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MASK-air: An OECD (Organisation for Economic Co-operation and Development) Best Practice for Public Health on Integrated Care for Chronic Diseases

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In the recent report of the Organisation for Economic Co-operation and Development (OECD) on Best Practices (BPs) for Integrating Care to Prevent and Manage Chronic Diseases, an app on rhinitis and asthma (MASK-air [Mobile Airways Sentinel networK for airway diseases]) has been listed. The OECD is a reliable source of evidence-based policy analysis and economic data largely used by governments. It has published several BPs on public health. On May 10, 2023, the OECD published 13 BPs for Integrating Care to Prevent and Manage Chronic Diseases in the European Union. The report did not cover all models of integrated care; rather, it "focuse(d) on those that are of key strategic interest to policy makers." New MASK-air studies (not published in the report) include equity, usability of the app in old-age adults, economic impact, quality of life, and allergen immunotherapy. MASK-air is freely available on iOS and Android in 30 countries and has been recently introduced in the United States. The MASK-air OECD BP represents a model of digitally enabled, patient-centered care for chronic diseases using a holistic approach of shared decision making.   © 2024 The Authors. Published by Elsevier Inc. on behalf of the American Academy of

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Abbreviations used
AIT- allergen immunotherapy
BP- best practice
OECD- Organisation for Economic Co-operation and Development
MASK-air- Mobile Airways Sentinel networK for airway diseases
UCRAID- Ukrainian Citizen and Refugee electronic support in respiratory diseases, Allergy, Immunology and Dermatology
VAS- visual analogue scale

INTRODUCTION

A best practice (BP) is a "procedure shown by research and experience to produce optimal results and established or proposed as a standard suitable for widespread adoption."[1]

In the recent report of the Organisation for Economic Co-operation and Development (OECD) on Best Practices for Integrating Care to Prevent and Manage Chronic Diseases, an app on rhinitis and asthma (MASK-air [Mobile Airways Sentinel networK for airway diseases]) has been listed for consideration by policymakers.[2] MASK-air is freely available on iOS and Android in 30 countries and has been recently introduced in the United States. The MASK-air OECD BP represents a model of digitally enabled, patient-centered care for chronic diseases using a holistic approach of shared decision making. More than 65,000 users have been registered.

OECD BPs FOR INTEGRATING CARE TO PREVENT AND MANAGE CHRONIC DISEASES

The OECD is an international organization that works to build better policies for better lives. The goal is to shape policies that foster prosperity, equality, opportunity, and well-being for all. Together with governments, policymakers, and citizens, the OECD works on establishing evidence-based international standards and finding solutions to a range of social, economic, and environmental challenges. The OECD provides a unique forum and knowledge hub for data and analysis, exchange of experiences, and BP sharing.[3]

"The OECD provides a setting where governments can compare experiences, seek answers to common challenges, identify BPs, and develop high standards for economic policy. The OECD has been a reliable source of evidence-based policy analysis.[4]

The rising rates of noncommunicable diseases pose a health and economic burden. The OECD has published several BPs on public health.[5] "This work by the OECD helps countries tackle […] challenges and therefore strengthen their public health systems by encouraging the assessment and dissemination of proven BP interventions focused on those designed to prevent and manage non-communicable diseases."[5] The analyses are based on an OECD standard framework described in the Guidebook on BPs in Public Health[5]:

- Select interventions according to 5 BP criteria and assess their transferability potential to a new region.
- Implement BP interventions in a new region using a general framework.
- Evaluate implemented BP interventions by laying out the steps involved in developing and executing an evaluation study.

On May 10, 2023, the OECD published 13 BPs for Integrating Care to Prevent and Manage Chronic Diseases.[2] This report examined 13 integrated care models implemented in OECD and EU27 countries. Case studies were selected in consultation with the European Commission (Directorate General Health and Food Safety) and analyzed by the OECD using a validated performance assessment framework (Tables I and II).[5] The OECD report included MASK-air as a BP, stating that "[t]hirteen case studies (including MASK-air) were selected... For this reason, the report does not cover all models of integrated care, rather, it focuses on those that are of key strategic interest to policy makers" and that "[d]igital tools play a key role in supporting integrated care…. This is highlighted by selected case studies including …. an mHealth app for patients with asthma."

MASK-AIR, A BP OF OECD

MASK-air is among these 13 BPs.[2] It is the only app and the only BP in allergy and respiratory medicine.

