion based on performance over this six month period:

- An investment of £20,000, would result in 4,202 conversions (with an upper confidence limit of 5,747 and a lower confidence limit of 3,311)
- An investment of £10,000, would result in 2,100 conversions (with an upper confidence limit of 2,874 and a lower confidence limit of 1,656)

The data available from this campaign does not enable examination of whether there was any variation in conversions between socioeconomic groups or specific demographics with known childhood asthma risks. However, where DHP users downloading the app via TikTok have completed their registration and chosen to complete the relevant ethnicity and address fields, it is possible to see the distribution across specific demographic dimensions, which may be very early indications of whether this campaign approach has resulted in more downloads from diverse or deprived communities.

Table 5 show the number of registrations (up to 22nd January 2024) by deprivation quintile where TikTok was the identified campaign placement.

Table 5: Number of registrations flagged as via TikTok campaign before 31st January 2024 by socioeconomic deprivation quintile

Quintile	Registrations
1- Most deprived	2
2	6
3	7
4	5
5 - least deprived	4

This shows proportionally more registrations via the TikTok campaign in the mid- and least-deprived quintiles, but identified numbers are low and may not be representative; overall (i.e. from all campaigns) registrations are skewed slightly towards more deprived quintiles (c.54% in quintiles 1 and 2, where IMD quintile was completed).

Table 6: Number of registrations flagged as via TikTok campaign before 31st January 2024 by ethnicity

Ethnicity	Registrations
Asian, British Asian	6
Black, Black British, Caribbean or African	1
Mixed or multiple ethnic groups	2
White	36
Prefer not to say	1

Registrations via the TikTok campaign are largely from White groups but the overall distribution across ethnicities is similar to that for all registrations.

Subsequent TikTok campaign

Following this initial campaign, Tiny Medical Apps opted to bring subsequent campaigns 'in house', commissioning specialist influencer (Dr Bodalia) to support with the production of eight short-form TikTok videos targeted at a younger demographic and formatted for mobile devices. This was undertaken to help reduce the cost of campaigns but also to increase skills and knowledge to help maximise flexibility and optimisation of campaigns.

The target audience for this campaign was the 18-24 age group and a 50:50 split of male to female. This was broadly achieved, with 55% of viewers from the 18-24 age bracket and approximately 54% male.

In the initial weeks of the campaign, an additional 100 conversions were recorded, although this dropped to 60 by week three. This gave rise to an average CPA of just £2.50, well below the £4.76 of the 2023, consultancy led, campaign.

It is unclear whether this subsequent campaign has successfully targeted more deprived or minority ethnic communities specifically. However, where DHP users downloading the app after 31st January 2024 as a result of the TikTok campaign have completed their registration and chosen to complete the relevant ethnicity and address fields, it is possible to see the distribution across specific demographic dimensions, which may be very early indications of whether this subsequent campaign approach has resulted in more downloads from diverse or deprived communities.

Table 7: Number of registrations flagged as via TikTok campaign after 31st January 2024 by socioeconomic deprivation quintile

Quintile	Registrations
1- Most deprived	4
2	4
3	3
4	4
5 - least deprived	4

This shows an even spread of registrations via TikTok across the quintiles. Identified numbers are very low and are not representative of the whole sample, which skews towards more deprived quintiles.

Table 8: Number of registrations flagged as via TikTok campaign after 31st January 2024 by ethnicity

Ethnicity	Registrations
Asian, British Asian	7
Black, Black British, Caribbean or African	1
Mixed or multiple ethnic groups	1
White	22

This shows a similar pattern to that seen in the 2023 campaign; most registrations via TikTok campaign are from White groups, but the overall distribution is similar to that for all registrations.

Health economic analysis

As noted above there are multiple options within the evaluation data collected to support and analysis of cost effectiveness of the DHP. First is the absolute reduction in emergency care usage, as reported through the asthma check questions. This has the advantage of being a direct measure of service usage which is a key metric for the health service perspective and reduces the assumptions required to translate other measures into units suitable for costing. However, the current interim data set does not indicate any change in self-reported emergency care usage or change in steroid prescriptions.

As these measures are self-reported and not subject to validation, the alternative approach using ACT to estimate change in economic impact is utilised here. This is balanced against the cost of implementation, consisting of an initial implementation and set up cost, and an ongoing annual maintenance/training cost. These are outlined in tables 9 and 10.

Table 9: Estimated one-off DHP implementation costs per ICB

	Cost basis	Unit cost	Number of units	Total cost
License fee (inc. training costs)	Per ICB	£69,300	1	£69,300
IG (band 7)	Days	£510	1	£510
Senior management lead (band 8d)	Days	£953	0.5	£476
Senior clinical lead (GP)	Days	£1,500	0.5	£750
Asthma specialist nurse (band 7)	Days	£510	5	£2,550
Nurse/GP/pharmacy practitioners (band 7)	Hours	£68	50	£3,400
Total				£76,986

Table 30: Estimated recurrent annual costs of maintenance/training for DHP per ICB

	Cost basis	Unit cost	Number of units	Total cost
License fee (inc. training costs)	Per ICB	£69,300	1	£69,300
Senior management lead (band 8d)	Days	£953	0.25	£238
Senior clinical lead (GP)	Days	£1,500	0.25	£375
Asthma specialist nurse (band 7)	Days	£510	2.5	£1,275
Nurse/GP/pharmacy practitioners (band 7)	Hours	£68	25	£1,700
Total				£72,888

As shown above the average adult ACT score improved in this patient cohort from an average of 15.9 to 17.4. In DHP users that had ACT scores below 20, and thus had uncontrolled asthma at baseline, the change in ACT score was an average of 2.23. Vervloet et al. (2006)⁸, Nguyen et al (2017)¹⁰, and others demonstrate a clear relationship between ACT score and cost of asthma management, largely driven by asthma exacerbations leading to emergency care attendance and admission to hospital. Using cost data from these studies, adjusted to the UK context, it is possible to estimate the overarching cost of asthma management for a cohort of DHP using ACT scores at baseline, and compare these to the overarching costs following DHP use for three months.

The results for the 177 DHP users who had a complete record of ACT scores at baseline (T1) and after three months (T2) is shown in table 11 and figure 7.

Table 11: Estimated annualised costs for asthma management for 177 patients by ACT score (adults only) as reported at baseline (T1) and after 3 months of DHP use (T2)

ACT score	No. patients (T1)	No. patients (T2)	Cost per annum per patient*	Total cost (T1)	Total cost (T2)
Severely uncontrolled: <15	71	51	£2,569	£182,374	£131,001
Moderately uncontrolled: 15-19	59	60	£820	£48,375	£49,195
Controlled: 20+	47	66	£372	£17,462	£24,521
Total				£248,211	£204,717

* Exchange rate at 0.85 Euro to GBP, adjusted for inflation at 3% per year as per Bank of England inflation calculator

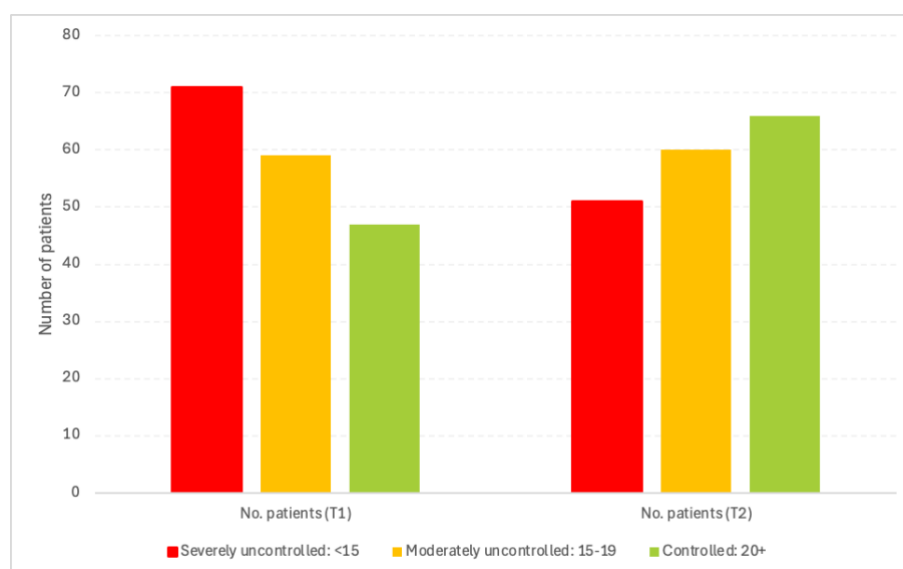


Figure 7: Numbers of patients by level of asthma control, based on ACT score at time 1 (T1) and time 2 (T2)

These results estimate that changes in the makeup of level of asthma control in this cohort of 177 DHP users after three months could result in £43,494 'saved' in the costs of asthma management.

