Impact of Allergic Rhinitis on Academic Performance in Adolescents and Adults: a Bayesian Analysis of MASK-air® Real-world Direct Patient Data

Vieira RJ[1,2], Pereira AM[1,3,4], Papadopoulos NG[5], Zuberbier T[6,7], Pham-Thi N[8,9,10], Giovannini M[11,12], Melén E[13,14], Azevedo LF[1,2], Fonseca JA[1,2], Bousquet J[6,7,15], Sousa-Pinto B[1,2]

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

[2]CINTESIS@RISE - Centre for Health Technology and Services Research, Health Research Network, Faculty of Medicine, University of Porto, Porto, Portugal

[3]Allergy Unit, Instituto and Hospital CUF, Porto, Portugal

[4]PaCeIT – Patient Centered Innovation and Technologies, Center for Health Technology and Services Research (CINTESIS), Faculty of Medicine, University of Porto, Porto, Portugal

[5]Allergy Department, 2nd Pediatric Clinic, University of Athens, Athens, Greece

[6]Fraunhofer Institute for Translational Medicine and Pharmacology ITMP, Immunology and Allergology, Berlin, Germany

[7]Institute of Allergology, Charité – Universitätsmedizin Berlin, Corporate Member of Freie Universität Berlin and Humboldt-Universität zu Berlin, Berlin, Germany

[8]École Polytechnique de Palaiseau, Palaiseau, France

[9]IRBA (Institut de Recherche Bio-Médicale des Armées), Brétigny sur Orge, France

[10]Université Paris Cité, Paris, France

[11]Allergy Unit, Department of Pediatrics, Meyer Children's University Hospital IRCCS, Florence, Italy

[12]Department of Health Sciences, University of Florence, Florence, Italy

[13]Sach's Children and Youth Hospital, Södersjukhuset, Stockholm, Sweden

[14]Department of Clinical Science and Education, Södersjukhuset, Karolinska Institutet, Stockholm, Sweden

[15]MASK-air, Montpellier, France

J Investig Allergol Clin Immunol 2024; Vol. 34(6): 409-411
doi: 10.18176/jiaci.1010

Key words: Allergic rhinitis. Asthma. Academic performance. Real-world data.

Palabras clave: Rinitis alérgica. Asma. Desempeño académico. Datos clínicos reales.

Previous studies have shown that allergic rhinitis (AR) can negatively impact academic performance [1,2]. Real-world data provide improved knowledge in this field [3], particularly by helping to quantify how the control and treatment of AR affect academic performance. In this study, we aimed to use real-world patient data to quantify the proportion of school hours lost per week according to (1) control of allergic disease and (2) asthma-associated multimorbidity.

We conducted a cross-sectional analysis of data from the MASK-air® mobile app. MASK-air is a Best Practice of the

Organisation for Economic Co-operation and Development and is freely available in 29 countries. The MASK-air app encompasses a daily monitoring questionnaire enabling patients to register their symptoms and medication usage [4]. In addition, MASK-air includes, as an optional questionnaire, the Work Productivity and Activity Impairment Questionnaire plus Classroom Impairment Questions: Allergy Specific (WPAI+CIQ:AS) [5,6]. This questionnaire assesses academic absenteeism (hours of school or classes missed in the previous 7 days owing to allergies), presenteeism (perceived impact of allergy symptoms on academic productivity [attention span, comprehension, and taking tests] in students not missing classes), and total duration of impaired academic performance (absenteeism + presenteeism).

We assessed MASK-air users aged between 13-16 years (depending on the age of digital consent in the country [7]) and 29 years.

We performed 2 separate analyses. For the first, we assessed the percentage of school hours lost (due to absenteeism, presenteeism, and total impairment) by level of AR control. To do so, we included data from all weeks where patients responded to the MASK-air daily monitoring questionnaire on at least 5 days and then completed the WPAI+CIQ:AS questionnaire. We applied a previously described longitudinal k-means–based approach to classify weeks according to disease control [8]. This enabled us to identify (in an unsupervised way and considering the longitudinal nature of the data) weekly patterns based on the visual analog scale applied to assess the overall impact of allergy symptoms reported on the different days of each week. In this study, we classified weeks into well-controlled or uncontrolled (the latter including the weeks with partial, variable, and poor control described in the original study [8]). A stratified analysis was performed according to whether patients had AR alone or AR+self-reported asthma.

For the second analysis, we included all individual responses to the WPAI+CIQ:AS questionnaire irrespective of the number of daily monitoring questionnaires in the respective weeks and compared the percentage of school hours lost between patients with AR alone and patients with AR+asthma.

