Mobile technology offers novel insights into the control and treatment of allergic rhinitis: The MASK study

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Background: Mobile health can be used to generate innovative insights into optimizing treatment to improve allergic rhinitis (AR) control.
Objectives: A cross-sectional real-world observational study was undertaken in 22 countries to complement a pilot study and provide novel information on medication use, disease control, and work productivity in the everyday life of patients with AR.
Methods: A mobile phone app (*Allergy Diary*, which is freely available on Google Play and Apple stores) was used to collect the data of daily visual analogue scale (VAS) scores for (1) overall allergic symptoms; (2) nasal, ocular, and asthma symptoms; (3) work; and (4) medication use by using a treatment scroll list including all allergy medications (prescribed and over-the-counter) customized for 22 countries. The 4 most common intranasal medications containing intranasal corticosteroids and 8 oral H_1-antihistamines were studied.
Results: Nine thousand one hundred twenty-two users filled in 112,054 days of VASs in 2016 and 2017. Assessment of days was informative. Control of days with rhinitis differed between no (best control), single (good control for intranasal corticosteroid–treated days), or multiple (worst control) treatments. Users with the worst control increased the range of treatments being used. The same trend was found for asthma, eye symptoms, and work productivity. Differences between oral H_1-antihistamines were found.
Conclusions: This study confirms the usefulness of the *Allergy Diary* in accessing and assessing behavior in patients with AR. This observational study using a very simple assessment tool (VAS) on a mobile phone had the potential to answer questions previously thought infeasible. (J Allergy Clin Immunol 2019;144:135-43.)

Key words: *Allergic rhinitis, antihistamines, asthma, conjunctivitis, corticosteroids, mobile health, MASK, treatment*

The treatment of allergic rhinitis (AR) is complex because many drugs are available in oral and/or topical formulations. Many guidelines for AR are evidence based and have led to a

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Abbreviations used

AR:	Allergic rhinitis
AzeFlu:	Intranasal azelastine–fluticasone propionate
FF:	Fluticasone furoate
FP:	Fluticasone propionate
INCS:	Intranasal corticosteroid
MF:	Mometasone furoate
OAH:	Oral H_1-antihistamine
p25-75:	25th-75th Percentile
RCT:	Randomized controlled trial
VAS:	Visual analogue scale

better management of AR. However, guidelines are mostly based on randomized controlled trials (RCTs), which are typically undertaken in highly selected populations, often with limited/unclear generalizability to routine care contexts.[1,2] They propose to increase treatment to achieve disease control (ie, sleep, social, and school/work impairment), which is the ultimate aim of the treatment. Intranasal corticosteroids (INCSs) represent the most effective AR treatment for most patients, but their effect is relatively slow, taking several hours,[3] and many patients prefer oral medications. A formulation of fluticasone propionate (FP) and azelastine (AzeFlu) is more effective than INCSs alone[4] and has the advantage of acting within minutes.[5]

Patients are poorly adherent to treatment and often self-medicate.[6,7] They want more effective and fast-acting treatments. Therefore observational real-life studies are needed to complement RCTs to better understand the efficacy of INCS-containing medications because RCTs do not select patients and report their behavior.

Mobile Airways Sentinel Network (MASK) for allergic rhinitis, an information and communications technology system centered around the patient[8-12] that is operational in 23 countries, uses a treatment scroll list including all medications customized for each country and a visual analogue scale (VAS) to assess rhinitis control. A pilot study in more than 2,900 users allowed differentiation between treatments.[13] Patients did not necessarily use treatment on a daily basis in a regular way but appeared to increase treatment use when their symptom control worsened. However, the pilot study needs to be confirmed with a larger number of users and more medications tested.

The present cross-sectional observational study was undertaken in 9,122 users in 22 countries (data collection had only just started in Argentina) to confirm the pilot study[13] using the same methods and to bring novel information on medication use and associated disease control, work productivity,[14] and allergic multimorbidity.[13] The study was focused first on the 4 most commonly used intranasal medications containing INCSs: fluticasone furoate (FF), FP, mometasone furoate (MF), and AzeFlu. We did not perform the same analysis with oral H_1-antihistamines (OAHs) because they are often associated with INCSs, and many patients would have been analyzed twice. In the second analysis, we examined some widely used OAHs: bilastine, cetirizine, desloratadine, ebastine, fexofenadine, levocetirizine, loratadine, and rupatadine. In the first analysis, we compared days with single treatment with days with multiple treatments. In the second analysis, we just used days with a single treatment.

