



HAL
open science

Allergic Rhinitis and its Impact on Asthma (ARIA) Classes in MASK-air Users

Bernardo Sousa-Pinto, M Savouré, Rj Vieira, R Amaral, Wienczyslawa Czarlewski, Anna Bedbrook, Arunas Valiulis, Violeta Kvedariene, L Brussino, Bilun Gemicioğlu, et al.

► To cite this version:

Bernardo Sousa-Pinto, M Savouré, Rj Vieira, R Amaral, Wienczyslawa Czarlewski, et al.. Allergic Rhinitis and its Impact on Asthma (ARIA) Classes in MASK-air Users. *Journal of Investigational Allergology and Clinical Immunology*, 2025, 35 (5), <10.18176/jiaci.1047>. <hal-04923769>

HAL Id: hal-04923769

<https://ehesp.hal.science/hal-04923769v1>

Submitted on 16 Jun 2025

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons CC BY-NC 4.0 - Attribution - Non-commercial use - International License

Allergic Rhinitis and its Impact on Asthma (ARIA) Classes in MASK-air Users

Sousa-Pinto B^{1,2}, Savouré M³, Vieira RJ^{1,2}, Amaral R^{1,2,4,5}, Czarlewski W^{6,7,8}, Bedbrook A^{7,8}, Valiulis A^{9,10}, Kvedariene V^{11,12}, Brussino L^{13,14}, Gemicioglu B^{15,16}, Haahela T¹⁷, Klimek L^{18,19}, Kraxner H²⁰, Larenas-Linnemann DE²¹, Pfaar O²², Regateiro FS²³⁻²⁶, Samolinski B²⁷, Tabora-Barata L^{26,28}, Toppila-Salmi S^{17,29}, Ventura MT^{30,31}, Ansotegui IJ³², Braidó F^{33,34}, Canonica GW^{35,36}, Cecchi L³⁷, Cruz AA³⁸, Devillier P³⁹, Fokkens WJ⁴⁰, Gil-Mata S^{1,2}, Giuliano AFM⁴¹, Ivancevich JC⁴², Kuna P⁴³, Kupczyk M⁴³, Louis G^{44,45}, Louis R^{45,46}, Makris M⁴⁷, Morais-Almeida M⁴⁸, Mullol J⁴⁹, Nadif R^{50,51}, Niedozytko M⁵², Okamoto Y^{53,54}, Ollert M^{55,56}, Papadopoulos NG⁵⁷, Patella V⁵⁸⁻⁶⁰, Pawankar R⁶¹, Pereira AM^{1,2,62}, Pétré B⁴⁴, Pham-Thi N⁶³⁻⁶⁵, Roche N^{51,66,67}, Rouadi PW^{68,69}, Sastre J⁷⁰, Scichilone N⁷¹, Sheikh A⁷², Sova M⁷³, Todo-Bom A⁷⁴, Yorgancioglu A⁷⁵, Zidarn M^{76,77}, Anto JM⁷⁸⁻⁸⁰, Zuberbier T^{81,82}, Fonseca JA^{1,2}, Bousquet J^{7,8,51,81,82}

¹MEDCIDS - Department of Community Medicine, Information and Health Decision Sciences; Faculty of Medicine, University of Porto, Porto, Portugal

²CINTESIS@RISE- Health Research Network, Faculty of Medicine, University of Porto, Porto, Portugal

³Université de Rennes, Inserm, EHESP, Irset (Institut de recherche en santé, environnement et travail) - UMR_S 1085, Rennes, France

⁴Department of Cardiovascular and Respiratory Sciences, Porto Health School, Polytechnic Institute of Porto, Porto, Portugal

⁵Department of Women's and Children's Health, Paediatric Research, Uppsala University, Uppsala, Sweden

⁶Medical Consulting Czarlewski, Levallois, France

⁷MASK-air, Montpellier, France

⁸ARIA, Montpellier, France

⁹Institute of Clinical Medicine and Institute of Health Sciences, Medical Faculty of Vilnius University, Vilnius, Lithuania

¹⁰Clinic of Asthma, Allergy and Chronic Lung Diseases, Vilnius, Lithuania

¹¹Institute of Clinical Medicine, Clinic of Chest Diseases and Allergology, Faculty of Medicine, Vilnius University, Vilnius, Lithuania

¹²Institute of Biomedical Sciences, Department of Pathology, Faculty of Medicine, Vilnius University, Vilnius, Lithuania

¹³Department of Medical Sciences, University of Torino, Torino, Italy

¹⁴Allergy and Clinical Immunology Unit, Mauriziano Hospital, Torino, Italy

¹⁵Department of Pulmonary Diseases, Istanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine, Istanbul, Turkey

¹⁶Institute of Pulmonology and Tuberculosis, Istanbul University-Cerrahpaşa, Istanbul, Turkey

¹⁷Skin and Allergy Hospital, Helsinki University Hospital, and University of Helsinki, Helsinki, Finland

¹⁸Department of Otolaryngology, Head and Neck Surgery, Universitätsmedizin Mainz, Mainz, Germany

¹⁹Center for Rhinology and Allergology, Wiesbaden, Germany

²⁰Department of Otorhinolaryngology, Head and Neck Surgery, Semmelweis University, Budapest, Hungary

²¹Center of Excellence in Asthma and Allergy, Médica Sur Clinical Foundation and Hospital, México City, Mexico

²²Section of Rhinology and Allergy, Department of Otorhinolaryngology, Head and Neck Surgery, University Hospital Marburg, Philipps-Universität Marburg, Marburg, Germany

²³Allergy and Clinical Immunology Unit, Centro Hospitalar e Universitário de Coimbra, Coimbra, Portugal

²⁴Center for Innovative Biomedicine and Biotechnology (CIBB), Faculty of Medicine, University of Coimbra, Portugal

²⁵Institute of Immunology, Faculty of Medicine, University of Coimbra, Coimbra, Portugal

²⁶UBIAir - Clinical & Experimental Lung Centre and CICS-UBI Health Sciences Research Centre, University of Beira Interior, Covilhã, Portugal

²⁷Department of Prevention of Environmental Hazards, Allergology and Immunology, Medical University of Warsaw, Warsaw, Poland

²⁸Department of Immunoallergology, Cova da Beira University Hospital Centre, Covilhã, Portugal

²⁹Department of Allergy, Skin and Allergy Hospital, Inflammation Center, Helsinki University Hospital and University of Helsinki, Helsinki, Finland

³⁰Unit of Geriatric Immunoallergology, University of Bari Medical School, Bari, Italy

³¹Institute of Sciences of Food Production, National Research Council (ISPA-CNR), Bari, Italy

³²Department of Allergy and Immunology, Hospital Quironsalud Bizkaia, Bilbao, Spain

³³Department of Internal Medicine (DIM), University of Genoa, Genoa, Italy

³⁴Respiratory and Allergy Clinic, IRCCS - Policlinico San Martino, Genoa, Italy

³⁵Department of Biomedical Sciences, Humanitas University, Pieve Emanuele, Milan, Italy

³⁶IRCCS Humanitas Research Hospital, Rozzano, Milan, Italy

³⁷SOS Allergology and Clinical Immunology, USL Toscana Centro, Prato, Italy

³⁸Fundação ProAR, Federal University of Bahia and GARD/WHO Planning Group, Salvador, Bahia, Brazil

³⁹VIM Suresnes, UMR 0892, Pôle des Maladies des Voies Respiratoires, Hôpital Foch, Université Paris-Saclay, Suresnes, France

⁴⁰Department of Otorhinolaryngology, Amsterdam University Medical Centres, AMC, Amsterdam, the Netherlands

⁴¹Department of Internal Medicine "A. Murri" and Unit of Geriatric Immunoallergology, University of Bari Medical School, Bari, Italy

