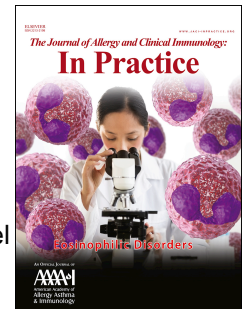


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Digital Health Technology in Asthma: A Comprehensive Scoping Review

Giselle Mosnaim, MD, MS, Guilherme Safioti, MD, Randall Brown, MD, MPH, Michael DePietro, MD, Stanley J. Szefer, MD, David M. Lang, MD, Jay M. Portnoy, MD, Don A. Bukstein, MD, Leonard B. Bacharier, MD, Rajan K. Merchant, MD, FAAAAI



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Digital Health Technology in Asthma: A Comprehensive Scoping Review

Authors:

Giselle Mosnaim, MD, MS^a, Guilherme Safioti, MD^b, Randall Brown MD, MPH^c, Michael DePietro MD^c, Stanley J Szeffler, MD^d, David M Lang, MD^e, Jay M Portnoy, MD^f, Don A Bukstein, MD^g, Leonard B Bacharier, MD^h, Rajan K Merchant, MD, FAAAAⁱ

Affiliations:

^aDivision of Pulmonary, Allergy and Critical Care, Department of Medicine, NorthShore University HealthSystem, Evanston, IL, USA

^bTeva Pharmaceutical Industries, Ltd, Amsterdam, The Netherlands

^cTeva Branded Pharmaceutical Products R&D, Inc, West Chester, PA, USA

^dThe Breathing Institute and Pulmonary Medicine Section, Children's Hospital Colorado and University of Colorado School of Medicine, Anschutz Medical Campus, Aurora, CO, USA

^eDepartment of Allergy and Clinical Immunology, Respiratory Institute, Cleveland Clinic, Cleveland, OH, USA

^fPediatric Allergy and Immunology, Children's Mercy Hospital, Kansas City School of Medicine, Kansas City, MO, USA

^gAllergy, Asthma and Sinus Center, Milwaukee, Greenfield, WI, USA

^hDepartment of Pediatrics, Monroe Carell Jr Children's Hospital at Vanderbilt University Medical Center, Nashville, TN, USA

ⁱWoodland Clinic Medical Group, Allergy Department, Dignity Health, Woodland, CA, USA

Corresponding Author:

Michael DePietro, MD

Teva Branded Pharmaceutical Products R&D, Inc, West Chester, PA, USA.

Tel: 1-484-886-9832. Email: Michael.Depietro01@tevapharm.com

Author Email Addresses:

- GMosnaim@northshore.org
- Guilherme.Safioti@tevapharm.com
- Randall.Brown@tevapharm.com
- Michael.Depietro01@tevapharm.com
- Stanley.Szeffler@childrenscolorado.org
- langd@ccf.org
- jportnoy@cmh.edu
- donabukstein@gmail.com
- leonard.bacharier@vumc.org
- Rajan.Merchant@dignityhealth.org

Key words (up to 10)

Asthma, eHealth, connectivity, inhalers, adherence, monitoring, disease control, perception, acceptability, feasibility

Abbreviations:

ACT – Asthma Control Test

ED – Emergency Department

EHR – Electronic Health Record

HCP – Healthcare Professional

ICS – Inhaled Corticosteroids

LABA – Long-acting Beta-2 Agonist

PRISMA-SCR - Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews

SABA – Short-acting Beta Agonist

SMS – Short Message Service

Highlights Box (max. 35 words/answer)**1. What is already known about this topic?**

Digital technology provides an opportunity to significantly improve and individualize asthma self-management across a variety of intervention types; however, the impact of different digital intervention characteristics has yet to be assessed

2. What does this article add to our knowledge?

There exists significant heterogeneity in study designs, patient populations and outcomes measurement for digital interventions, and more alignment is needed to accurately measure impacts on different dimensions of care and to guide future successful interventions

3. How does this study impact current management guidelines?

This scoping review does not directly impact current guidelines for asthma self-management, but will hopefully inform the design of future digital intervention studies

Abstract

Background: A variety of digital intervention approaches have been investigated for asthma therapy during the last decade, with different levels of interactivity and personalization, with a range of impacts on different outcome measurements.

Objective: To assess the effectiveness of digital interventions in asthma with regards to acceptability and outcomes and evaluate the potential of digital initiatives for monitoring or treating patients with asthma.

Methods: We evaluated digital interventions using a scoping review methodology via literature search and review. Of 871 articles identified, 121 were evaluated to explore intervention characteristics, the perception and acceptability of digital interventions to patients and physicians, and effects on asthma outcomes. Interventions were categorized by their level of interactivity with the patient.

Results: Interventions featuring non-individualized content sent to patients appeared capable of promoting improved adherence to inhaled corticosteroids, but with no identified improvement in asthma burden, and data-gathering interventions appeared to have little effect on adherence or asthma burden. Evidence of improvement in both adherence and patients' impairment due to asthma were seen only with interactive interventions involving two-way responsive patient communication. Digital interventions were generally positively perceived by patients and physicians. Implementation was considered feasible, with certain preferences for design and features important to drive usage.

Conclusions: Digital health interventions show substantial promise for asthma disease monitoring and personalization of treatment. To be successful, future interventions will need to include both inhaler device and software elements, combining accurate measurement of clinical parameters with careful consideration of ease of use, personalization and patient engagement aspects.

Introduction

Rationale

Asthma continues to be a significant chronic disease burden, with estimated patient numbers approaching 350 million globally¹. Asthma is a major source of direct and indirect economic cost, in addition to reduced quality of life and premature death in patients of all ages, including children². There are several areas of unmet clinical need associated with conventional asthma management; while medications such as inhaled short-acting beta-agonists (SABA) and inhaled corticosteroids (ICS) are efficacious, considerable long-term commitment to asthma self-management on behalf of the patient is required for therapeutic success.

Asthma self-management includes advice and education on self-monitoring and a defined asthma management plan supported by regular professional review. Self-management is recognized as an effective method to improve asthma control and quality of life and reduce unscheduled consultations and hospitalizations across diverse demographic groups³. For the patient, adherence to medication regimens is a key element of successful asthma management, in conjunction with wide-ranging factors including disease perception, patient education and understanding of symptoms, comorbidities, inhaler technique, access to medications and healthcare professional support⁴. On the part of clinicians, implementation of evidence-supported management guidelines for assessment, monitoring, patient education, control of environmental factors, and pharmacologic treatment is a key factor, although adherence to such guidelines varies between different physician groups^{5,6}.

Several areas of asthma self-management could be improved using digital technology, including disease disparity, medication adherence, patient-clinician communication, personalized patient education and passive monitoring of patient characteristics and behaviors that could prompt timely intervention. Technological innovations have the potential to support patients with disease self-management, allow for remote management by healthcare providers, and make future asthma management more proactive⁷.

Researchers have explored a variety of different digital asthma approaches including passive education, interactive websites, and electronic medication monitoring devices. Given the increasing prevalence of asthma worldwide and patient dependence on traditional inhaler devices to manage their disease, the inclusion of more advanced technology as a part of asthma self-management will be an essential next step in the improvement of therapy for respiratory diseases. Lockdown and social distancing as a result of the COVID-19 pandemic has caused increased uptake and reliance on videoconferencing and telemedicine in various therapy areas⁸. Increased familiarity with

telemedicine provides an opportunity for remote monitoring and disease management, particularly in areas where access to healthcare professionals is challenging.

Given the wealth of available literature and heterogeneity of digital technologies used to varying degrees of success, we performed a scoping review to assess the available research in this field. Scoping reviews provide a preliminary assessment of the size and scope of available literature on a topic and characterize the nature of published studies to provide an overview of large, heterogeneous bodies of literature. Furthermore, scoping reviews provide a platform for more precise systematic reviews to look at specific research questions. This scoping review therefore seeks to evaluate the different options that have already been explored and assess the future utility of digital health technology in asthma.

Objective

To evaluate the current and potential future usability, acceptability, uptake, effectiveness and adoption of digital health technology for treating or monitoring asthma using a scoping review methodology. The potential future reach and durability of these technologies will also be considered.

Methods

Scoping review approach

We conducted a systematic scoping review based on the methodology described⁹ and the PRISMA-ScR guidelines (Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews)¹⁰, including identifying the research question, identifying relevant studies, study selection, data charting, collating, summarizing and reporting the results. The purpose of a scoping review is to give a broad overview of the available literature, without being directed towards a single discrete research question.

Sources and searches

We searched PubMed, Embase and the Cochrane Library for January 2010–June 2019 using the search terms and criteria in Supplementary Table 1, adapted for each database, to identify asthma studies that assessed the effect of digital health technology interventions on patient outcomes, including symptoms, adherence and medications usage/therapy regimen. We also included studies that incorporated the acceptability of digital interventions to patients and HCPs and the feasibility of their wider uptake. Congress abstracts were excluded from our results. Database searches were supplemented by manual searches and references as appropriate.

Non-relevant articles and duplicates were excluded; the titles and abstracts of remaining citations were reviewed by two authors (GS, GM) in parallel, with a third author (RM) used to adjudicate discrepancies. Full text articles were then obtained and a second round of screening was conducted (with two reviewers working in parallel, with adjudication performed by a third reviewer) and further articles excluded as necessary. Articles were assessed for the type of digital health technology employed, study design, size of study and outcomes assessed.

Data extraction and synthesis

The full text of the selected articles was used to identify the types of technology used. Interventions were grouped (**Table 1**) according to their primary characteristic (where interventions contained more than one aspect); specifically, according to their level of interactivity with the patient. Interventions in which non-individualized information was sent to patients on an automated basis (e.g. SMS-based dose reminders and automated pharmacy prescription refill calls, or access to non-interactive, non-patient-specific digital educational material) were termed ‘Generalized studies’. Interventions where individualized information was gathered *from* or sent *to* patients (e.g. parameter monitoring by a device with no feedback to the patient, or provision of patient-specific education) were termed ‘Patient-specific, non-interactive studies’. Interventions comprising an interactive relationship with the patient, whereby insights based upon data collected from the patient or resulting from patient behavior are fed back to the patient to assist with asthma management on a personalized basis (e.g. an asthma management platform which responds to adherence data from a digital inhaler or questionnaire feedback from the patient) were termed ‘Patient-specific interactive studies’. Within these broad intervention categories, studies were further grouped according to the type of technology involved (**Table 1**).

Details of the studies performed (e.g. subject characteristics, sample size, randomization) and outcomes, including adherence, asthma control/impairment and healthcare utilization were captured in a standardized table format as part of the data charting process. Adherence outcomes were assessed for being subjective (i.e. reliant on questionnaire data or patient recollection) or objective (i.e. monitored automatically as a result of medication use [including one study which calculated adherence from electronic medical records]).

To assess the impact of different the intervention categories, we identified studies in which a positive effect (vs no effect or a negative effect) was reported with the intervention in three domains: adherence to ICS (and long-acting beta-2 agonist [LABA]) therapy, impairment due to asthma (most commonly assessed by ACT score, but also including changes in symptoms and quality of life where reported), and healthcare resource utilization (urgent consultations, emergency

department visits or hospitalizations). Due to the heterogeneity in data reporting, to include as many studies as possible in our broad overview, we considered statistically significant, numerical and anecdotal reports of benefit as evidence of positive effects in each of these three domains. Counts for studies reporting positive vs no effect/negative effects were then summarized.

Articles that reported patient and HCP perceptions of digital technologies were assessed separately, and relevant observations extracted.

INSERT TABLE 1

Results

Selection of sources of evidence

Our selection process identified 121 articles for inclusion in this scoping review (**Figure 1**); 17 articles describing Generalized studies, 23 describing Patient-specific, non-interactive interventions, and 66 describing Patient-specific interactive interventions. **Figure 2** shows a bubble plot of the number of articles for each intervention category published each year; during the last 5 years, interactive interventions have been investigated more frequently than the non-interactive initiatives, possibly because of the increased availability of mobile internet access and personal smart devices. Fourteen articles were identified that investigated patients' and clinicians' perceptions of digital interventions.

Table 2 summarizes the number of studies reporting positive effects on outcomes for different intervention types.

INSERT TABLE 2

Generalized studies

There were 17 generalized interventions, eight employing reminders or automated phone calls for medication doses or pharmacy-fills, and nine providing asthma education or asthma management motivation (n=9). Most were randomized (n=12), and most had an intervention period of ≥ 3 months (n=15) (**Table 3**).

Six of the studies reported change in adherence with the intervention; all of these reported a positive effect (6 positive vs 0 no effect/negative). Adherence in these studies was measured using both subjective (n=3) and objective (n=3) approaches.

Few studies of generalized interventions reported a positive effect on asthma impairment (3 positive vs 7 no effect/negative), and none reported meaningful improvements in healthcare use (0 positive vs 5 no effect/negative) (**Table 2** and **Figure 3**).

INSERT TABLE 3**Patient-specific, non-interactive, unidirectional interventions**

Of the 24 studies using patient-specific, non-interactive, unidirectional interventions, most focused on either digital questionnaire-based studies (n=9) or device monitoring studies (without feedback to the patient; n=8). Thirteen studies were randomized and 11 were single-arm. Nine interventions lasted for <3 months. (**Table 4**)

Overall, few studies reported positive effects, with only 2 studies finding benefit in each of the adherence and asthma impairment domains and none reporting improvements in healthcare utilization (**Table 2** and **Figure 3**). Positive effects on adherence were noted in one study of education provision and one involving adherence tracking with an automated reminder call, and positive effects on asthma impairment resulted from one study involving a smartphone symptom/ACT diary with additional education and motivation, and one study in which a decision support algorithm was used to enter patients into different RCTs.

INSERT TABLE 4**Patient-specific interactive, bidirectional interventions**

Patient-specific, bidirectional interactive interventions were the largest group of interventions (n=66). Most often, these entailed an asthma management platform (n=32), a digital inhaler combined with an asthma management platform (n=14), or a telemedicine-based intervention (n=14). Most of the studies (n=45) were randomized, and 15 of the interventions lasted <3 months (including 2 with study period not stated) (**Table 5**).

Reported positive effects outweighed no effect for both adherence (17 vs 8 studies, respectively) and asthma impairment (31 vs 15 studies, respectively) (**Table 2** and **Figure 3**). Adherence was measured subjectively (n=18) and objectively (n=14) in a similar number of studies. Twelve studies found reductions in healthcare usage, although a similar number (n=14) found no effect.

This was the only intervention category within which improvements in both adherence and asthma impairment were more often than not reported, and were seen consistently across the three most-studied intervention types.

INSERT TABLE 5**Acceptability and feasibility of interventions**

Where reported, all types of digital interventions were considered to be acceptable/favorable to patients or their caregivers, and feasible to implement, although this aspect was not rigorously investigated in articles reporting intervention results^{13,14,16–19,22–24,26,28,43,56,87,105,108, 109, 111, 115, 117}. Digital inhaler systems were described as feasible to implement^{31,61,62,65,69–71} and acceptable to most patients^{11,31,61,70,118}. Similarly, digital asthma management platforms were reported to be both feasible^{52,57,82,84,93,119} and acceptable^{75,76,92,96,100–102,107}. One study reported low usage of a web portal which was not specifically targeted at symptomatic asthma patients⁸¹.

While patients were generally satisfied with digital devices and were willing to use them, alerts were sometimes felt to be unwelcome if they were received at inopportune times³⁵. Non-inhaler devices, (including Fitbits to track activity levels and sleep, and devices designed to assess lung function) were also considered acceptable by patients^{35,52,54}.

Cost effectiveness

Only one¹¹² of the five studies to comment on cost-effectiveness^{13,22,109,112,116} found that the digital intervention was not cost-effective, although formal investigations of cost-effectiveness were not performed. A smart nebulizer system was associated with decreased costs of additional treatments associated with asthma, such as antibiotics and corticosteroids⁶⁴. Web-based monitoring of asthma control was deemed likely to be cost-effective following analysis of an economic model³⁹.

Perceptions of digital health technology

Fourteen articles commented on perceptions towards digital interventions^{63,95,119,120–128,130,131}, and all intervention types were widely considered to be acceptable and useful across groups of patients, prescribers and families.