Because of the relatively large cost per annum of severely uncontrolled asthma patients (defined as ACT scores below 15) even small changes in the numbers in this category can have a disproportionate impact on overall costs. Note that even well controlled asthma has a management cost, so any improvement in the uncontrolled groups will be offset to some extent.

This is a relatively small cohort of individuals and there is an inherent risk in using small numbers to scale up to a system/ICB level. However, as an indicative exercise that can be repeated with at-scale data at a later stage, table 12 outlines the estimated cost of DHP implementation, maintenance and asthma management over a three-year period, with year 0 as

a baseline year assuming no other asthma management interventions in place. This is modelled for a 'typical' ICB and is applied to 12-24 years olds only to reflect that costs are only available in relation to adult ACT. The findings in table 12 suggest an ROI of £9.28 for every £1 spent over three years.

Table 42: Estimated costs and savings against baseline (year 0) for three years per ICB*

	Year 0 (baseline)	Year 1	Year 2	Year 3
Implementation costs	£0	£76,986	£0	£0
Maintenance costs	£0	£0	£75,075	£77,327
Costs of asthma management-DHP users	£0	£1,170,811	£1,790,796	£1,916,465
Costs of asthma management-other asthma patients	£9,463,739	£8,044,178	£7,008,828	£6,101,145
Total	£9,463,739	£9,291,975	£8,874,698	£8,094,937
Estimated savings		£171,764	£589,040	£1,368,802

Note the following assumptions underpinning this model:

- The only recurring cost for DHP is the stated licensing, maintenance and training costs; any additional requirement for (e.g.) IG support is not include.
- All non-DHP users have the same uncontrolled/controlled category mix as DHP users at baseline and maintain this throughout the three year period
- The level of take up each year among the 12-24 years asthma cohort increases year on year, from 15% in year 1 (~1,900 users), to 30% in year 2 (~3,600 users), to 45% in year 3 (~5,000 users)
- DHP users onboarded in year 1 continue to make progress in terms of category of asthma control in years 2 and 3 at the same rate as in year 1, based on the data outlined in table 11
- Patients aged 12-24 with a new asthma diagnosis in year 2 and 3 have the same take up rate as the initial cohort and make progress in terms of category of asthma control in subsequent years in the same pattern as those onboarded in year 1
- There is an 8% attrition rate per year based on patients 'aging out' of the target cohort
- Based on a 'typical' ICB 12-24 years asthma prevalence of 16%¹¹ and a population size on the 12-24 years age group of 77,490¹² and an incident asthma rate of approximately 12%¹³

This analysis is based on translating ACT scores into a level of 'asthma control'. A single point increase in ACT score will not necessarily change the control category used in table 11 to estimate costs but this grouping conceals detail of changes in underlying risk of asthma-related events that can be predicted by even small changes in ACT score. An alternative approach to estimating the cost impact of reductions in ACT score could be to profile the change in risk of asthma-related adverse events and cost the difference.

Schatz et al. (2009)¹⁴ estimate that in patients with uncontrolled asthma (ACT score below 20) a single point change can make a material difference in odds ratio for asthma exacerbations. For an asthma patient with an ACT score of 15 the odds of suffering an asthma exacerbation in the next six months is estimated to be 1.6 times the odds of a patient with an ACT score of 20 or above (OR = 1.6, 95% CI = 1.58-1.62). An increase in ACT score to 16 reduces this to odds of 1.46

(OR = 1.46, 95% CI = 1.44-1.48). Similarly, ACT shows the odds of high usage of SABA inhalers (6+ inhalers in a six month period) in patients with an ACT score of 15 to be 2.57 times more than the odds of patients with controlled asthma (OR = 2.57, 95% CI = 2.54-2.60). Improving ACT score to 16 reduces this to odds of 2.13 (OR = 2.13, 95% CI = 2.10-2.16). At scale, applying this risk reduction associated with just 1 point average improvement in ACT score to a whole population suggests significant cost saving opportunities.

The amount of data available at this stage prevents this alternative approach from being feasible but could be explored with larger sample sizes.

Patient interviews

In total, 51 DHP users were recruited through the app to undertake a short telephone interview. Of these, 13 did not attend (25%), leaving 38 completed interviews suitable for analysis. Four clear cohort groups of participants emerged from the analysis:

Table 53: Participants in DHP user telephone interviews by cohort group

Group	Number of participants (completed interview)
Parents/carers using DHP on behalf of child or young person	15
Child or young person using DHP for themselves	5
Adults (25+) using DHP for themselves	15
Asthma nurses using DHP for demonstration or educational purposes	3

As noted above, responses from asthma nurses were analysed separately as their responses would not be appropriate in the context of the continuous use model. Their feedback has been considered as part of clinician feedback.

Findings from the remaining 35 interview are summarised by domains of the continuous use model (see figure 1).

Information quality

Generally, participants found the information on the DHP easy to understand and felt the articles included were the right length and shared the right amount of information. The DHP was felt to be unique in providing a single source for varied, high quality information on asthma.

To me it's got the right balance... This has the right level of information to have lots of information, but in a digestible form for people of varying abilities.- Adult user

This did vary by levels of baseline knowledge; DHP users with long-standing asthma felt that the information contained in the DHP would benefit newly diagnosed asthma patients, or those without access to an asthma nurse. Participants using the DHP for themselves who had asthma for a longer period reported less benefit from the information included in the DHP, although this was not universal.

Some participants reflected on specific formats and areas of information being particularly relevant or useful, highlighting videos on inhaler technique. Of particular interest was the reflection from some participants that the DHP helped users to better understand the *personal* nature of their asthma and improved their communication of their symptoms. It was felt that the information provided was supporting DHP users and their carers to be empowered to take more ownership of their asthma.

When I did the other review, one of my questions I was asked is can you trust the videos? And I said, well, no I can't because I don't know where they're sourced. - Adult user

There was some less positive reflection on the information quality element of the DHP. Some participants reported information provided in the DHP conflicted with information they have been given previously (e.g. recommended frequency of inhaler use in an emergency). In addition, some participants shared that they preferred to collect

information from other sources they have previously used, such as BBC Weather for allergen information. Finally, some participants felt that the information included in the DHP did not take patients with multiple conditions that could affect their asthma into consideration (bronchiectasis was an example given).

Usability

Overall, users found the DHP easy to use; 100% of all interview participants confirmed it was easy to use. They felt it was well structured, straightforward and visually appealing. Parent and carers reported that they tended to use the DHP on behalf of older children, in part due to children not taking 'ownership' of their condition.

It does seem very user friendly, very easy to use and also very much from a patient perspective rather than say too clinical or whatever.- Adult user

Some users reported they would like features which already exist in the DHP, for example a calendar view of symptom tracker, suggesting they have not been prompted to access these features. Feedback on improved wayfinding and navigation, for example a search bar, suggested ways this could be improved and potentially reduce the time that participants reported it could take to explore all the DHP's capabilities.

It is difficult because at the bottom there is various buttons that you can press, but there's no actual button to say "enter today's reading"... That would be essential really.... think that's where I've discovered I'm going wrong. I think it's down to the wording.- Adult user

Specifically, some interview participants shared they find the prompts to complete surveys too frequent and can find it "intrusive". In addition, occasionally the wording and instructions on the DHP were not clear to all participants, for example use of the word "hacks", and the labelling of the button to add peak flow readings. More flexibility to review their data recorded with the DHP (e.g. peak flow) was also a usability improvement suggested.

More broadly, interview participants acknowledged that the high usability of the DHP in their experience may not be the same for users who use, for example, a screen reader, do not read English well or have low digital literacy.

Support quality

As a concept, support quality has been difficult to assess in relation to the DHP because no interview participants reported the need to seek support with using it. No interview participants have used the support pages accessible from within the DHP; participants generally know where the relevant button is on the DHP but did not feel they had a need for it.

I haven't come across anything that hasn't worked for me - Parent/carer

Some interview participants said that if they did have issues with the DHP they might seek support from their GP, asthma nurse, or call 111; this may be a concern in terms of using clinical resource for DHP app support.