⁴²Servicio de Alergia e Inmunología, Clínica Santa Isabel, Buenos Aires, Argentina

⁴³Division of Internal Medicine, Asthma and Allergy, Barlicki University Hospital, Medical University of Lodz, Lodz, Poland

⁴⁴Department of Public Health, University of Liège, Liège, Belgium

⁴⁵GIGA I3 Research Group, University of Liège, Liège, Belgium

⁴⁶Department of Pulmonary Medicine, CHU Liège, Liège, Belgium

⁴⁷Allergy Unit "D Kalogeromitros", 2nd Department of Dermatology and Venereology, National and Kapodistrian University of Athens, "Attikon" University Hospital, Athens, Greece

⁴⁸Allergy Center, CUF Descobertas Hospital, Lisbon, Portugal

⁴⁹Rhinology Unit & Smell Clinic, ENT Department, Hospital Clinic; Clinical & Experimental Respiratory Immunoallergy, FRBC-IDIBAPS, CIBERES, University of Barcelona, Barcelona, Spain

⁵⁰Université Paris-Saclay, UVSQ, Univ. Paris-Sud, Villejuif, France

⁵¹Inserm, Equipe d'Epidémiologie Respiratoire Intégrative, CESP, Villejuif, France

⁵²Department of Allergology, Medical University of Gdańsk, Gdansk, Poland

⁵³Chiba Rosai Hospital, Chiba, Japan

⁵⁴Chiba University Hospital, Chiba, Japan

- ⁵⁵Department of Infection and Immunity, Luxembourg Institute of Health, Esch-sur-Alzette, Luxembourg
- ⁵⁶Department of Dermatology and Allergy Center, Odense Research Center for Anaphylaxis (ORCA), Odense University Hospital, Odense, Denmark
- ⁵⁷Allergy Department, 2nd Pediatric Clinic, University of Athens, Athens, Greece
- ⁵⁸Division of Allergy and Clinical Immunology, Department of Medicine, "Santa Maria della Speranza" Hospital, Battipaglia, Salerno, Italy
- ⁵⁹Agency of Health ASL, Salerno, Italy
- ⁶⁰Postgraduate Programme in Allergy and Clinical Immunology, University of Naples Federico II, Naples, Italy
- ⁶¹Department of Pediatrics, Nippon Medical School, Tokyo, Japan
- ⁶²Allergy Unit, Instituto and Hospital CUF, Porto, Portugal
- ⁶³Ecole Polytechnique de Palaiseau, Palaiseau, France
- ⁶⁴IRBA (Institut de Recherche Bio-Médicale des Armées), Brétigny sur Orge, France
- ⁶⁵Université Paris Cité, Paris, France
- ⁶⁶Pneumologie, AP-HP Centre Université de Paris Cité, Hôpital Cochin, Paris, France
- ⁶⁷UMR 1016, Institut Cochin, Paris, France
- ⁶⁸Department of Otolaryngology-Head and Neck Surgery, Eye and Ear University Hospital, Beirut, Lebanon
- ⁶⁹Department of Otorhinolaryngology-Head and Neck Surgery, Dar Al Shifa Hospital, Salmiya, Kuwait
- ⁷⁰Allergy Service, Fundacion Jimenez Diaz, Autonoma University of Madrid, CIBERES-ISCIII, Madrid, Spain
- ⁷¹PROMISE Department, University of Palermo, Palermo, Italy
- ⁷²Usher Institute, The University of Edinburgh, Edinburgh, UK
- ⁷³Department of Respiratory Medicine and Tuberculosis, University Hospital, Brno, Czech Republic
- ⁷⁴Imunoalergologia, Centro Hospitalar Universitário de Coimbra, Faculty of Medicine, University of Coimbra, Coimbra, Portugal
- ⁷⁵Department of Pulmonary Diseases, Celal Bayar University, Faculty of Medicine, Manisa, Turkey
- ⁷⁶University Clinic of Respiratory and Allergic Diseases, Golnik, Slovenia
- ⁷⁷University of Ljubljana, Faculty of Medicine, Ljubljana, Slovenia
- ⁷⁸ISGlobal, Barcelona Institute for Global Health, Barcelona, Spain
- ⁷⁹Universitat Pompeu Fabra (UPF), Barcelona, Spain
- ⁸⁰CIBER Epidemiología y Salud Pública (CIBERESP), Barcelona, Spain
- ⁸¹Fraunhofer Institute for Translational Medicine and Pharmacology ITMP, Immunology and Allergology, Berlin, Germany
- ⁸²Institute of Allergology, Charité – Universitätsmedizin Berlin, Corporate Member of Freie Universität Berlin and Humboldt-Universität zu Berlin, Berlin, Germany

J Investig Allergol Clin Immunol 2025; Vol. 35(5)

doi: 10.18176/jiaci.1047

■ Abstract

Background: The Allergic Rhinitis and its Impact on Asthma (ARIA) guidelines classify rhinitis as "intermittent" or "persistent" and "mild" or "moderate-severe".

Objectives: To assess ARIA classes in a real-world study in terms of phenotypic differences and their association with asthma.

Methods: We performed a cross-sectional real-world study based on users of the MASK-air® app who reported data for at least 3 different months. We assessed the frequency of users according to the ARIA classes and compared these classes in terms of rhinitis symptoms, use of comedication, frequency of comorbid asthma, and the association between comorbid asthma and rhinitis control.

Results: A total of 2273 users (180 796 days) were assessed. Most users had moderate-severe rhinitis (n=2003; 88.1%) and persistent rhinitis (n=1144; 50.3%). The frequency of patients with probable asthma was 35.7% (95%CI, 34.5%-37.0%) for intermittent rhinitis and 48.5% (95%CI, 47.1%-49.9%) for persistent rhinitis. The maximum values on the visual analog scale (VAS) for rhinitis symptoms and the combined symptom-medication score were lower in patients with mild rhinitis than in those with moderate-severe rhinitis (irrespective of whether they had persistent or intermittent rhinitis). In most ARIA classes, VAS nose and VAS eye and rhinitis comedication were more frequent in patients with rhinitis+asthma than in those with rhinitis alone.

Conclusion: This study suggests that the presence of asthma is more closely related to persistence of rhinitis than to severity and that the presence of comorbid asthma may be associated with poorer control of rhinitis across the different ARIA classes.

Key words: Allergic rhinitis. Asthma. mHealth.

■ Resumen

Antecedentes: Las guías de Rinitis Alérgica y su Impacto en el Asma (ARIA) clasifican la rinitis como "intermitente" o "persistente" y como "leve" o "moderadamente severa".

Objetivos: Evaluar las clases de ARIA en un estudio en vida real, considerando las diferencias fenotípicas y su asociación con el asma.

Métodos: Realizamos un estudio transversal en vida real basado en usuarios de la aplicación MASK-air® que reportaron datos en al menos tres meses diferentes. Evaluamos la frecuencia de usuarios según las clases ARIA y comparamos estas clases en cuanto a los niveles de síntomas de rinitis, uso de co-medicación, frecuencia de asma como comorbilidad y su asociación con el control de la rinitis.

Resultados: Se evaluaron un total de 2273 usuarios (180.796 días). La mayoría de los usuarios (N=2003; 88,1%) tenían rinitis moderadamente severa y rinitis persistente (N=1144; 50,3%). La frecuencia de pacientes con probable asma fue del 35,7% (IC95%=34,5-37,0%) para rinitis intermitente y del 48,5% (IC95%=47,1-49,9%) para rinitis persistente. Los valores máximos en la escala visual analógica (EVA) para los síntomas de rinitis y del puntaje combinado máximo de síntomas y medicación (CSMS) fueron más bajos en pacientes con rinitis leve en comparación con aquellos con rinitis moderadamente severa (independientemente de si tenían rinitis persistente o intermitente). En la mayoría de las clases de ARIA, la EVA para nariz y ojos y la co-medicación para rinitis aumentaron en pacientes con rinitis+asma en comparación con aquellos con solo rinitis.