METHODS

Users

All consecutive users from January 1, 2016, to December 31, 2017 were included with no exclusion criteria according to methods previously described.[13,14]

Setting

Users from 22 countries filled in the *Allergy Diary* (Table I). Data collection had only just started in Argentina, and results are not included.

Ethics

The *Allergy Diary* is CE1. CE marking is a certification that indicates conformity with health, safety, and environmental protection standards for products made in the European Union and meets the essential requirements of all relevant European Medical Device Directives.[15] CE1 includes sterile and nonsterile products and assesses whether the device has a measuring function.

Data were anonymized, including data related to geolocalization, by using k-anonymity.[16] Independent review board approval was not required because the study was observational, and users had agreed to having their data analyzed (terms of use).

Allergy Diary

Geolocalized users assess their daily symptom control by using the touchscreen functionality on their smart phone to click on 5 consecutive VAS scores (ie, general, nasal symptoms, ocular symptoms, asthma, and work). Users input their daily medications using a scroll list that contains all country-specific over-the-counter medications and prescribed medications available for each country (see Fig E1 in this article's Online Repository at www.jacionline.org). The list has been populated with Information Management System data. Days reported by users included days with or without treatment.

The present study is another *Allergy Diary* study. Some of the raw data used in the first article (up to November 2016)[13] were used in this study, but analyses differed.

Medication selection

The International Nonproprietary Names classification was used for drug nomenclature.[17] Monotherapy was defined as days when only a single medication for rhinitis was reported. AzeFlu contains 2 drugs, but because it is a fixed combination, it was considered a monotherapy. Comedication was defined as days with 2 or more medications for rhinitis. Asthma medications were not considered in comedication.

Study size

In this study, all registered users were included to obtain the best possible estimates for the specified time window. From the pilot study, numbers tested largely exceed those needed to find significant differences in the full-set analysis.[13] However, we did not consider medications with a sample size of less than 1,000 days of reporting.

Statistical methods

A non-Gaussian distribution was found for the data. Nonparametric tests and medians (and percentiles) were used. Correction for multiple testing was made, when appropriate.

Some users reported VAS scores more than once a day. In the pilot study, we found that the highest reported value should be used, and we followed this study.[13] However, in an exploratory analysis, we tested VAS scores in duplicates and multiplicates.

Data analysis

As previously published,[13] we conducted separate analyses by using the full set of data and data on just the first day of reporting. In the first analysis,

TABLE I. Country and number of users recording VAS scores by using the *Allergy Diary* in the full data set

	VAS measurements (d)				
Country	**1**	**2-7**	**8-14**	**>14**	**Total**
Austria	226 (56.6%)	121	16	36	399
Australia	49 (49.0%)	30	10	11	100
Belgium	48 (49.5%)	35	5	9	97
Brazil	572 (55.9%)	323	67	62	1024
Canada	6 (35.3%)	7	3	1	17
Czech Republic	1 (20.0%)	0	1	3	5
Denmark	37 (45.1%)	29	4	12	82
Finland	117 (44.8%)	93	25	26	261
France	319 (61.3%)	147	19	35	520
Germany	208 (39.8%)	141	35	139	523
Greece	47 (23.7%)	43	24	84	198
Italy	554 (44.6%)	389	87	213	1243
Lithuania	59 (17.7%)	89	52	134	334
Mexico	101 (13.0%)	207	128	343	779
The Netherlands	167 (53.9%)	94	23	26	310
Poland	286 (54.9%)	159	28	48	521
Portugal	647 (49.2%)	505	64	100	1316
Spain	129 (30.5%)	124	53	117	423
Sweden	33 (39.3%)	34	6	11	84
Switzerland	247 (64.0%)	111	11	17	386
Turkey	81 (52.6%)	42	10	21	154
United Kingdom	148 (42.8%)	104	46	48	346
Total	4082 (44.7%)	2827 (31.0%)	717 (7.9%)	1496 (16.4%)	9122