MASK-air, a mobile health app assessing the daily control of allergic rhinitis and asthma, is freely available on the Apple App and Google Play Stores of 27 countries. It is Medical Device Regulation Class IIa registered and fully complies with the General Data Protection Regulation. MASK-air is classified as a Good Practice of DG Santé for digitally enabled, patient-centered care in rhinitis and asthma multimorbidity.[6] Several cross-sectional and longitudinal mHealth studies have been carried out in rhinitis,[7,8] asthma,[9-11] and allergen immunotherapy (AIT).[12] MASK-air is used first by patients and then by physicians to optimize shared decision making.[11] The strategic overview of MASK-air is presented in Table E1, the maturity level in Table E2, methodology and the General Data Protection Regulation in Table E3, and major achievements in Table E4 in this article's Online Repository at www.jaci-inpractice.org. These tables were published in January 2023[7] and have been updated in the present article.

The OECD has made a detailed assessment of MASK-air (Table III). The results are presented in its conclusion (Table IV).

The OECD has pointed out that MASK-air "offers the same level of care for AR and asthma to people across the world." It is available in 30 countries and 5 others will be included within the next 6 months. Importantly, MASK-air was released in the United States in November 2023 (Figure 1).

NEW STUDIES OF MASK-AIR STRENGTHENING THE OECD BP

In its conclusion, the OECD proposed that certain studies should be carried out. However, the report was based on an evaluation of MASK-air in 2021 and many studies have now already been performed. Additional studies that were carried out

TABLE I. The 13 BPs of OECD for integrating care to prevent and manage chronic diseases

Name and description	Country*
OptiMedis, regionally based integrated care model	EU-supported Joint Action — JADECARE†
The OptiMedis integrated care model emerged in 2005 following reforms in Germany to promote care coordination. The model of care, which operates in the west (state of Hesse) and south-west (state of Baden-Württemberg) regions of Germany, aims to improve patient experiences and population health, while reducing per capita costs. A key feature of the care model is its "shared savings contract," which incentivizes the delivery of high-quality, preventative care	
Hospital-at-Home program	H&S
The Hospital-at-Home program offers patients acute, home-based care that would otherwise be delivered in a hospital setting	Catalonia, Spain
Oulu's Self-Care Service (SCS)	Finland
SCS is a digital patient provider portal available to all residents. The SCS offers patients a range of online primary care services such as online appointment booking and ePrescriptions. For health professionals, the SCS provides guidelines and care pathways based on individual patient data	
Integrated care model for multimorbid patients	Basque Country, Spain
As part of the strategy for chronicity in the Basque Country, Spain, an integrated care model was implemented that includes a comprehensive baseline assessment; individualized care plans; care from a multidisciplinary team; co-ordinated hospital discharge; patient empowerment programs; and a strong health information system. Eligible patients are identified through a sophisticated risk stratification system, which covers 100% of the population.	
Badalona Health care Services	Badalona, Spain
The Badalona City Council developed an integrated care organization bringing together health and social care sectors—Badalona Serveis Assistencials, BSA. In addition to organizational integration (ie, combining health and social care), BSA creates other forms of integration such as professional integration with the use of multidisciplinary teams and normative integration by developing a shared organizational and professional culture	
Medical Diagnostic Centre (MDC)	Poland
The MDC is a primary care model for patients with chronic conditions. Patients who access MDC obtain an Individual Medical Care Plan based on a comprehensive assessment by a general practitioner. Results from the comprehensive assessment are used to stratify patients into risk groups, which helps health professionals proactively manage patient needs. Following the comprehensive assessment, patients receive care from a multidisciplinary care team, which is co-ordinated through a case manager	
TeleHomeCare	Italy
TeleHomeCare is a digital intervention designed to support home care through telemonitoring and teleconsultation for patients who suffer from 1 or more of the following chronic diseases: heart failure, chronic obstructive pulmonary diseases, and diabetes. The program operates in the Italian town of Ceglie Messapica	
Digital Roadmaps toward an integrated healthcare system	Southern Denmark
The Digital Roadmap initiative aims to improve coordination across healthcare settings and therefore care for patients, with a specific focus on those living with 1 or multiple chronic conditions. The initiative comprises several digital care interventions such as TeleCOPD, Telepsychiatry, virtual rehabilitation services, and an mHealth app	
Technology-Enabled Care (TEC)	Scotland
The TEC program in Scotland is to ensure that successful digital health and care initiatives are mainstreamed. At the national level, TEC provides leadership, evidence, and guidance on mainstreaming TEC to the government, healthcare providers, and other stakeholders. It also invests in national infrastructure, such as national licenses for digital care tools. At a local level, it helps to grow TEC initiatives by providing dedicated funding, as well as change management support and knowledge exchange, to organizations implementing or trialing such initiatives	
Telemonitoring for patients with advanced heart failure	The Czech Republic
The University Hospital Olomouc in the Czech Republic implemented a telemonitoring intervention for patients with advanced heart failure. As part of the intervention, a patient's vital signs are automatically shared daily with health professionals at the hospital including blood pressure, blood saturation, and results from electrocardiograms	