Conclusión: Este estudio sugiere que la presencia de asma está más relacionada con la persistencia de la rinitis que con la severidad de la rinitis, y que la presencia de asma como comorbilidad puede estar asociada con un peor control de la rinitis en las diferentes clases de ARIA.

Palabras clave: Rinitis alérgica. Asma. eSalud.

Summary box

- **What do we know about this topic?**

The Allergic Rhinitis and its Impact on Asthma (ARIA) guidelines classify allergic rhinitis as “intermittent” or “persistent” and as “mild” or “moderate-severe”.

- **How does this study impact our current understanding and/or clinical management of this topic?**

This mHealth study suggests that comorbid asthma may be associated with poorer control of rhinitis in all ARIA classes. However, the presence of asthma is more closely related to whether rhinitis is persistent or intermittent than to rhinitis severity.

Introduction

The Allergic Rhinitis and its Impact on Asthma (ARIA) guidelines have classified “intermittent” allergic rhinitis as a condition involving the presence of symptoms for fewer than 4 days per week or for fewer than 4 consecutive weeks. By contrast, “persistent” allergic rhinitis involves the presence of symptoms on at least 4 days per week and for at least 4 consecutive weeks. Disease severity is classified as mild when patients’ sleep is unimpaired and they can perform normal activities (including work and school) and as moderate-severe if symptoms substantially affect sleep or activities of daily living and/or if they are considered bothersome [1].

ARIA was initiated to assess the links between rhinitis and asthma. It was hypothesized that asthma was more often associated with persistent than with intermittent rhinitis [1]. Although several studies displayed results in line with this hypothesis (indicating the persistence of symptoms to be more frequently associated with asthma) [2-7], this was not observed in all studies [8]. The association between the multimorbidity of rhinitis and asthma and severity of rhinitis is largely unclear. However, direct patient data can help address the links between asthma and the different ARIA rhinitis classes in the real world. Mobile health apps comprise a key source of direct patient data. MASK-air® is one such app. MASK-air assesses the daily control of allergic rhinitis and asthma, is freely available, and has been launched in 29 countries [9]. It has been classified as a Good Practice of the Directorate General for Health and Food Safety (European Commission) for digitally enabled, patient-centered care in multimorbid rhinitis and asthma [10]. Furthermore, it is one of the 13 Organisation of Economic Cooperation and Development (OECD) Best Practices in integrated care for chronic diseases [11].

The aim of this study was to analyze the phenotypic characteristics of MASK-air users according to the ARIA classes. In particular, we aimed to compare patients in the different ARIA classes based on their rhinitis symptoms, patterns of rhinitis medication use, and frequency of comorbid asthma. In addition, we aimed to assess, across the different ARIA classes, how the presence of comorbid asthma was associated with control of rhinitis and medication patterns.

Methods

Study design

We performed a cross-sectional study based on direct patient data from MASK-air users who reported data for at least 3 different months [12]. We assessed the frequency of MASK-air users according to the ARIA classification and compared the frequency of asthma, rhinitis symptoms, and rhinitis comedication (use of more than 1 rhinitis medication formulation on the same day) across the 4 ARIA classes. In addition, for the different ARIA classes, we compared users with “no evidence of asthma”, “possible asthma”, and “probable asthma” [12], assessing whether the presence of comorbid asthma was associated with more severe rhinitis symptoms.

Settings and Participants

We assessed MASK-air data provided between June 2015 and December 2022 by users aged between 13-16 years (age of digital consent depending on the country [13]) and 90 years. We assessed all users with self-reported rhinitis, whose data enabled them to be classified into 1 of the 4 ARIA classes and who reported data for at least 3 different months. This last criterion enabled the classification of patients into those having “no evidence of asthma” (rhinitis alone), “possible asthma”, or “probable asthma”. The classification is based on self-reported asthma, reported asthma symptoms, and asthma medication use patterns and has been applied elsewhere [14].

Ethics

MASK-air complies with the General Data Protection Regulation [15]. All data are anonymously entered by users. Geolocation-related data are subsequently “blurred” using k-anonymity [16]. Users consented to having their data analyzed in the terms of use of the app. The use of MASK-air data has been approved by an independent review board (Köln-Bonn, Germany) [17]. Consequently, and given that this is an observational noninterventional study, specific ethics committee approval was not necessary.

Data Sources and Variables

MASK-air currently includes a daily monitoring questionnaire to assess the control and impact of allergy

symptoms through 4 mandatory visual analog scales (VAS) scored 0 to 100 (eTable 1). In the daily monitoring questionnaire, MASK-air users also provide their daily medication use via a scroll list customized for each country and regularly updated.

Symptom and medication data provided daily by patients enable the calculation of the daily combined symptom-medication score (CSMS), which assesses daily control of rhinitis [18], as follows:

$$[(0.037 \times \text{VAS global symptoms}) + (0.033 \times \text{VAS eyes}) + (0.020 \times \text{VAS nose}) + (0.027 \times \text{VAS asthma}) + (0.450 \text{ if azelastine-fluticasone is used}) + (0.424 \text{ if nasal corticosteroids are used}) + (0.243 \text{ if asthma medication is used}) + (0.380 \text{ if other rhinitis relief medication is used})] \times 7.577$$

In addition to the daily monitoring of symptoms and medication, MASK-air users provide clinical and demographic information when setting up their profile [19-22]. This information enables the classification of patients according to that of ARIA [19].

Sample Size

We analyzed all valid data from users meeting the eligibility criteria. No sample size calculation was performed.

Statistical Analysis

When responding to the MASK-air daily monitoring questionnaire, it is not possible to skip any of the questions, and data are saved to the dataset only after the final answer. This precludes missing data for each questionnaire.

We compared the frequency of self-reported asthma across the 4 ARIA classes. In addition, we compared median values of the symptoms VAS and of the CSMS. These values were compared both across the aforementioned groups and in patients classified as having “no evidence of asthma” (rhinitis alone), “possible asthma”, or “probable asthma”.

This classification was developed according to a previously reported clustering methodology (based on self-reported asthma, reported asthma symptoms, and asthma medication use patterns). It aims to overcome the limitations associated with classifying patients based solely on the presence of self-reported asthma [12,14].

Categorical variables were described using absolute and relative frequencies, while continuous variables were described using median (IQR) or mean (SD). With a large sample such as that of MASK-air, statistical tests of hypotheses will almost always result in *P* values indicating significance, even in the case of small differences. We therefore used Cohen effect sizes to quantify the differences [23]. Values >0.2 were considered to represent clinically meaningful differences (ie, large enough to be potentially relevant from a clinical standpoint). Values of 0.2-0.5 were considered to represent small clinically relevant effect sizes, 0.5-0.8 medium effect sizes, and >0.8 large effect sizes [23].

Results

Demographic Characteristics of the Users

We classified 2273 users (28.0% of all MASK-air users) who provided data over at least 3 different months, reporting a total of 180 796 days (Table 1; eFigure 1). Most participants (n=1302; 57.3%) were female, and the mean age was 39.8 (14.4) years. Table 1 shows the demographic and clinical characteristics of the participants by ARIA class; eTable 2 shows the participants' distribution by country.

Distribution of ARIA Classes

Most users (n=2003; 88.1%) had moderate-severe rhinitis. The remainder (n=270; 11.9%) had mild rhinitis. A similar percentage of patients had persistent rhinitis (50.3%) and intermittent rhinitis (49.7%). The average number of days

Table 1. Demographic and Clinical Characteristics of Assessed Participants According to ARIA Class.