only users who reported no treatment or treatment with intranasal FF, FP, MF, and AzeFlu were studied (see Fig E2 in this article's Online Repository at www.jacionline.org). Those receiving other INCSs were excluded. For comedication, we initially selected second-generation OAHs: cetirizine, desloratadine, ebastine, fexofenadine, levocetirizine, loratadine, and rupatadine (group + OAH). There are many other OAHs, but we did not consider them because their pharmacologic properties vary widely, and they were not used often. We considered 2 other groups in INCS users for comedication: users who reported an OAH and another medication (group OAH + other) and users who reported another medication (+ other). Users who reported other medications but no INCSs were not analyzed. As a primary end point, using the full data set, we studied median VAS global scores ("Overall, how much are your allergic symptoms bothering you today?") levels for days with FF, FP, MF, and AzeFlu and for days without medications. The primary and secondary end points were analyzed by using the Kruskal-Wallis test and Wilcoxon and Mann-Whitney tests with Dunn-Bonferroni *post hoc* analysis to correct for multiple testing. Moreover, we analyzed the data using 3 cutoffs, according to a consensus[18] and available data of the pilot study[13,14]: controlled days, VAS score of less than 20 of 100; days with moderate control, VAS score of 20 to 49; and days with poor control, VAS score of 50 or greater. The same analyses were conducted for the first day of VAS report. Secondary end points included VAS eye, asthma, and work.

In the second analysis, we compared days with monotherapy for the most common OAH: cetirizine, desloratadine, ebastine, fexofenadine, levocetirizine, loratadine, and rupatadine monotherapy. We did not consider other OAHs with a sample size of less than 1,000 days (or close to this number). We only compared VAS global scores measured. The mean number of days of reporting was considered for each treatment.

We then performed exploratory analyses to investigate whether there are temporal patterns in the reporting of VAS among app users. We assessed VAS scores on (1) days with more than 1 VAS reported, (2) the first day of reporting and first day of new reporting in users with nonconsecutive data, (3) days without treatment followed by a day with treatment, and (4) days with treatment followed by a day without treatment.

RESULTS

Demographic characteristics

The study included 9,122 users. Roughly 5% of users did not report their age and were ascribed to 0. Users ranged in age from 0 to 92 years (mean ± SD, 32.4 ± 15.2 years). There were 54.7% women and 45.3% men. The age repartition is shown in Fig E3 in this article's Online Repository at www.jacionline.org.

A total of 112,054 days were recorded. Duplicates or multiplicates for the same day were found for 14,767 days. Global VAS scores were not recorded in 754 (0.8%) days with app data reported. There were 52,706 (54.6%) days without treatment and 18,117 days with the targeted INCS (Fig 1).

Analysis of VAS global scores measured

On visual inspection, no clear trajectory of VAS scores could be easily identified because users erratically reported their VAS and treatment data. Fig E4 in this article's Online Repository at www.jacionline.org reports trajectories for French users as an example. In the figure, each user is identified by a member identifier number (vertical axis), and each user's trajectory is represented horizontally by dots, with each dot representing a day of VAS recording. Results are reported in Figs 2 and 3 and Table II.

Analysis of VAS global scores measured on days without treatment and days with INCS treatment

On the first day of reporting, VAS scores were reported by 4,991 users without treatment, 1,395 users with OAH treatment, and 1,281 users with INCS treatment (Table II). The percentage of users with a single treatment ranged from 34.0% (FP) to 39.2%

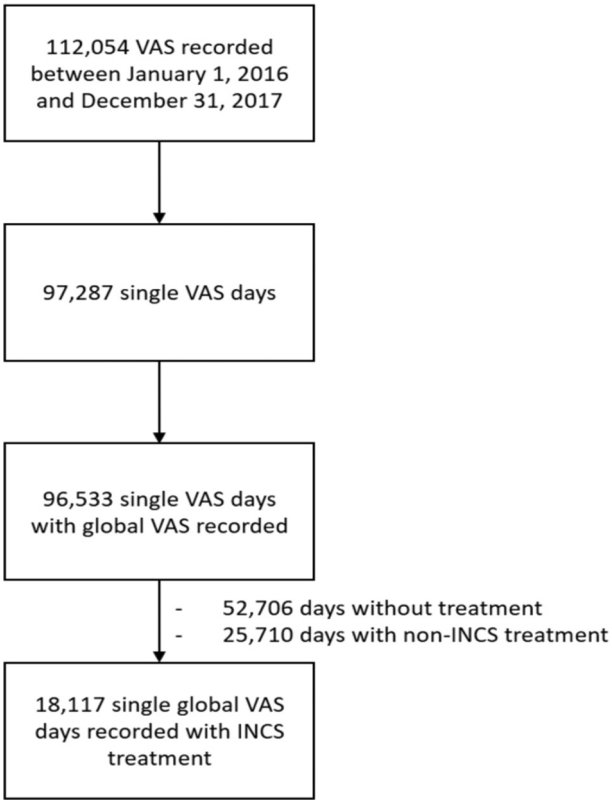

FIG 1. Flowchart of the study population.