(continued)

TABLE I. *(Continued)*

Name and description	Country*
ParkinsonNet	The Netherlands
ParkinsonNet was developed to deliver high-quality, specialist care for Parkinson's disease. Through regional networks, allied health interventions are delivered by specially trained therapists who work according to evidence-based guidelines	
Personalized Action Plans (PAPs)	Andalusia, Spain
Andalusia, Spain, introduced PAPs for people living with 1 or more chronic diseases. The PAP program outlines a formal process whereby practitioners and patients collaborate to create a longitudinal treatment plan	
MASK	Several OECD and EU-27 countries
MASK is an mHealth intervention designed to reduce the burden of AR and asthma. MASK is broken into 2 components—one for individuals and the other for health professionals. Individuals can download the MASK-air app, which includes an allergy diary, for free. Health professionals have access to a *MASK-air Companion*, an electronic decision support system to promote personalized treatment for patients with AR and asthma	

AR, Allergic rhinitis.
*Country region or EU Grant.
†The best practice is described in the OECD document.

in response to the 2021 recommendations are summarized in Table E4.

Age groups

MASK-air has been tested in old-age people up to 80 years. It can be used without any difference in comparison to younger-age people.[13] Adolescents reported a better rhinitis and asthma control than young adults and adults, even though similar medication adherence levels were observed across age groups.[14]

Equity-enhancing app

The OECD specifically identified MASK-air as an equity-enhancing app. "MASK promotes equity by offering the same level of care to people across the world, further, the intervention has been designed to boost uptake amongst vulnerable populations. MASK is a demonstration project part of the WHO Global Alliance against Chronic Respiratory Diseases (GARD), which places a strong emphasis on ensuring equity of access to healthcare. MASK promotes equity by offering people across the world (including those in low- to high-income countries) access to the same quality of care for treating patients with AR and asthma (i.e. the clinical guidelines are the same across the world). Further, the app has been designed to accommodate the needs of certain priority populations by making it easy-to-use and free of charge."

A humanitarian proposal has been developed for Ukrainian refugees. Among the 8 million Ukrainian refugees in the European Union, many have asthma, allergic rhinitis, and/or urticaria, and around 100,000 may have a severe disease. Cultural and language barriers are major obstacles to appropriate management. Two mHealth apps—MASK-air (rhinitis and asthma) and CRUSE (Chronic Urticaria Self Evaluation)—are available in most European Union countries and languages. Ukrainian patients can fill in the questionnaires and daily symptom-medication scores for asthma, rhinitis, or urticaria in Ukrainian. Following the General Data Protection Regulation, patients grant their physician access to the app by scanning a QR code displayed on the physician's computer.[15] This enables the physician to read the app contents in his or her own language. The service is available free of charge, and it takes less than a minute to show patient data to the physician in the physician's web browser. UCRAID (Ukrainian Citizen and Refugee electronic support in respiratory diseases, Allergy, Immunology and Dermatology)—developed by ARIA (Allergic Rhinitis and its Impact on Asthma) and UCARE (Urticaria Centers of Reference and Excellence)—is under the auspices of the Ministry of Health of Ukraine as well as European and national societies (including the European Academy of Allergy and Clinical Immunology [EAACI], the European Respiratory Society, and the European Society of Dermatologic Research).

Productivity and economic impact

MASK-air comprises several questionnaires for economic evaluation including (1) the WPAI-AS (Work Productivity and Activity Impairment-Allergy specific) questionnaire,[16] (2) a visual analogue scale (VAS) on work productivity,[16-18] and (3) the EuroQOL five-dimensional questionnaire[19] and VAS, allowing for the computation of utilities. It has consistently been found that work is impaired depending on the lack of control of both rhinitis and asthma. Work impairment due to rhinitis or asthma control levels was found to be correlated with the combined symptom-medication score[20] and the electronic daily symptom-medication score for asthma.[10]

The impact of allergic rhinitis on academic performance has been tested using VAS education and the WPAI+CIQ:AS (WPAI plus Classroom Impairment Questions) questionnaire.[21] Allergy symptoms and worse rhinitis control were associated with worse academic productivity, while AIT was associated with higher productivity.