	Moderate-severe persistent rhinitis	Moderate-severe intermittent rhinitis	Mild persistent rhinitis	Mild intermittent rhinitis	Maximal effect size
Patients, No. (%)	1013 (44.6)	990 (43.6)	131 (5.8)	139 (6.1)	-
No. of days (mean no. of days per user)	88934 (87.8)	71955 (72.7)	10865 (82.9)	9042 (65.1)	-
Females, No. (%)	601 (59.3)	555 (56.1)	75 (57.3)	71 (51.1)	0.17
Mean (SD) age, y	40.1 (14.3)	38.5 (14.4)	43.3 (14.6)	42.4 (14.8)	0.33 ^a
Self-reported conjunctivitis, No. (%) [95%CI]	859 (84.8) [84.0-85.6]	791 (79.9) [78.9-80.9]	83 (63.3) [59.3-67.3]	79 (56.8) [52.7-60.9]	0.63 ^b
No evidence of asthma, No. (%) [95%CI]	284 (28.0) [26.8-29.2]	356 (36.0) [34.6-37.4]	50 (38.2) [34.2-42.2]	47 (33.8) [30.1-37.5]	0.22 ^a
Possible asthma, No. (%) [95%CI]	234 (23.1) [22.0-24.2]	274 (27.7) [26.4-28.9]	21 (16.0) [13.7-18.3]	49 (35.3) [31.5-39.1]	0.45 ^a
Probable asthma, No. (%) [95%CI]	495 (48.9) [47.4-50.4]	360 (36.4) [35.0-37.8]	60 (45.8) [41.5-50.1]	43 (30.9) [27.4-34.4]	0.37 ^a

Abbreviation: ARIA, Allergic Rhinitis and its Impact on Asthma.

^aSmall effect size.

^bMedium meaningful effect.

reported per user was higher among those with persistent rhinitis than among those with intermittent rhinitis, based on both moderate-severe rhinitis (87.8 vs 72.7 days per user) and mild rhinitis (82.9 vs 65.1 days per user).

ARIA Classes and Comorbidities

No evidence of asthma (“rhinitis alone”) was detected in 737 users (32.4%), possible asthma was recorded in 578 (25.4%), and probable asthma in 958 (42.1%) (Table 1). Probable asthma was more common in persistent rhinitis (moderate-severe, 48.9% [95%CI, 47.4%-50.4%]; and mild, 45.8% [95%CI, 41.5%-50.1%]) than in intermittent rhinitis (moderate-severe, 36.4% [95%CI, 35.0-37.8%]; mild, 30.9% [95%CI, 27.4%-34.4%]) (Table 1). This ranking order was not found for possible asthma. On the other hand, an increased prevalence of conjunctivitis was observed from mild intermittent rhinitis to mild persistent rhinitis, moderate-severe intermittent rhinitis, and moderate-severe persistent rhinitis (mild intermittent rhinitis, 56.8% [95%CI, 52.7%-60.9%]; moderate-severe persistent rhinitis, 84.8% [95%CI, 84.0%-85.6%]).

Rhinitis Symptoms and Medication Use Patterns

Patients with moderate-severe rhinitis tended to have higher maximal nose and eye VAS and CSMS values than those with mild rhinitis (effect sizes, 0.24-0.36). For median values, patients with persistent rhinitis tended to have higher nose/eye VAS and CSMS values than those with intermittent rhinitis (effect sizes, 0.61-0.76). Comedication was more common in

patients with persistent rhinitis than in those with intermittent rhinitis (maximal effect size, 0.45) (Table 2).

Differences in VAS and in Allergens Depending on Asthma in the Different ARIA Classes

In most ARIA classes, VAS global, VAS nose, and VAS eye values were higher in patients with probable asthma than in those with no evidence of asthma (Table 3; Figure). Probable or possible asthma (vs no evidence of asthma) was associated with a larger difference in maximal VAS values for mild than for moderate-severe rhinitis (Figure). For median VAS nose values, the smallest difference was for mild intermittent rhinitis. The presence of “possible asthma” or “probable asthma” was also associated with a higher percentage of days using comedication (eFigure 2).

Overall, across the different ARIA classes, patients with probable asthma tended to have a higher frequency of allergy to indoor allergens than patients with no evidence of asthma (eTable 3). No such differences were observed for pollen allergy. In addition, patients with probable asthma displayed higher across-ARIA class differences in the frequency of pollen and house dust mite allergy.

Discussion

The present study is the first to assess ARIA classes in the MASK-air database and provides important, novel information.

Table 2. Demographic and Clinical Characteristics of Assessed Participants According to ARIA Class.

	Moderate-severe persistent rhinitis	Moderate-severe intermittent rhinitis	Mild persistent rhinitis	Mild intermittent rhinitis	Maximal effect size
Maximum values					
VAS global	72 (38)	71 (36)	63 (38)	63 (47)	0.30 ^a
VAS nose	74 (41)	75 (40)	68 (37)	68 (53)	0.24 ^a
VAS eye	59 (41)	58 (40)	52 (37)	49 (53)	0.32 ^a
CSMS	49.2 (28.8)	48.2 (28.8)	41.7 (27.2)	42.6 (29.9)	0.36 ^a
Median values					
VAS global	13 (24)	9 (22)	15 (25)	6 (16)	0.64 ^b
VAS nose	13 (26)	9 (23)	16 (24)	6 (18)	0.76 ^b
VAS eye	5 (26)	2 (23)	11 (24)	3 (18)	0.61 ^b
CSMS	11.4 (16.7)	7.5 (14.8)	13.9 (21.0)	5.5 (11.8)	0.76 ^b
Medication – No. of days (%) [95%CI]					
No medication	29 459 (33.1) [33.0-33.2]	42 535 (59.1) [58.9-59.3]	2969 (27.3) [26.9-27.7]	5469 (60.5) [60.0-61.0]	0.68 ^b
Single medication	32 550 (36.6) [36.4-36.8]	18 693 (26.0) [25.9-26.1]	4754 (43.8) [43.3-44.3]	2465 (27.3) [26.9-27.7]	0.38 ^a
Comedication	26 925 (30.3) [30.2-30.4]	10 727 (14.9) [14.8-15.0]	3142 (28.9) [28.5-29.3]	1108 (12.3) [12.1-12.5]	0.45 ^a

Abbreviations: ARIA, Allergic Rhinitis and its Impact on Asthma; CSMS, combined symptom-medication score; VAS, visual analog scale.

^aSmall meaningful effect.

^bMedium meaningful effect.

Table 3. VAS Values and Comedication Frequency per ARIA Class and According to the Presence of Asthma.