(MF) to 40.5% (FF) to 59.6% (AzeFlu). Days with INCSs alone had similar median VAS scores (35-44).

For the full data set of 96,533 days, VAS scores were reported by 6,236 users without treatment, 3,664 users with OAH treatment, and 2,575 users with INCS treatment (Table II). Monotherapy was reported on 45% to 55% of these days (FF or MF vs AzeFlu, Fig 2). For monotherapy, median VAS scores ranged from 5 (FF) to 23.5 (FP). For day 1 and the full data set, the same trend was found in INCS-treated users: lowest median levels were found for monotherapy, increased levels for comedication with OAHs, and highest levels for comedication with OAHs plus other treatments (Fig 3). Variable VAS scores were observed for comedication with other treatments. The numbers of days of comedication with another INCS were too low to make any comparison (Table II).

Analysis of VAS global scores measured on days with OAH treatment alone

The first day of reporting, days with no treatment and days with INCS monotherapy had similar median VAS scores (range, 34-44). On the other hand, there were some variations for OAHs in monotherapy. Levocetirizine days had a median VAS score of intermediate between untreated or INCS-treated days and the other OAHs. For the full data set of 96,533 days, median VAS scores of days with INCSs were lower than those of days with OAHs, but bilastine, fexofenadine, levocetirizine, and rupatadine had scores similar to those of INCSs (Table II).

Apart from days with FP treatment (low numbers), the mean numbers of days of reporting medications per user ranged from 4.00 (cetirizine) to 8.98 (AzeFlu).

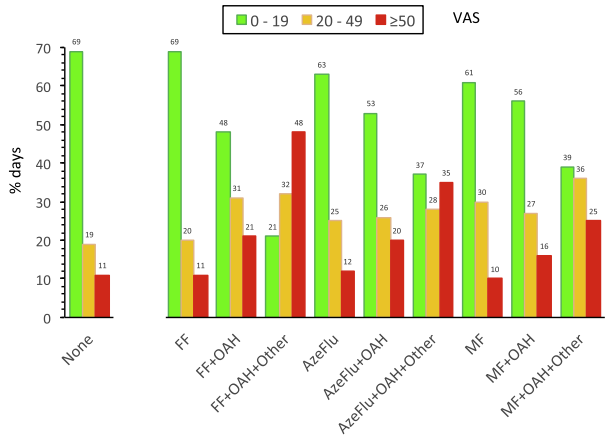

FIG 2. Percentage of days in each category of INCS treatment (first day and full data set).

Analyses of VAS scores for eye symptoms, asthma, and work productivity

Analyses of VAS scores for eye symptoms, asthma, and work productivity are reported in Fig E5 in this article's Online Repository at www.jacionline.org. Trends for the 3 secondary end points are similar to those of VAS global scores measured (ie, low median scores similar to those of untreated days for the single treatment, increased scores with comedication with an OAH, and highest scores for comedication with an OAH plus another medication and the highest percentage of users with single treatment observed for AzeFlu). Fewer users reported VAS work, but the trends were similar.

Exploratory analyses investigating potential temporal patterns in the reporting of VAS scores

Assessment of duplicates or multiplicates for day 1. Days with 2 or more VAS scores reported at least 1 hour apart within the same day were selected. The data set included 1,576 days for VAS global scores measured. A significantly higher VAS score was found at the second reporting compared with the first. When data were stratified by the type of treatment recorded at first entry (no treatment, AzeFlu FF, MF, and FP), these findings were only significant for days with no treatment. No difference was found for days with (any) treatment (see Table E1 in this article's Online Repository at www.jacionline.org).

VAS scores depending on consecutive and nonconsecutive data. There were 4,132 users with at least 2 nonconsecutive calendar days of VAS scores reported (n = 89,473 days in total). Global VAS scores measured on day 1 were found to be significantly greater when compared with global VAS scores measured on the first day of new reporting (ie, on first nonconsecutive calendar day reported), regardless of the presence/type of treatment (Table III).

Distribution of global VAS scores on the 391 consecutive couple of calendar days consisting of a day without treatment followed by a day with treatment showed a nonsignificant increased score in treated days (median, 23 [25th-75th percentile {p25-75}, 11-49] to 28 [p25-75, 14-50]; $P = .07$, Wilcoxon W test).