Perceived health status

In the context of the Continuous Use Model, perceived health status refers to an individual's self-assessment of their overall health and well-being, which can influence their motivation to continuously engage with health-related technologies or digital platforms. In the model, perceived health status has a negative association with continuous use, that is, if a user feels they have good health status (i.e. their asthma is under control) they may engage with the technology or platform less. This may be the case with the DHP.

.....my daughter actually had an asthma attack and she had been...admitted into hospital due to it because it was quite severe. And I actually pulled out the [DHP] . I showed the NHS when I was there as well because that's what I went from as I got regarding what kind of symptoms I needed to look out for. And so that really helped at the moment in time when you don't have anything lying around, you kind of got that app to kind of help see ...what kind of symptoms you're looking for in a child - Parent/carer

In general, most interview participants reported accessing specific parts of the app regularly, for example notifications and alerts, as they do not require regular interaction or input. Some interview participants reported that they will only actively use the app in times of heightened symptoms such as over the summer, or when in crisis, for example during an asthma attack, and will use different parts of the DHP in response including emergency section and the care plan functionality.

This was similar for interview participants who used the DHP on behalf of children or young people; some parents/carers described using the

DHP only on specific occasions where their child had been admitted to hospital, where access to the tracker and care plan was really beneficial.

As per the continuous use model, some users reported they may use the app less if their asthma symptoms were to improve; those interview participants in whom their asthma is well controlled and have had the condition for a while report using the app less frequently and finding it less useful. There are some aspects that are still useful in this context such as peak flow tracking and weather updates, but interview participants in this cohort reported already having access to the support elsewhere, including an alternative app (PeakFlow) and BBC Weather Alerts.

Because I'm well controlled, I'm not in a position to be looking for assistance. If I'd have to flare up Perhaps so, yes....I think I think the app would be useful for anyone that's newly diagnosed or poorly controlled. - Adult user

However, in interview participants with well controlled asthma the DHP was still cited as being useful in helping those who have controlled symptoms to be more reflective of their health and indicate early when it may be deteriorating. In addition, many interview participants are using it to identify and monitor triggers, for instance where they need to gather evidence to indicate whether their treatment is working.

Perceived benefit

Interview participants reported direct and indirect benefits of using the DHP. In direct terms the benefits reflecting improvements in:

- Awareness: Most interview participants feel their awareness of asthma and allergies have improved using the app, from general awareness of asthma to awareness of specific, individual triggers of asthma. Even interview participants who identified as being well-educated in asthma have learned something new in the DHP, for example the video on inhaler technique for new inhalers.
- Management: Timed medication reminders have supported interview participants to take the appropriate medications at the appropriate times. Symptom tracking has helped interview participants identify when their condition may be deteriorating and take appropriate action and access care. Air quality alerts have also supported interview participants to adapt their behaviour to avoid it exacerbating their asthma, for example taking an antihistamine or closing windows at peak pollen count.
- Control: Some interview participants reported fewer asthma attacks since using the app which they attributed to better inhaler usage and risk minimisation. However, some interview participants could not identify a link between using the app and improving their asthma, or shared that it was too subjective to know definitively.

It has not only taught me new information about [asthma], but it has also made me refresh information that I was given in the past ...It's helped me think about my disease in different ways.

So instead of just thinking about treating my disease, I'm thinking about ways of minimizing it from occurring.- Adult user

Indirect benefits identified by interview participants were on several themes:

- Exposure to other helpful resources: the Asthma Spotlight podcast was cited as an example.
- Reducing need to find resources themselves: Adult interview participants described previously collecting the information provided on the DHP through disparate, potentially unreliable sources. Now it is available in one place it reduces the time and energy required to collect this, for example about air quality alerts.
- Reducing cognitive load: Most interview participants reported a benefit of the medication alerts was reducing their cognitive load, particularly where adult users are on lots of medications or parents are managing a busy family life.
- Normalising asthma: Some parents using the DHP for their child reported the videos were particularly useful in normalising asthma, and making them more likely to engage with self-management, for example using a spacer.

I think if I didn't have [the reminders] now, I would very quickly get out of that habit of, you know, taking my inhalers in the morning, taking them at night, taking my tablets at night, all those sorts of things... I see that visual reminder. It's that alone really has made a big difference - Adult user

My daughter ...was so embarrassed of having asthma and she wouldn't take her inhaler and that and I think being able [to] have something like this ...she would realise that there's nothing to be embarrassed about. – Parent/carer

- Supporting & engaging the whole family: Some parents/carers reported that multiple members of the family were using the DHP to support their asthma needs, supporting each other and finding benefit from different perspectives. Parents/carers also reporting that using the DHP has supported their

children/young people to understand the significance of their asthma, take more ownership of it, and ultimately support improving their outcomes. Some carers reported children becoming enthusiastic about using the app and caring for their asthma. In particular, seeing content of children and young people using inhalers has made some children and young people more likely to engage with their condition.

- Backing up essential documents: Many adult carers also noted the benefit of having the asthma plan on their phone, due to the risk of losing a paper copy.

User satisfaction

Most interview participants were very satisfied or satisfied with the DHP (95%) with the primary areas driving satisfaction being:

- The “all-in-one” convenience of the DHP
- Reminders and air quality alerts
- Symptom tracking

Most interview participants would recommend it to adults or children and young people with asthma (97%), and some already have.

These findings were despite different types of users using the DHP in different ways; all received some form of benefit.

The key component of the DHP that prevented some interview participants from rating ‘very satisfied’ was the tracker function in terms of difficulty navigating to it, difficulty in reviewing previous results and lack of options to adjust the visualisations (as noted under ‘Usability’).

But what I love about this app is it's not just a reminder app. It's not just an information app or whatever. It's an all-inclusive thing, and it embraces everything you need as a patient to have, and I think there is nothing worse than maybe having multiple health apps on your phone..The more you can fit something in one app, I think it's the better route to take really – Adult user

DHP in the context of the continuous use model

Most of the interview participants intend to continue use of the DHP (97%). The findings on the various domains of the continuous use model align with the hypothesized relationships between these dimensions and the intent to continue. Figure 8 below shows how each dimension, in relation to DHP, relates to the intention to continue based on the findings outlined above.

In general, the intention to continue use of the DHP has been driven by high level of perceived benefit (both direct and indirect), high levels of user satisfaction, and high usability, as predicted by the model. Also as predicted, interview participants’ perceived health status has a negative

association with continuous use intention, where those with better asthma control are less likely to continue to use the DHP. As such, the perception of the DHP as a means of primarily improving control or 'being more useful for people with a new asthma diagnosis' is one that may need to be challenged to maintain long term engagement. Similarly, information quality also appeared to be more of a risk area for the DHP with some feedback that may impact trust and therefore perceived benefit.

Findings in relation to this model have indicated a relationship between support quality and usability. Where usability is high, the requirement for support has been low and as such has not played a significant role in the continuous use model as applied to the DHP.