Patients' uptake of smartphone apps was affected by perceived need (i.e. favorable if asthma not considered to be well controlled)¹²⁵, and for smartphone app uptake in general, ease of access (i.e. downloading) was considered important. While social media could attract many initial downloads, long-term engagement was more successful with face-to-face recruitment via practices¹²⁴.

Adolescents thought that smartphone apps should be designed to be visually simple, easy to use, informative, customizable, and include familiar components (e.g. alerts that appear and sound like

their usual messaging apps) and were open to using apps for support and information^{121,122,130,131}.

They preferred time-based to event-based reminders⁶³ and favored video and peer-chat functionality in addition to medication reminders¹¹⁹. They were also sensitive to design choices that were too childish for their age range, but appreciated gamification of asthma management^{121–123}.

Adolescent patients and pharmacists had a positive attitude towards interactive mobile health interventions¹¹⁹, and adults and adolescents were receptive towards educational and directive SMS messaging; adolescents were also in favor of sending messages to a support person (i.e. parent or guardian)¹²⁵. Tablet- and smartphone-based asthma questionnaires were acceptable to patients and useful in certain situations (e.g. where HCP time was limited or in rural areas)¹²⁶. Patients and caregivers were supportive of interactive web-based education provision based on patient information and preferences, and of augmented reality inhaler technique training¹²⁸.

Patients considered that smart devices/inhalers should be easy to use and convenient in terms of size and portability^{95,127}.

Clinicians valued the concept of inter-visit improvement of adherence and lung function data and considered adherence data to be especially important, with a preference for ICS adherence data. Rescue inhaler information was considered valuable to access if patients were over-using them, as this could indicate a need to adjust their ICS regimen. The opportunity to use a patient's data to illustrate how their adherence affected their symptoms or impairment during consultations was also appreciated¹²⁰.

Some interesting concerns for clinicians included liability for acting on real-time data collection between visits when they could not respond, a preference to see data only before patient visits, and validation of data accuracy and security where devices could be shared^{120,132}.

Discussion

In this scoping review, we have surveyed a wide variety of approaches to the implementation of digital technology for improving patient outcomes from asthma therapy. Such interventions are usually focused on improving patient's adherence to their treatment regimen, via dose and prescription-fill reminder systems, behavior change as a result of education and motivation, or increased access to healthcare professionals and asthma advice via telemedicine or interactive asthma management platforms. We considered the interventions identified by our literature search based on their interactivity with the patients, and whether data communication was unidirectional (data sent either from or to the patient) or bidirectional (data received from the patient prompted a response from the intervention). In terms of study outcomes, we looked for evidence of

improvement with the various interventions in terms of patients' adherence to ICS regimens, improvements in impairment due to asthma, and improvements in healthcare utilization (via reductions in unplanned or emergency consultations).

Generalized dose and prescription reminders and non-personalized education and motivation were effective in improving adherence, but not impairment due to asthma. While subjective measurement of adherence is thought to overestimate adherence compared with objective measurement^{33,36}, both types of adherence measurement were employed across these generalized studies; it is possible that adherence improvements were not sustained long enough to make a meaningful impact on asthma impairment. The patient-specific, non-interactive interventions included several different intervention types, but few reported positive impacts on either adherence or asthma impairment. However, the most-studied category of intervention, patient-specific interactive bidirectional interventions, reported the greatest number of improvements in adherence and asthma impairment. These benefits were largely found in studies of the most interactive interventions; those using interactive telemedicine or those using an interactive management platform, with or without a digital inhaler. Each of these intervention types provides a high level of interactivity and instant feedback for patients either via live HCP consultation (telemedicine), or responses to monitored data or questionnaires (digital platforms $\pm$ digital inhalers). Correlating patients' own asthma experiences (via ACT scores or other measured parameters) with their asthma management behaviors (e.g. ICS adherence, trigger avoidance, etc.) may be a powerful engagement tool to motivate and educate patients on the need to stay on top of managing their condition.

We were able to identify broad trends in adherence and changes in asthma impairment between different intervention categories. The included studies generally did not find differences in healthcare utilization with interventions, either because it was not studied, or because the incidence of ED visits or other unscheduled consultations was generally low.

All types of digital health interventions were well-received and acceptable to patients, caregivers and clinicians. While it is intuitive to think that digital interventions would be easily scalable to large populations and therefore be cost-effective, there are currently few formal cost-effectiveness studies to confirm this assumption. In particular, the translation of improved adherence to improved symptom control and reduced healthcare usage is not guaranteed, although several studies noted reductions in reliever or oral steroid use, and reductions in unscheduled primary care visits. There may also be difficulties in transitioning coding and billing practices to accommodate digital interventions.

The progression of digital health monitoring and associated interventions in asthma still faces significant challenges. It is clear that a successful intervention must be able to combine objective monitoring with active patient engagement and education/motivation to maintain behaviors helpful to asthma therapy, and we have yet to develop an ideal system in this respect. Although there is further opportunity to incorporate digital interventions into patient care with respect to linking to patients' EHRs and using data monitoring to trigger further HCP interventions, there is also the possibility of providing regular patient support via education on inhaler technique, avoidance of asthma triggers and environmental monitoring and advice (e.g. warnings related to high pollen count or air pollution), which could be equally important to reduce asthma burden.

The extensive implementation of digital interventions is attractive from the perspective of real-time population health monitoring as well as the increased opportunity and ability to improve individual asthma outcomes via treatment personalization and day-to-day disease management. Data analysis may also assist the understanding of relationships and causal mechanisms between patient characteristics, environment and asthma symptoms and exacerbations, ultimately leading to the development of patient digital phenotypes.

However, beyond the challenge of developing suitable technologies, considerable financial, technological, and political barriers still need to be overcome. The development of artificial intelligence protocols to interpret and apply the huge amount of monitoring data involved will be key. There will also be a considerable emphasis on the infrastructure necessary to incorporate continuous monitoring into patients' overall healthcare to support physicians. Such a fundamental change in the organization and delivery of healthcare will also have significant effects on liability for physicians making artificial intelligence-augmented decisions^{133,134}. Large-scale personal health data collection naturally generates concern over data security and usage, and patients and physicians must be confident about how their data will be used, who will have access to it, and the extent to which individual patients will own their data¹³⁵.

Regardless of pharmacological therapy, consultations can already be implemented regularly via videoconference, which is especially important for patients with reduced mobility, reduced free time or in remote locations; videoconferencing could also be used to easily provide support between face-to-face appointments. In the context of a pandemic such as COVID-19, reducing face-to-face contact between clinicians and selected patients has been a necessity. The use of telemedicine and video consultation was implemented as an elegant solution to this challenge for patient assessment and education, both of which can be delivered remotely^{136,137}. One related effect of the current pandemic situation is a large-scale uptake of videoconference technology for work and social contact

in the general population, which could help acclimatize patients and physicians to accessing and providing healthcare in this way. We consider it likely that many of the benefits of telemedicine realized, initially through necessity, during the pandemic, will continue to gain increasing acceptance and continue to form an integral part of respiratory care in the future^{137,138}.

Limitations

Conclusions from this scoping review are limited by heterogeneity, in terms of the wide variety of study designs, outcome measures and different ways of implementing similar interventions for patient-independent and patient-dependent initiatives. In addition, study heterogeneity limited our interpretation of different outcomes for the same intervention category, e.g. the changes observed in adherence were not necessarily measured in the same studies as changes in ACT. ACT was the most common measure of asthma burden and is a subjective measure of patients' perception of impairment due to asthma, rather than a measure of risk of an asthma exacerbation. Changes in asthma exacerbations were not commonly used as a primary outcome measure, possibly due to the expected number of exacerbations in study populations not being sufficiently frequent to make this a useful endpoint.

As patients were generally monitored for no more than 12 months (and commonly only 3 or 6 months), the long-term effects of the various interventions are unknown. Studies also typically did not account for seasonality or incorporate environmental information (such as aeroallergen or air pollution levels). Most of the studies analyzed did not specify participants' asthma severity at baseline and lacked stratification by asthma severity; there was also an abundance of studies that reported outcomes either at single specific timepoints only or as a single assessment for the whole study period, rather than assessing change over time associated with a specific intervention.

The relationship between asthma controller adherence and healthcare utilization is an important issue, but one which is challenging to study. In addition to the acknowledged problems with the accuracy of self-reported adherence,^{48,139,140} in a general population of treated asthma patients who are not under close clinical supervision it would be expected that the frequency of emergency or unplanned clinical consultation would be low, and statistically significant changes would therefore be difficult to detect. The studies identified for this review rarely assessed healthcare utilization in a systematic way, and few reported on both adherence and healthcare utilization. Furthermore, correlating changes in adherence with changes in utilization outcomes is confounded by several patient-related and sociobehavioral factors including symptom severity, ethnicity, level of educational achievement, household income and attitude towards treatment.¹⁴¹

Therefore, the fact that reductions in healthcare utilization were not reported with digital asthma interventions in the studies discussed in this review does not mean that these interventions are not associated with benefit in terms of healthcare resource utilization in the real world. The patient populations, intervention assessments and data collection methods might not have been capable of accurately detecting healthcare utilization changes, even where these may have occurred. Further research into the effects of adherence on healthcare utilization is undoubtedly needed, and considerable effort will be required to account for the above factors in the design of future studies assessing digital interventions. Furthermore, future research into digital technology as a part of asthma interventions would benefit from a convention on standard approaches to outcomes and their measurement to enhance similarity in the ways in which we assess asthma treatment.

Conclusions

Digital health interventions are acceptable to asthma patients and clinicians, and the relative ubiquity of mobile internet- and Bluetooth-connected devices in everyday life makes real-time monitoring of asthma treatment and symptoms extremely feasible. However, an effective digital intervention must fulfill several important design criteria. Both inhaler devices and software should be intuitive and easy to use, hardware should be unobtrusive with accurate and objective measurement of adherence/other parameters and be seamlessly integrated with software providing convenient assessment of symptoms and asthma control. Software should be designed to educate and maintain patients' engagement (at a variety of different ages), provide clear communication of hardware- and software-measured parameters for access by patients and clinicians, and be customizable by the patient to fit into their lives and routines. Motivating patients to take an active role in managing their condition and maintaining their interest in doing so is of paramount importance in designing a successful future digital intervention.

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Figures and Tables

Figure 1. Articles selected for analysis

Figure 2. Bubble plot showing relative numbers of publications for different intervention

categories by year by year

Figure 3. Balance of articles reporting positive effect vs no effect on adherence, asthma

impairment and healthcare utilisation for a) generalized, b) non-interactive, and c) interactive

interventions

A. Generalized studies (n=17)

B. Patient-specific, non-interactive, unidirectional (n=24)

C. Patient-specific interactive, bidirectional (n=66)

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Intervention category	Intervention types
Generalized studies (not patient-specific or bidirectional) – content given to the patient	- Automated/speech recognition and SMS dose and pharmacy refill reminders - Non-interactive education or motivational coaching by telephone, text, email and other digital means (e.g. simple access to static content, etc)
Patient-specific, non-interactive studies (unidirectional) – data collected <i>from</i> or sent <i>to</i> the patient	- Decision support tool for RCT enrolment - Device monitoring: Non-inhaler digital parameter tracking (e.g. lung function) not resulting in immediate/ongoing asthma management feedback to the patient (i.e. data collection to inform HCP at next visit) - Individualized static education and/or motivation - Digital questionnaires (by SMS/web/phone) including ecological momentary association (EMA) for data collection only (i.e. not informing therapy) - Inhaler only: Data collected on device from digital inhalers/adherence monitors but not fed back to patient for self-management - Inhaler platform: Data collected from digital inhalers and a web/app platform but not fed back to patient for self-management - Platform only: Online digital chat platform (by web/mobile app) providing non-individualized education
Patient-specific interactive studies including telehealth/video counselling – bidirectional interaction	- Interactive education or motivational coaching - Device monitoring: Non-inhaler digital parameter tracking (e.g. lung function, inhaler technique) with feedback to the patient (usually via smartphone app) - Digital inhalers with electronic adherence monitors and individualized patient feedback - Digital inhaler studies with an accompanying individualized asthma management web/app platform - Interactive asthma management platforms that support self-management via collection of symptoms or ACT/other data and give responses to guide patient's asthma treatment - Telemedicine interventions by phone, video or SMS

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Table 2. Summary of outcomes reporting for intervention categories and types

Intervention	No. articles	Adherence		Asthma impairment		Healthcare utilisation	
		Positive	No effect	Positive	No effect	Positive	No effect
Generalized studies	17	6	0	3	7	0	5
Reminders and pharmacy fill	8	6	0	0	5	0	3
EM	9	0	0	3	2	0	2
Patient-specific, non-interactive, unidirectional	24	2	4	2	4	0	2
Decision support	1	0	0	1	0	0	0
Digital questionnaire	9	0	1	1	1	0	1
Device monitoring	8	0	1	0	1	0	0
EM	2	1	1	0	0	0	0
Inhaler only	2	1	0	0	1	0	0
Inhaler platform	1	0	0	0	0	0	0
Platform only	1	0	1	0	1	0	1
Patient-specific interactive, bidirectional	66	17	8	31	15	12	14
EM	2	0	1	1	1	0	1
Inhaler only*	2	1	0	1	0	0	1
Inhaler platform	14	5	0	5	2	3	0

Platform only	32	9	6	15	9	5	8
Telemedicine	14	2	1	8	3	4	3
Device monitoring	2	0	0	1	0	0	1

*article [11] not included in positive/negative calculations as same study as article [12]

EM, education and/or motivation

Table 3. Generalized studies

Reference	Patient age group	N	Asthma severity	Intervention type	Intervention details	Study type	Study period	Effect on ICS adherence with intervention	Effect on asthma impairment or symptoms with intervention	Effect on healthcare utilization and/or hospitalization with intervention
13	Adults only	4,510	NS	Reminder	Refill	SA	2 years	Significant but small improvement	–	No change in ED visits or hospitalizations
14	Adolescent or younger	1,187	NS	Reminder	Refill	R	24 months	Significant improvement in ICS adherence at 24 months	–	No difference in ED visits, primary care visits or hospitalizations
15	Adults only	100	NS	Reminder	SMS reminder	SA	5 years	–	No difference in the ACT scores between groups	–
16	Adolescents & adults	64	NS	Reminder	SMS reminder	R	6 months	2.75% increase in adherence each month, but improvements were not sustained	No significant difference between arms	ED visits and hospitalizations for asthma were rare
17	Adolescent or younger	89	NS	Reminder	SMS reminder + static education	R	3 weeks	Significant improvement in self-reported 7-day adherence	No significant change in ACT	–
18	Adults only	26	Mild, mod, sev	Reminder	SMS reminder	R	12 weeks	Significant increase vs control	–	–
19	Adolescents & adults	12	NS	Reminder	SMS reminder	R	3 months	–	No significant change in mean self-reported asthma control	–
20	Adults only	8517	NS	Reminder	Refill	R	18 months	Modest but significant increase in ICS adherence	No significant change in asthma control	No significant effect on acute asthma health care utilization
21	Adolescent or younger	359	NS	EM	Static education to prompt physician questioning	R	1 year	–	–	–

22	Adults only	655	NS	EM	Static education by DVD for breathing retraining	R	12 months	–	No significant improvement in symptom scores	–
23	Adults only	150	NS	EM	SMS education	R	13 months	–	–	No significant difference in incidence of ED visits between groups
24	Adolescent or younger	64	NS	EM	Static EM, updated at intervals	R	3 months	–	Significant increase in cACT	–
25	Adults only	330	NS	EM	Static education to encourage written asthma plan use	R	12 months	–	No statistically significant change in ACQ scores	No significant change in ED or non-emergency HCP visits
26	Adults only	144	NS	EM	Static video education during face-to-face visits	SA	1 month	–	Significant improvement in ACT score	–
27	Adults only	34	NS	EM	Static web-based education	SA	1 year	–	–	–
28	Adolescent or younger	50	NS	EM	Static web-based education	SA	2 weeks	–	–	–
29	Adults only	51	NS	EM	Static web-based education	R	3 months	–	Significant improvements in self-reported asthma symptoms and control	–

(c)ACT, (childhood) Asthma Control Test; ACQ, Asthma Control Questionnaire; ED, emergency department; EM, education/motivation; HCP, healthcare professional; ICS, inhaled corticosteroid; Mod, moderate; SA, single-arm; NS, not specified; R, randomized; sev, severe; SMS, short message service