Distribution of global VAS scores on the 350 consecutive couple of calendar days consisting of a day with treatment

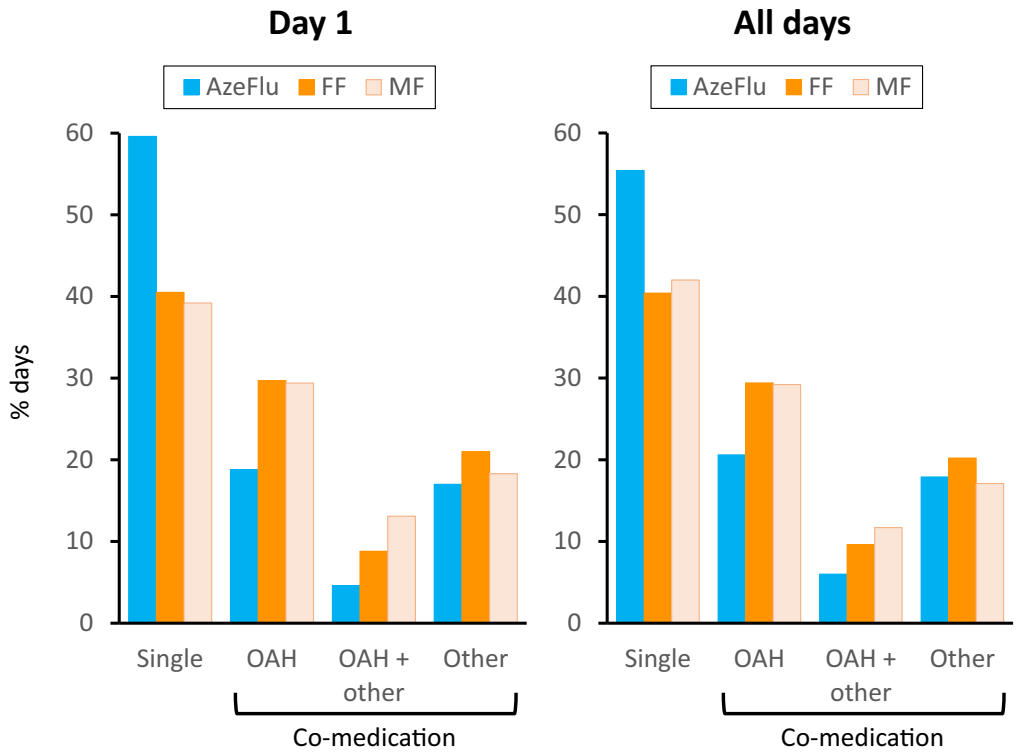

FIG 3. Percentage of days in each category of treatment for VAS global measured (full data set).

TABLE II. Results of VAS global scores measured

	Day 1		Full set (96,533 d)		
	No. of days	Median (p25-p75)	No. of days (users)	Median (p25-p75)	Mean no of days per user
No treatment	4,991	34 (10-60)	52,706 (6,236)	8 (0-26)	8.45
Bilastine*	128	48 (19-69.5)	1,563 (261)	16 (6-37)	6.00
Cetirizine*	350	52 (28-70)	2,169 (545)	22 (9-50)	4.00
Desloratadine*	300	50 (26-71)	2,085 (504)	21 (8-46)	4.14
Ebastine*	115	50 (26-72)	980 (201)	23 (9-48)	4.88
Fexofenadine*	112	55 (32.5-71.5)	1,128 (183)	14 (8-35)	6.17
Levocetirizine*	149	43 (16-67)	1,512 (260)	14 (5-28)	5.81
Loratadine*	175	49 (28-72)	1,680 (344)	21 (10-39)	4.88
Rupatadine*	66	49 (23-63)	1,138 (146)	18 (5-36)	7.69
FF	176	35 (19.5-58.5)	2,182 (336)	5 (0-27)	6.49
+ OAH	129	51 (22-66)	1,317 (247)	21 (4-45)	5.33
+ OAH + other	38	64 (49-77)	307 (80)	48 (24-63)	3.84
+ other (no OAH)	84	53.5 (28-72)	968 (168)	23 (9-47)	5.76
+ other INCS	7	50 (4-90)	113 (16)	61 (26-95)	7.06
AzeFlu	155	37 (16-60)	2,722 (303)	13 (3-29)	8.98
+ OAH	49	58 (40-73)	994 (113)	17 (7-40)	8.72
+ OAH + other	12	54 (26-80)	174 (33)	31 (9-60)	5.27
+ other (no OAH)	37	40 (21-65)	871 (98)	22 (11-42)	8.89
+ other INCS	7	50 (33-77)	193 (21)	36 (12-73)	8.39
MF	192	36.5 (16.5-59.5)	3,420 (409)	15 (5-28)	7.92
+ OAH	144	48 (23-68)	2,181 (284)	17 (8-37)	7.68
+ OAH + other	64	61.5 (33.5-75)	914 (114)	26 (14-49)	8.02
+ other (no OAH)	83	53 (26-68)	1,158 (167)	26 (9-45)	6.93
+ other INCS	7	33 (0-77)	113 (21)	20 (6-79)	5.38
FP	33	44 (30-65)	156 (55)	23.5 (3.5-52)	2.83
+ OAH	34	56 (40-67)	305 (64)	19 (10-46)	4.77
+ OAH + other	14	52.5 (45-80)	60 (21)	54 (24.5-82.5)	2.89
+ other (no OAH)	13	41 (31-59)	121 (22)	22 (18-41)	5.50
+ other INCS	3	4 (0-65)	127 (11)	22 (8-48)	11.55