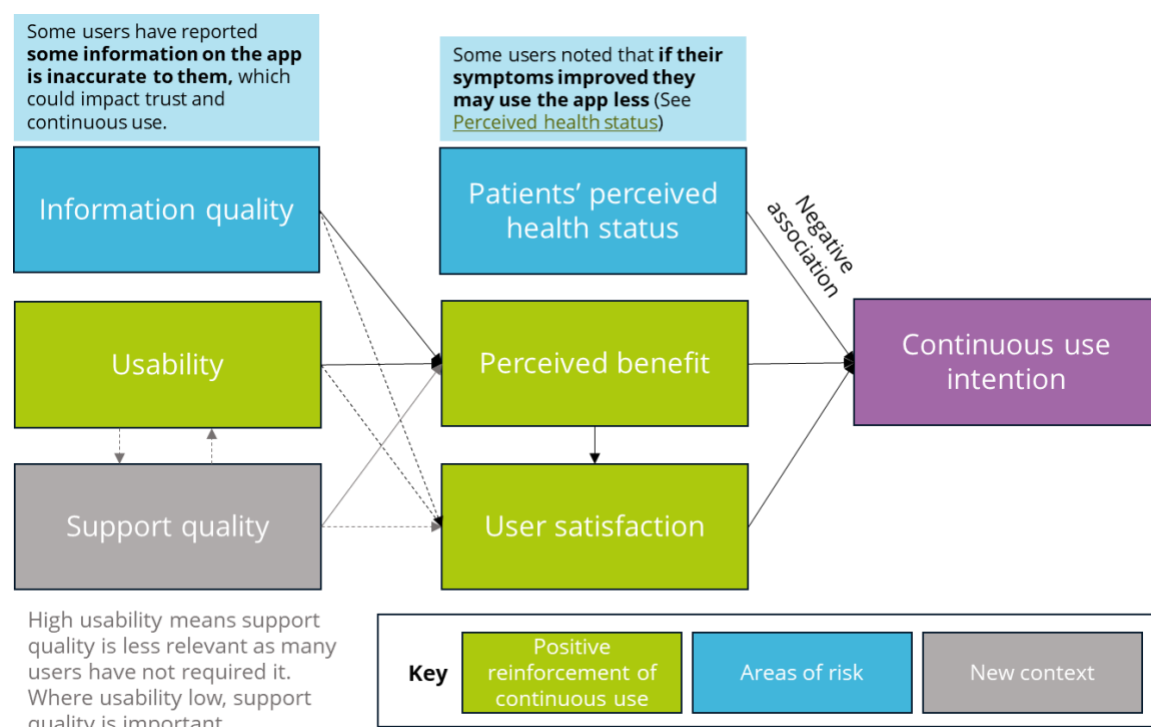


Figure 8: Findings from the DHP patient interviews in the context of the continuous use model (Song et al., 2021)

Additional findings from patient interviews

The telephone interviews, whilst primarily structured around the dimensions of the continuous use model, gave rise to additional insights, particularly in relation to engagement and the link between DHP use and outcomes. Insights regarding initial engagement with the DHP are included in the previous section on findings related to adoption strategies.

With regard to outcomes, most interview participants reported an improvement in their asthma knowledge and management, however a smaller number reported an improvement in outcomes, particularly those who have been using the DHP for a short time. Many participants shared that they considered that 'improvement in outcomes' including factors such as reducing attacks but more so improving their peak flow readings, reducing the need for their preventer inhaler and minimising risk by taking antihistamines when required. Interview participants shared an awareness of the link between medication understanding, optimisation and adherence with improved management and outcomes.

These findings could indicate the importance of delineating between leading indicators (e.g. peak flow, preventer inhaler usage) and lagging indicators (e.g. asthma attack incidence) when considering the measurement of outcomes for DHP users.

Review of findings

Interpretation of findings against KEQs

The eight key evaluation questions outlined on page 3 are reviewed below in the light of the findings described above.

Has the use of the DHP impacted on patient activation?

There is strong evidence that the DHP has impacted on patient activation in terms of overall score on the PIH scale reflecting a *general* improvement. There are also some significant impacts on some of the individual dimensions that the PIH instrument consists of. The following dimensions are particularly noteworthy:

- Overall knowledge of condition
- Overall knowledge of treatment, including medications for condition
- Sharing in decisions about asthma with doctor or healthcare worker
- Keeping track of symptoms and early warning signs
- Taking action when early warning signs and symptoms get worse
- Managing the effects of the condition on physical activity
- Managing the effects of the condition on emotions and mental health
- Managing the effects of the condition on social life
- Overall, managing to live a healthy life

The results for each of the nine dimensions listed above were found to have statistically significantly improved. Some degree of improvement was evident across all the dimensions of the PIH patient activation instrument. However, the validity of using these single dimensions of a composite measurement instrument such as PIH is far from certain and should be interpreted with caution.

Feedback from user interviews also suggests that the DHP has supported individuals or their parents/carers to become more engaged with their condition and take action to prevent issues. The direct benefits identified by users, particularly in relation to management and awareness are particularly strong indicators of increased activation.

This suggests overall that the DHP has driven an improvement in patient activation, with clear themes relating to knowledge and education and self-management.

The two questions appended to the PIH instrument regarding confidence in discussing asthma with health care professionals and family members showed small increases in mean score but were not statistically significant. Measures of confidence are an important facet of patient activation; improved knowledge and skills are obviously useful but without the confidence to discuss and apply this knowledge the benefits may not be as readily realised.

Whilst there is evidence of DHP user's impact on patient activation, this does not hold for DHP users under 13. The reasons for this are not obvious but may be a result of the data mainly being reported by carers. A more in-depth analysis within this age band with a larger sample size may give rise to some indication of whether there is a relationship between age and activation.

Thus, whilst findings do illustrate an impact on patient activation of the DHP, some caution is warranted with regard to the degree of change in behavior and therefore outcomes that this

could influence without a change in confidence as well as knowledge and skills, and the apparent differential impact on younger age groups.

Have people using the DHP demonstrated changed asthma control, according to results from remote asthma control tests (ACTs)?

There is a clear indication of an impact on ACT scores. ACT scores appear to improve with use of the DHP, changing by an average of 1.5 points in the adult (12+years) cohort. Whilst this is below the proposed minimum clinically important difference of 3 points* (Schatz et al., 2009)¹⁴, there is some nevertheless evidence that even small changes reduce risk of asthma-related adverse events such as exacerbations and admissions.

Results in the paediatric (<12) cohort of DHP users are less striking with a mean change of 0.1 points on the overall score. This is below the minimum clinically important change of 1.6 suggested by Voorend van Bergen et al (2014)¹⁷ for users 4-11 years of age.

If the cohort of DHP users undertaking the adult ACT is limited to those who showed uncontrolled asthma at baseline (T1), defined by a score of less than 20, the improvement in ACT score is larger than the overall average at 2.24 points ($\bar{x}_{t1} = 13.58$, $\bar{x}_{t2} = 15.82$) and closer to the minimum clinically important difference as described by Schatz et al. (2009). It is this larger improvement that drives the potential economic impact as the shift from very uncontrolled to moderately uncontrolled to controlled has significant implications for the cost of management. This is a relatively small sample of users (n= 130) but demonstrates that the DHP may have a greater effect on ACT results for users who are particularly challenged in terms of control and have implications for initial targeting of users to garner greatest benefit.

From the available data it can be concluded that the DHP appears to have influenced changed asthma control as defined by improvement in results from the ACT score; however this is only well evidenced in the 12+ years cohort as the sample for the pACT is much smaller and does not come close to any estimate of minimum clinically important change.

Have people using the DHP demonstrated changes in self-reported quality of life?

There is no evidence in this analysis that the DHP has influenced changes in quality of life. The results overall, and within different age groups were not significant, and no individual dimension showed a change between T1 and T2 than any others.

It is possible that the measurement instrument was not sensitive enough for this particular cohort. An asthma-focused quality of life measurement may be more suitable for this purpose but it is possible such an instrument may have significant overlap with other measures in the survey such as ACT and PIH.

Evidence from the user interviews suggests that there may be some impact on quality of life as described through identification of indirect benefits, such as decreased cognitive load. However, this feedback is not aligned to the key dimensions of quality of life as described in the EQ-5D and should be viewed as contextual information only.

Have people using the DHP reported a change in NHS service usage, including prescribing?

There is no evidence in this analysis of a change in NHS service usage. The self-reported 'asthma check' measures which are used to indicate this show that, in DHP users where T1 and T2

* * Voorend van Bergen et al (2014) suggest a lower MCID of 2 on the ACT test for users aged 12-18. The variance between age groups has not been considered specifically here due to low numbers but should be included in future analysis

responses are complete, there is no statistically significant change in number of asthma attacks, prescribed steroids or urgent and emergency care use episodes. These measures are less robust than others in the survey; they are both self-reported and have not been subject to validation checks with potential data quality issues in the early respondents at T1 that could be affecting results. Nevertheless, it is important to note that the potential benefits from improved ACT score described above in terms of medication use, exacerbations and use of urgent and emergency care are not reflected in the self-reported measures.

The self-reported measures only look at steroid prescription, which may be prescribed either as 'preventer' therapy or, short term, to treat exacerbations; the reason for steroid prescribing is not differentiated in the question asked of DHP users making it difficult to use this data to make a judgement about changes in medication. However, as noted in the findings above, there is some evidence from one question in the ACT of a small improvement in DHP users rating of the frequency with which they use their *rescue* medication, changing by an average of 0.29 points. However, the significance of this size of effect is unknown and the validity of using this single dimension of a composite measurement instrument such as the ACT is far from certain.

Overall, this analysis does not support DHP impacting on NHS service usage. A longitudinal analysis linked to DHP users' primary care records could be a more objective way of measuring service usage to enable a more robust answer to this key evaluation question and has the additional advantage of being easier to include in economic models.