Table 4. Patient-specific, non-interactive, unidirectional interventions

Reference	Patient age group	N	Asthma severity	Intervention type	Intervention details	Study type	Study period	Effect on ICS adherence with intervention	Effect on asthma impairment or symptoms with intervention	Effect on healthcare utilization and/or hospitalization with intervention
30	Adolescent or younger	1143	NS	Decision support	Computerized RCT decision support	R	16 weeks	Change in adherence during therapy not reported	Significant increase in proportion of participants gaining good control	–
31	Adolescent or younger	41	NS	Device monitoring	Propeller Health platform for data collection only	R	30 days	Similar average daily adherence between intervention and control groups	Mean change in cACT similar between intervention and control groups	–
32	Adults only	239	Sev	Device monitoring	INCA adherence and inhaler technique for data collection only	SA	3 months	Change in adherence during therapy not reported	–	–
33	Adults only	184	NS	Device monitoring	INCA adherence and inhaler technique for periodic assessment	R	3 months	Change in adherence during therapy not reported; adherence via dose counter was significantly lower than by objective monitoring	Adherence was predictive of asthma exacerbations	–
34	Adults only	200	NS	Device monitoring	Smart spirometer for data collection only	SA	2 months	–	–	–
35	Adolescent or younger	32	NS	Device monitoring	PEFR monitoring by SMS and digital peak flow meter, cold symptom monitoring by SMS	SA	3 weeks	–	–	–
36	Adults only	111	NS	Device monitoring	Adherence monitor for data collection only	R	24 weeks	Change in adherence during therapy not reported; consistent overestimation of self-reported adherence vs digitally monitored	–	–

37	Adolescent or younger	90	NS	Device monitoring	Adherence monitor for data collection only	SA	3 months	Change in adherence during therapy not reported, ethnicity correlated with adherence	–	–
38	Adults only	123	NS	Device monitoring	INCA adherence and inhaler technique for data collection only	SA	2–4 weeks	Overall change in adherence during therapy not reported; significant correlation between adherence and socioeconomic class, education. Inclusion of inhaler technique errors significantly reduced adherence by dose counter.	–	–
39	Adolescent or younger	272	NS	Digital questionnaire	Cost-effectiveness data for [23]; Web-based ACT used to periodically adjust treatment	R	4 months	–	ACT used to adjust treatment	–
40	Adolescent or younger	272	NS	Digital questionnaire	See also [39]; Web-based ACT used to periodically adjust treatment	R	1 year	–	No significant change in ACT in the web intervention group	No significant differences between groups in hospitalizations or steroid courses
41	Adolescent or younger	84	NS	Digital questionnaire	ADAM iPod cough monitoring and smartphone asthma diary for data collection only	SA	7 days	–	–	High cough counts were associated with higher use of health care services, hospitalizations, and office visits
42	Adolescent or younger	53	NS	Digital questionnaire	Automated telephone EMA	SA	1 month	Change in adherence during therapy not reported	Change in ACT during therapy not reported	–
43	Adolescents & adults	410	NS	Digital questionnaire	ACT by SMS	R	5±1 weeks	–	Significant improvements in ACT were detectable using SMS reporting	–

44	Adults only	16	NS	Digital questionnaire	EMA by SMS with automated prompts for data collection	SA	2 weeks	Change in adherence during therapy not reported	Change in symptoms during therapy not reported	–
45	Adolescent or younger	228	NS	Digital questionnaire	Web-based symptom diary for data collection only	R	4 weeks	Change in adherence during therapy not reported	Change in ACT and cACT score during therapy not reported	–
46	Adolescent or younger	50	Mod	Digital questionnaire	Smartphone app symptom diary plus EM	R	3 months	No significant difference in self-reported medication adherence between groups with additional education/motivation	Significant improvement in cACT	–
47	All ages	7593	Mild, mod, sev	Digital questionnaire	Regular data surveys from asthma patients	SA	6 months	Change during study not reported	Change during study not reported	–
48	Adolescent or younger	68	NS	EM	Individualized static education	R	13 weeks	No significant difference in adherence at weeks 5 and 10	–	–
49	Adolescents & adults	216	NS	EM	Tailored static EM	R	9 months	Significant improvement in adherence but less than the clinically relevant level	–	–
50	Adolescent or younger	81	NS	Inhaler only	Adherence monitor for data collection only	SA	12 months	Change in adherence during therapy not reported; median adherence was 87%, and relatively constant in most patients	Asthma control during the 12-month study period was high and lung function was normal	–
51	Adults only	50	NS	Inhaler only	Automated interactive call + electronic dose tracker	R	10 weeks	32% improvement in adherence over 10 weeks	No difference in ACT	–
52	Adolescent or younger	82	NS	Inhaler platform	kHealth platform and digital phenotyping - unidirectional; data only available to HCP	SA	1 OR 3 months	Effect of intervention on controller adherence during study not reported; poor adherence associated with poor asthma control	Effect of intervention on ACT during study not reported; poor adherence associated with poor asthma control	–

53	Adults only	67	NS	Platform only	WeChat platform with education and HCP interaction	R	3 months	No significant difference in medication adherence between groups	No significant difference in improvement of asthma control between intervention and control groups	No significant difference between groups
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(c)ACT, (childhood) Asthma Control Test; EM, education/motivation; EMA, ecological momentary association; HCP, healthcare professional; ICS, inhaled corticosteroid; Mod, moderate; PEFR, peak expiratory flow rate; RCT, randomized clinical trial; SA, single-arm; NS, not specified; R, randomized; sev, severe; SMS, short message service

Journal Pre-proof

Table 5. Patient-specific interactive, bidirectional interventions

Reference	Patient age group	N	Asthma severity	Intervention type	Intervention details	Study type	Study period	Effect on ICS adherence with intervention	Effect on asthma impairment or symptoms with intervention	Effect on healthcare utilization and/or hospitalization with intervention
54	Adolescent or younger	22	NS	Device monitoring	Vortex whistle and smartphone app for PEV	SA	1 month	–	–	–
55	Adults only	72	All	Device monitoring	FEV measurement with smartphone asthma monitoring app	R	6 months	–	Significant improvement in asthma control	No significant differences in unscheduled healthcare visits
56	Adults only	44	NS	EM	Individualized education in response to assignments	SA	6 weeks	–	Significant increase in mean ACT score (greater than MID) at 3 months after the intervention	–
57	Adults only	51	Mod	EM	Interactive website for education and improving adherence	R	3 months	No significant difference between groups	No significant difference in ACQ between groups	No significant difference between groups in HCP contact or steroid prescriptions
11	Adolescent or younger	220	NS	Inhaler only	Reliability data for [12]; Adherence monitor ± reminders	R	not stated	–	Significant perceived and objective improvement in asthma control in conjunction with [12]	–
12	Adolescent or younger	220	NS	Inhaler only	See also [11]; Adherence monitor ± reminders	R	6 months	Significant improvement in adherence with the reminder function in a poorly adherent population at baseline; adherence then decline over 6 months	Significant improvement in cACT vs control	No difference in frequency of ED visits

58	Adults only	39	NS	Inhaler platform	Adherence monitor and AMP platform	R	3 months	Baseline adherence and adherence vs control not reported. Slight reduction in adherence in intervention group during study	Greater improvement from baseline to 3 months for intervention compared with control group	–
59	All ages	495	NS	Inhaler platform	Propeller Health platform monitoring of SABA use	R	12 months	–	Significant improvements in ACT in initially uncontrolled adults only; significantly larger decrease in SABA use vs routine care	–
60	Adolescent or younger	77	NS	Inhaler platform	Adherence monitor with periodic feedback	R	12 months	Significantly higher adherence in intervention group over 12 months	No significant difference in improvement of asthma control between intervention and control groups	Significantly fewer hospital admissions in the intervention group
61	Adolescent or younger	14	Mod-sev	Inhaler platform	Adherence monitor with motivational interviewing and feedback	SA	3 months	Change in adherence during therapy not reported	Borderline significant improvement in ACT (p=0.05)	–
62	Adolescent or younger	7	NS	Inhaler platform	Adherence monitor and smartphone app	SA	12 weeks	Not performed due to low patient numbers	–	–
63	All ages	224	NS	Inhaler platform	Propeller Health platform monitoring of SABA and ICS use	SA	1 year	–	–	Significant reduction in asthma-related ED visits, and combined ED and hospitalization events

64	Adolescent or younger	65	NS	Inhaler platform	Smart nebulizer with smartphone app for HCP contact	R	12 weeks	Statistically significantly higher adherence at all timepoints vs control	–	Significantly lower frequency of ED visits, respiratory infections, antibiotics or systemic steroid usage, and therapeutic cost vs control
65	Adolescent or younger	12	NS	Inhaler platform	Adherence monitor with smartphone app	SA	not stated	Clinically significant improvement during pilot study	–	–
66	Adults only	30	NS	Inhaler platform	Adherence monitor for SABA use and interactive web interface	SA	4 months	–	Small, but statistically significant improvement in ACT scores	–
67	Adolescents & adults	120	NS	Inhaler platform	Adherence monitor for SABA use and interactive web interface	SA	1 month	Rescue medication monitored rather than ICS	Significant reduction in SABA use during study	–
68	Adolescent or younger	12	NS	Inhaler platform	Adherence monitor and smartphone app	SA	8 weeks	Patients meeting target ICS adherence ($\geq 50\%$) increased from 8% to 58% at week 8	58% of patients reached the MID for ACT scores	–
69	Adolescents & adults	143	Mod-sev	Inhaler platform	Adherence monitor and web interface	R	6 months	Significant increase in adherence in groups receiving reminders/feedback	No significant difference in ACT between groups	–
70	Adults only	32	NS	Inhaler platform	Adherence monitor for data collection with customisable reminders	SA	3 weeks	Change in adherence during therapy not reported	–	–
71	All ages	497	NS	Inhaler platform	Adherence monitor with interactive smartphone app	SA	12 months	Rescue medication monitored rather than ICS	Significant increase in symptom-free days over 12 months	–

72	Adults only	138	NS	Platform only	breathe mobile health platform	R	12 months	Self-reported controller use increased prior to clinic visits	Post-hoc analysis associated high ACT scores with app usage	–
73	Adults only	408	NS	Platform only	Online asthma care tool	R	12 months	No significant difference between groups	Significant improvement in total ACT score with intervention	No significant difference between groups
74	Adults only	60	NS	Platform only	Interactive smartphone app	SA	4 months	–	Significant increase in ACT	–
75	Adults only	100	NS	Platform only	Online MAP asthma educational and monitoring portal	R	6 months	–	ACT evaluated but not reported separately	No significant difference in hospitalizations
76	Adults only	327	All	Platform only	POPET interactive smartphone app	R	6 months	–	Significant improvements in ACT and proportion of well controlled patients	Significant reduction in unplanned hospital visits and ED visits
77	Adolescent or younger	152	Mild-mod	Platform only	Asthma management smartphone app	R	12 months	Statistically significant higher treatment adherence vs control group	Statistically significantly higher cACT scores and fewer exacerbations vs control	–
78	Adolescent or younger	193	NS	Platform only	AsthmaCare smartphone asthma management app	R	6 months	–	–	Significant reduction in urgent care visits, but not ED visits or hospitalizations
79	Adolescent or younger	34	NS	Platform only	Smartphone AMP	R	6 months	–	Overall, no changes in ACT and self-efficacy scores between groups; adolescents with uncontrolled asthma had improved ACT within the intervention group	–
80	Adults only	103	NS	Platform only	Online asthma patient community	R	9 weeks	No change in self-reported adherence	–	–

81	Adolescent or younger	237	All	Platform only	MyAsthma online asthma management portal	R	12 months	Significant increase in asthma medication changes/refills for children with uncontrolled asthma following parental use of the portal	–	Significantly more medication changes and primary care asthma visits with portal use
82	Adults only	44	NS	Platform only	snuCare smartphone AMP and PFM	R	8 weeks	Significant improvement in adherence	–	–
83	Adults only	48	NS	Platform only	Interactive motivational interviewing and EMA	R	3 months	Trend for fewer doses missed vs control, but not statistically significant	Trend for improved ACT vs control, but not statistically significant	–
84	Adolescent or younger	58	NS	Platform only	Interactive smartphone app	R	6 months	Significant improvement in patients with low (<75%) baseline adherence	–	No significant change in ED or acute visits during study
85	Adolescent or younger	20	NS	Platform only	Smartphone AMP	SA	8 weeks	–	Significant increase in ACT for participants with uncontrolled asthma at baseline	–
86	Adults only	21	Mod-sev	Platform only	Online P'ASMA asthma management portal	R	4 weeks	No significant difference between groups	No significant difference between groups	–
87	Adolescent or younger	26	Mod-sev	Platform only	EM by phone plus tailored SMS	R	3 months	Reduced barriers to adherence	Clinically meaningful improvement in symptoms with medium to large effect sizes over 3months	–
88	Adults only	89	Mod-sev	Platform only	Smartphone asthma diary with management feedback	R	6 months	–	Asthma symptom scores used to adjust therapy	Significantly fewer patients with unscheduled ED visits
89	Adults only	120	NS	Platform only	SMS monitoring with HCP feedback as necessary	R	3 months	–	No significant difference between groups	No significant difference between groups

90	Adults only	424	NS	Platform only	SMS monitoring with HCP feedback as necessary	R	3 months	–	No significant difference between groups	No significant difference in ED visits or hospitalizations between groups after 5 weeks
91	Adults only	80	NS	Platform only	CARAT smartphone app for asthma monitoring with email feedback	R	6 months	No difference between groups for medication adherence	No significant difference between groups	–
92	Adolescent or younger	40	NS	Platform only	CHANGE Asthma smartphone app with education and AMP	R	4 months	–	No significant difference in cACT between groups	–
93	Adolescent or younger	234	NS	Platform only	ADAPT interactive smartphone app including CARAT	R	6 months	Significant improvement in self-reported adherence patients with poor baseline adherence $\pm$ uncontrolled asthma; no significant difference overall	No significant difference in CARAT score between groups	–
94	Adolescent or younger	87	NS	Platform only	ADAPT interactive smartphone app including CARAT	R	6 months	No significant change in self-reported adherence	Change in CARAT score during therapy not reported	–
95	Adolescent or younger	15	NS	Platform only	mASMAA interactive SMS asthma diary system	SA	2 weeks	Anecdotal reports of improved adherence	Anecdotal reports of improved control over asthma symptoms	–
96	Adults only	107	NS	Platform only	Web platform for asthma monitoring, AMP and HCP contact	R	30 months	–	Significant and sustained (≥ 30 months) improvement in asthma control via AQLQ and ACQ	–
97	Adolescent or younger	24	All	Platform only	Web-based peak flow and symptom tracker with feedback	SA	2–15 months	–	Significant reduction in number of wheezing episodes	Significant reduction in doctor or clinic visits

98	Adolescent or younger	90	All	Platform only	Web-based peak flow and symptom tracker with education, AMP and feedback	R	1 year	No significant difference in self-reported medication adherence between groups	Significant improvement in ACQ scores but not sustained beyond 12 months	–
99	Adults only	200	Mod	Platform only	Web-based peak flow and symptom tracker with AMP and feedback	R	1 year	–	Significant improvement in ACQ for patients with partly controlled or uncontrolled asthma only	–
100	Adults only	106	NS	Platform only	Web-based AMP with SMS feedback	R	12 months	Change in adherence during therapy not reported	No significant difference in ACT between groups	No significant difference in hospitalizations or ED visits between groups
101	Adolescent or younger	24	NS	Platform only	AsthmaCare smartphone asthma management app	SA	30 days	Increased adherence in 85% of subjects	–	–
102	Adults only	22	NS	Platform only	Web-based AMP and symptom/peak flow diary with feedback	SA	8 days	Change in adherence during therapy not reported	Significant improvement in CACG symptom benchmarks	No significant difference in urgent health care visits
103	Adolescents	422	All	Platform only	Web-based platform with tailored feedback to questions	R	12 months	–	Significant reduction in symptom days	No difference in frequency of ED visits
104	Adults only	51	Mod-sev	Telemed	EM by phone plus static education	SA	9 months	31.4% of 35 subjects indicated improved adherence	Change in ACT statistically significant, but less than the MID	No difference in ED visits or hospitalizations between baseline and end of study
105	Adolescent or younger	400	NS	Telemed	Telemed visits	R	1 school year	–	Significant improvement in symptom-free days per 2 weeks	Reduced likelihood of ED visit or hospitalization for asthma