	Moderate-severe persistent	Moderate-severe intermittent	Mild persistent	Mild intermittent	Maximal effect size
A. No evidence of asthma					
Maximum values					
Median (IQR) VAS global –	66 (38)	64 (39)	56 (36)	61 (46)	0.36 ⁿ
Median (IQR) VAS nose	67 (47)	69 (43)	56 (34)	60 (49)	0.42 ^a
Median (IQR) VAS eye	47 (47)	48 (43)	49 (34)	45 (49)	0.12
Median (IQR) CSMS	38.4 (26.4)	38.6 (27.1)	35.1 (22.8)	37.0 (27.3)	0.18
Median values					
Median (IQR) VAS global	8 (23)	6 (16)	11 (20)	6 (15)	0.44 ^a
Median (IQR) VAS nose	8 (24)	6 (17)	11 (21)	6 (16)	0.41 ^a
Median (IQR) VAS eye	0 (24)	0 (17)	4 (21)	0 (16)	0.33 ^a
Median (IQR) CSMS	5.9 (14.2)	4.2 (9.9)	8.2 (12.7)	3.4 (10.0)	0.70 ^b
Medication – No. of days (%) [95%CI]					
No medication	8755 (43.0) [42.7-43.3]	14 640 (64.3) [64.0-64.6]	726 (27.1) [26.4-27.8]	2270 (67.6) [66.9-68.3]	0.84 ^c
Single medication	6510 (31.9) [31.6-32.2]	5350 (23.5) [23.3-23.7]	1163 (43.4) [42.5-44.3]	833 (24.8) [24.2-25.4]	0.43 ^a
Comedication	5116 (25.1) [24.8-25.4]	2784 (12.2) [12.1-12.3]	792 (29.5) [28.7-30.3]	253 (7.5) [7.3-7.7]	0.59 ^b
B. Possible asthma					
Maximum values					
Median (IQR) VAS global	76 (39)	78 (34)	68 (44)	62 (46)	0.52 ^b
Median (IQR) VAS nose	81 (41)	80 (36)	69 (50)	68 (58)	0.35 ^a
Median (IQR) VAS eye	67 (41)	70 (36)	64 (50)	43 (58)	0.96 ^c
Median (IQR) CSMS	52.3 (28.2)	55.1 (27.3)	47.6 (34.9)	42.2 (30.2)	0.58 ^b
Median values					
Median (IQR) VAS global	13 (24)	11 (22)	26 (39)	5 (14)	1.02 ^c
Median (IQR) VAS nose	12 (24)	12 (23)	19 (28)	6 (15)	0.87 ^c
Median (IQR) VAS eye	5 (24)	6 (23)	17 (28)	4 (15)	0.87 ^c
Median (IQR) CSMS	9.7 (15.0)	8.8 (14.7)	18.4 (25.2)	5.0 (9.8)	0.98 ^c
Medication – No. of days (%) [95%CI]					
No medication	6069 (33.8) [33.4-34.1]	10,660 (57.1) [56.7-57.5]	599 (38.4) [37.2-39.6]	1714 (60.1) [59.2-61.0]	0.53 ^b
Single medication	6895 (38.4) [38.1-38.7]	4866 (26.1) [25.8-26.4]	403 (25.8) [24.9-26.8]	834 (29.2) [29.2-30.0]	0.27 ^a
Comedication	4970 (27.7) [27.4-28.0]	3151 (16.9) [16.7-17.1]	557 (35.7) [34.6-36.8]	304 (10.7) [10.3-11.1]	0.61 ^b
C. Probable asthma					
Maximum values					
Median (IQR) VAS global	72 (35)	73 (33)	69 (35)	72 (37)	0.15
Median (IQR) VAS nose	75 (36)	73 (41)	77 (37)	80 (43)	0.25 ^a
Median (IQR) VAS eye	62 (36)	63 (37)	51 (41)	66 (43)	0.50 ^a
Median (IQR) CSMS	55.0 (27.5)	53.3 (26.2)	45.4 (29.0)	51.6 (30.8)	0.45 ^a

(continued)

Table 3. VAS Values and Comedication Frequency per ARIA Class and According to the Presence of Asthma (*continuation*).

	Moderate-severe persistent	Moderate-severe intermittent	Mild persistent	Mild intermittent	Maximal effect size
Median values					
Median (IQR) VAS global	15 (25)	10 (23)	16 (22)	6 (17)	0.76 ^b
Median (IQR) VAS nose	16 (26)	11 (26)	17 (25)	8 (20)	0.62 ^b
Median (IQR) VAS eye	6 (26)	4 (26)	14 (25)	4 (20)	0.69 ^b
Median (IQR) CSMS	14.2 (17.5)	10.1 (17.0)	16.6 (22.0)	8.8 (17.9)	0.60 ^b
Medication – No. of days (%) [95%CI]					
No medication	14 635 (28.9) [28.7-29.1]	17 235 (56.5) [56.2-56.8]	1644 (24.8) [24.4-25.2]	1485 (52.4) [51.5-53.3]	0.66 ^b
Single medication	19 145 (37.8) [37.6-38.0]	8477 (27.8) [27.6-28.0]	3188 (48.1) [47.5-48.7]	798 (28.2) [27.5-28.9]	0.42 ^a
Comedication	16 839 (33.3) [33.1-33.5]	4792 (15.7) [15.6-15.8]	1793 (27.1) [26.6-27.6]	551 (19.4) [18.8-20.0]	0.42 ^a

Abbreviations: CSMS, combined symptom-medication score; VAS, visual analog scale.

^aSmall meaningful effect.

^bMedium meaningful effect.

^cLarge meaningful effect.

Our findings indicate the following: (*i*) persistence of rhinitis is more strongly associated with asthma than severity of rhinitis, as users with persistent rhinitis more often have asthma than those with intermittent disease; and (*ii*) the presence of asthma is associated with more severe nasal and ocular symptoms.

Strengths and Weaknesses

Selection bias is inherent to any study reporting app-generated data, and the participants assessed are not representative of the general population. This is demonstrated by the fact that, in a general population study in France (Constances cohort), 60% of patients were classified as having mild rhinitis [24], compared with 11% in our study. There may also be a selection bias within the MASK-air sample, as we only assessed participants who could be placed in an ARIA class and who reported data in at least 3 different months. These selection biases may result in an overrepresentation of patients with severe rhinitis or patients who are more concerned or aware of their disease and of days where control of rhinitis was poorer. While these selection biases warrant caution in terms of generalizability, they are unlikely to substantially alter the results of the study for the association between ARIA class and asthma. Importantly, we are not able to generalize our results on the frequency of participants in the different ARIA classes to the general population. However, such was not the aim of this study. In addition, patients were enrolled using different methods, ie, by physicians or by downloading the app spontaneously.

Given the smaller number of patients and their more restricted geographical distribution, we did not solely assess patients with asthma recruited by physicians. That is, patients were classified as having asthma based on self-reported information, thus leading to information biases, which could potentially affect our conclusions. To decrease the risk of misclassification, we did not rely solely on self-reported

asthma either, but rather on an asthma-related classification, which was found to overcome some of the limitations of self-reporting [12]. This classification was tested in a small sample of patients diagnosed by physicians, with 92% of the “probable asthma” patients diagnosed by a physician as having current or past asthma and 90% of the “no evidence of asthma” patients diagnosed by a physician as having no current asthma [12]. Nevertheless, future studies should include patients enrolled in a clinical setting and assessed by a physician with respect to the severity of their rhinitis and presence of asthma.

Finally, as ours is a cross-sectional observational study, we were unable to establish a causal relationship between asthma and rhinitis symptoms.

A major strength of this study is that we used the exact wording of ARIA, as proposed in 1999. Moreover, the patients were selected in different countries. Finally, we included patients reporting data for at least 3 different months, with an average app adherence higher than other users (79.5 vs 4.4 days).

Interpretation of Results

This study should be compared with a recent study of ARIA classes in Constances, a French general population cohort [24], where the percentage of participants with mild rhinitis was far higher than that of the present study. However, the same phenotypic trends were found (*i*) for participants with comorbid rhinitis and asthma and in those with rhinitis alone and (*ii*) when the 4 ARIA classes were compared. For all 4 ARIA classes, the VAS nose values were higher in patients with rhinitis+asthma than in those with rhinitis alone. The results of these 2 studies are in line with the ARIA-MeDALL hypothesis, which proposes that rhinitis+asthma and rhinitis alone are 2 distinct diseases [25]. Interestingly, in the present study, for mild rhinitis, there is a clear difference between the 2 diseases for maximal nose VAS values only. For