Is the DHP cost effective from a health system perspective?

From the ICB perspective there is clear evidence that the implementation of the DHP could be cost effective over a three year period, on the assumption that the impact on ACT score can be generalized across a population and that the costs of uncontrolled asthma remain differentially much higher than the cost of managing well controlled asthma. There is a low implementation and maintenance cost, largely driven by the recurring license cost but with some workforce implications.

The large costs of asthma management to a 'typical' ICB, mean that even relatively low take up, particularly in the *uncontrolled asthma cohort* is likely to generate savings in the cost of asthma management. Whilst the model in this report has not attempted to breakdown where these savings might be made, they are most likely to be generated through a reduction in urgent and emergency care use (including OOH GPs) and high levels of rescue medication prescribing. Note that even well controlled asthma has a cost implication in terms of management and these costs will offset any saving realised by improving asthma control in DHP users with poor control at baseline.

Overall, this analysis supports the DHP as cost-effective to health systems within a short time period. As with all economic forecasts, caution should be exercised given the vagaries of local costs and variation within asthma populations and between ICB areas.

To what extent is the DHP acceptable to users and which elements of the DHP are particularly useful to the individuals using the product?

The interviews with DHP users showed very clearly that users find the DHP acceptable, evidenced by positive feedback on usability, satisfaction and benefit. Even where users do not utilise all the features of the DHP, because their condition is well controlled, they had positive feedback on the features they do use.

Users reported in interviews that they use the DHP in many ways, ranging from using it to remind them to take regular medication, through to using information in the symptom tracker with their child's care team in an emergency. This range of use cases shows that the DHP is acceptable in different contexts and to different individuals.

The elements that were most universally utilised and discussed in the user interviews were the symptom tracking, medication reminders and air quality alerts. Users made helpful suggestions about how these might be improved (e.g. greater flexibility on the data visualisation functionality on the symptom tracker), indicating a high level of engagement.

Overall, the acceptability and usability of the DHP is very high among a range of users with differing needs. Future evaluation may wish to undertake interviews or surveys with a larger sample that can be disaggregated on key demographics to ensure there are no differences between specific groups. Furthermore, engagement with users who have stopped using the platform would also provide more balanced insight, including potential barriers to use including digital inequity and accessibility to non-English speakers.

Do people using the DHP intend to continue usage?

DHP user interviews suggest that most users intend to continue using the app in managing their asthma or that of their child/dependent. The dimensions of the continuous use model (Song et al., 2021²¹) that predict continuous usage are well evidenced, particularly usability, perceived benefit and user satisfaction.

The only factors that may be a risk to continued usage are perceived issues with information quality amongst some interview participants; of particular note was the disparity with other sources of information that could lead to mistrust of the DHP if these other sources are deemed especially reliable.

The other risk factor is the expected negative link between perceived health status and continued use; users are less likely to use DHP if they feel their asthma is under control. To some extent that could be viewed positively; the DHP could be said to have 'done its job' if it is no longer needed. However, this also provides an opportunity to position the DHP as an app that doesn't just support you when you have a new diagnosis or are feeling unwell, but also to help you *keep* your asthma controlled. Features such as alerts and tracking could be used to strengthen continuous use intention by flagging their importance as preventive tools.

Which of three scalable adoption strategies has been most successful?

All three of the adoption strategies have been successful to some extent and the answer to this KEQ is largely dependent on what 'success' looks like. In terms of value for money, it is hard to compare as the conversion from engagement with DHP materials or educational content to adoption of DHP is not available for all three strategies. Broadly, a spend of about £5,000 on traditional materials over the course of ten months *could* have reached up to 500,000 asthma patients, whilst a six month TikTok campaign for around the same cost generated 2.2 million impressions. The two measures of engagement cannot really be compared but the social media strategy is likely to have a much greater reach and, arguably, into an area where young people with asthma are far more likely to be. In addition, it is much easier to track progress and engagement with this approach, leading to a much more granular understanding of the impact of specific content and better control over spend and campaign planning.

However, traditional methods and the use of training with clinicians to increase awareness amongst clinical staff *and* young people together does have its own benefits. Firstly, these adoption strategies are more likely to target those young people who have uncontrolled asthma and evidence from focus groups suggests that these higher risk young people are the primary group that clinical specialists engage with. Patients with uncontrolled asthma are more likely to be in contact with health care services, either due to exacerbations or regular visits to primary care and are therefore more likely to be where the promotional material is. It is this group of uncontrolled-at-baseline asthma patients that has been shown from other findings in relation to the ACT to benefit the most from use of the app.

It could also be argued that by increasing clinician awareness of the DHP and its potential benefits through traditional NHS communications and training, is more likely to lead to the development of a working partnership between patient and healthcare team with the DHP as an enabler. Feedback from the focus groups and survey suggested that DHP was a useful tool for engaging with young people about their asthma and forming the basis for reinforcing self-management conversations. More traditional approaches are also more likely to mitigate digital inequality issues. There is also a supposition that patients adopting the DHP via clinical intervention or healthcare settings may see the DHP as 'part of their treatment' which may give rise to improved adherence with tools such as symptom tracking; however, this is hypothetical and additional research would be required to assess this in detail.

Overall, it is hard to distinguish which adoption strategy has been most successful given the varying approaches to measurement of impact. It seems that the social media approach is likely to generate the most conversions across a broader population base, but for patients either with specific needs, or who may be more likely to benefit most from the DHP in tandem with clinical guidance, the more traditional or clinician centric approaches could continue to be useful strategies.

Which adoption strategy best promotes inclusion and diversity of DHP users?

In adoption strategies involving traditional communications and clinical training it is hard to assess which groups or communities are exposed to which materials, and even less easy to understand which lead to adoption of the DHP, without making assumptions about the evenness of distribution across the target population of a particular area. Therefore, an objective answer to this question is difficult to judge on the current data available. However, at scale, TikTok allows for much greater precision in targeting at-risk or underrepresented groups, utilising big data and ongoing algorithmic development to identify and target groups and communities of interest. The rapidity with which content can be created and adjusted for specific audiences is also likely to contribute to better promotion of inclusion and diversity, for example by using popular influencers that resonate with the communities and age ranges being targeted.

There is evidence from this analysis that the TikTok based approach does help address known inequalities in terms of demographic factors such as ethnicity and socioeconomic status, but there are other dimensions that TikTok would not be able to address, for example neurodivergence and digital inequity, the latter of which is more likely in more socioeconomically deprived areas. Therefore, whilst TikTok and other social media strategies clearly takes the message out to where young people potentially at higher risk of inequity are, consideration of other groups should be taken into account.

Interpretation against key objectives for the DHP

In this section, analysis findings are interpreted against the key areas that are of concern to NHS systems which are in turn a focus for the DHP and its developers. This analysis uses the same data and findings but seeks to interpret them through the lens of different set of questions, namely:

- Does the DHP address over reliance on reliever medications?
- Does the DHP support with decreasing the number of asthma attacks?
- Does the DHP contribute to NHS systems delivering against national standards?

Does the DHP address over reliance on reliever medications?

The evidence from this analysis on change of use of reliever (or rescue) medications is limited. The data collected does not allow assessment in absolute terms although there is some evidence from one dimension of the adult ACT that suggests a small improvement in DHP users rating of the frequency with which they use their rescue medication, changing by an average of 0.29 points. However, the significance of this size of effect is unknown and the validity of using this single dimension of a composite measurement instrument such as ACT is far from certain.

However, the evidence of improvements in ACT scores and patient activation outlined in the previous section indicates that a reduction in use of reliever medication should follow. Evidence suggests that there is a moderate relationship between ACT score and rescue medication use; Schatz et al (2009)¹⁴ suggests the odds of having 6+ rescue inhalers dispensed in a six month time frame increases significantly at lower ACT scores (i.e. poor control) and statistically significant correlations between ACT score and the number of rescue inhalers dispensed were identified in Wojtczak et al (2012)¹⁷, although note that neither of these studies were limited to younger people and the latter was US based.

Similarly, increased knowledge and skills in the management of asthma should lead to reduced reliance on medication. A Cochrane review of 36 randomised control studies concluded that adult asthma sufferers in receipt of an asthma self-management intervention, which included asthma education, used less rescue medication compared to patients receiving usual care¹⁸.

Overall, the impact of the DHP on ACT score and patient activation, particularly from an education perspective, predicts an impact on use of reliever or rescue medication but this is not demonstrated directly within the current data set.