Adherence

An observational cross-sectional study has assessed the adherence to treatment in patients with allergic rhinitis using MASK-air.[22] Secondary adherence was assessed by using the modified Medication Possession Ratio and the Proportion of Days Covered approach. A total of 1887 users reported 7 or more days of VAS data; 11.3% of users were adherent (Medication Possession Ratio $\geq$ 70% and Proportion of Days Covered $\leq$ 1.25), 4.2% were partly adherent (Medication Possession Ratio $\geq$ 70% and Proportion of Days Covered $=$ 1.50), and 14.6% were switchers.

Adherence to asthma treatment has been studied.[23] The adherence to inhaled corticosteroids $+$ long-acting β_2-agonists

TABLE II. Evidence measuring effectiveness by selected case studies

Program	Measured changes in objective health outcomes	Measured changes in subjective health outcomes (ie, patient experiences)	Measured changes in utilization of health care services	No evidence
OptiMedis, regionally based integrated care model	X	X	X	
Hospital-at-Home	X		X	
MASK-air app	X	X		
Oulu Self-Care Service (patient portal)			X	
Integrated care model for multimorbidity, Basque Country	X	X	X	
Badalona Healthcare Services	X		X	
Medical Diagnostic Centre				X
TeleHomeCare in the Italian city of Ceglie Messapica		X	X	
Digital Roadmaps toward an integrated health care system		X	X	
Technology-Enabled Care (TEC)*		X	X	
Telemonitoring for patients with advanced heart failure				X
ParkinsonNet	X	X	X	
Personalized Action Plans		X	X	

*This report evaluated TEC as opposed to the individual interventions within TEC. An evaluation of each program funded by TEC fell outside the scope of this review; therefore, it is possible that individual TEC-funded programs collected data on objective health outcomes.

TABLE III. OECD BP assessment of MASK-air

Effectiveness
MASK has enhanced the knowledge base on AR and asthma, which has been used to improve treatment guidelines
Future evaluations of MASK aim to assess the impact of the intervention on work productivity, quality of life, adherence, and symptoms
Efficiency
Real-world data from the MASK-air app found that 97% of work days are impaired with uncontrolled AR symptoms compared to 20% when controlled
An evaluation to estimate the cost per quality-adjusted life-year of MASK is underway involving more than 17,000 users
Equity
MASK promotes equity by offering the same level of care for AR and asthma to people across the world. Furthermore, the intervention is designed to boost uptake among vulnerable populations (eg, by making the app free of charge). However, mHealth apps can widen existing health inequalities given they are more popular among younger, higher-educated populations
Evidence base
A mixture of prospective observational and cross-sectional studies was used to build the knowledge base on AR and asthma. For example, cross-sectional data from over 90,000 days were used to calculate the correlation between AR/asthma symptoms and work productivity
Extent of coverage
MASK-air has been downloaded by more than 40,000 people across 27 countries. This translates into a participation rate of around 0.1% based on high-level calculations
The proportion of physicians and pharmacists who use MASK in their practice is not known for legal reasons

AR, Allergic rhinitis.

was studied in users of the MASK-air app, who were highly adherent to the app. Adherence to inhaled corticosteroid + other long-acting β_2-agonist was high. Inhaled corticosteroid + formoterol users reported a slightly lower adherence but also a lower short-acting β-agonist use and a similar level of control.

Quality of life

European Quality of Life 5 Dimensions 5 Levels (EQ-5D-5L) is the most widely used generic health-related quality-of-life instrument, comprising 5 domains. In a cross-sectional study, worse rhinitis and asthma control was associated with higher pain/discomfort and greater impairments in the performance of daily activities. Worse rhinitis control was also associated with anxiety/depression, whereas worse asthma control was associated with worse mobility.[19]

Allergen immunotherapy

Data from 317,176 days of 17,870 MASK-air users revealed a lower median global allergy symptoms VAS in patients treated with AIT (11% of reporting MASK-air users) than data of users (89%) not treated with AIT (for review, see Sousa-Pinto et al[12]). A subsequent study assessing 42,756 days from 1093 patients with grass pollen allergy demonstrated that patients treated with sublingual AIT (tablets) displayed a lower global allergy symptoms VAS, work VAS, and combined symptom-medication score when compared with those treated with subcutaneous AIT or with those not receiving AIT.

FUTURE DIRECTIONS

The BP has already been updated following the recommendations made by the OECD expert panel. Several different directions are being considered to make the BP a dynamic process:

TABLE IV. OECD conclusions on MASK-air

Enhancement options: To *enhance effectiveness,* policymakers should continue efforts to boost levels of health literacy (HL) and digital HL, particularly among priority populations. Boosting digital HL among health professionals is also important to ensure they feel confident using digital products when treating patients. To *enhance equity,* MASK administrators could run promotion campaigns targeting priority populations. Furthermore, to better understand the needs of priority population, new demographic questions could be added to the app, allowing data (eg, education as a proxy for socioeconomic status). To *enhance the evidence base,* an evaluation to determine the impact of MASK on outcomes such as quality of life is encouraged. To *enhance the extent of coverage,* a multipronged targeted approach is needed.