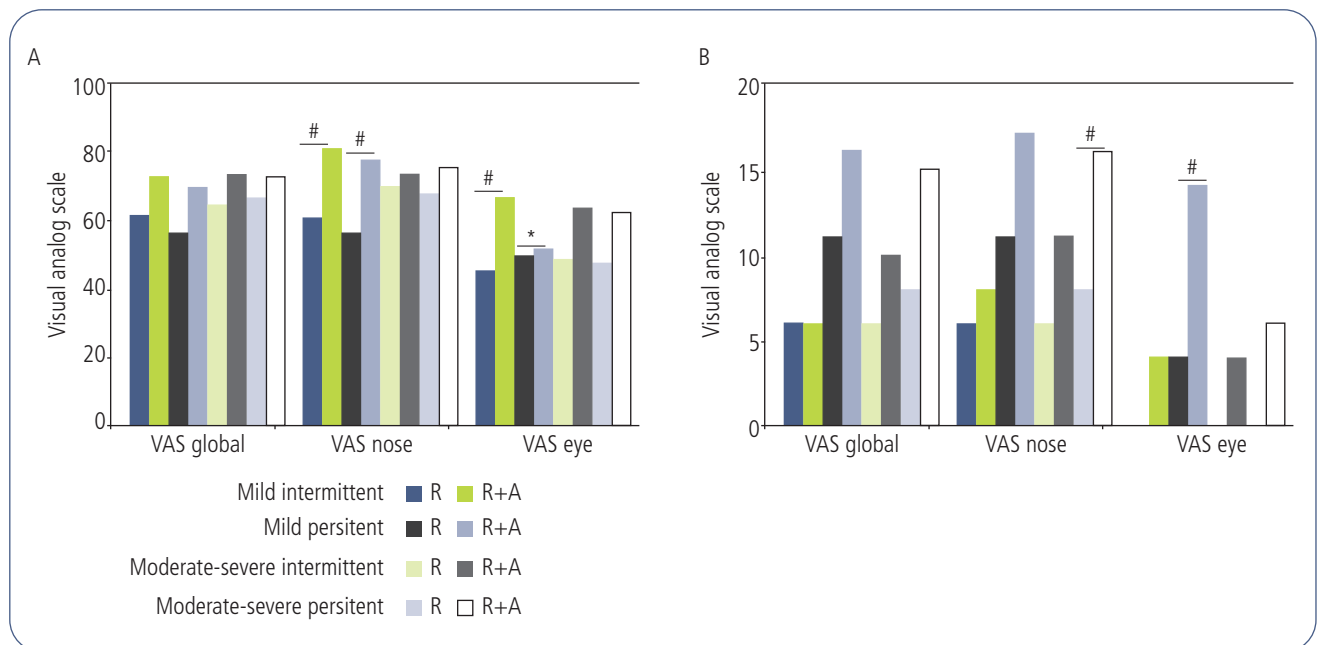


Figure. Maximum (A) and median (B) values of rhinitis visual analog scales (VAS) in patients with no evidence of asthma (R) and in patients with probable asthma (R+A) across the different Allergic Rhinitis and its Impact on Asthma (ARIA) classes. Unless otherwise specified, there are small clinically relevant differences in VAS values for each ARIA class. #Clinically relevant moderate difference in VAS values (Cohen d between 0.5 and 0.8); *Difference not clinically relevant in VAS values (Cohen d <0.2)

conjunctivitis, on the other hand, the presence of asthma was, in most cases, associated with increased maximal and median VAS values. Most of our results are in line with those of the Constances study (except for asthma, since the definitions differed between the studies [24]) and with a recent study on MASK-air using the CSMS [14].

In addition, both studies suggest that the ARIA-MeDALL hypothesis might be extended to conjunctivitis. In Constances, the frequency of conjunctivitis ranged from 47% (mild intermittent) to 57% (moderate/severe persistent) in patients with rhinitis alone and from 65% (mild intermittent) to 75% (moderate/severe persistent) in patients with asthma+rhinitis. In the present study, VAS eye values were higher in patients with rhinitis+asthma than in those with rhinitis alone. The involvement of conjunctivitis in allergic multimorbidity patterns had also been proposed elsewhere [26,27]. However, further studies are needed to understand the role of conjunctivitis in the complex multimorbid patterns of allergic diseases.

For most outcomes, there is a trend in the results obtained when no asthma is compared with possible and probable asthma. For example, in most classes of rhinitis, the frequency of comedication increases when patients with no evidence of asthma are compared with those with possible asthma and probable asthma (eFigure 1). The only class for which this was not observed was that of mild persistent rhinitis, although the finding may reflect variability in sampling.

The MASK-air population is similar to patients seen in primary care [28] and specialist care [3] and differs from patients in general population cohorts [24]. This study is therefore important, given that it improves identification of the population of MASK-air users reporting data for at least

3 months. We previously found that, in patients with asthma, there are differences between this selected population and the general population [12].

Conclusions

Our person-centered study assessed the ARIA classification in the real world. Moreover, it explored the association between asthma and the severity and persistence of rhinitis, suggesting that persistence of rhinitis is more strongly associated with the presence of asthma than its severity and that the presence of asthma is associated with increased severity of nasal and ocular symptoms. In addition, our study provides information on the co-occurrence of conjunctivitis, indicating that ocular comorbidity should be considered more carefully in future randomized controlled trials and observational studies. The results of this study will impact the revision of the ARIA 2024 guidelines.

Funding

MASK-air was supported by EU grants (from the Impact of air Pollution on Asthma and Rhinitis [POLLAR] project of the European Institute of Innovation and Technology Health; Structural and Development Funds, Région Languedoc Roussillon, and Provence-Alpes-Côte d'Azur; Twinning, European Innovation Partnership on Active and Healthy Ageing, DG Santé and DG Connect; H2020 and CATALYSE, Horizon Europe) and educational grants from Mylan-Viatrix, Allergologisk Laboratorium København, GlaxoSmithKline, Novartis, Stallergenes, and Noucor.

Conflicts of Interest

Dr J. Bousquet reports personal fees from Cipla, Menarini, Mylan, Novartis, Purina, Sanofi-Aventis, Teva, Noucor, KYomed-Innov, and Mask-air-SAS, outside the submitted work.

Dr M. Kupczyk reports personal fees from Adamed, personal fees from Astra Zeneca, personal fees from Berlin Chemie, personal fees from Chiesi, personal fees from Celon Pharma, personal fees from GSK, personal fees from Novartis, personal fees from Sanofi, personal fees from Teva, personal fees from AbbVie, personal fees from Aurovitas, personal fees from LEK-AM, personal fees from Zentiva, personal fees from Polpharma, personal fees from Sun-Pharm, personal fees from HAL Allergy, personal fees from EMMA, and personal fees from Opella Healthcare, outside the submitted work.

Dr S. Toppila-Salmi reports personal fees from ALK-Abelló, personal fees from GSK, personal fees from Clario, personal fees from Sanofi, personal fees from OrionPharma, personal fees from Novartis, personal fees from AstraZeneca, grants from GSK, and grants from Sanofi, outside the submitted work.

Dr J.C. Ivancevich reports personal fees from Laboratorios Casasco Argentina.

Dr Y. Okamoto reports personal fees from Torii pharmaceutical Co., Ltd., personal fees from Tanabe-Mitsubishi Pharmaceutical Co., Ltd., personal fees from Kirin Holdings Co., Ltd., personal fees from Novartis Co., Ltd., personal fees from Allergologisk Laboratorium København, personal fees from Shionogi Co., Ltd., personal fees from Stallergenes-Greer, and personal fees from Daiichi-Sankyo, outside the submitted work.

Dr T. Zuberbier reports grants and personal fees from Novartis, grants and personal fees from Henkel, personal fees from Bayer, personal fees from FAES, personal fees from Astra Zeneca, personal fees from AbbVie, personal fees from ALK, personal fees from Almirall, personal fees from Astellas, personal fees from Bayer, personal fees from Bencard, personal fees from Berlin Chemie, personal fees from FAES, personal fees from Hal, personal fees from Leti, personal fees from Mesa, personal fees from Menarini, personal fees from Merck, personal fees from MSD, personal fees from Novartis, personal fees from Pfizer, personal fees from Sanofi, personal fees from Stallergenes, personal fees from Takeda, personal fees from Teva, personal fees from UCB, personal fees from Henkel, personal fees from Kryolan, and personal fees from L'Oreal, outside the submitted work. Dr T Zuberbier also reports organizational affiliations: Committee member, WHO-Initiative "Allergic Rhinitis and Its Impact on Asthma" (ARIA); Member of the Board, German Society for Allergy and Clinical Immunology (DGAKI); Head, European Centre for Allergy Research Foundation (ECARF); President, Global Allergy and Asthma European Network (GA2LEN); Member, Committee on Allergy Diagnosis and Molecular Allergology, World Allergy Organization (WAO).