106	Adolescent or younger	210	NS	Telemed	Online virtual asthma clinic	R	16 months	–	Significant improvement in cACT but not ACT, in children and adolescents, respectively	No significant difference between groups
107	Adults only	100	NS	Telemed	Telemed and SMS asthma monitoring	R	12 months	–	Statistically, but not clinically, significant increase in ACT score for intervention and control (between-group interaction not reported)	No hospitalizations during the study
108	All ages	20	NS	Telemed	Telemed education	SA	1 year	–	Increase in proportion of well-controlled patients by ACT score	–
109	Adolescent or younger	210	NS	Telemed	Telemed visits	R	16 months	–	Significant increase in cACT but no difference in ACT for teenagers, after 16 months	Online asthma management was associated with fewer outpatient clinic visits
110	Adolescent or younger	50	Sev	Telemed	Telemonitoring of FEV1 and intervention if necessary	R	12 months	–	No significant difference between groups for exacerbations	–
111	Adolescent or younger	48	NS	Telemed	Telemed evaluation compared with face-to-face	SA	7 months	–	–	–
112	Adults only	422	NS	Telemed	Telemed EM	R	2 years	–	Significantly improved ACT scores after 2 years	Significant reduction in asthma-related hospitalization
113	Adolescent or younger	362	NS	Telemed	Telemed EM	R	1 year	–	Significant reduction in the proportion of children with poorly controlled asthma	Urgent care events decreased in both groups with no significant difference between groups

114	Adolescent or younger	393	NS	Telemed	Telemed EM	R	6 months	Significant increase in caregiver-reported adherence but no significant difference in asthma medication ratio	No statistically significant difference between groups in reported symptom free days	–
115	Adults only	30	NS	Telemed	Telemed education and inhaler technique	SA	2 weeks	–	–	–
116	Adolescent or younger	295	NS	Telemed	Telemed education	R	1 year	–	–	Significant reduction in ED visits and hospitalizations during follow-up
117	Adults only	98	NS	Telemed	Telemed education	R	3 months	Within-group improvement in adherence in the intervention group	No significant between-group difference in ACT; within-group improvement in the intervention group	–

AMP, asthma management plan; (c)ACT, (childhood) Asthma Control Test; ACQ, Asthma Control Questionnaire; AQLQ, Asthma Quality of Life Questionnaire; EM, education/motivation; EMA, ecological momentary association; FEV, forced expiratory volume; HCP, healthcare professional; ICS, inhaled corticosteroid; MID, minimal important difference; Mod, moderate; PEFR, peak expiratory flow rate; PEV, peak expiratory volume; RCT, randomized clinical trial; SA, single-arm; NS, not specified; R, randomized; SABA, short-acting beta agonist; sev, severe; SMS, short message service; Telemed, telemedicine intervention

Supplementary Material

Supplementary Table 1: Search terms, limits and results

Pubmed searches

Search	Query Digital inhaler	Results	Search	Query General digital	Results
#1	Search ("Asthma"[Mesh] OR "Asthma"[tiab] OR Asthma*[tiab] OR antiasthma[tiab] OR "anti-asthma"[tiab] OR antiasthma*[tiab] OR "anti asthma"[tiab] OR "Respiratory Sounds"[Mesh] OR "respiratory sounds"[tiab] OR "respiratory sound"[tiab] OR "breathing sounds"[tiab] OR "breathing sound"[tiab] OR "lung sound"[tiab] OR "lung sounds"[tiab] OR stridor[tiab] OR stridors[tiab] OR Rale[tiab] OR Rales[tiab] OR Crackle[tiab] OR Crackles[tiab] OR "Pleural Rub"[tiab] OR "pleural rubs"[tiab] OR Rhonchi[tiab] OR Rhoncus[tiab] OR Wheezing[tiab] OR Wheezings[tiab] OR wheez*[tiab] OR "Bronchial Spasm"[Mesh] OR "Bronchial Spasm"[tiab] OR "Bronchial Spasms"[tiab] OR Bronchospas*[tiab] OR "Bronchoconstriction"[Mesh] OR Bronchoconstrict*[tiab] OR "Bronchial Constriction"[tiab] OR "Bronchial Constrictions"[tiab] OR "Bronchial Hyperreactivity"[Mesh] OR "Bronchial Hyperreactivity"[tiab] OR "Bronchial Hyperreactivities"[tiab] OR "Respiratory Hypersensitivity"[Mesh] OR "Respiratory	219727	#1	Search ("Asthma"[Mesh] OR "Asthma"[tiab] OR Asthma*[tiab] OR antiasthma[tiab] OR "anti-asthma"[tiab] OR antiasthma*[tiab] OR "anti asthma"[tiab] OR "Respiratory Sounds"[Mesh] OR "respiratory sounds"[tiab] OR "respiratory sound"[tiab] OR "breathing sounds"[tiab] OR "breathing sound"[tiab] OR "lung sound"[tiab] OR "lung sounds"[tiab] OR stridor[tiab] OR stridors[tiab] OR Rale[tiab] OR Rales[tiab] OR Crackle[tiab] OR Crackles[tiab] OR "Pleural Rub"[tiab] OR "pleural rubs"[tiab] OR Rhonchi[tiab] OR Rhoncus[tiab] OR Wheezing[tiab] OR Wheezings[tiab] OR wheez*[tiab] OR "Bronchial Spasm"[Mesh] OR "Bronchial Spasm"[tiab] OR "Bronchial Spasms"[tiab] OR Bronchospas*[tiab] OR "Bronchoconstriction"[Mesh] OR Bronchoconstrict*[tiab] OR "Bronchial Constriction"[tiab] OR "Bronchial Constrictions"[tiab] OR "Bronchial Hyperreactivity"[Mesh] OR "Bronchial Hyperreactivity"[tiab] OR "Bronchial Hyperreactivities"[tiab] OR "Respiratory	219727

	Hypersensitivity"[tiab] OR "Respiratory Hypersensitivities"[tiab] OR "Airway Hyper-Responsiveness"[tiab] OR "Airway Hyper Responsiveness"[tiab])			Hypersensitivity"[Mesh] OR "Respiratory Hypersensitivity"[tiab] OR "Respiratory Hypersensitivities"[tiab] OR "Airway Hyper-Responsiveness"[tiab] OR "Airway Hyper Responsiveness"[tiab])	
#2	Search ("Smart inhaler"[tiab] OR "Smart inhalers"[tiab] OR "Digihaler"[tiab] OR "Digihalers"[tiab] OR BreatheSmart[tiab] OR Smartinhaler[tiab] OR Inspiromatic[tiab] OR "Nebulizer Chronolog"[tiab] OR "MDI Chronolog"[tiab] OR "Aerosol Actuation Counter"[tiab] OR "Turbuhaler Inhalation Computer"[tiab] OR "Doser"[tiab] OR "Electronic Diskhaler"[tiab] OR "SmartMist"[tiab] OR "MDILog"[tiab] OR "Diskus Adherence Logger"[tiab] OR "Smart Inhaler Tracker"[tiab] OR "SmartTrack"[tiab] OR "SmartDisk"[tiab] OR "SmartTurbo"[tiab] OR "SmartFlow"[tiab] OR "SmartMat"[tiab] OR "Inhaler Compliance Assessment Device"[tiab] OR "INCA"[tiab] OR "Asthmapolis"[tiab] OR "Propeller Health"[tiab] OR "Chameleon"[tiab] OR "SmartTouch"[tiab] OR "MDI Acoustic Actuation Detector"[tiab] OR "pMDI Datalogger"[tiab] OR "Geckocap"[tiab] OR "CareTRx"[tiab] OR "Sensohaler"[tiab] OR "T-Haler"[tiab]) OR (("Sensor"[tiab] OR "Sensors"[tiab] OR "electronic"[tiab] OR digital[tiab] OR "monitoring"[tiab] OR "sensing"[tiab]) AND ("Metered dose inhalers"[Mesh] OR "Inhaler"[tiab] OR "Inhalers"[tiab] OR "Inhalation"[tiab] OR	4641	#2	Search (("Digital"[tiab] OR "Digitally"[tiab] OR "Mobile Applications"[Mesh] OR "Cell Phone"[mesh] OR "cell phone"[tiab] OR "cell phones"[tiab] OR "cellphone"[tiab] OR "cellphones"[tiab] OR "Smartphone"[Mesh] OR "smartphone"[tiab] OR "smartphones"[tiab] OR "smart-phone"[tiab] OR "smart phone"[tiab] OR "telehealth"[tiab] OR "tele health"[tiab] OR "tele-health"[tiab] OR "telemonitoring"[tiab] OR "tele monitoring"[tiab] OR "tele-monitoring"[tiab] OR "mobile technology"[tiab] OR "mobile technologies"[tiab] OR "mobile app"[tiab] OR "mobile apps"[tiab] OR "mobile application"[tiab] OR "mobile applications"[tiab] OR "bluetooth"[tiab] OR "blue-tooth"[tiab] OR "blue tooth"[tiab] OR "iphone"[tiab] OR "i-phone"[tiab] OR "mobile phone"[tiab] OR "cellular phone"[tiab] OR "tablet apps"[tiab] OR "wireless"[tiab] OR "wirelessly"[tiab] OR "wifi"[tiab] OR "wi-fi"[tiab] OR "Telemedicine"[Mesh] OR "telemedicine"[tiab] OR "mhealth"[tiab] OR "m-health"[tiab] OR "m health"[tiab] OR "mobile health"[tiab] OR "mobile-health"[tiab] OR "mobile self-management"[tiab] OR "mobile	225496

	Respimat[tiab]))			self management"[tiab] OR "text message"[tiab] OR "text messages"[tiab] OR "text messaging"[tiab] OR "text-message"[tiab] OR "text-messages"[tiab] OR "text-messaging"[tiab] OR "sms message"[tiab] OR "sms messages"[tiab] OR "sms messaging"[tiab] OR "sms-message"[tiab] OR "sms-messages"[tiab] OR "sms-messaging"[tiab] OR "short message services"[tiab] OR "short message service"[tiab] OR "short messaging services"[tiab] OR "smart messaging"[tiab] OR "intelligent messaging"[tiab] OR "eHealth"[tiab] OR "e-Health"[tiab] OR "e health"[tiab] OR "electronic health"[tiab] OR "mobile device"[tiab] OR "mobile devices"[tiab] OR "mobile phone"[tiab] OR "mobile phones"[tiab] OR "phone app"[tiab] OR "phone apps"[tiab] OR "phone application"[tiab] OR "phone applications"[tiab] OR iPad[tiab] OR "i-Pad"[tiab] OR etherapy[tiab] OR "e therapy"[tiab] OR "e-therapy"[tiab] OR SMS[tiab] OR "Wearable Electronic Devices"[Mesh] OR "wearable electronic devices"[tiab] OR "wearable electronic device"[tiab] OR "wearable technology"[tiab] OR "wearable technologies"[tiab] OR "wearable tech"[tiab] OR "wearable devices"[tiab] OR "wearable device"[tiab] OR uhealth[tiab] OR "u-health"[tiab] OR "Electronics, Medical"[Mesh] OR "medical electronics"[tiab] OR "Electronic Sensor"[tiab] OR "electronic Sensors"[tiab] OR ("MP3-Player"[Mesh] OR "MP3	
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				Player"[tiab] OR "MP3-Players"[tiab] OR "i-POD"[tiab] OR "i-POD"[tiab] OR "iPOD"[tiab] OR "iPODs"[tiab] OR "MP3"[tiab] OR "MPEG"[tiab] OR "MPEG-1"[tiab] OR "e-monitoring"[tiab] OR "smart"[tiab] OR "smartwatch"[tiab] OR "smartwatches"[tiab])) NOT ("electronic health care records"[tiab] OR "electronic health care record"[tiab] OR "electronic health record"[tiab] OR "electronic health records"[tiab] OR EHR[tiab])	
#3	Search #1 AND #2	656	#3	Search #1 AND #2	1216
#4	Search study[tiab] OR studies[tiab] OR trial[tiab] OR trials[tiab]	9496085	#4	Search study[tiab] OR studies[tiab] OR trial[tiab] OR trials[tiab]	9496085
#5	Search #3 AND #4	428	#5	Search #3 AND #4	755
#6	Search ("Forced expiratory volume in one second"[tiab] OR FEV1[ti]) OR ("Peak expiratory flow"[tiab] OR PEF[ti]) OR ("Dyspnea"[Mesh] OR dyspnea[tiab] OR Dyspneas[tiab] OR Dyspnoea[tiab] OR Dyspnoeas[tiab] OR "Shortness of Breath"[tiab] OR "Breath Shortness"[tiab] OR "Breath Shortnesses"[tiab] OR "Breathlessness"[tiab] OR "Breathlessnesses"[tiab]) OR ("short-acting β 2-agonist"[tiab] OR "short-acting β 2-agonist"[tiab] OR SABA[tiab] OR "rapid-onset beta(2)-agonist"[tiab] OR "Rescue therapy"[tiab] OR "Short-Acting Beta Agonist"[tiab] OR "Short-acting beta2-agonist" OR ((beta[tiab] AND agonist*[tiab]) AND short[tiab]) OR	218613	#6	Search ("Forced expiratory volume in one second"[tiab] OR FEV1[ti]) OR ("Peak expiratory flow"[tiab] OR PEF[ti]) OR ("Dyspnea"[Mesh] OR dyspnea[tiab] OR Dyspneas[tiab] OR Dyspnoea[tiab] OR Dyspnoeas[tiab] OR "Shortness of Breath"[tiab] OR "Breath Shortness"[tiab] OR "Breath Shortnesses"[tiab] OR "Breathlessness"[tiab] OR "Breathlessnesses"[tiab]) OR ("short-acting β 2-agonist"[tiab] OR "short-acting β 2-agonist"[tiab] OR SABA[tiab] OR "rapid-onset beta(2)-agonist"[tiab] OR "Rescue therapy"[tiab] OR "Short-Acting Beta Agonist"[tiab] OR "Short-acting beta2-agonist" OR ((beta[tiab] AND agonist*[tiab]) AND short[tiab])	218613

	(bronchodilator*[tiab] AND short[tiab])) OR (Salbutamol[tiab] OR albuterol[tiab] OR terbutaline[tiab] OR isoproterenol[tiab] OR reproterol[tiab] OR fenoterol[tiab] OR orciprenaline[tiab] OR metaproterenol[tiab]) OR Exacerbat*[tiab] OR ("oral corticosteroid"[tiab] OR "oral corticosteroids"[tiab] OR "OCS"[tiab] OR "oral cortico-steroid"[tiab] OR "oral corti-costeroids"[tiab] OR "systemic corticosteroid"[tiab] OR "systemic corticosteroids"[tiab] OR "systemic cortico-steroid"[tiab] OR "systemic cortico-steroids"[tiab])			OR (bronchodilator*[tiab] AND short[tiab])) OR (Salbutamol[tiab] OR albuterol[tiab] OR terbutaline[tiab] OR isoproterenol[tiab] OR reproterol[tiab] OR fenoterol[tiab] OR orciprenaline[tiab] OR metaproterenol[tiab]) OR Exacerbat*[tiab] OR ("oral corticosteroid"[tiab] OR "oral corticosteroids"[tiab] OR "OCS"[tiab] OR "oral cortico-steroid"[tiab] OR "oral corti-costeroids"[tiab] OR "systemic corticosteroid"[tiab] OR "systemic corticosteroids"[tiab] OR "systemic cortico-steroid"[tiab] OR "systemic cortico-steroids"[tiab])	
#7	Search ("Asthma Control Test"[tiab] OR "asthma control questionnaire"[tiab] OR "Global Initiative for Asthma"[tiab] OR "BTS/SIGN"[tiab] OR "National Asthma Education and Prevention Program"[tiab] OR NAEPP[tiab]) OR ((ACT[tiab] OR "ACQ"[tiab] OR GINA[tiab]) AND (score[tiab] OR measure*[tiab]))	30301	#7	Search ("Asthma Control Test"[tiab] OR "asthma control questionnaire"[tiab] OR "Global Initiative for Asthma"[tiab] OR "BTS/SIGN"[tiab] OR "National Asthma Education and Prevention Program"[tiab] OR NAEPP[tiab]) OR ((ACT[tiab] OR "ACQ"[tiab] OR GINA[tiab]) AND (score[tiab] OR measure*[tiab]))	30301
#8	Search (("Office Visits"[Mesh] OR visit*[tiab]) AND ("asthma-specialist"[tiab] OR "asthma-specialists"[tiab] OR "asthma specialist"[tiab] OR "asthma specialists"[tiab] OR "Pulmonologists"[Mesh] OR "Pulmonologist"[tiab] OR "Pulmonologists"[tiab] OR "Immunologist"[tiab] OR "Immunologists"[tiab] OR "Allergists"[Mesh] OR "Allergist"[tiab] OR "Allergists"[tiab] OR "Primary Health Care"[Mesh] OR "primary health care"[tiab] OR "primary healthcare"[tiab] OR	349771	#8	Search (("Office Visits"[Mesh] OR visit*[tiab]) AND ("asthma-specialist"[tiab] OR "asthma-specialists"[tiab] OR "asthma specialist"[tiab] OR "asthma specialists"[tiab] OR "Pulmonologists"[Mesh] OR "Pulmonologist"[tiab] OR "Pulmonologists"[tiab] OR "Immunologist"[tiab] OR "Immunologists"[tiab] OR "Allergists"[Mesh] OR "Allergist"[tiab] OR "Allergists"[tiab] OR "Primary Health Care"[Mesh] OR "primary health care"[tiab] OR "primary	349771