*Monotherapy.

TABLE III. Day 1 versus nonconsecutive days

	Day 1		First nonconsecutive day		Other nonconsecutive day		*P* value*
	No.	VAS global, median (p25-p75)	No.	VAS global, media (p25-p75)	No.	VAS global, median (p25-p75)	Day 1 vs first nonconsecutive day
All days	4,132	34 (12-60)	4,132	25 (7-51)	24,680	12 (2-32)	<.001
No treatment	2,214	26 (7-51)	2,154	18 (4-44)	13,651	8 (0-24)	<.001
AzeFlu	162	44 (19-69)	187	26 (9-55)	1,566	17 (6-35)	<.001
Other INCS treatment	555	43 (22-64)	601	30 (11-55)	3,403	17 (6-38)	<.001

*Statistical analysis by using Wilcoxon and Mann-Whitney tests.

followed by a day without treatment showed a significantly decreased score in untreated days (median, 23 [p25-75, 13-45] to 20 [p25-75, 9-38]; $P = .01$ Wilcoxon W test).

DISCUSSION

A pilot study using a very simple assessment (VAS) on a cell phone in 2,871 users who filled in 17,091 days of data suggested that an app might provide novel information concerning the treatment of AR.[13] However, the sample size was possibly too small to draw definite conclusions. This study in a larger sample (9,111 users in 22 countries, 97,287 days) confirms the findings of the pilot study, showing that in real life the assessment of days can inform a patient's treatment and bring novel insight into the behavior of patients with AR toward treatment and novel concepts for change management of AR.[19] The control of days differs between no treatment (best control), single treatment, or comedication (worst control). For the first time, this study showed that the same trends were observed for global symptoms, ocular symptoms, asthma, and work productivity. This study suggests contrary behavior between physicians and patients because the range of treatments was increased in those with poor control, whereas, according to guidelines, physicians are recommended to increase the treatment to achieve control. This major gap in AR treatment might explain the overall low level of satisfaction of patients with severe AR reported in many studies.

Strengths and limitations

The current study has many strengths, including larger numbers, multiple countries, range of treatments studied, and patient/person-generated data.

As for all studies using participatory data, potential biases include (1) the likelihood of a sampling bias being present and the difficulty of assessing the generalizability of the study and (2) outcome misclassification that cannot be assessed and, by definition because of ethical problems, very little information on patient (or day) characteristics. App users are not representative of all patients with rhinitis. The issue of potential selection bias was limited by the fact that we considered days and not patients in the analyses.

As in other studies,[13,20] we used days in a cross-sectional analysis because there is no clear pattern of treatment, and a longitudinal study was not feasible because users mostly use the app intermittently. Although this observation might differ from RCTs, our study is a real-life approach.

For this study, other biases should be considered. The diagnosis of AR was not supported by a physician but was a response to the following question: "Do you have allergic rhinitis? Yes/No." Therefore there could be some users without AR who might have responded "yes" to the question. There are potential measurement biases when using apps, including collection of information, education of the patient, availability, and ability to use a smartphone.[13] Users self-identified themselves as having AR without confirmation of the diagnosis. Precise patient characterization is impossible by using an app, but every observational study using the *Allergy Diary* was able to identify days with poor control or criteria of severity.[20-24] Adherence to treatment is impossible to prove because users do not report data on all days and might not report all medications used. Nonetheless, mobile technology is becoming an important tool for better understanding and managing AR and for providing novel information that was not available with other methods.[20-26]

Asthma was assessed by using a single VAS largely validated in patients with rhinitis.[27] In asthmatic patients, VAS scores were shown to be an effective measure of control.[28] In the present study, we did not investigate specific symptoms or perform any pulmonary function tests. Thus it is possible that some users might have misunderstood the question or overestimated the disease. However, the results are extremely consistent.