Dr P. Devillier reports personal fees and nonfinancial support from Astra Zeneca, personal fees and nonfinancial support from Boehringer Ingelheim, personal fees and nonfinancial support from Chiesi, personal fees from GlaxoSmithKline, personal fees from IQVIA, personal fees

and nonfinancial support from ALK-Abello, personal fees from Menarini, personal fees and nonfinancial support from Stallergenes, personal fees from Viatrix, and personal fees from Procter & Gamble Health, outside the submitted work.

Dr H. Kraxner reports speaker's fees and congress support from Sanofi, speaker's fees and congress support from Viatrix, and speaker's fees from Berlin-Chemie.

Dr N. Papadopoulos reports grants from Capricare, Nestle, Numil, Vianex, and REG and other support from Abbott, AbbVie, AstraZeneca, GSK, HAL, Medscape, Menarini/Faes Farma, Mylan, Novartis, Nutricia, OM Pharma, and Regeneron/Sanofi, outside the submitted work.

Dr L. Cecchi reports personal fees from Novartis, personal fees from Sanofi, personal fees from Menarini, personal fees from Thermo Fisher, personal fees from AstraZeneca, personal fees from GSK, personal fees from ALK, and personal fees from Lofarma, outside the submitted work.

Dr J. Mullol reports the following, outside the submitted work: personal fees and other support from Sanofi-Genzyme & Regeneron; personal fees and other support from Novartis; grants, personal fees, and other support from Viatrix/Meda Pharma; grants and personal fees from Noucor/Noucor Group; personal fees from Menarini; personal fees from UCB; personal fees and other support from AstraZeneca; grants, personal fees, and other support from GSK; personal fees from MSD; personal fees and other support from Lilly; and personal fees and other support from Glenmark.

Dr V. Kvedarrienė reports nonfinancial support from Norameda, nonfinancial support from Berlin Chemie Menarini, and nonfinancial support from Dimuna, outside the submitted work.

Dr J. Sastre reports grants and personal fees from Sanofi, personal fees from GSK, personal fees from Novartis, personal fees from AstraZeneca, personal fees from Mundipharma, personal fees from Faes Farma, outside the submitted work.

Dr T. Haahtela reports personal fees from Orion Pharma, outside the submitted work.

Dr O. Pfaar reports grants and personal fees from ALK-Abelló, grants and personal fees from Allergopharma, grants and personal fees from Stallergenes Greer, grants and personal fees from HAL Allergy Holding B.V./HAL Allergie GmbH, grants from Bencard Allergie GmbH/Allergie Therapeutics, grants from Lofarma, grants and personal fees from ASIT Biotech Tools S.A., grants and personal fees from Laboratorios LETI/LETI Pharma, grants and personal fees from GlaxoSmithKline, personal fees from ROXALL Medizin, personal fees from Novartis, grants and personal fees from Sanofi-Aventis and Sanofi-Genzyme, personal fees from Med Update Europe GmbH, personal fees from streamedup! GmbH, grants from Pohl-Boskamp, grants from Immunotek S.L., personal fees from John Wiley and Sons, AS, personal fees from Paul-Martini-Stiftung (PMS), personal fees from Regeneron Pharmaceuticals Inc., personal fees from RG Aertzefortbildung, personal fees from Institut für Disease Management, personal fees from Springer GmbH, grants and personal fees from AstraZeneca, personal fees from IQVIA Commercial, personal fees from Ingress Health, personal fees from Wort&Bild Verlag, personal fees from Verlag ME, personal fees from Procter&Gamble, personal

fees from Altamira, personal fees from Meinhardt Congress GmbH, personal fees from Deutsche Forschungsgemeinschaft, personal fees from Thieme, grants from Deutsche AllergieLiga e.V., personal fees from AeDA, personal fees from Alfried-Krupp Krankenhaus, personal fees from Red Maple Trials Inc., personal fees from Königlich Dänisches Generalkonsulat, personal fees from Medizinische Hochschule Hannover, personal fees from ECM Expro&Conference Management, personal fees from Technical University Dresden, personal fees from Lilly, personal fees from Paul Ehrlich Institut, personal fees from Japanese Society of Allergy, and personal fees from Forum für Medizinische Fortbildung and from Dustri-Verlag, outside the submitted work. Dr. O Pfaar is also a member of EAACI Excom, a member of the external board of directors of DGAKI, and the coordinator, main author, or coauthor of various position papers and guidelines in rhinology, allergology, and allergen-immunotherapy. Dr. Pfaar is also Associate Editor of *Allergy and Clinical Translational Allergy*.

Dr M. Zidarn reports personal fees from Takeda, outside the submitted work.

Dr D. Larenas Linnemann reports the following: personal fees from ALK, AstraZeneca national and global, Bayer, Chiesi, Grunenthal, Grin, GSK national and global, Viatrix, Menarini, MSD, Novartis, Pfizer, Sanofi, Siegfried, Carnot; grants from AbbVie, Bayer, Lilly, Sanofi, AstraZeneca, Pfizer, Novartis, Pulmonair, GSK, and Chiesi, outside the submitted work.

Dr P. Kuna reports personal fees from Adamed, personal fees from Berlin Chemie Menarini, personal fees from AstraZeneca, personal fees from FAES, personal fees from Glenmark, personal fees from GSK, personal fees from Celon Pharma, personal fees from Novartis, personal fees from Polpharma, personal fees from Sandoz, personal fees from Sanofi, and personal fees from Teva, outside the submitted work.

Dr A. Todo Bom reports personal fees from GSK, grants and personal fees from AbbVie, grants and personal fees from Mylan, grants from Leti, personal fees from AstraZeneca, outside the submitted work.

Dr L. Taborda-Barata reports personal fees from Sanofi, personal fees from LETI, personal fees from AstraZeneca, and personal fees from Novartis, outside the submitted work.

Dr N. Roche reports grants and personal fees from Boehringer Ingelheim, grants and personal fees from Novartis, grants and personal fees from GSK, personal fees from AstraZeneca, personal fees from Chiesi, grants and personal fees from Pfizer, personal fees from Sanofi, personal fees from Zambon, personal fees from MSD, personal fees from Austral, and personal fees from Biosency, outside the submitted work.

Dr A. Cruz reports personal fees from AstraZeneca, personal fees from Boehringer Ingelheim, personal fees from Chiesi, personal fees from Crossject, personal fees from Eurofarma, personal fees from GSK, personal fees from Glenmark, personal fees from Farmoquímica, personal fees from Abdi Ibrahim, personal fees from Novartis, and personal fees from Sanofi, outside the submitted work.

Dr R. Louis reports grants from GSK, Chiesi, and AstraZeneca and advisory board and lecture fees from AstraZeneca, GSK, and Chiesi.

Dr M. Makris reports personal fees from Menarini, personal fees from AstraZeneca, personal fees from GSK, personal fees from Sanofi, personal fees from Pfizer, and personal fees from Chiesi, outside the submitted work.

Dr M. Ollert reports personal fees from Hycor Diagnostics, personal fees from Allergy Therapeutics/Bencard, outside the submitted work, and is a scientific cofounder of Tolerogenicis SARL, Luxembourg.

Dr I. Ansotegui reports personal fees from Abbott, personal fees from Bayer, personal fees from Bial, personal fees from Eurodrug, personal fees from Faes Farma, personal fees from Gebro, personal fees from Menarini, personal fees from MSD, personal fees from Roxall, and personal fees from Sanofi, outside the submitted work.