	"primary care"[tiab] OR "Physicians, Primary Care"[Mesh] OR "primary care physician"[tiab] OR "primary care physicians"[tiab] OR "primary care practitioner"[tiab] OR "primary care practitioners" OR "PCP"[tiab] OR "General Practitioners"[Mesh] OR "general practitioner"[tiab] OR "general practitioners"[tiab] OR "GP"[tiab])) OR ("Hospitalization"[Mesh] OR Hospitalization*[tiab] OR Hospitalisation*[tiab]) OR ("prescription medication costs"[tiab]) OR (("Office Visits"[Mesh] OR visit*[tiab]) AND ("Emergency Service, Hospital"[Mesh] OR "Hospital Emergency Service"[tiab] OR "Hospital Emergency Services"[tiab] OR "Emergency Departments"[tiab] OR "Emergency Department"[tiab] OR "Emergency Hospital Service"[tiab] OR "Emergency Hospital Services"[tiab] OR "Emergency Units"[tiab] OR "Emergency Unit"[tiab] OR "Emergency Ward"[tiab] OR "Emergency Wards"[tiab] OR "Hospital Emergency Service"[tiab] OR "Hospital Service Emergency"[tiab] OR "Hospital Service Emergencies"[tiab] OR "Accident and Emergency Department"[tiab] OR "Emergency Room"[tiab] OR "Emergency Rooms"[tiab] OR "Emergency Outpatient Unit"[tiab] OR "Emergency Outpatient Units"[tiab]))			healthcare"[tiab] OR "primary care"[tiab] OR "Physicians, Primary Care"[Mesh] OR "primary care physician"[tiab] OR "primary care physicians"[tiab] OR "primary care practitioner"[tiab] OR "primary care practitioners" OR "PCP"[tiab] OR "General Practitioners"[Mesh] OR "general practitioner"[tiab] OR "general practitioners"[tiab] OR "GP"[tiab])) OR ("Hospitalization"[Mesh] OR Hospitalization*[tiab] OR Hospitalisation*[tiab]) OR ("prescription medication costs"[tiab]) OR (("Office Visits"[Mesh] OR visit*[tiab]) AND ("Emergency Service, Hospital"[Mesh] OR "Hospital Emergency Service"[tiab] OR "Hospital Emergency Services"[tiab] OR "Emergency Departments"[tiab] OR "Emergency Department"[tiab] OR "Emergency Hospital Service"[tiab] OR "Emergency Hospital Services"[tiab] OR "Emergency Units"[tiab] OR "Emergency Unit"[tiab] OR "Emergency Ward"[tiab] OR "Emergency Wards"[tiab] OR "Hospital Emergency Service"[tiab] OR "Hospital Service Emergency"[tiab] OR "Hospital Service Emergencies"[tiab] OR "Accident and Emergency Department"[tiab] OR "Emergency Room"[tiab] OR "Emergency Rooms"[tiab] OR "Emergency Outpatient Unit"[tiab] OR "Emergency Outpatient Units"[tiab]))	
#9	Search "patient-reported outcome"[tiab] OR "patient reported outcome"[tiab] OR "patient-reported outcomes"[tiab] OR	223142	#9	Search "patient-reported outcome"[tiab] OR "patient reported outcome"[tiab] OR "patient-reported	223142

	"patient reported outcomes"[tiab] OR "PRO"[tiab] OR "Health Utilities Index"[tiab] OR "EQ5D"[tiab] OR "EuroQol"[tiab] OR "SF-36"[tiab] OR "SF-6"[tiab] OR "ED-50"[tiab] OR "EQ 5D-5L"[tiab] OR "EQ-5D-5L"[tiab] OR "5-level EQ-5D version"[tiab] OR "5 level EQ-5D version"[tiab] OR "Short Form Health Survey-36 (SF-36)"[tiab] OR "36-Item Short Form Survey (SF-36)"[tiab] OR "SF-36"[tiab] OR "Short Form Health Survey-36"[tiab] OR "36-Item Short Form Survey"[tiab] OR "short form 36 health survey"[tiab] OR "Short Form (SF)-36"[tiab] OR "Short Form SF-36"[tiab] OR "36-item Short-Form Health Survey"[tiab] OR "Short Form Survey-36 (SF-36)"[tiab] OR "Short Form Survey-36"[tiab] OR "36-Item Short Form Health Survey (SF-36)"[tiab] OR "short form 36 survey"[tiab] OR "Short Form Health Survey-12 (SF-12)"[tiab] OR "12-Item Short Form Survey (SF-12)"[tiab] OR "short form 12 health survey"[tiab] OR "SF-12"[tiab] OR "Short Form Health Survey-12"[tiab] OR "12-Item Short Form Survey"[tiab] OR "Short Form (SF)-12"[tiab] OR "Short Form SF-12"[tiab] OR "12-item Short-Form Health Survey"[tiab] OR "Short Form Survey-12 (SF-12)"[tiab] OR "Short Form Survey-12"[tiab] OR "12-Item Short Form Health Survey (SF-12)"[tiab] OR "short form 12 survey"[tiab]			outcomes"[tiab] OR "patient reported outcomes"[tiab] OR "PRO"[tiab] OR "Health Utilities Index"[tiab] OR "EQ5D"[tiab] OR "EuroQol"[tiab] OR "SF-36"[tiab] OR "SF-6"[tiab] OR "ED-50"[tiab] OR "EQ 5D-5L"[tiab] OR "EQ-5D-5L"[tiab] OR "5-level EQ-5D version"[tiab] OR "5 level EQ-5D version"[tiab] OR "Short Form Health Survey-36 (SF-36)"[tiab] OR "36-Item Short Form Survey (SF-36)"[tiab] OR "SF-36"[tiab] OR "Short Form Health Survey-36"[tiab] OR "36-Item Short Form Survey"[tiab] OR "short form 36 health survey"[tiab] OR "Short Form (SF)-36"[tiab] OR "Short Form SF-36"[tiab] OR "36-item Short-Form Health Survey"[tiab] OR "Short Form Survey-36 (SF-36)"[tiab] OR "Short Form Survey-36"[tiab] OR "36-Item Short Form Health Survey (SF-36)"[tiab] OR "short form 36 survey"[tiab] OR "Short Form Health Survey-12 (SF-12)"[tiab] OR "12-Item Short Form Survey (SF-12)"[tiab] OR "short form 12 health survey"[tiab] OR "SF-12"[tiab] OR "Short Form Health Survey-12"[tiab] OR "12-Item Short Form Survey"[tiab] OR "Short Form (SF)-12"[tiab] OR "Short Form SF-12"[tiab] OR "12-item Short-Form Health Survey"[tiab] OR "Short Form Survey-12 (SF-12)"[tiab] OR "Short Form Survey-12"[tiab] OR "12-Item Short Form Health Survey (SF-12)"[tiab] OR "short form 12 survey"[tiab]	
#10	Search "Health-Related Productivity Loss"[tiab] OR ("physical activity"[tiab] AND limit*[tiab]) OR ("WPAI-GH"[tiab] OR	9571	#10	Search "Health-Related Productivity Loss"[tiab] OR ("physical activity"[tiab] AND limit*[tiab]) OR ("WPAI-GH"[tiab] OR	9571

	"WPAI:GH"[tiab] OR "Work Productivity and Activity Impairment Questionnaire: General Health"[tiab] OR "Work Productivity and Activity Impairment _ General Health Questionnaire"[tiab] OR "WPAI-general health version"[tiab] OR "WPAI: general health version"[tiab]) OR (loss[tiab] AND productivity[tiab]) AND (work[tiab] OR employment[tiab] OR study[tiab] OR school[tiab])			"WPAI:GH"[tiab] OR "Work Productivity and Activity Impairment Questionnaire: General Health"[tiab] OR "Work Productivity and Activity Impairment _ General Health Questionnaire"[tiab] OR "WPAI-general health version"[tiab] OR "WPAI: general health version"[tiab]) OR (loss[tiab] AND productivity[tiab]) AND (work[tiab] OR employment[tiab] OR study[tiab] OR school[tiab])	
#11	Search "Patient Compliance"[Mesh] OR "Medication Adherence"[Mesh] OR Adherence[all] OR adhere[all] OR Cooperation[all] OR "Non-Compliance"[all] OR "Non Compliance"[all] OR Nonadherence[all] OR Noncompliance[all] OR "Non-Adherence"[all] OR "Non Adherence"[all] OR Compliance[all] OR compliant[all] OR comply[all]	414540	#11	Search "Patient Compliance"[Mesh] OR "Medication Adherence"[Mesh] OR Adherence[all] OR adhere[all] OR Cooperation[all] OR "Non-Compliance"[all] OR "Non Compliance"[all] OR Nonadherence[all] OR Noncompliance[all] OR "Non-Adherence"[all] OR "Non Adherence"[all] OR Compliance[all] OR compliant[all] OR comply[all]	414540
#12	Search persist*[all] OR "non persistence"[all] OR "non persistent"[all] OR "non-persistence"[all] OR "non-persistent"[all] OR "nonpersistence"[all] OR "nonpersistent"[all]	450330	#12	Search persist*[all] OR "non persistence"[all] OR "non persistent"[all] OR "non-persistence"[all] OR "non-persistent"[all] OR "nonpersistence"[all] OR "nonpersistent"[all]	450330
#13	Search (#6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12) AND #5	283	#13	Search (#6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12) AND #5	373
#14	Search animals[Mesh] NOT humans[Mesh]	4595961	#14	Search animals[Mesh] NOT humans[Mesh]	4595961
#15	Search #13 NOT #14	281	#15	Search #13 NOT #14	372
#16	Search "review"[tiab] OR review[Publication Type] OR	4970203	#16	Search "review"[tiab] OR review[Publication Type] OR	4970203

	Comment[Publication Type] OR Editorial[Publication Type] OR Letter[Publication Type] OR News[Publication Type]			Comment[Publication Type] OR Editorial[Publication Type] OR Letter[Publication Type] OR News[Publication Type]	
#17	Search "systematic review"[Publication Type] OR ("systematic"[tiab] AND "review"[tiab]) OR ("meta-analysis"[tiab] OR "meta-analyses"[tiab])	260737	#17	Search "systematic review"[Publication Type] OR ("systematic"[tiab] AND "review"[tiab]) OR ("meta-analysis"[tiab] OR "meta-analyses"[tiab])	260737
#18	Search #16 NOT #17	4761135	#18	Search #16 NOT #17	4761135
#19	Search #15 NOT #18	252	#19	Search #15 NOT #18	321
#20	Search #15 NOT #18 Filters: Publication date from 2011/01/01	109	#20	Search #15 NOT #18 Filters: Publication date from 2011/01/01	225
#21	Search #15 NOT #18 Filters: Publication date from 2011/01/01; English	107	#21	Search #15 NOT #18 Filters: Publication date from 2011/01/01; English	218

Embase searches

Search	Query Digital inhaler	Results	Search	Query General digital	Results
#1	'asthma'/exp OR 'asthma' OR asthma:ti,ab OR asthma*:ti,ab OR antiasthma:ti,ab OR 'anti-asthma':ti,ab OR antiasthma*:ti,ab OR 'anti asthma':ti,ab OR 'abnormal respiratory sound'/exp OR 'abnormal respiratory sound' OR 'respiratory sounds':ti,ab OR 'respiratory sound':ti,ab OR 'breathing sounds':ti,ab OR 'breathing sound':ti,ab OR 'lung sound':ti,ab OR 'lung	410401	#1	'asthma'/exp OR 'asthma' OR asthma:ti,ab OR asthma*:ti,ab OR antiasthma:ti,ab OR 'anti-asthma':ti,ab OR antiasthma*:ti,ab OR 'anti asthma':ti,ab OR 'abnormal respiratory sound'/exp OR 'abnormal respiratory sound' OR 'respiratory sounds':ti,ab OR 'respiratory sound':ti,ab OR 'breathing sounds':ti,ab OR 'breathing sound':ti,ab OR 'lung	410401

	sounds':ti,ab OR stridor:ti,ab OR stridors:ti,ab OR rale:ti,ab OR rales:ti,ab OR crackle:ti,ab OR crackles:ti,ab OR 'pleural rub':ti,ab OR 'pleural rubs':ti,ab OR rhonchi:ti,ab OR rhoncus:ti,ab OR wheezing:ti,ab OR wheezings:ti,ab OR wheez*:ti,ab OR 'bronchospasm'/exp OR 'bronchospasm' OR 'bronchial spasm':ti,ab OR 'bronchial spasms':ti,ab OR bronchospas*:ti,ab OR 'bronchoconstriction'/exp OR 'bronchoconstriction' OR bronchoconstrict*:ti,ab OR 'bronchial constriction':ti,ab OR 'bronchial constrictions':ti,ab OR 'bronchus hyperreactivity'/exp OR 'bronchus hyperreactivity' OR 'bronchial hyperreactivity':ti,ab OR 'bronchial hyperreactivities':ti,ab OR 'respiratory tract allergy'/exp OR 'respiratory tract allergy' OR 'respiratory hypersensitivity':ti,ab OR 'respiratory hypersensitivities':ti,ab OR 'airway hyper-responsiveness':ti,ab OR 'airway hyper responsiveness':ti,ab			sound':ti,ab OR 'lung sounds':ti,ab OR stridor:ti,ab OR stridors:ti,ab OR rale:ti,ab OR rales:ti,ab OR crackle:ti,ab OR crackles:ti,ab OR 'pleural rub':ti,ab OR 'pleural rubs':ti,ab OR rhonchi:ti,ab OR rhoncus:ti,ab OR wheezing:ti,ab OR wheezings:ti,ab OR wheez*:ti,ab OR 'bronchospasm'/exp OR 'bronchospasm' OR 'bronchial spasm':ti,ab OR 'bronchial spasms':ti,ab OR bronchospas*:ti,ab OR 'bronchoconstriction'/exp OR 'bronchoconstriction' OR bronchoconstrict*:ti,ab OR 'bronchial constriction':ti,ab OR 'bronchial constrictions':ti,ab OR 'bronchus hyperreactivity'/exp OR 'bronchus hyperreactivity' OR 'bronchial hyperreactivity':ti,ab OR 'bronchial hyperreactivities':ti,ab OR 'respiratory tract allergy'/exp OR 'respiratory tract allergy' OR 'respiratory hypersensitivity':ti,ab OR 'respiratory hypersensitivities':ti,ab OR 'airway hyper-responsiveness':ti,ab OR 'airway hyper responsiveness':ti,ab	
#2	'smart inhaler':ti,ab OR 'smart inhalers':ti,ab OR 'digihalter':ti,ab OR 'digihalers':ti,ab OR breathesmart:ti,ab OR smartinhaler:ti,ab OR inspiromatic:ti,ab OR 'nebulizer chronolog':ti,ab OR 'mdi chronolog':ti,ab OR 'aerosol actuation counter':ti,ab OR 'turbuhaler inhalation computer':ti,ab OR 'doser':ti,ab OR 'electronic diskhaler':ti,ab OR 'smartmist':ti,ab OR 'mdilog':ti,ab OR 'diskus adherence logger':ti,ab OR 'smart inhaler	6913	#2	('digital':ti,ab OR 'digitally':ti,ab OR 'mobile application'/exp OR 'mobile phone'/exp OR 'cell phone':ti,ab OR 'cell phones':ti,ab OR 'cellphone':ti,ab OR 'cellphones':ti,ab OR 'smartphone'/exp OR 'smartphone':ti,ab OR 'smartphones':ti,ab OR 'smart-phone':ti,ab OR 'smart phone':ti,ab OR 'telehealth':ti,ab OR 'tele health':ti,ab OR 'tele-health':ti,ab OR 'telemonitoring':ti,ab OR 'tele	531626