Transferability: MASK was originally implemented in 18 countries and was subsequently transferred to a further 10 (most of which are OECD and non-OECD European countries, although MASK is also available in non-European countries—eg, Japan, Australia, Canada, Mexico, Brazil, and Argentina). MASK is considered highly transferable given its simple design. Furthermore, experts from an international AR/asthma workgroup (ARIA) are located across the world who take responsibility for adapting the intervention to the local context.

Conclusion: MASK is an equity-enhancing digital health intervention that has improved the knowledge base on AR and asthma. Subsequent evaluations of MASK using adherence, productivity, and quality of life as outcomes should be of key interest to policymakers and therefore strongly supported.

AR, Allergic rhinitis.
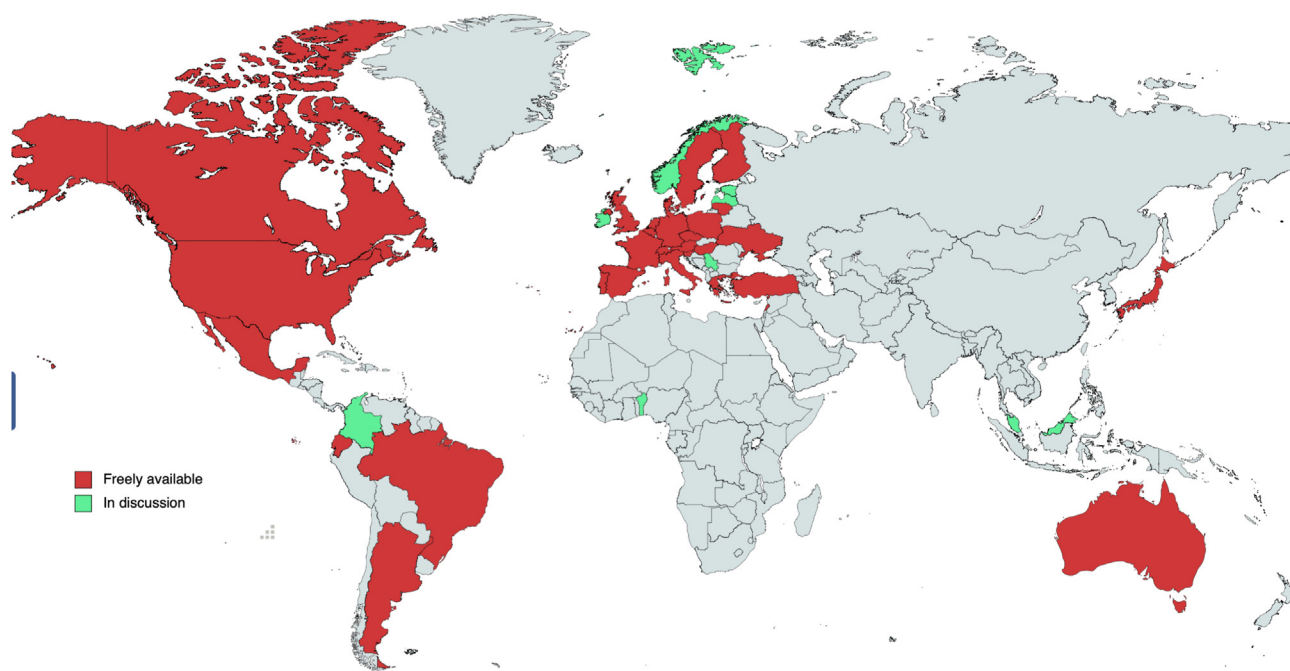
FIGURE 1. Availability of the MASK-air app.

1. **Patient-centered digital biomarkers in severe asthma:** An ARIA-EAACI Task Force (2022) proposed that an approach similar to the management of diabetes may be used in severe asthma using MASK-air[11]: The daily management of asthma (analogous to glycemia) can be carried out using the electronic daily symptom-medication score for asthma,[10] and the 1-month assessment using CARAT (Control of Allergic Rhinitis and Asthma Test; analogous to Hb1ac in diabetes).[24] Clinical studies to test this approach are ongoing.