For both analyses, we employed Bayesian methods, modelling the probability of losing 1 hour [9]. We used a ß distribution defined by mean and precision (respectively with the noninformative uniform priors dunif[0,1] and dunif[0,1000]). We updated these priors based on data collected from the WPAI+CIQ:AS questionnaire in MASK-air, assuming that the proportion of hours lost in a week could be approximated using a binomial distribution. For all analyses, we ran a minimum of 20 000 iterations. The percentage of academic hours lost were described using the median (IQR) of the respective posterior predictive distributions (more information can be found in the Supplementary Methods).

Data from 91 weeks and 70 patients enabled us to assess the impact of disease control on academic performance (mean [SD] participant age, 21.0 [3.8] years), including 37 weeks with well-controlled AR and 54 weeks with uncontrolled AR (considering all patients with AR, regardless of asthma state) (Tables S1-2 and Figure S1). Median absenteeism per week in AR was 0.1% hours lost (0.0%-1.7%) for well-controlled weeks and 1.1% (0.0%-13.5%) for uncontrolled weeks (Table S2). Regarding presenteeism, the median impact was 8.7% hours lost (1.8%-24.0%) for well-controlled weeks and 32.8% (15.4%-55.4%) for uncontrolled weeks (Table S2 and Figure).

For the comparison between AR alone and AR+asthma, we included 662 responses to the WPAI+CIQ:AS questionnaire (mean participant age, 20.7 [4.1] years), of which 414 responses came from patients with AR alone compared with 248 with AR+asthma (Table S1 and Figure S1). Regarding absenteeism, AR alone was associated with a median of 0.1% hours lost (0.0%-6.8%), as was AR+asthma (0.0%-7.4%) (Table S3). For presenteeism, AR alone displayed a median impact of 26.5% academic hours lost (8.0%-55.1%), with comparable results observed for AR+asthma (26.7% [9.1%-52.3%]) (Table S3 and Figure). Similar results were observed for AR alone and AR+asthma in analyses stratified by disease control (Table S4).

Our study presents a series of limitations. First, our sample size is limited, particularly in the stratified analyses for AR alone and AR+asthma according to disease control. However, despite the small sample size, our results consistently showed no major differences between AR and AR+asthma. Second, we did not consider differences in the Allergic Rhinitis and Its Impact on Asthma (ARIA) classes [10] or the Global Initiative for Asthma (GINA) steps owing to limitations in sample size [11]. Third, our sample comprised mostly young adults,

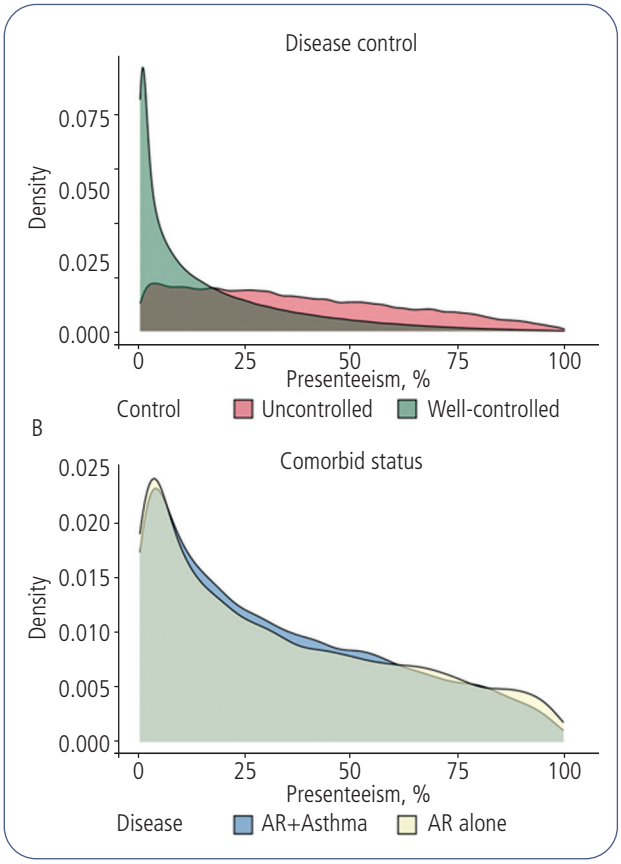

Figure. Presenteeism (academic productivity losses not implying school absenteeism) in allergic rhinitis (AR) according to weekly disease control (A) and comorbid status (B).

and these results may not be generalizable to children. Finally, the WPAI+CIQ:AS is not specific for AR, and we relied on self-reported information on the presence of AR and asthma.