Does the DHP support with decreasing the number of asthma attacks?

In a similar way to the question above with regard to reliever medication use, the evidence from this analysis does not directly support a reduction in the number of asthma attacks. On average, the number of self-reported asthma attacks in the past 3 months decreased very slightly, but not significantly ($\bar{x}_{t1} = 1.02$, $\bar{x}_{t2} = 0.93$), although there are also issues with data quality for this measure that may be impacting results.

However, studies of the relationship between ACT scores and patient activation and asthma exacerbations follow a similar pattern to that of reliever use, whereby there is a correlation between incidence of exacerbation and lower ACT score (Schatz et al, 2009) and a clear relationship between provision of self-management interventions, specifically education, and a fall in exacerbations and associated need for admissions to hospital or other urgent care usage¹⁸.

Both reliever use and asthma exacerbation are clinical priority areas included in the CORE20PLUS5 approach to reducing health inequalities for children and young people¹⁹ and critical deliverables for NHS systems. The demographic profile for DHP users, in part due to the targeted adoption strategies employed, skews towards to more deprived quintile (c.54% from quintiles 1 and 2), and is representative of non-white ethnic groups (compared to England as a whole). This demonstrates that the evidenced impact can be realised in a population generally more diverse and more socioeconomically deprived than England as a whole.

Taken together, this supports the DHP as a potential support in helping ICBs realise the ambitions of the CORE2PLUS5 approach. Further analysis stratified by IMD quintile and ethnic group may provide additional insight on the differential impact, and the additional work on adoption strategies could also contribute to a wider understanding of how specific groups could be recruited to the DHP either using successful social media-based strategies or more tailored approaches to help combat health inequity in children and young people with asthma.

Supporting systems to deliver against national standards

In terms of supporting systems to deliver against national standards, table 14 summarises the evidence from findings to date against each of the relevant national standards that ICBs are held to in the National Bundle of Care for Children and Young People with Asthma¹⁵. Please note that analysis of contribution to some of these standards cannot be undertaken at the current time where data collection is still ongoing; this is noted in the table.

Table 14: summary of evidence for DHP support against relevant national standards for asthma care for ICBs

National standard (short text)	Evidence from findings	Notes & future development
E12: CYP, parents and carers should always receive information on how they can manage asthma with regards to air pollution. Information should be accessible in such a way that is appropriate to that CYP, this may include live updates through digital apps.	CYP users and parent/carer users interviewed report the educational content and alert functionality with regard to air pollution as useful and usable. The 'one stop shop' element of the DHP has reduced the need for users to search for this information elsewhere.	A larger sample of users could provide greater insight into how this functionality is used, and allow for focus on high pollution areas (e.g. major cities)
EAD4: ICSs should develop health education strategies for their local population to: • Improve awareness about what asthma is • Its potential severity • Symptoms that should warrant review by a healthcare professional	DHP user interviews show users to be satisfied with information quality and felt the content provided to be accessible and digestible. In the case of parents/carers using the DHP on behalf of an asthma patient, video content normalising asthma and how to manage it was especially welcome.	A larger sample of users could provide greater insight into how educational functionality is used, and allow for focus on different and/or high risk demographic groups
EPM 5: All CYP with asthma should have a Personalised Asthma Action Plan	The completion of the ACT (or pACT) provides an objective review of key features of asthma control, all of which will inform PAAPs if shared with GPs or asthma nurses. This has been	Over time, a better picture will emerge of the frequency with which PAAPs and ACTs are refreshed by DHP users, thus reflecting how relevant

National standard (short text)	Evidence from findings	Notes & future development
	completed at least once by 85% of all DHP users included in the dataset.	current data in the app is to ongoing management.
EPM 7: Patient self management should be encouraged to reflect their known triggers including stress and air pollution	Data from the PIH scale reflects improvement for DHP users in recognition of and taking action in response to early warning signs and symptoms, coupled with improvement in keeping track of symptoms.	This doesn't speak specifically to known triggers but does reflect an improvement in awareness of how to prevent exacerbation
EPM 8: All patient encounters should be viewed as an opportunity to improve the understanding of children and their families.	Clear evidence of statistically significant improvement in knowledge of asthma as a condition and the treatment and medications used to manage it is evident from the patient activation measures.	Evident across all participants completing T1 and T2 survey. When sample size is bigger, differentiation by age would be advisable.
EPM 9: Parents and children, and those who care for or teach them, should be educated about managing asthma.	Clear evidence of statistically significant improvement in knowledge of asthma as a condition and the treatment and medications used to manage it is evident from the patient activation measures.	Evident across all participants completing T1 and T2 survey. When sample size is bigger, differentiation by age would be advisable.

Limitations

As with all evaluations, findings and interpretations are based on accessible data and, whilst analysed robustly, should be viewed with requisite caution. Specifically, the reader is asked to consider the following limitations in their reading of this report:

- The sample of participants completing both T1 and T2 surveys is reasonable, but larger sample sizes are always desirable to improve the power of statistical tests and therefore the veracity of the conclusions drawn from these. However, the common directionality of the findings across a broad range of measures are indicative of an effect.
- Costings used in the health economic analysis are indicative and reflect 'average' costs. Individual systems are likely to have differing local workforce costs (e.g. subject to differing market forces factors), varying overhead inclusions and variability in asthma management approaches that may all impact DHP implementation costs and the cost of asthma care.
- As with any data collection there are limitations due to data quality and validation issues. For example, in the case of the DHP user survey dataset 13.9% of participants did not record their age. Ethnicity was also an issue, with 12.1% of participants not recording ethnicity. Lack of validation on some data items, specifically in the 'asthma check' and some EQ5D questions has required some 'trimming' of values to eliminate outliers, and exclusion of cases in order to ensure completion of all data items. Going forward, improvement of data quality using mandatory fields and validation for open fields would improve the analysis quality further.

- The sample for the user interviews was smaller than hoped; in total, 75 interviews were planned, 51 booked and 38 completed. A larger sample of users could provide greater insight into how the DHP is used and allow for greater differentiation by user group and demographics.
- Comparison of the three adoption strategies was difficult due to the varying nature of how dissemination and cost was tracked, and impact was assessed. In addition, staff surveys and participation in focus groups attracted only very small numbers. A more in-depth assessment of DHP usage across multiple professional groups could yield additional insight and confirm the early finding outlined in this report.

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Appendix A: Partners In Health Scale

For asthma users

For each statement, please choose the number that most closely fits for you.

PIH1. Overall, what I know about my asthma is:

0 – Very little 1 2 3 4- Something 5 6 7 8- A lot

PIH2. Overall, what I know about my treatment, including medications for my asthma is:

0 – Very little 1 2 3 4- Something 5 6 7 8- A lot

PIH3. I take medications or carry out the treatments asked by my doctor or health worker:

0 – Never 1 2 3 4- Sometimes 5 6 7 8- Always

PIH4. I share in decisions made about my asthma with my doctor or health worker:

0 – Never 1 2 3 4- Sometimes 5 6 7 8- Always

PIH5. I am able to collaborate with health professionals to get the services I need:

0 – Never 1 2 3 4- Sometimes 5 6 7 8- Always

PIH6. I attend appointments as asked by my doctor or health worker:

0 – Never 1 2 3 4- Sometimes 5 6 7 8- Always

PIH7. I keep track of my symptoms and early warning signs (e.g. peak flow, shortness of breath):

0 – Never 1 2 3 4- Sometimes 5 6 7 8- Always

PIH8. I take action when my early warning signs and symptoms get worse:

0 – Never 1 2 3 4- Sometimes 5 6 7 8- Always

PIH9. I manage the effect of my asthma on my physical activity (i.e. walking, sports):

0 – Not very well 1 2 3 4- Fairly well 5 6 7 8- Very well

PIH10. I manage the effect of my asthma on how I feel (i.e. my emotions and mental health):

0 – Not very well 1 2 3 4- Fairly well 5 6 7 8- Very well

PIH11. I manage the effect of my asthma on my social life (i.e. how I mix with other people):

0 – Not very well 1 2 3 4- Fairly well 5 6 7 8- Very well

PIH12. Overall, I manage to live a healthy life (e.g. healthy food, regular physical activity):

0 – Not very well 1 2 3 4- Fairly well 5 6 7 8- Very well

PIH13. I feel confident talking about my asthma with healthcare professionals:

0 – Disagree strongly 1 2 3 4- Neither agree nor disagree 5 6 7 8- Agree strongly

PIH14. I feel confident talking to my family about my asthma:

0 – Disagree strongly 1 2 3 4- Neither agree nor disagree 5 6 7 8- Agree strongly

For parents/carers

For each statement, please choose the number that most closely fits for you or for your child/person you care for.