We only considered days and not patients' trajectories because these are highly variable, with patients using automedication depending on AR control, as previously shown.[13]

Longitudinal capture is very challenging with this app, but this appears to be the case for all apps. Patient engagement with digital health in real-world scenarios is usually lower than in RCTs. Although this is a limitation in relation to causal inference, it suggests that a new methodological approach is needed. It appears that treatment trajectories are specific for almost each user, and most users have gaps in their treatment when their symptoms are well controlled.

Interpretation of the results and generalizability

This real-world assessment of the *Allergy Diary* using the VAS allows assessment of treatment efficacy by days, which represents real-life estimation of AR control. It also most likely reflects real life better than patients' assessments at regular intervals because (1) it is known that AR is a highly variable disease and control varies widely between days in relation to allergen and environmental exposure, (2) patients are rarely adherent to their treatment, (3) patients often stop treatment when they feel better, and (4) patients increase their treatment when symptoms are uncontrolled.

VAS scores were greater on days with treatment than on days without treatment. This study confirms the results of the pilot study,[13] in which median VAS scores on days without treatment were similar in users who never reported any medication use and in those who were occasionally treated. Moreover, in a small sample it was found that consecutive days with treatment

are less well controlled than days without treatment. In INCS-treated users, days with a single treatment were better controlled than days with multiple treatments. An important message from this article is that overall in real life patients treat themselves when they have symptoms and stop their treatment when their symptoms are controlled. This is in agreement with previous data.[29,30] Using objective data, this study confirmed that adherence is poor. Most patients with AR can have mild and/or intermittent disease that does not require regular treatment to achieve control. The concept of proactive medication and patient participation,[31] with the patient starting treatment when experiencing symptoms and continuing for a few days after getting control, might be of great interest and could be tested with the app. In asthmatic patients, self-guided treatment was found to be of interest.[31-33] Such real-life findings might ultimately affect the way in which guidelines are constructed to align them more with human behavior. We have already initiated a program entitled change management in patients with rhinitis and asthma[19] in which we propose to develop next-generation care pathways and test the recommendations of GRADE guidelines in AR[3,4] according to real-world evidence using MASK data. A first meeting was held at the Pasteur Institute, Paris, France (December 3, 2018), to provide guidance for their development.

This observational study made it possible to differentiate OAHs and INCSs, confirming known data,[34] and was able to differentiate between OAHs. Levocetirizine was found to be the most effective OAH, confirming clinical experience. On the other hand, cetirizine appeared not to have been as effective. However, there were a large number of generics for cetirizine, and this could be studied when more users are available. This study could also differentiate the 3 medications containing INCSs, FF, MF, and MP-AzeFlu, and confirm previous studies,[35,36] extending our understanding of how AR treatment is used. RCTs showed that MP-AzeFlu is more effective than single components available in pharmacies[37] or components using the same formulation.[38]

The same trends for INCS-containing medications were observed for VAS global scores measured, eye symptoms, asthma, and work productivity. However, the percentages of well-controlled, controlled, and poorly controlled days differed, indicating the independence of data already observed. Moreover, data on work are extremely important for facilitating an economic evaluation of treatments.

An important result is that VAS scores on day 1 were higher than those on any other consecutive/nonconsecutive day. This indicates that patients start using the app when symptoms are uncontrolled. This is one specificity of analyzing app data and should be considered in studies that assess control of allergic diseases in relation to risk factors, such as air pollutants and allergen exposure.

CONCLUSIONS

Real-world data and real-world evidence play an increasing role in health care decisions, supporting clinical trial designs and observational studies to generate innovative and new treatment approaches. These data hold potential to answer questions previously thought infeasible,[39] such as the true patient's attitude toward treatment. This observational study shows highly consistent results between different outcomes (VAS scores) and provides novel concepts for the management of allergic diseases. When the patient experiences increased symptoms, indicating a loss of control, he or she increases the number of medications used that day. A total behavioral disconnection was found because most patients treat themselves on demand when they are not controlled, whereas the vast majority of physicians prescribe long-term treatment to achieve control. Shared decision making might offer a more rewarding approach to AR management. The results of this article will be of importance for the implementation of the MASK Good Practices recently recognized by D. G. Santé.

Clinical implications: A behavioral disconnect was found in the study because patients are not adherent to treatment and treat themselves on demand when their symptoms are not controlled, whereas the vast majority of physicians prescribe long-term treatment to achieve control. Shared decision making is essential.