	tracker':ti,ab OR 'smarttrack':ti,ab OR 'smartdisk':ti,ab OR 'smartturbo':ti,ab OR 'smartflow':ti,ab OR 'smartmat':ti,ab OR 'inhaler compliance assessment device':ti,ab OR 'inca':ti,ab OR 'asthmapolis':ti,ab OR 'propeller health':ti,ab OR 'chameleon':ti,ab OR 'smarttouch':ti,ab OR 'mdi acoustic actuation detector':ti,ab OR 'pmdi datalogger':ti,ab OR 'geckocap':ti,ab OR 'caretrx':ti,ab OR 'sensohaler':ti,ab OR 't-haler':ti,ab OR (('sensor':ti,ab OR 'sensors':ti,ab OR 'electronic':ti,ab OR digital:ti,ab OR 'monitoring':ti,ab OR 'sensing':ti,ab) AND ('metered dose inhaler'/exp OR 'inhaler':ti,ab OR 'inhalers':ti,ab OR 'inhalation':ti,ab OR respimat:ti,ab))			monitoring':ti,ab OR 'tele-monitoring':ti,ab OR 'mobile technology':ti,ab OR 'mobile technologies':ti,ab OR 'mobile app':ti,ab OR 'mobile apps':ti,ab OR 'mobile application':ti,ab OR 'mobile applications':ti,ab OR 'bluetooth':ti,ab OR 'blue-tooth':ti,ab OR 'blue tooth':ti,ab OR 'iphone':ti,ab OR 'i-phone':ti,ab OR 'cellular phone':ti,ab OR 'tablet apps':ti,ab OR 'wireless':ti,ab OR 'wirelessly':ti,ab OR 'wifi':ti,ab OR 'wi-fi':ti,ab OR 'telemedicine'/exp OR 'telemedicine':ti,ab OR 'mhealth':ti,ab OR 'm-health':ti,ab OR 'm health':ti,ab OR 'mobile health':ti,ab OR 'mobile-health':ti,ab OR 'mobile self-management':ti,ab OR 'mobile self management':ti,ab OR 'text message':ti,ab OR 'text messages':ti,ab OR 'text messaging':ti,ab OR 'text-message':ti,ab OR 'text-messages':ti,ab OR 'text-messaging':ti,ab OR 'sms message':ti,ab OR 'sms messages':ti,ab OR 'sms messaging':ti,ab OR 'sms-message':ti,ab OR 'sms-messages':ti,ab OR 'sms-messaging':ti,ab OR 'short message services':ti,ab OR 'short message service':ti,ab OR 'short messaging services':ti,ab OR 'smart messaging':ti,ab OR 'intelligent messaging':ti,ab OR 'ehealth':ti,ab OR 'e-health':ti,ab OR 'e health':ti,ab OR 'electronic health':ti,ab OR 'mobile device':ti,ab OR 'mobile devices':ti,ab OR 'mobile phone':ti,ab OR 'mobile phones':ti,ab OR 'phone app':ti,ab OR 'phone apps':ti,ab OR 'phone application':ti,ab OR 'phone	
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				applications':ti,ab OR ipad:ti,ab OR 'i-pad':ti,ab OR etherapy:ti,ab OR 'e therapy':ti,ab OR 'e-therapy':ti,ab OR sms:ti,ab OR 'electronic device'/exp OR 'wearable electronic devices':ti,ab OR 'wearable electronic device':ti,ab OR 'wearable technology':ti,ab OR 'wearable technologies':ti,ab OR 'wearable tech':ti,ab OR 'wearable devices':ti,ab OR 'wearable device':ti,ab OR uhealth:ti,ab OR 'u-health':ti,ab OR 'medical electronics'/exp OR 'medical electronics':ti,ab OR 'electronic sensor':ti,ab OR 'electronic sensors':ti,ab OR 'mp3 player'/exp OR 'mp3 player':ti,ab OR 'mp3-players':ti,ab OR 'i- pod':ti,ab OR 'i pod':ti,ab OR 'ipod':ti,ab OR 'ipods':ti,ab OR 'mp3':ti,ab OR 'mpeg':ti,ab OR 'mpeg-1':ti,ab OR 'e- monitoring':ti,ab OR 'smart':ti,ab OR 'smartwatch':ti,ab OR 'smartwatches':ti,ab) NOT ('electronic health care records':ti,ab OR 'electronic health care record':ti,ab OR 'electronic health record':ti,ab OR 'electronic health records':ti,ab OR ehr:ti,ab)	
#3	#1 AND #2	1230	#3	#1 AND #2	5224
#4	study:ti,ab OR studies:ti,ab OR trial:ti,ab OR trials:ti,ab	122306 44	#4	study:ti,ab OR studies:ti,ab OR trial:ti,ab OR trials:ti,ab	122306 44
#5	#3 AND #4	805	#5	#3 AND #4	3083
#6	'forced expiratory volume in one second':ti,ab OR fev1:ti OR 'peak expiratory flow':ti,ab OR pef:ti OR 'dyspnea'/exp OR	397559	#6	'forced expiratory volume in one second':ti,ab OR fev1:ti OR 'peak expiratory flow':ti,ab OR pef:ti OR 'dyspnea'/exp OR	397559

	dyspnea:ti,ab OR dyspneas:ti,ab OR dyspnoea:ti,ab OR dyspnoeas:ti,ab OR 'shortness of breath':ti,ab OR 'breath shortness':ti,ab OR 'breath shortnesses':ti,ab OR 'breathlessness':ti,ab OR 'breathlessnesses':ti,ab OR 'short-acting β2-agonist':ti,ab OR saba:ti,ab OR 'rapid-onset beta(2)- agonist':ti,ab OR 'rescue therapy':ti,ab OR 'short-acting beta agonist':ti,ab OR 'short-acting beta2-agonist' OR (beta:ti,ab AND agonist*:ti,ab AND short:ti,ab) OR (bronchodilator*:ti,ab AND short:ti,ab) OR salbutamol:ti,ab OR albuterol:ti,ab OR terbutaline:ti,ab OR isoproterenol:ti,ab OR reproterol:ti,ab OR fenoterol:ti,ab OR orciprenaline:ti,ab OR metaproterenol:ti,ab OR exacerbat*:ti,ab OR 'oral corticosteroid':ti,ab OR 'oral corticosteroids':ti,ab OR 'ocs':ti,ab OR 'oral cortico-steroid':ti,ab OR 'oral corti-costeroids':ti,ab OR 'systemic corticosteroid':ti,ab OR 'systemic corticosteroids':ti,ab OR 'systemic cortico- steroid':ti,ab OR 'systemic cortico-steroids':ti,ab			dyspnea:ti,ab OR dyspneas:ti,ab OR dyspnoea:ti,ab OR dyspnoeas:ti,ab OR 'shortness of breath':ti,ab OR 'breath shortness':ti,ab OR 'breath shortnesses':ti,ab OR 'breathlessness':ti,ab OR 'breathlessnesses':ti,ab OR 'short- acting β2-agonist':ti,ab OR saba:ti,ab OR 'rapid-onset beta(2)- agonist':ti,ab OR 'rescue therapy':ti,ab OR 'short-acting beta agonist':ti,ab OR 'short-acting beta2-agonist' OR (beta:ti,ab AND agonist*:ti,ab AND short:ti,ab) OR (bronchodilator*:ti,ab AND short:ti,ab) OR salbutamol:ti,ab OR albuterol:ti,ab OR terbutaline:ti,ab OR isoproterenol:ti,ab OR reproterol:ti,ab OR fenoterol:ti,ab OR orciprenaline:ti,ab OR metaproterenol:ti,ab OR exacerbat*:ti,ab OR 'oral corticosteroid':ti,ab OR 'oral corticosteroids':ti,ab OR 'ocs':ti,ab OR 'oral cortico-steroid':ti,ab OR 'oral corti- costeroids':ti,ab OR 'systemic corticosteroid':ti,ab OR 'systemic corticosteroids':ti,ab OR 'systemic cortico- steroid':ti,ab OR 'systemic cortico-steroids':ti,ab	
#7	'asthma control test':ti,ab OR 'asthma control questionnaire':ti,ab OR 'global initiative for asthma':ti,ab OR 'bts/sign':ti,ab OR 'national asthma education and prevention program':ti,ab OR naepp:ti,ab OR ((act:ti,ab OR 'acq':ti,ab OR gina:ti,ab) AND (score:ti,ab OR measure*:ti,ab))	45079	#7	'asthma control test':ti,ab OR 'asthma control questionnaire':ti,ab OR 'global initiative for asthma':ti,ab OR 'bts/sign':ti,ab OR 'national asthma education and prevention program':ti,ab OR naepp:ti,ab OR ((act:ti,ab OR 'acq':ti,ab OR gina:ti,ab) AND (score:ti,ab OR measure*:ti,ab))	45079
#8	('ambulatory care'/exp OR visit*:ti,ab) AND ('asthma- specialist':ti,ab OR 'asthma-specialists':ti,ab OR 'asthma	481476	#8	('ambulatory care'/exp OR visit*:ti,ab) AND ('asthma- specialist':ti,ab OR 'asthma-specialists':ti,ab OR 'asthma	481476

	specialist':ti,ab OR 'asthma specialists':ti,ab OR 'pulmonologist'/exp OR 'pulmonologist':ti,ab OR 'pulmonologists':ti,ab OR 'immunologist':ti,ab OR 'immunologists':ti,ab OR 'immunologist'/exp OR 'allergist':ti,ab OR 'allergists':ti,ab OR 'primary health care'/exp OR 'primary health care':ti,ab OR 'primary healthcare':ti,ab OR 'primary care':ti,ab OR 'general practitioner'/exp OR 'primary care physician':ti,ab OR 'primary care physicians':ti,ab OR 'primary care practitioner':ti,ab OR 'primary care practitioners' OR 'pcp':ti,ab OR 'general practitioner':ti,ab OR 'general practitioners':ti,ab OR 'gp':ti,ab) OR 'hospitalization'/exp OR hospitalization*:ti,ab OR hospitalisation*:ti,ab OR 'prescription medication costs':ti,ab OR (('ambulatory care'/exp OR visit*:ti,ab) AND ('hospital emergency service'/exp OR 'hospital emergency services':ti,ab OR 'emergency departments':ti,ab OR 'emergency department':ti,ab OR 'emergency hospital service':ti,ab OR 'emergency hospital services':ti,ab OR 'emergency units':ti,ab OR 'emergency unit':ti,ab OR 'emergency ward':ti,ab OR 'emergency wards':ti,ab OR 'hospital emergency service':ti,ab OR 'hospital service emergency':ti,ab OR 'hospital service emergencies':ti,ab OR 'accident and emergency department':ti,ab OR 'emergency room':ti,ab OR 'emergency rooms':ti,ab OR 'emergency outpatient unit':ti,ab OR 'emergency outpatient units':ti,ab))		specialist':ti,ab OR 'asthma specialists':ti,ab OR 'pulmonologist'/exp OR 'pulmonologist':ti,ab OR 'pulmonologists':ti,ab OR 'immunologist':ti,ab OR 'immunologists':ti,ab OR 'immunologist'/exp OR 'allergist':ti,ab OR 'allergists':ti,ab OR 'primary health care'/exp OR 'primary health care':ti,ab OR 'primary healthcare':ti,ab OR 'primary care':ti,ab OR 'general practitioner'/exp OR 'primary care physician':ti,ab OR 'primary care physicians':ti,ab OR 'primary care practitioner':ti,ab OR 'primary care practitioners' OR 'pcp':ti,ab OR 'general practitioner':ti,ab OR 'general practitioners':ti,ab OR 'gp':ti,ab) OR 'hospitalization'/exp OR hospitalization*:ti,ab OR hospitalisation*:ti,ab OR 'prescription medication costs':ti,ab OR (('ambulatory care'/exp OR visit*:ti,ab) AND ('hospital emergency service'/exp OR 'hospital emergency services':ti,ab OR 'emergency departments':ti,ab OR 'emergency department':ti,ab OR 'emergency hospital service':ti,ab OR 'emergency hospital services':ti,ab OR 'emergency units':ti,ab OR 'emergency unit':ti,ab OR 'emergency ward':ti,ab OR 'emergency wards':ti,ab OR 'hospital emergency service':ti,ab OR 'hospital service emergency':ti,ab OR 'hospital service emergencies':ti,ab OR 'accident and emergency department':ti,ab OR 'emergency room':ti,ab OR 'emergency	
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				rooms':ti,ab OR 'emergency outpatient unit':ti,ab OR 'emergency outpatient units':ti,ab))	
#9	'patient-reported outcome':ti,ab OR 'patient reported outcome':ti,ab OR 'patient-reported outcomes':ti,ab OR 'patient reported outcomes':ti,ab OR 'pro':ti,ab OR 'health utilities index':ti,ab OR 'eq5d':ti,ab OR 'euroqol':ti,ab OR 'sf-6':ti,ab OR 'ed-50':ti,ab OR 'eq 5d-5l':ti,ab OR 'eq-5d-5l':ti,ab OR '5-level eq-5d version':ti,ab OR '5 level eq-5d version':ti,ab OR 'short form health survey-36 (sf-36)':ti,ab OR '36-item short form survey (sf-36)':ti,ab OR 'sf-36':ti,ab OR 'short form health survey-36':ti,ab OR '36-item short form survey':ti,ab OR 'short form 36 health survey':ti,ab OR 'short form (sf)-36':ti,ab OR 'short form sf-36':ti,ab OR '36-item short-form health survey':ti,ab OR 'short form survey-36 (sf-36)':ti,ab OR 'short form survey-36':ti,ab OR '36-item short form health survey (sf-36)':ti,ab OR 'short form 36 survey':ti,ab OR 'short form health survey-12 (sf-12)':ti,ab OR '12-item short form survey (sf-12)':ti,ab OR 'short form 12 health survey':ti,ab OR 'sf-12':ti,ab OR 'short form health survey-12':ti,ab OR '12-item short form survey':ti,ab OR 'short form (sf)-12':ti,ab OR 'short form sf-12':ti,ab OR '12-item short-form health survey':ti,ab OR 'short form survey-12 (sf-12)':ti,ab OR 'short form survey-12':ti,ab OR '12-item short form health survey (sf-12)':ti,ab OR 'short form 12 survey':ti,ab	348581	#9	'patient-reported outcome':ti,ab OR 'patient reported outcome':ti,ab OR 'patient-reported outcomes':ti,ab OR 'patient reported outcomes':ti,ab OR 'pro':ti,ab OR 'health utilities index':ti,ab OR 'eq5d':ti,ab OR 'euroqol':ti,ab OR 'sf-6':ti,ab OR 'ed-50':ti,ab OR 'eq 5d-5l':ti,ab OR 'eq-5d-5l':ti,ab OR '5-level eq-5d version':ti,ab OR '5 level eq-5d version':ti,ab OR 'short form health survey-36 (sf-36)':ti,ab OR '36-item short form survey (sf-36)':ti,ab OR 'sf-36':ti,ab OR 'short form health survey-36':ti,ab OR '36-item short form survey':ti,ab OR 'short form 36 health survey':ti,ab OR 'short form (sf)-36':ti,ab OR 'short form sf-36':ti,ab OR '36-item short-form health survey':ti,ab OR 'short form survey-36 (sf-36)':ti,ab OR 'short form survey-36':ti,ab OR '36-item short form health survey (sf-36)':ti,ab OR 'short form 36 survey':ti,ab OR 'short form health survey-12 (sf-12)':ti,ab OR '12-item short form survey (sf-12)':ti,ab OR 'short form 12 health survey':ti,ab OR 'sf-12':ti,ab OR 'short form health survey-12':ti,ab OR '12-item short form survey':ti,ab OR 'short form (sf)-12':ti,ab OR 'short form sf-12':ti,ab OR '12-item short-form health survey':ti,ab OR 'short form survey-12 (sf-12)':ti,ab OR 'short form survey-12':ti,ab OR '12-item short form health survey (sf-12)':ti,ab OR 'short form 12 survey':ti,ab	348581