PIH1. Overall, what I know about their asthma is:

0 – Very little 1 2 3 4- Something 5 6 7 8- A lot

PIH2. Overall, what I know about their treatment, including medications for their asthma is:

0 – Very little 1 2 3 4- Something 5 6 7 8- A lot

PIH3. I help them take medications or carry out the treatments asked by their doctor or health worker:

0 – Never 1 2 3 4- Sometimes 5 6 7 8- Always

PIH4. I share in decisions made about their asthma with their doctor or health worker:

0 – Never 1 2 3 4- Sometimes 5 6 7 8- Always

PIH5. I am able to collaborate with health professionals to get the services they need:

0 – Never 1 2 3 4- Sometimes 5 6 7 8- Always

PIH6. I attend appointments as asked by their doctor or health worker:

0 – Never 1 2 3 4- Sometimes 5 6 7 8- Always

PIH7. I keep track of their symptoms and early warning signs (e.g. peak flow, shortness of breath):

0 – Never 1 2 3 4- Sometimes 5 6 7 8- Always

PIH8. I take action when their early warning signs and symptoms get worse:

0 – Never 1 2 3 4- Sometimes 5 6 7 8- Always

PIH9. I help them manage the effect of their asthma on their physical activity (i.e. walking, sports):

0 – Not very well 1 2 3 4- Fairly well 5 6 7 8- Very well

PIH10. I help them manage the effect of their asthma on how they feel (i.e. their emotions and mental health):

0 – Not very well 1 2 3 4- Fairly well 5 6 7 8- Very well

PIH11. I help them manage the effect of their asthma on their social life (i.e. how they mix with other people):

0 – Not very well 1 2 3 4- Fairly well 5 6 7 8- Very well

PIH12. Overall, I help them to live a healthy life (e.g. healthy food, regular physical activity):

0 – Not very well 1 2 3 4- Fairly well 5 6 7 8- Very well

PIH13. I feel confident talking about their asthma with healthcare professionals:

0 – Disagree strongly 1 2 3 4- Neither agree nor disagree 5 6 7 8- Agree strongly

PIH14. I feel confident talking to my child about their asthma:

0 – Disagree strongly 1 2 3 4- Neither agree nor disagree 5 6 7 8- Agree strongly

Appendix B: Asthma Control Test

1. In the past 4 weeks, how much of the time did your asthma keep you from getting as much done at work or at home?

None of the time	A little of the time	Some of the time	Most of the time	All of the time
▼	▼	▼	▼	▼
☐ 5	☐ 4	☐ 3	☐ 2	☐ 1

2. During the past 4 weeks, how often have you had shortness of breath?

Not at all	Once or twice a week	3 to 6 times a week	Once a day	More than once a day
▼	▼	▼	▼	▼
☐ 5	☐ 4	☐ 3	☐ 2	☐ 1

3. During the past 4 weeks, how often did your asthma symptoms (wheezing, coughing, shortness of breath, chest tightness or pain) wake you up at night or earlier than usual in the morning?

Not at all	Once or Twice	Once a week	2 to 3 nights a week	4 or more nights a week
▼	▼	▼	▼	▼
☐ 5	☐ 4	☐ 3	☐ 2	☐ 1

4. During the past 4 weeks, how often have you used your rescue inhaler or nebulizer medication (such as Albuterol, Ventolin®, Proventil®, Maxair® or Primatene Mist®)?

Not at all	Once a week or less	2 or 3 times per week	1 or 2 times per day	3 or more times per day
▼	▼	▼	▼	▼
☐ 5	☐ 4	☐ 3	☐ 2	☐ 1

5. How would you rate your asthma control during the past 4 weeks?

Completely Controlled	Well Controlled	Somewhat Controlled	Poorly Controlled	Not Controlled at all
▼	▼	▼	▼	▼
☐ 5	☐ 4	☐ 3	☐ 2	☐ 1

To score the ACT: Each response to the 5 ACT questions has a point value from a 1 to 5 as shown on the form. To score the ACT, add up the point values for each response to all five questions.

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Appendix C1: Interview protocol and topic guide for DHP user interview

Children and Young People

Tiny Medical Apps – Digital Health Passport Evaluation

Start of call procedure

- Brief introductions (aim to put the person at ease and reassure them!)
 - Thank you for your time
 - I am working for an organisation called UCLPartners. We are finding out what people think about the Digital Health Passport app. We want to know what you think about the app and how you think it could be improved
 - I will run through what to expect from this call and answer any questions that you have before I ask you some questions about the app
 - This call should take around 10 - 15 minutes
- Check if this amount of time is OK. If the participant has less time available, prioritise starred * interview questions*
- If it is OK with you, I will record this call so that notes of what you have said can be produced. The recording and notes will be saved securely on UCLPartners computers and we will only store them whilst we need them– only people working on this project will have access to the notes
- Check if recording is OK. If the participant doesn't want their interview to be recorded, ask if it is OK to type / write notes and ask the participant if they would be willing to check these notes for accuracy after the interview via email correspondence*
- The feedback you provide will be shared anonymously. This means that we might include things you have said when we report the findings, but we will not include anything that could identify you, your family or any other person
 - There are no right or wrong answers, we just want to know what you think
 - If there are any questions you don't want to answer that is OK
 - If you want to stop the recording / the call at any time that's OK, just let me know
 - If you change your mind about taking part that's OK, please let me know within the next few days and we won't include your feedback in our reports [make sure the person knows how to contact you]
 - In appreciation of your time you will be given a £20 voucher; this will come directly to you from the Digital Health Passport team.
 - Do you have any questions before we start?

CHECK IF OK TO START RECORDING

BEGIN RECORDING

Interview questions – Children and Young People

Topic	Interview questions
Intro question	How long you have been using the Digital Health Passport app for? How often do you use the Digital Health Passport app? Could you tell me a bit about why you have been using the Digital Health Passport app?
Useability*	What parts of the Digital Health Passport app do you like most? Why? What parts of the Digital Health Passport app do you like least? Why?

	What do you think could be improved? <i>Prompt if needed: App features include: information on pollen and pollution (asthma triggers); ability to track asthma symptoms and peak flow; ability to upload, view and share an asthma action plan; emergency instructions for asthma attacks and anaphylaxis; regular bitesize learning</i>
Information quality	Is the information on the Digital Health Passport app easy to understand or not? Do you find the length of articles work well for you? <i>Prompt: are they too long or too short? Would you like to have more information available?</i>
Support quality	Is the app easy to use or not? <i>Prompt if needed: is the information you need, or are the tasks (such as making an asthma plan) you want to perform in the app easy to find?</i> Can you get help to use the Digital Health Passport if you need it?
Perceived benefit	Has the Digital Health Passport app helped you learn more about your asthma or not? <i>Prompt if needed: what have you learned?</i>
Perceived health status*	Does using the Digital Health Passport help you to better manage or control your asthma or not? If yes, how does using Digital Health Passport app help? <i>Prompts if needed:</i> <i>What do you do differently because of using the app?</i> <i>Do you use your inhalers differently since using the app? How?</i> <i>Have you noticed any difference in the number of asthma attacks that you have?</i>
Satisfaction*	Overall, how satisfied are you with the Digital Health Passport? <i>Select one: very satisfied / satisfied / neutral / dissatisfied / very dissatisfied</i> Would you recommend the Digital Health Passport to other young people who have asthma? <i>Select one: yes / no</i> What is the reason for this answer?
Intent to continue*	Do you think you will carry on using the Digital Health Passport in the future? Which aspects of the app in particular would you be likely to continue to use?
Close*	Is there anything else you'd like to tell me about the Digital Health Passport?

**Prioritise starred questions if short on time*

STOP RECORDING

Many thanks for your time today. As we mentioned at the start, in appreciation of your time you will be given a £20 voucher; this will come directly to you from the Digital Health Passport team. If you haven't done so already, we would encourage you to complete the follow-up survey in the app, for which you will receive an additional £5.

Thank you and goodbye

SAVE RECORDING IN: Tiny Medical Apps Evaluation -> Interviews channel on Teams. This is a private channel for the evaluation team only.