2. **Patient-centered digital biomarkers in AIT:** A new ARIA-EAACI Task Force (2023) is proposing to use mHealth apps for AIT management and a novel approach for clinical trials. The strategy includes, among others, minimizing confounders such as longitudinal differences of pollen exposure in distinct geolocalized regions and "real-life" insights into the impact on pharmacotherapy treatment and effectiveness under these conditions.

3. **Studies on equity** are essential, because digital tools are likely to be less accessible to underserved people, to the elderly, and/or to those living in remote areas. mHealth is largely deployed in low- and middle-income countries, but not all people have access to smartphones. A study using a general population cohort (Constances) is underway to compare MASK-air users with the French general population. Specific studies have been carried out in old-age people.[13,25] A study in rural regions of Portugal is also underway to assess barriers to MASK-air use among the elderly (Taborda-Barata L, MD, PhD, 2023, unpublished data). It is expected that MASK-air may be of great benefit in underserved populations such as inner-city asthma.

4. **Traveling with asthma and allergies:** Many patients with uncontrolled disease suffer from exacerbations when traveling and may have difficulties to find a physician speaking their own language. Using the same method as UCRAID, foreign

patients with asthma, rhinitis, or urticaria may benefit from this novel approach (ARIA-EAACI Task Force).

5. **Development of digitally enabled, ARIA person-centered care** following next-generation ARIA guidelines.[26]

6. **Expansion to other chronic diseases using the same approach:** MASK-air has been considered—right from its inception—as a model for other chronic diseases. CRUSE is an existing app for chronic urticaria, with features derived from MASK-air. A joint project has already been initiated for Ukrainian refugees (UCRAID). The next diseases currently being considered are chronic obstructive pulmonary disease and obstructive sleep apnea syndrome.

CONCLUSIONS: TOWARD CHANGE MANAGEMENT IN CHRONIC DISEASES

Allergic diseases and asthma are extremely common and represent a major public health challenge inducing a high economic burden. The digital system used by MASK-air should be expanded to other chronic diseases. The MASK-air OECD BP represents a model of digitally enabled, patient-centered care for chronic diseases using a holistic approach of shared decision making. It should be implemented using a strategic change management approach such as the Kotter's model.[27]

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TABLE E1. Strategic overview: From ARIA to MASK-air

Acronym and reference	Name	Dates
WHO-associated projects		
ARIA	Allergic Rhinitis and its Impact on Asthma*	1999-
WHO collaborating Center on rhinitis and asthma (Montpellier)*		2004-2014
GARD[E1]	Global Alliance against Chronic Respiratory Diseases-Demonstration project†	2003-
WHO-ITU[E2]	"Be He@lthy, Be Mobile" handbook on asthma and COPD†	2017
EU grants and projects		
GA²LEN	Global Allergy and Asthma European Network (FP6)*	2004-
MeDALL	Mechanisms of the Development of Allergy (FP7)*	2009-2014
EIP on AHA[E3]	European Innovation Partnership on Active and Healthy Ageing (DG Santé & CONNECT)	2012-2020
ASSEHS[E4,E5]	Activation of Stratification Strategies and Results of the interventions on frail patients of Healthcare Services (DG Sanco)	2014-2015
Joint Research Center (JRC) Scientific and Policy Reports on (SIMPHS3)[E6†]	Strategic Intelligence Monitor on Personal Health Systems Phase 3	2015
MASK-air grant	*European Regional Development Fund* (*ERDF*), Région Languedoc Roussillon	2015-2017
Twinning[E7]	Transfer of Innovation (DG Santé & CONNECT)	2017-2019
DHE Twinning[E8]	Transfer of innovation in severe asthma (H2020)	2019-2020
POLLAR[E9]	Impact of POLLution on Asthma and Rhinitis (EIT Health)†	2018-2019
MASK@PACA	Région Provence-Alpes Côte d'Azur: Pollution and allergy (ERDF)	2021-2023
CATALYSE[E10]	Climate change (Horizon Europe)†	2022-2027
EO4EU	AI-augmented ecosystem for Earth Observation data accessibility with Extended reality User Interfaces for Service and data exploitation (Horizon Europe)†	2023-2027
Good Practice on digitally enabled, patient-centered care (DG Health and Food Safety)[E11†]		2018
Best Practice for Public Health on integrated care for chronic diseases (OECD-DG Health and Food Safety)[E12†]		2023
ARIA-EAACI Task Forces, position papers, and others		
Combined symptom-medication score in allergic diseases[E13]		2021
Combined symptom-medication score in asthma[E14]		2022
Patient-centered digital biomarkers for allergic respiratory diseases and asthma[E15]		2023
Patient-centered digital biomarkers for allergen immunotherapy (unpublished data, accepted in Allergy)		2023
Ukrainian Citizen and refugee electronic support in Respiratory diseases, Allergy, Immunology and Dermatology (UCRAID)[E16]		2023
Digitally enabled, person-centered care to support traveling patients with asthma, rhinitis, urticaria (INTER-RAID)		2024