#10	('health-related productivity loss':ti,ab OR ('physical activity':ti,ab AND limit*:ti,ab) OR 'wpai-gh':ti,ab OR 'wpai:gh':ti,ab OR 'work productivity and activity impairment questionnaire: general health':ti,ab OR 'work productivity and activity impairment _ general health questionnaire':ti,ab OR 'wpai-general health version':ti,ab OR 'wpai: general health version':ti,ab OR (loss:ti,ab AND productivity:ti,ab)) AND (work:ti,ab OR employment:ti,ab OR study:ti,ab OR school:ti,ab)	14404	#10	('health-related productivity loss':ti,ab OR ('physical activity':ti,ab AND limit*:ti,ab) OR 'wpai-gh':ti,ab OR 'wpai:gh':ti,ab OR 'work productivity and activity impairment questionnaire: general health':ti,ab OR 'work productivity and activity impairment _ general health questionnaire':ti,ab OR 'wpai-general health version':ti,ab OR 'wpai: general health version':ti,ab OR (loss:ti,ab AND productivity:ti,ab)) AND (work:ti,ab OR employment:ti,ab OR study:ti,ab OR school:ti,ab)	14404
#11	'patient compliance'/exp OR 'medication compliance'/exp OR adherence OR adhere OR cooperation OR 'non-compliance' OR 'non compliance' OR nonadherence OR noncompliance OR 'non-adherence' OR 'non adherence' OR compliance OR compliant OR comply	648569	#11	'patient compliance'/exp OR 'medication compliance'/exp OR adherence OR adhere OR cooperation OR 'non-compliance' OR 'non compliance' OR nonadherence OR noncompliance OR 'non-adherence' OR 'non adherence' OR compliance OR compliant OR comply	648569
#12	persist* OR 'non persistence' OR 'non persistent' OR 'non-persistence' OR 'non-persistent' OR 'nonpersistence' OR 'nonpersistent'	607751	#12	persist* OR 'non persistence' OR 'non persistent' OR 'non-persistence' OR 'non-persistent' OR 'nonpersistence' OR 'nonpersistent'	607751
#13	(#6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12) AND #5	567	#13	(#6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12) AND #5	1350
#14	'animal'/exp NOT 'human'/exp	5273007	#14	'animal'/exp NOT 'human'/exp	5273007
#15	#13 NOT #14	559	#15	#13 NOT #14	1312
#16	'review':ti,ab OR 'review'/it OR 'editorial'/it OR 'erratum'/it OR 'letter'/it OR 'note'/it OR 'short survey'/it OR 'conference	10283425	#16	'review':ti,ab OR 'review'/it OR 'editorial'/it OR 'erratum'/it OR 'letter'/it OR 'note'/it OR 'short survey'/it OR 'conference	10283425

	abstract'/it OR 'conference paper'/it OR 'conference review'/it			abstract'/it OR 'conference paper'/it OR 'conference review'/it	
#17	systematic:ti,ab AND review:ti,ab OR 'meta-analysis':ti,ab OR 'meta-analyses':ti,ab	316223	#17	systematic:ti,ab AND review:ti,ab OR 'meta-analysis':ti,ab OR 'meta-analyses':ti,ab	316223
#18	#16 NOT #17	100222 43	#18	#16 NOT #17	100222 43
#19	#15 NOT #18	282	#19	#15 NOT #18	616
#20	#15 NOT #18 AND [2011-2019]/py	125	#20	#15 NOT #18 AND [2011-2019]/py	440
#21	#15 NOT #18 AND [2011-2019]/py AND [english]/lim	121	#21	#15 NOT #18 AND [2011-2019]/py AND [english]/lim	424

Cochrane database

Search	Query Digital inhaler	Results	Search	Query General digital	Results
#1	([mh Asthma] OR "Asthma":ti,ab,kw,kw OR Asthma*:ti,ab,kw OR antiasthma:ti,ab,kw OR "anti-asthma":ti,ab,kw OR antiasthma*:ti,ab,kw OR "anti asthma":ti,ab,kw OR [mh "Respiratory Sounds"]	38247	#1	([mh Asthma] OR "Asthma":ti,ab,kw,kw OR Asthma*:ti,ab,kw OR antiasthma:ti,ab,kw OR "anti-asthma":ti,ab,kw OR antiasthma*:ti,ab,kw OR "anti asthma":ti,ab,kw OR [mh "Respiratory Sounds"]	38247

	OR "respiratory sounds":ti,ab,kw OR "respiratory sound":ti,ab,kw OR "breathing sounds":ti,ab,kw OR "breathing sound":ti,ab,kw OR "lung sound":ti,ab,kw OR "lung sounds":ti,ab,kw OR stridor:ti,ab,kw OR stridors:ti,ab,kw OR Rale:ti,ab,kw OR Rales:ti,ab,kw OR Crackle:ti,ab,kw OR Crackles:ti,ab,kw OR "Pleural Rub":ti,ab,kw OR "pleural rubs":ti,ab,kw OR Rhonchi:ti,ab,kw OR Rhoncus:ti,ab,kw OR Wheezing:ti,ab,kw OR Wheezings:ti,ab,kw OR wheez*:ti,ab,kw OR [mh "Bronchial Spasm"] OR "Bronchial Spasm":ti,ab,kw OR "Bronchial			OR "respiratory sounds":ti,ab,kw OR "respiratory sound":ti,ab,kw OR "breathing sounds":ti,ab,kw OR "breathing sound":ti,ab,kw OR "lung sound":ti,ab,kw OR "lung sounds":ti,ab,kw OR stridor:ti,ab,kw OR stridors:ti,ab,kw OR Rale:ti,ab,kw OR Rales:ti,ab,kw OR Crackle:ti,ab,kw OR Crackles:ti,ab,kw OR "Pleural Rub":ti,ab,kw OR "pleural rubs":ti,ab,kw OR Rhonchi:ti,ab,kw OR Rhoncus:ti,ab,kw OR Wheezing:ti,ab,kw OR Wheezings:ti,ab,kw OR wheez*:ti,ab,kw OR [mh "Bronchial Spasm"] OR "Bronchial Spasm":ti,ab,kw OR "Bronchial	
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	Spasms":ti,ab,kw OR Bronchospas*:ti,ab,kw OR [mh "Bronchoconstriction"] OR Bronchoconstrict*:ti,ab,kw OR "Bronchial Constriction":ti,ab,kw OR "Bronchial Constrictions":ti,ab,kw OR [mh "Bronchial Hyperreactivity"] OR "Bronchial Hyperreactivity":ti,ab,kw OR "Bronchial Hyperreactivities":ti,ab,kw OR [mh "Respiratory Hypersensitivity"] OR "Respiratory Hypersensitivity":ti,ab,kw OR "Respiratory Hypersensitivities":ti,ab,kw OR "Airway Hyper- Responsiveness":ti,ab,kw OR "Airway Hyper			Spasms":ti,ab,kw OR Bronchospas*:ti,ab,kw OR [mh "Bronchoconstriction"] OR Bronchoconstrict*:ti,ab,kw OR "Bronchial Constriction":ti,ab,kw OR "Bronchial Constrictions":ti,ab,kw OR [mh "Bronchial Hyperreactivity"] OR "Bronchial Hyperreactivity":ti,ab,kw OR "Bronchial Hyperreactivities":ti,ab,kw OR [mh "Respiratory Hypersensitivity"] OR "Respiratory Hypersensitivity":ti,ab,kw OR "Respiratory Hypersensitivities":ti,ab,kw OR "Airway Hyper- Responsiveness":ti,ab,kw OR "Airway Hyper	
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	Responsiveness":ti,ab,kw)			Responsiveness":ti,ab,kw)	
#2	("Smart inhaler":ti,ab,kw OR "Smart inhalers":ti,ab,kw OR "Digihaler":ti,ab,kw OR "Digihalers":ti,ab,kw OR BreatheSmart:ti,ab,kw OR Smartinhaler:ti,ab,kw OR Inspiromatic:ti,ab,kw OR "Nebulizer Chronolog":ti,ab,kw OR "MDI Chronolog":ti,ab,kw OR "Aerosol Actuation Counter":ti,ab,kw OR "Turbuhaler Inhalation Computer":ti,ab,kw OR "Doser":ti,ab,kw OR "Electronic Diskhaler":ti,ab,kw OR "SmartMist":ti,ab,kw OR "MDILog":ti,ab,kw OR "Diskus Adherence Logger":ti,ab,kw OR "Smart Inhaler Tracker":ti,ab,kw OR "SmartTrack":ti,ab,kw OR	1948	#2	(("Digital":ti,ab,kw OR "Digitally":ti,ab,kw OR [mh "Mobile Applications"] OR [mh "Cell Phone"] OR "cell phone":ti,ab,kw OR "cell phones":ti,ab,kw OR "cellphone":ti,ab,kw OR "cellphones":ti,ab,kw OR [mh "Smartphone"] OR "smartphone":ti,ab,kw OR "smartphones":ti,ab,kw OR "smart-phone":ti,ab,kw OR "smart phone":ti,ab,kw OR "telehealth":ti,ab,kw OR "tele health":ti,ab,kw OR "tele- health":ti,ab,kw OR "telemonitoring":ti,ab,kw OR "tele monitoring":ti,ab,kw OR "tele-monitoring":ti,ab,kw OR "mobile technology":ti,ab,kw OR "mobile technologies":ti,ab,kw OR "mobile app":ti,ab,kw OR "mobile apps":ti,ab,kw OR "mobile application":ti,ab,kw OR "mobile	25908

"SmartDisk":ti,ab,kw OR "SmartTurbo":ti,ab,kw OR "SmartFlow":ti,ab,kw OR "SmartMat":ti,ab,kw OR "Inhaler Compliance Assessment Device":ti,ab,kw OR "INCA":ti,ab,kw OR "Asthmapolis":ti,ab,kw OR "Propeller Health":ti,ab,kw OR "Chameleon":ti,ab,kw OR "SmartTouch":ti,ab,kw OR "MDI Acoustic Actuation Detector":ti,ab,kw OR "pMDI Datalogger":ti,ab,kw OR "Geckocap":ti,ab,kw OR "CareTRx":ti,ab,kw OR "Sensohaler":ti,ab,kw OR "T-Haler":ti,ab,kw) OR (("Sensor":ti,ab,kw OR "Sensors":ti,ab,kw OR "electronic":ti,ab,kw OR digital:ti,ab,kw OR "monitoring":ti,ab,kw OR			applications":ti,ab,kw OR "bluetooth":ti,ab,kw OR "blue- tooth":ti,ab,kw OR "blue tooth":ti,ab,kw OR "iphone":ti,ab,kw OR "i- phone":ti,ab,kw OR "mobile phone":ti,ab,kw OR "cellular phone":ti,ab,kw OR "tablet apps":ti,ab,kw OR "wireless":ti,ab,kw OR "wirelessly":ti,ab,kw OR "wifi":ti,ab,kw OR "wi- fi":ti,ab,kw OR [mh "Telemedicine"] OR "telemedicine":ti,ab,kw OR "mhealth":ti,ab,kw OR "m- health":ti,ab,kw OR "m health":ti,ab,kw OR "mobile health":ti,ab,kw OR "mobile- health":ti,ab,kw OR "mobile self-management":ti,ab,kw OR "mobile self management":ti,ab,kw OR "text message":ti,ab,kw OR "text messages":ti,ab,kw OR "text messaging":ti,ab,kw OR "text-message":ti,ab,kw OR
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	"sensing":ti,ab,kw) AND ([mh "Metered dose inhalers"] OR "Inhaler":ti,ab,kw OR "Inhalers":ti,ab,kw OR "Inhalation":ti,ab,kw OR Respimat:ti,ab,kw))			"text-messages":ti,ab,kw OR "text-messaging":ti,ab,kw OR "sms message":ti,ab,kw OR "sms messages":ti,ab,kw OR "sms messaging":ti,ab,kw OR "sms-message":ti,ab,kw OR "sms-messages":ti,ab,kw OR "sms-messaging":ti,ab,kw OR "short message services":ti,ab,kw OR "short message service":ti,ab,kw OR "short messaging services":ti,ab,kw OR "smart messaging":ti,ab,kw OR "intelligent messaging":ti,ab,kw OR "eHealth":ti,ab,kw OR "e- Health":ti,ab,kw OR "e health":ti,ab,kw OR "electronic health":ti,ab,kw OR "mobile device":ti,ab,kw OR "mobile devices":ti,ab,kw OR "mobile phone":ti,ab,kw OR "mobile phones":ti,ab,kw OR "phone app":ti,ab,kw OR "phone apps":ti,ab,kw OR "phone application":ti,ab,kw OR	
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				"phone applications":ti,ab,kw OR iPad:ti,ab,kw OR "i- Pad":ti,ab,kw OR etherapy:ti,ab,kw OR "e therapy":ti,ab,kw OR "e- therapy":ti,ab,kw OR SMS:ti,ab,kw OR [mh "Wearable Electronic Devices"] OR "wearable electronic devices":ti,ab,kw OR "wearable electronic device":ti,ab,kw OR "wearable technology":ti,ab,kw OR "wearable technologies":ti,ab,kw OR "wearable tech":ti,ab,kw OR "wearable devices":ti,ab,kw OR "wearable device":ti,ab,kw OR uhealth:ti,ab,kw OR "u- health":ti,ab,kw OR [mh "Electronics, Medical"] OR "medical electronics":ti,ab,kw OR "Electronic Sensor":ti,ab,kw OR "electronic Sensors":ti,ab,kw OR ([mh "MP3-Player"] OR "MP3 Player":ti,ab,kw OR "MP3- Players":ti,ab,kw OR "i-	
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				POD":ti,ab,kw OR "i POD":ti,ab,kw OR "iPOD":ti,ab,kw OR "iPODs":ti,ab,kw OR "MP3":ti,ab,kw OR "MPEG":ti,ab,kw OR "MPEG- 1":ti,ab,kw OR "e- monitoring":ti,ab,kw OR "smart":ti,ab,kw OR "smartwatch":ti,ab,kw OR "smartwatches":ti,ab,kw)) NOT ("electronic health care records":ti,ab,kw OR "electronic health care record":ti,ab,kw OR "electronic health record":ti,ab,kw OR "electronic health records":ti,ab,kw OR EHR:ti,ab,kw)	
#3	#1 AND #2	448	#3	#1 AND #2	544
#4	study:ti,ab,kw OR studies:ti,ab,kw OR trial:ti,ab,kw OR trials:ti,ab,kw	1239777	#4	study:ti,ab,kw OR studies:ti,ab,kw OR trial:ti,ab,kw OR trials:ti,ab,kw	1239777
#5	#3 AND #4	422	#5	#3 AND #4	475