Appendix C2: Interview protocol and topic guide for DHP parent/carers interview

Parents & Carers

Tiny Medical Apps – Digital Health Passport Evaluation

Start of call procedure

- Brief introductions (aim to put the person at ease and reassure them!)
- Thank you for participating / for your time
- Before getting started with the interview questions I will run through what to expect from the interview and answer any questions that you may have
- This interview is part of the Digital Health Passport Evaluation which is being conducted by UCLPartners as an independent partner. The evaluation aims to understand how useful and acceptable the app is for children and young people with asthma and their parents or carers and to produce findings that are helpful in improving the app
- I am not part of the Digital Health Passport team, so if you have any specific questions about using the app this is best directed to them [have contact details available]
- The interview expected to take around 10 - 15 minutes

*Check if this amount of time is OK. If the participant has less time available, prioritise starred * interview questions*

- With your permission, I will record the interview so that a written transcript (notes of what you have said) can be produced. All of the transcripts produced through the course of the evaluation will be analysed by the evaluation team to generate themes that describe people's experiences of the app and suggestions for improvement. The recording and written transcript will be saved securely on UCLPartners computers and destroyed when the evaluation project is completed.

Check if recording is OK. If the participant doesn't want their interview to be recorded / transcribed, ask if it is OK to take notes and ask the participant if they would be willing to check these notes for accuracy after the interview via email correspondence

- Findings from the evaluation will be reported anonymously. This means that while direct quotations of things you have said may be used when reporting the findings, the evaluation team will not include anything in the reporting that could identify you, your child(ren) or any other individual

- The findings will be shared within written reports and via presentations
- Honest, open feedback will be most useful. There are no right or wrong answers.

Examples of your experiences when using the app are helpful

- If there are any questions you do not want to answer that is OK
- If you want to stop the recording / the interview at any time that's OK, just let me know
- If you change your mind about taking part in the evaluation that's OK, please let me know within the next few days so that your interview transcript can be excluded from the analysis
- In appreciation of your time you will be given a £20 voucher; this will come directly to you from the Digital Health Passport team.
- Do you have any questions before we start?

CHECK IF OK TO START RECORDING

BEGIN RECORDING

Interview questions – parents & carers

Topic	Interview questions
Intro questions	How long have you/your child been using the Digital Health Passport app for? How often do you use the Digital Health Passport app? Could you tell me a bit about why you have been using the Digital Health Passport app?
Useability*	What parts of the Digital Health Passport app do you like most? Why? What parts of the Digital Health Passport app do you like least? Why? What improvements would you like to see? <i>Prompt if needed: App features include: information on pollen and pollution (asthma triggers); ability to track asthma symptoms and peak flow; ability to upload, view and share an asthma action plan; emergency instructions for asthma attacks and anaphylaxis; regular bitesize learning</i>
Information quality	How would you describe the quality of the information available on the Digital Health Passport? Do you find the length of articles work well for you? <i>Prompt: is the information relevant? Easy to understand?</i>
Support quality	Is the app easy to use or not? <i>Prompt if needed: is the information you need, or are the tasks (such as making a asthma plan) you want to perform in the app easy to find?</i> Are you able to obtain help to use the Digital Health Passport if you need it?
Perceived benefit	Has the Digital Health Passport increased your knowledge of asthma? Has it increased your child's knowledge? Has the Digital Health Passport improved your / [your child's] asthma self-management skills, e.g. inhaler technique?
Perceived health status*	Do you think [your child's] asthma is better managed or controlled because of using the Digital Health Passport or not? Why? <i>Prompts if needed:</i> <i>What do you / your child do differently because of using the app?</i> <i>Does your child use their inhalers differently since using the app? How?</i> <i>Have you noticed any difference in the number of asthma attacks that your child has?</i>
Satisfaction*	Overall, how satisfied are you with the Digital Health Passport? <i>Select one: very satisfied / satisfied / neutral / dissatisfied / very dissatisfied</i> Would you recommend the Digital Health Passport to other children and young people who have asthma and their parents or carers? <i>Select one: yes / no</i> What is your reason for this answer?
Intent to continue*	Do you intend to continue using the Digital Health Passport with [child] in the future?
Close*	Is there anything we haven't already covered that you'd like to tell me about the Digital Health Passport?

*Prioritise starred questions if short on time

STOP RECORDING

Many thanks for your time today. As we mentioned at the start, in appreciation of your time you will be given a £20 voucher; this will come directly to you from the Digital Health Passport team. If you haven't done so already, we would encourage you to complete the follow-up survey in the app on behalf of [child], for which you will receive an additional £5.

Thank you and goodbye

SAVE RECORDING IN: Tiny Medical Apps Evaluation -> Interviews channel on Teams. This is a private channel for the evaluation team only.

Appendix D: Clinician survey

1. How often do you use the Digital Health Passport? *

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Less frequently than monthly
- ☐ Never

2. Which features of the Digital Health Passport are most useful to you when working with your patients? (select all that apply) *

- ☐ Health tracker
- ☐ Health and emergency action plan
- ☐ Health Hacks: Health and wellbeing education resource videos and links
- ☐ Air Quality, Pollution and weather alerts
- ☐ Remote condition review; in advance medication use and health check
- ☐ Training modules
- ☐ None of the features are useful
- ☐ Other

3. Are there additional features or improvements to the app you would like to see? Please state them here.

4. For each of the following statements, please select the option that most closely reflects your own experience with the Digital Health Passport app *

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Not applicable
I find the Digital Health Passport easy to use	☐	☐	☐	☐	☐	☐
I have found the Digital Health Passport easy to learn how to use	☐	☐	☐	☐	☐	☐
The support pages and FAQs have been able to resolve any problems I had when using the Digital Health Passport	☐	☐	☐	☐	☐	☐
Information provided by the Digital Health Passport is relevant to me and my needs as a clinician providing care	☐	☐	☐	☐	☐	☐
Information provided by the Digital Health Passport is up to date with latest clinical guidance for asthma management	☐	☐	☐	☐	☐	☐
The Digital Health Passport helps me manage children/young people with asthma	☐	☐	☐	☐	☐	☐
I am satisfied with the Digital Health Passport	☐	☐	☐	☐	☐	☐
I intend to continue using the Digital Health Passport rather than discontinue its use	☐	☐	☐	☐	☐	☐

5. In your view, to what extent do you think the Digital Health Passport offers potential improvement in the following areas for those patients, parents and carers who use it? *

	Lots of potential for improvement	Some potential for improvement	Limited potential for improvement	No potential for improvement
Improving asthma education	☐	☐	☐	☐
Improving asthma self-management skills	☐	☐	☐	☐
Improving knowledge of their (or their childrens') condition	☐	☐	☐	☐
Improving asthma outcomes, such as A&E attendances	☐	☐	☐	☐
Improving the experience of asthma care	☐	☐	☐	☐

6. How likely would you be to recommend the Digital Health Passport to a child or young person **in your care**

(where 1 would mean you would be very unlikely to recommend the Digital Health Passport, a score of 10 would mean you would definitely recommend the Digital Health Passport) *

1	2	3	4	5	6	7	8	9	10
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7. How likely would you be to recommend the Digital Health Passport to a child or young person **who you know personally**

(where 1 would mean you would be very unlikely to recommend the Digital Health Passport, a score of 10 would mean you would definitely recommend the Digital Health Passport) *

1	2	3	4	5	6	7	8	9	10
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8. How likely would you be to recommend the Digital Health Passport to a **fellow clinician** looking after a child or young person with asthma

(where 1 would mean you would be very unlikely to recommend the Digital Health Passport, a score of 10 would mean you would definitely recommend the Digital Health Passport) *

1	2	3	4	5	6	7	8	9	10
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9. How likely would you be to recommend the Digital Health Passport to **a commissioner** working in your PCN, ICB or region.

*(where 1 would mean you would be very unlikely to recommend the Digital Health Passport, a score of 10 would mean you would definitely recommend the Digital Health Passport) **

1	2	3	4	5	6	7	8	9	10
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10. Did you undertake the 1hr training in Digital tools for Asthma Self-Management provided by Rotherham Respiratory? *

☐ Yes

☐ No

11. How effective did you find the training session in preparing you to use the asthma app with your patients? *

☐ Very effective

☐ Somewhat effective

☐ Neither effective nor ineffective

☐ Somewhat ineffective

☐ Very ineffective

12. What aspects of the training session were most useful for you?

13. What aspects of the training session do you think need improvement?