CARAT, Control of Allergic Rhinitis and Asthma Test; *CATALYSE*, Climate Action to Advance Healthy Societies in Europe; *e-CDSS*, electronic clinical decision support system; *EU*, European Union; *GA²LEN*, Global Allergy and Asthma European Network; *GARD*, Global Alliance against Chronic Respiratory Diseases; *ITU*, International Telecommunication Union; *OECD*, Organisation for Economic Co-operation and Development; *POLLAR*, Impact of Air Pollution on Asthma and Rhinitis; *WHO*, World Health Organization.
*ARIA-associated projects before MASK-air.
†EU or WHO projects and grants of particular importance.

TABLE E2. Maturity level

Rhinitis platform	TRL*	Reference	Asthma platform	TRL	Reference
App for rhinitis and asthma (MASK-air): 28 countries, 17 languages, >50,000 users	9	E17-E19	Adaptation of the MASK-air app for severe asthma: DHE SA-TWINNING	8	E8
PROMs for rhinitis	9		PROMS for asthma	9	E20
CARAT questionnaire for screening and control of rhinitis and asthma, 20 countries	9	E21-E24	The same questionnaire will be used	9	E21-E23
e-physician questionnaire for rhinitis (available on the MASK-air website) deployed in 28 countries and 17 languages	9		Adaptation of the MASK questionnaire for SA developed by the DHE SA-TWINNING	7	E8
Electronic clinical decision support system in English for rhinitis	7	E25			
Embedding air quality (outdoor air pollution) and pollen data in MASK-air (POLLAR)	9	E9	Alerts for air pollution and pollens predicting asthma exacerbations	5	E10
			Alerts for rhinovirus predicting asthma exacerbations	4	E26,E27
EAACI-ARIACARE-digital network (35 countries, 20 languages)	9		The same network will be used	9	
Symptom-medication score for allergic symptoms (rhinitis)	9	E28	Daily control-medication score for asthma	9	E14
			Sensors for pulmonary function	5	
Embedding artificial intelligence in MASK-air	4			3	

TLR, Technology Readiness Level.
*TRL ranging from 0 to 9.[E30]

TABLE E3. Methodology and GDPR

	Study name	Reference	Study type	No. of users	No. of days	No. of countries
1†	COSMIN guidelines	E30	Obs, CS-L	2,497	14,612*	15
2†	Test-retest, intraclass coefficient	E31	Obs, CS-L	17,780	317,176	25
3†	Quality of data (intraindividual response variability)		Obs, CS	14,189	205,904	23
4†	Independence of data	E31	Obs, CS	1,136	5,889	18
5-8†	VAS work	E34	Obs, CS	14,189	205,904	18
9, 10	EQ-5D	E33-E35	Obs, CS	1,288	NA	18
6-9, 11	Work Productivity and Activity Impairment Allergic Specific (WPAI:AS)	E32-E34,E38	Obs, CS	1,288	NA	18
12	CARAT	E24	Obs, CS	1,086	2,042	22
13	CARAT*	E37	Systematic review			
14	PROMs in severe asthma	E20	Obs, CS	86	2,349	12
15	MASK-air in old-age adults	E38	Obs, CS	19,888	349,045	27
16†	Combined symptom-medication scores for allergic rhinitis (ARIA-EAACI CSMS)	E13	Obs, CS	17,780	317,176	25
17†	Electronic daily control-medication score in asthma (e-DATHMA)	E14	Obs, CS	1,666		25
18	Cutoff levels	E39	Obs, CS-L	2,320	395,223	27
19	Mobile health app for monitoring AR and asthma in real life in Lithuanian MASK-air users	E40	Obs, L	149	NA	Lithuania
20	Implementation of the MASK-air app for rhinitis and asthma in old-age adults. MASK@Puglia	E41	Obs, CS	174	NA	Italy
21	Patient's view in Poland	E42	Review			Poland
22	Comparison of antihistamine reporting by MASK-air, Google Trends, and sales in Europe	E43	Obs, CS			Europe
23†	CDSS (Clinical Decision Support System)	E25		NA	NA	NA
23†	CHRODIS guidelines	E44		NA	NA	NA
24†	Geolocation (GDPR)	E45		NA	NA	NA
25†	GDPR	E46		NA	NA	NA
26	IT infrastructure	E47	Review	NA	NA	NA

CARAT, Control of Rhinitis and Asthma test; *CHRODIS*, Joint Action on Chronic Diseases; *COSMIN*, Consensus-based Standards for the Selection of Health Measurement Instruments; *CS*, cross-sectional; *EQ-5D*, EuroQol five-dimensional questionnaire; *GDPR*, General Data Protection Regulation; *L*, longitudinal; *Obs*, observational; *NA*, not applicable; *PROM*, patient-reported outcome measure.