#6	("Forced expiratory volume in one second":ti,ab,kw OR FEV1:ti) OR ("Peak expiratory flow":ti,ab,kw OR PEF:ti) OR ([mh "Dyspnea"] OR dyspnea:ti,ab,kw OR Dyspneas:ti,ab,kw OR Dyspnoea:ti,ab,kw OR Dyspnoeas:ti,ab,kw OR "Shortness of Breath":ti,ab,kw OR "Breath Shortness":ti,ab,kw OR "Breath Shortnesses":ti,ab,kw OR "Breathlessness":ti,ab,kw OR "Breathlessnesses":ti,ab,kw) OR ("short-acting β 2- agonist":ti,ab,kw OR "short- acting β 2-agonist":ti,ab,kw OR SABA:ti,ab,kw OR "rapid-onset beta(2)- agonist":ti,ab,kw OR "Rescue therapy":ti,ab,kw	41053	#6	("Forced expiratory volume in one second":ti,ab,kw OR FEV1:ti) OR ("Peak expiratory flow":ti,ab,kw OR PEF:ti) OR ([mh "Dyspnea"] OR dyspnea:ti,ab,kw OR Dyspneas:ti,ab,kw OR Dyspnoea:ti,ab,kw OR Dyspnoeas:ti,ab,kw OR "Shortness of Breath":ti,ab,kw OR "Breath Shortness":ti,ab,kw OR "Breath Shortnesses":ti,ab,kw OR "Breathlessness":ti,ab,kw OR "Breathlessnesses":ti,ab,kw) OR ("short-acting β 2- agonist":ti,ab,kw OR "short- acting β 2-agonist":ti,ab,kw OR SABA:ti,ab,kw OR "rapid-onset beta(2)- agonist":ti,ab,kw OR "Rescue therapy":ti,ab,kw	41053
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	OR "Short-Acting Beta Agonist":ti,ab,kw OR "Short-acting beta2-agonist" OR ((beta:ti,ab,kw AND agonist*:ti,ab,kw) AND short:ti,ab,kw) OR (bronchodilator*:ti,ab,kw AND short:ti,ab,kw)) OR (Salbutamol:ti,ab,kw OR albuterol:ti,ab,kw OR terbutaline:ti,ab,kw OR isoproterenol:ti,ab,kw OR reproterol:ti,ab,kw OR fenoterol:ti,ab,kw OR orciprenaline:ti,ab,kw OR metaproterenol:ti,ab,kw) OR Exacerbat*:ti,ab,kw OR ("oral corticosteroid":ti,ab,kw OR "oral corticosteroids":ti,ab,kw OR "OCS":ti,ab,kw OR "oral cortico-steroid":ti,ab,kw OR "oral corti-			OR "Short-Acting Beta Agonist":ti,ab,kw OR "Short-acting beta2-agonist" OR ((beta:ti,ab,kw AND agonist*:ti,ab,kw) AND short:ti,ab,kw) OR (bronchodilator*:ti,ab,kw AND short:ti,ab,kw)) OR (Salbutamol:ti,ab,kw OR albuterol:ti,ab,kw OR terbutaline:ti,ab,kw OR isoproterenol:ti,ab,kw OR reproterol:ti,ab,kw OR fenoterol:ti,ab,kw OR orciprenaline:ti,ab,kw OR metaproterenol:ti,ab,kw) OR Exacerbat*:ti,ab,kw OR ("oral corticosteroid":ti,ab,kw OR "oral corticosteroids":ti,ab,kw OR "OCS":ti,ab,kw OR "oral cortico-steroid":ti,ab,kw OR "oral corti-	
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	costeroids":ti,ab,kw OR "systemic corticosteroid":ti,ab,kw OR "systemic corticosteroids":ti,ab,kw OR "systemic cortico- steroid":ti,ab,kw OR "systemic cortico- steroids":ti,ab,kw)			costeroids":ti,ab,kw OR "systemic corticosteroid":ti,ab,kw OR "systemic corticosteroids":ti,ab,kw OR "systemic cortico- steroid":ti,ab,kw OR "systemic cortico- steroids":ti,ab,kw)	
#7	("Asthma Control Test":ti,ab,kw OR "asthma control questionnaire":ti,ab,kw OR "Global Initiative for Asthma":ti,ab,kw OR "BTS/SIGN":ti,ab,kw OR "National Asthma Education and Prevention Program":ti,ab,kw OR NAEPP:ti,ab,kw) OR ((ACT:ti,ab,kw OR "ACQ":ti,ab,kw OR GINA:ti,ab,kw) AND (score:ti,ab,kw OR	5452	#7	("Asthma Control Test":ti,ab,kw OR "asthma control questionnaire":ti,ab,kw OR "Global Initiative for Asthma":ti,ab,kw OR "BTS/SIGN":ti,ab,kw OR "National Asthma Education and Prevention Program":ti,ab,kw OR NAEPP:ti,ab,kw) OR ((ACT:ti,ab,kw OR "ACQ":ti,ab,kw OR GINA:ti,ab,kw) AND (score:ti,ab,kw OR	5452

	measure*:ti,ab,kw))			measure*:ti,ab,kw))	
#8	(([mh "Office Visits"] OR visit*:ti,ab,kw) AND ("asthma- specialist":ti,ab,kw OR "asthma- specialists":ti,ab,kw OR "asthma specialist":ti,ab,kw OR "asthma specialists":ti,ab,kw OR [mh "Pulmonologists"] OR Pulmonologist:ti,ab,kw OR Pulmonologists:ti,ab,kw OR Immunologist:ti,ab,kw OR Immunologists:ti,ab,kw OR [mh "Allergists"] OR Allergist:ti,ab,kw OR Allergists:ti,ab,kw OR [mh "Primary Health Care"] OR "primary health care":ti,ab,kw OR "primary healthcare":ti,ab,kw OR "primary care":ti,ab,kw OR [mh "Physicians, Primary	49527	#8	(([mh "Office Visits"] OR visit*:ti,ab,kw) AND ("asthma- specialist":ti,ab,kw OR "asthma- specialists":ti,ab,kw OR "asthma specialist":ti,ab,kw OR "asthma specialists":ti,ab,kw OR [mh "Pulmonologists"] OR Pulmonologist:ti,ab,kw OR Pulmonologists:ti,ab,kw OR Immunologist:ti,ab,kw OR Immunologists:ti,ab,kw OR [mh "Allergists"] OR Allergist:ti,ab,kw OR Allergists:ti,ab,kw OR [mh "Primary Health Care"] OR "primary health care":ti,ab,kw OR "primary healthcare":ti,ab,kw OR "primary care":ti,ab,kw OR [mh "Physicians, Primary	49527

	Care"] OR "primary care physician":ti,ab,kw OR "primary care physicians":ti,ab,kw OR "primary care practitioner":ti,ab,kw OR "primary care practitioners":ti,ab,kw OR PCP:ti,ab,kw OR [mh "General Practitioners"] OR "general practitioner":ti,ab,kw OR "general practitioners":ti,ab,kw OR GP:ti,ab,kw)) OR ([mh "Hospitalization"] OR Hospitalization*:ti,ab,kw OR Hospitalisation*:ti,ab,kw) OR ("prescription medication costs":ti,ab,kw) OR (([mh "Office Visits"] OR visit*:ti,ab,kw) AND ([mh "Emergency Service, Hospital"] OR "Hospital			Care"] OR "primary care physician":ti,ab,kw OR "primary care physicians":ti,ab,kw OR "primary care practitioner":ti,ab,kw OR "primary care practitioners":ti,ab,kw OR PCP:ti,ab,kw OR [mh "General Practitioners"] OR "general practitioner":ti,ab,kw OR "general practitioners":ti,ab,kw OR GP:ti,ab,kw)) OR ([mh "Hospitalization"] OR Hospitalization*:ti,ab,kw OR Hospitalisation*:ti,ab,kw) OR ("prescription medication costs":ti,ab,kw) OR (([mh "Office Visits"] OR visit*:ti,ab,kw) AND ([mh "Emergency Service, Hospital"] OR "Hospital	
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Emergency Service":ti,ab,kw OR "Hospital Emergency Services":ti,ab,kw OR "Emergency Departments":ti,ab,kw OR "Emergency Department":ti,ab,kw OR "Emergency Hospital Service":ti,ab,kw OR "Emergency Hospital Services":ti,ab,kw OR "Emergency Units":ti,ab,kw OR "Emergency Unit":ti,ab,kw OR "Emergency Ward":ti,ab,kw OR "Emergency Wards":ti,ab,kw OR "Hospital Emergency Service":ti,ab,kw OR "Hospital Service Emergency":ti,ab,kw OR "Hospital Service Emergencies":ti,ab,kw OR "Accident and Emergency			Emergency Service":ti,ab,kw OR "Hospital Emergency Services":ti,ab,kw OR "Emergency Departments":ti,ab,kw OR "Emergency Department":ti,ab,kw OR "Emergency Hospital Service":ti,ab,kw OR "Emergency Hospital Services":ti,ab,kw OR "Emergency Units":ti,ab,kw OR "Emergency Unit":ti,ab,kw OR "Emergency Ward":ti,ab,kw OR "Emergency Wards":ti,ab,kw OR "Hospital Emergency Service":ti,ab,kw OR "Hospital Service Emergency":ti,ab,kw OR "Hospital Service Emergencies":ti,ab,kw OR "Accident and Emergency	
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	Department":ti,ab,kw OR "Emergency Room":ti,ab,kw OR "Emergency Rooms":ti,ab,kw OR "Emergency Outpatient Unit":ti,ab,kw OR "Emergency Outpatient Units":ti,ab,kw))			Department":ti,ab,kw OR "Emergency Room":ti,ab,kw OR "Emergency Rooms":ti,ab,kw OR "Emergency Outpatient Unit":ti,ab,kw OR "Emergency Outpatient Units":ti,ab,kw))	
#9	"patient-reported outcome":ti,ab,kw OR "patient reported outcome":ti,ab,kw OR "patient-reported outcomes":ti,ab,kw OR "patient reported outcomes":ti,ab,kw OR "PRO":ti,ab,kw OR "Health Utilities Index":ti,ab,kw OR "EQ5D":ti,ab,kw OR "EuroQol":ti,ab,kw OR "SF- 36":ti,ab,kw OR "SF- 6":ti,ab,kw OR "ED- 50":ti,ab,kw OR "EQ 5D- 5L":ti,ab,kw OR "EQ-5D-	32601	#9	"patient-reported outcome":ti,ab,kw OR "patient reported outcome":ti,ab,kw OR "patient-reported outcomes":ti,ab,kw OR "patient reported outcomes":ti,ab,kw OR "PRO":ti,ab,kw OR "Health Utilities Index":ti,ab,kw OR "EQ5D":ti,ab,kw OR "EuroQol":ti,ab,kw OR "SF- 36":ti,ab,kw OR "SF- 6":ti,ab,kw OR "ED- 50":ti,ab,kw OR "EQ 5D- 5L":ti,ab,kw OR "EQ-5D-	32601

	5L":ti,ab,kw OR "5-level EQ-5D version":ti,ab,kw OR "5 level EQ-5D version":ti,ab,kw OR "Short Form Health Survey-36 (SF-36)":ti,ab,kw OR "36-Item Short Form Survey (SF-36)":ti,ab,kw OR "SF-36":ti,ab,kw OR "Short Form Health Survey-36":ti,ab,kw OR "36-Item Short Form Survey":ti,ab,kw OR "short form 36 health survey":ti,ab,kw OR "Short Form (SF)-36":ti,ab,kw OR "Short Form SF-36":ti,ab,kw OR "36-item Short-Form Health Survey":ti,ab,kw OR "Short Form Survey-36 (SF-36)":ti,ab,kw OR "Short Form Survey-36":ti,ab,kw OR "36-Item Short Form Health Survey (SF-36)":ti,ab,kw OR "short			5L":ti,ab,kw OR "5-level EQ-5D version":ti,ab,kw OR "5 level EQ-5D version":ti,ab,kw OR "Short Form Health Survey-36 (SF-36)":ti,ab,kw OR "36-Item Short Form Survey (SF-36)":ti,ab,kw OR "SF-36":ti,ab,kw OR "Short Form Health Survey-36":ti,ab,kw OR "36-Item Short Form Survey":ti,ab,kw OR "short form 36 health survey":ti,ab,kw OR "Short Form (SF)-36":ti,ab,kw OR "Short Form SF-36":ti,ab,kw OR "36-item Short-Form Health Survey":ti,ab,kw OR "Short Form Survey-36 (SF-36)":ti,ab,kw OR "Short Form Survey-36":ti,ab,kw OR "36-Item Short Form Health Survey (SF-36)":ti,ab,kw OR "short	
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	form 36 survey":ti,ab,kw OR "Short Form Health Survey-12 (SF-12)":ti,ab,kw OR "12-Item Short Form Survey (SF-12)":ti,ab,kw OR "short form 12 health survey":ti,ab,kw OR "SF-12":ti,ab,kw OR "Short Form Health Survey-12":ti,ab,kw OR "12-Item Short Form Survey":ti,ab,kw OR "Short Form (SF)-12":ti,ab,kw OR "Short Form SF-12":ti,ab,kw OR "12-item Short-Form Health Survey":ti,ab,kw OR "Short Form Survey-12 (SF-12)":ti,ab,kw OR "Short Form Survey-12":ti,ab,kw OR "12-Item Short Form Health Survey (SF-12)":ti,ab,kw OR "short form 12 survey":ti,ab,kw			form 36 survey":ti,ab,kw OR "Short Form Health Survey-12 (SF-12)":ti,ab,kw OR "12-Item Short Form Survey (SF-12)":ti,ab,kw OR "short form 12 health survey":ti,ab,kw OR "SF-12":ti,ab,kw OR "Short Form Health Survey-12":ti,ab,kw OR "12-Item Short Form Survey":ti,ab,kw OR "Short Form (SF)-12":ti,ab,kw OR "Short Form SF-12":ti,ab,kw OR "12-item Short-Form Health Survey":ti,ab,kw OR "Short Form Survey-12 (SF-12)":ti,ab,kw OR "Short Form Survey-12":ti,ab,kw OR "12-Item Short Form Health Survey (SF-12)":ti,ab,kw OR "short form 12 survey":ti,ab,kw	
#10	"Health-Related Productivity Loss":ti,ab,kw	3245	#10	"Health-Related Productivity Loss":ti,ab,kw	3245

	OR ("physical activity":ti,ab,kw AND limit*:ti,ab,kw) OR ("WPAI- GH":ti,ab,kw OR "WPAI:GH":ti,ab,kw OR "Work Productivity and Activity Impairment Questionnaire: General Health":ti,ab,kw OR "Work Productivity and Activity Impairment _ General Health Questionnaire":ti,ab,kw OR "WPAI-general health version":ti,ab,kw OR "WPAI: general health version":ti,ab,kw) OR (loss:ti,ab,kw AND productivity:ti,ab,kw) AND (work:ti,ab,kw OR employment:ti,ab,kw OR study:ti,ab,kw OR school:ti,ab,kw)			OR ("physical activity":ti,ab,kw AND limit*:ti,ab,kw) OR ("WPAI- GH":ti,ab,kw OR "WPAI:GH":ti,ab,kw OR "Work Productivity and Activity Impairment Questionnaire: General Health":ti,ab,kw OR "Work Productivity and Activity Impairment _ General Health Questionnaire":ti,ab,kw OR "WPAI-general health version":ti,ab,kw OR "WPAI: general health version":ti,ab,kw) OR (loss:ti,ab,kw AND productivity:ti,ab,kw) AND (work:ti,ab,kw OR employment:ti,ab,kw OR study:ti,ab,kw OR school:ti,ab,kw)	
#11	[mh "Patient Compliance"]	74455	#11	[mh "Patient Compliance"]	74455

	OR [mh "Medication Adherence"] OR Adherence OR adhere OR Cooperation OR "Non-Compliance" OR "Non Compliance" OR Nonadherence OR Noncompliance OR "Non- Adherence" OR "Non Adherence" OR Compliance OR compliant OR comply			OR [mh "Medication Adherence"] OR Adherence OR adhere OR Cooperation OR "Non-Compliance" OR "Non Compliance" OR Nonadherence OR Noncompliance OR "Non- Adherence" OR "Non Adherence" OR Compliance OR compliant OR comply	
#12	persist* OR "non persistence" OR "non persistent" OR "non- persistence" OR "non- persistent" OR "nonpersistence" OR "nonpersistent"	38481	#12	persist* OR "non persistence" OR "non persistent" OR "non- persistence" OR "non- persistent" OR "nonpersistence" OR "nonpersistent"	38481
#13	(#6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12) AND #5	334	#13	(#6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12) AND #5	337
#14	[mh animals] NOT [mh humans]	0	#14	[mh animals] NOT [mh humans]	0
#15	#13 NOT #14	334	#15	#13 NOT #14	337
#16	n/a		#16	n/a	

#17	n/a		#17	n/a	
#18	n/a		#18	n/a	
#19	n/a		#19	n/a	
#20	n/a		#20	n/a	
#21	From 01/01/2011; English	177	#21	From 01/01/2011; English	263