In conclusion, our findings suggest that lack of AR control is associated with a marked impairment in academic performance, mostly due to the effect of AR on presenteeism, further underscoring the substantial burden of uncontrolled AR. Additionally, in this sample of observations of mostly mild asthma (Table S2), we found a similar effect of AR alone and AR+asthma on academic performance. This was underpinned by our stratified analysis based on the level of control, as well as the fact that no major differences were found in the baseline severity of AR between patients with AR alone and AR+asthma (Table S1). This suggests that AR may be the main driver of impaired academic performance in patients with respiratory allergic disease.

Funding

This manuscript was supported by PhD grant reference 2022.12787.BD funded by the Portuguese national funds and community funds from the European Social Fund and Programa Por_Norte through Fundação para a Ciência e a Tecnologia (FCT-MCTES, Portugal).

Conflicts of Interest

JB reports personal fees from Cipla, Menarini, Mylan, Novartis, Purina, Sanofi-Aventis, Teva, Uriach, other fees from KYomed-Innov, and other fees from Mask-air-SAS outside the submitted work.

EM reports speaker's fees/advisory board fees from Airsonett, ALK, AstraZeneca, Chiesi, and Sanofi outside the study.

NP reports personal fees from NOVARTIS, personal fees from NUTRICIA, personal fees from HAL, personal fees from MENARINI/FAES FARMA, personal fees from SANOFI/REGENERON, personal fees from MYLAN/MEDA, personal fees from BIOMAY, personal fees from AstraZeneca, personal fees from GSK, personal fees from MSD, personal fees from ASIT BIOTECH, personal fees from Boehringer Ingelheim, grants from CAPRICARE, grants from Gerolymatos Int, grants from NUTRICIA, personal fees from MEDCARE, personal fees from ALK, personal fees from OM PHARMA, fees from ABBOTT outside the submitted work.

TZ 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, personal fees from L'Oreal outside the submitted work. TZ also reports the following 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).

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

References

1. Roger A, Arcalá Campillo E, Torres M, Millan C, Jáuregui I, Mohedano E, et al. Reduced work/academic performance and quality of life in patients with allergic rhinitis and impact of allergen immunotherapy. Allergy Asthma Clin Immunol. 2016;12(1):1-9.
2. Walker S, Khan-Wasti S, Fletcher M, Cullinan P, Harris J, Sheikh A. Seasonal allergic rhinitis is associated with a detrimental effect on examination performance in United Kingdom teenagers: case-control study. J Allergy Clin Immunol. 2007;120(2):381-7.
3. Vieira RJ, Pham-Thi N, Anto JM, Czarlewski W, Sá-Sousa A, Amaral R, et al. Academic productivity of young people with allergic rhinitis: A MASK-air Study. The J Allergy Clin Immunol Pract. 2022;10(11):3008-17. e4.
4. 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® approach. Clin Transl Allergy. 2023;13(1):e12215.
5. Reilly MC, Tanner A, Meltzer EO. Allergy impairment questionnaires: validation studies. J Allergy Clin Immunol. 1996;97:989.
6. Reilly MC, Zbrozek AS, Dukes EM. The validity and reproducibility of a work productivity and activity impairment instrument. Pharmacoeconomics. 1993;4:353-65.
7. Digital consent around the world - Taylor Wessing's Global Data Hub [Available from: https://globaldatahub.taylorwessing.com/article/digital-consent-around-the-world.
8. Sousa-Pinto B, Schünemann HJ, Sá-Sousa A, Vieira RJ, Amaral R, Anto JM, et al. Consistent trajectories of rhinitis control and treatment in 16,177 weeks: The MASK-air® longitudinal study. Allergy. 2023;78(4):968-83.
9. van de Schoot R, Depaoli S, King R, Kramer B, Märtens K, Tadesse MG, et al. Bayesian statistics and modelling. Nature Reviews Methods Primers. 2021;1(1):1.
10. Bousquet J, Van Cauwenberge P, Khaltaev N. Allergic rhinitis and its impact on asthma. J Allergy Clin Immunol. 2001;108(5 Suppl):S147-334.
11. Global Initiative for Asthma. Global Strategy for Asthma Management and Prevention. 2023 July 2023.

Manuscript received December 4, 2023; accepted for publication March 26, 2024.

Jean Bousquet
Fraunhofer Institute for Translational Medicine and Pharmacology ITMP, Immunology and Allergology
Berlin, Germany
E-mail: jean.bousquet@itmp-extern.fraunhofer.de; jean.bousquet@orange.fr
https://orcid.org/000-0002-4061-4766