*Systematic review carried out for MASK-air.

†Studies reviewed by OECD.

TABLE E4. Major achievements

Study name	Reference	Study type	No. of users	No. of days	No. of countries
Baseline characteristics					
Pilot study of mobile phone technology in AR in European countries. The MASK-rhinitis study†	E48	Obs, CS	3,260	NA	20
Treatment of AR during and outside the pollen season using mobile technology. A MASK study†	E49	Obs, CS	9,035	70,286	Europe 18
Phenotype of allergic diseases and asthma					
Daily allergic multimorbidities†	E18				
Clusters of asthma and rhinitis	E50	Obs, CS	8,075	297,169	26
Disentangling rhinitis and asthma using MASK-air	E51	Obs, CS + L	3,797	256,839	27
Adherence to treatment of AR using mobile technology					
Adherence to treatment of AR using mobile technology	E52	Obs, CS	6,949	NA	21
Real-world data in AR					
Treatment of AR using mobile technology with real-world data: the MASK observational pilot study†	E53	Obs, CS	2,871	39,634	
Mobile technology offers novel insights on control and treatment of AR. The MASK study†	E19	Obs, CS	9,122	112,054	23
Treatment of AR during and outside the pollen season using mobile technology. A MASK study†	E49	Obs, CS	9,035	70,286	Europe 18
Comparison of rhinitis treatments using MASK-air data considering the minimal important difference	E54	Obs, CS	10,860	269,837	28
Differences in behavioural patterns in AR medication in Europe: a study using MASK-air real-world data	E55	Obs, CS	13,122	222,024	Europe 18
Consistent trajectories of rhinitis treatment	E56	Obs, L	2590	113,239 16,177 wk	22
Real-world data in asthma					
Longitudinal severe asthma pilot study†	E57	Obs, CS	13	1,250	Italy
Treatment of asthma using mHealth real-world data†		Obs, CS	3,229	70,270	27
Adherence to asthma treatment	E58	Obs, L			
Impact of allergic diseases					
Academic productivity in AR: a MASK-air direct data cross-sectional study	E59	Obs, CS	1,970	13,454	28
Work productivity†	E34	Obs, CS	14,189	205,904	18
EQ-5D	E33-E35	Obs, CS	1,288	NA	18
Work Productivity and Activity Impairment Allergic Specific (WPAI:AS)	E32-E34,E36	Obs, CS	1,288	NA	18

Clinical trials					
Validation of the MASK-air app for assessment of AR†	E60	RCT	267	7,500	Spain
Effect of nasal irrigation on AR control in children; complementarity between CARAT and MASK outcomes†	E61	RCT	76	NA	Greece
Allergen immunotherapy					
Effect of AIT in the MASK-air study: proof-of-concept analysis†	E62	Obs, CS	17,780	317,176	25
Allergen AIT in MASK-air users in real-life: results of a Bayesian mixed-effects model	E63	Obs, CS	1,093	42,756	25
Daily improvement of allergy control by sublingual AIT: a MASK-air cross-sectional study	E64	Obs, CS	217	4,726	14
Comparison of rhinitis treatments using MASK-air data considering the minimal important difference	E54	Obs, CS	10,860	269,837	28
Academic productivity in AR: a MASK-air direct data cross-sectional study	E59	Obs, CS	1,970	13,454	28
Aerobiology and air pollution					
POLLAR†	E65	Obs, CS	3,323	36,440	15
POLLAR,†	E66	*Review of methods used in POLLAR*			
CATALYSE,†	E10	*Review of proposal for CATALYSE EU Grant*			

AIT, Allergen immunotherapy; *AR*, allergic rhinitis; *CARAT*, Control of Rhinitis and Asthma Test; *CS*, cross-sectional; *EQ-5D*, EuroQoL five-dimensional questionnaire ; *ICS*, inhaled corticosteroid; *L*, longitudinal; *LABA*, long-acting β_2-agonist; *NA*, not available; *Obs*, observational; *POLLAR*, Impact of air POLLution on Asthma and Rhinitis; *RCT*, randomized controlled trial.
*Review carried out for MASK-air.
†Studies reviewed by OECD.

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