The remaining authors declare that they have no conflicts of interest.

References

1. Bousquet J, Van Cauwenberge P, Khaltaev N. Allergic rhinitis and its impact on asthma. *J Allergy Clin Immunol*. 2001;108(5 Suppl):S147-334.
2. Ciprandi G, Capasso M. Association of childhood perennial allergic rhinitis with subclinical airflow limitation. *Clin Exp Allergy*. 2010;40(3):398-402.
3. Bousquet J, Annesi-Maesano I, Carat F, Leger D, Rugina M, Pribil C, et al. Characteristics of intermittent and persistent allergic rhinitis: DREAMS study group. *Clin Exp Allergy*. 2005;35(6):728-32.
4. del Cuvillo A, Montoro J, Bartra J, Valero A, Ferrer M, Jauregui I, et al. Validation of ARIA duration and severity classifications in Spanish allergic rhinitis patients - The ADRIAL cohort study. *Rhinology*. 2010;48(2):201-5.
5. Pite H, Pereira AM, Morais-Almeida M, Nunes C, Bousquet J, Fonseca JA. Prevalence of asthma and its association with rhinitis in the elderly. *Respir Med*. 2014;108(8):1117-26.
6. Antonicelli L, Braschi MC, Bresciani M, Bonifazi M, Baldacci S, Angino A, et al. The complex link between severity of asthma and rhinitis in mite allergic patients. *Respir Med*. 2013;107(1):23-9.
7. Moitra S, Simoni M, Baldacci S, Maio S, Angino A, Silvi P, et al. Symptom control and health-related quality of life in allergic rhinitis with and without comorbid asthma: A multicentre European study. *Clin Transl Allergy*. 2023;13(2):e12209.
8. Antonicelli L, Micucci C, Voltolini S, Feliziani V, Senna GE, Di Blasi P, et al. Allergic rhinitis and asthma comorbidity: ARIA classification of rhinitis does not correlate with the prevalence of asthma. *Clin Exp Allergy*. 2007;37(6):954-60.
9. Bousquet J, Anto JM, Sousa-Pinto B, Czarlewski W, Bedbrook A, Haahtela T, et al. Digitally-enabled, patient-centred care in rhinitis and asthma multimorbidity: The ARIA-MASK-air((R)) approach. *Clin Transl Allergy*. 2023;13(1):e12215.
10. Bousquet J, Bedbrook A, Czarlewski W, Onorato GL, Arnavielhe S, Laune D, et al. Guidance to 2018 good practice: ARIA digitally-enabled, integrated, person-centred care for rhinitis and asthma. *Clin Transl Allergy*. 2019;9:16.
11. Integrating Care to Prevent and Manage Chronic Diseases: Best Practices in Public Health, OECD. Éditions OCDE, Paris, <https://doi.org/10.1787/9acc1b1d-en>. 2023.

12. Bousquet J, Sousa-Pinto B, Anto JM, Amaral R, Brussino L, Canonica GW, et al. Identification by cluster analysis of patients with asthma and nasal symptoms using the MASK-air(R) mHealth app. *Pulmonology*. 2022;29:292-305.
 13. Digital consent around the world - Taylor Wessing's Global Data Hub [Available from: <https://globaldatahub.taylorwessing.com/article/digital-consent-around-the-world>].
 14. Bousquet J, Sousa-Pinto B, Regateiro FS, Pereira AM, Brussino L, Kvedariene V, et al. MASK-air(R) direct patient data support the ARIA-MeDALL hypothesis on allergic phenotypes. *Allergy*. 2023;78:2790-4.
 15. Laune D, Arnavielhe S, Viart F, Bedbrook A, Mercier J, Lun San Luk G, et al. [Adaptation of the General Data Protection Regulation (GDPR) to a smartphone app for rhinitis and asthma (MASK-air(R))]. *Rev Mal Respir*. 2019;36(9):1019-31. French.
 16. Samreth D, Arnavielhe S, Ingenrieth F, Bedbrook A, Onorato GL, Murray R, et al. Geolocation with respect to personal privacy for the Allergy Diary app - a MASK study. *World Allergy Organ J*. 2018;11(1):15.
 17. Bousquet J, Agache I, Aliberti MR, Angles R, Annesi-Maesano I, Anto JM, et al. Transfer of innovation on allergic rhinitis and asthma multimorbidity in the elderly (MACVIA-ARIA) - Reference Site Twinning (EIP on AHA). *Allergy*. 2017;73(1):77-92.
 18. Sousa-Pinto B, Azevedo LF, Jutel M, Agache I, Canonica GW, Czarlewski W, et al. Development and validation of combined symptom-medication scores for allergic rhinitis. *Allergy*. 2022;77(7):2147-62.
 19. Bousquet J, Arnavielhe S, Bedbrook A, Bewick M, Laune D, Mathieu-Dupas E, et al. MASK 2017: ARIA digitally-enabled, integrated, person-centred care for rhinitis and asthma multimorbidity using real-world-evidence. *Clin Transl Allergy*. 2018;8:45.
 20. Bousquet J, Arnavielhe S, Bedbrook A, Fonseca J, Morais Almeida M, Todo Bom A, et al. The ARIA score of allergic rhinitis using mobile technology correlates with quality-of-life: The MASK study. *Allergy*. 2018;73:505-10.
 21. Bousquet J, Caimmi DP, Bedbrook A, Bewick M, Hellings PW, Devillier P, et al. Pilot study of mobile phone technology in allergic rhinitis in European countries: the MASK-rhinitis study. *Allergy*. 2017;72(6):857-65.
 22. Bedard A, Basagana X, Anto JM, Garcia-Aymerich J, Devillier P, Arnavielhe S, et al. Treatment of allergic rhinitis during and outside the pollen season using mobile technology. A MASK study. *Clin Transl Allergy*. 2020;10(1):62.
 23. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. New York: Taylor and Francis Group; 1988. 567 p.
 24. Savoure M, Bousquet J, Leynaert B, Ribet C, Goldberg M, Zins M, et al. Asthma is associated with increased severity and duration of rhinitis: A study with the Allergic Rhinitis and its Impact on Asthma classes in the Constances cohort. *Clin Transl Allergy*. 2023;13(11):e12316.
 25. Bousquet J, Melen E, Haahtela T, Koppelman GH, Togias A, Valenta R, et al. Rhinitis associated with asthma is distinct from rhinitis alone: The ARIA-MeDALL hypothesis. *Allergy*. 2023;78(5):1169-203.
 26. Burte E, Bousquet J, Varraso R, Gormand F, Just J, Matran R, et al. Characterization of Rhinitis According to the Asthma Status in Adults Using an Unsupervised Approach in the EGEA Study. *PLoS One*. 2015;10(8):e0136191.
 27. Sanchez-Hernandez MC, Dordal MT, Navarro AM, Davila I, Fernandez-Parra B, Colas C, et al. Severity and duration of allergic conjunctivitis: are they associated with severity and duration of allergic rhinitis and asthma? *Eur Ann Allergy Clin Immunol*. 2022;54(6):277-83.
 28. Bousquet J, Neukirch F, Bousquet PJ, Gehano P, Klossek JM, Le Gal M, et al. Severity and impairment of allergic rhinitis in patients consulting in primary care. *J Allergy Clin Immunol*. 2006;117(1):158-62.
- *Manuscript received April 22, 2024; accepted for publication October 29, 2024.*
- **Jean Bousquet**
- <https://orcid.org/0000-0002-4061-4766>
Fraunhofer Institute for Translational Medicine and Pharmacology ITMP, Immunology and Allergology
Berlin, Germany
E-mail: jean.bousquet@orange.fr
jean.bousquet@itmp-extern.fraunhofer.de