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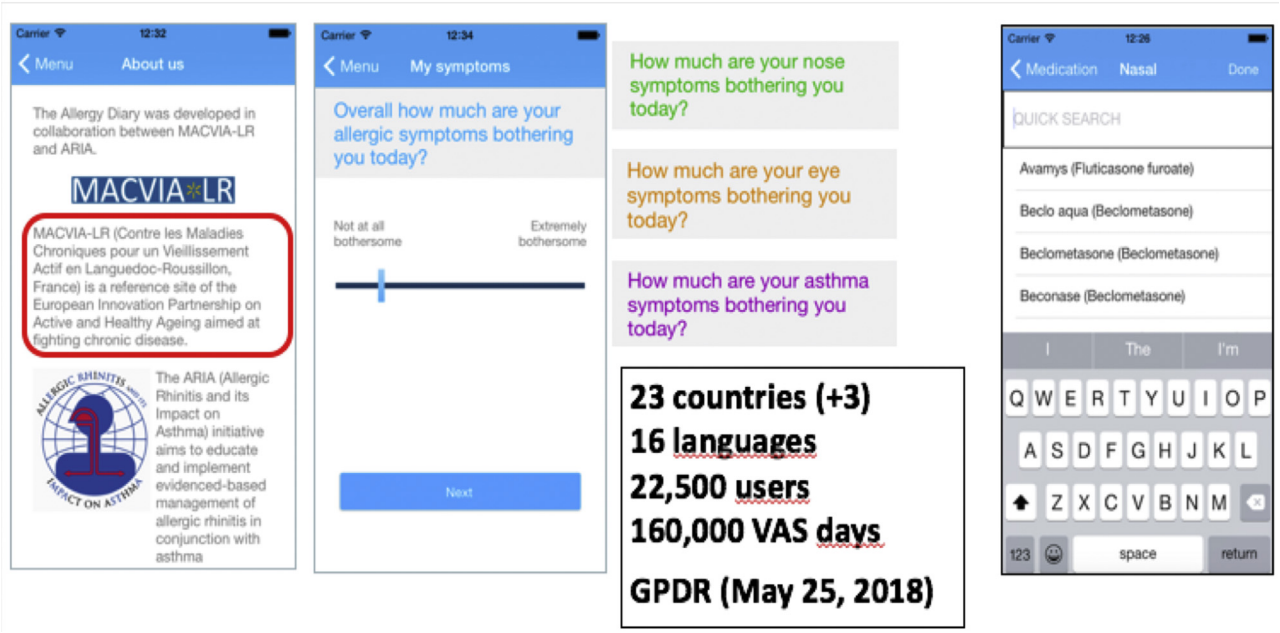

FIG E1. *Allergy Diary.*

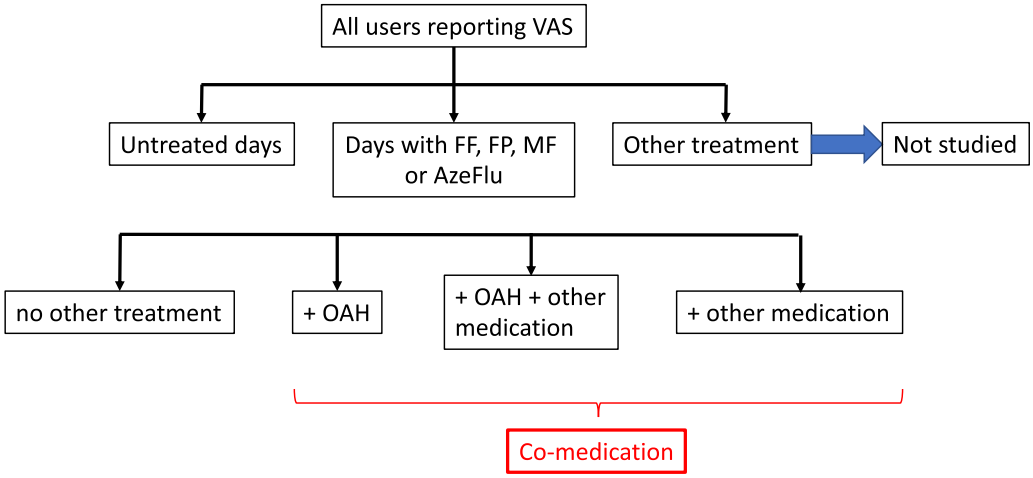

FIG E2. Groups of users studied and excluded in the first analysis.

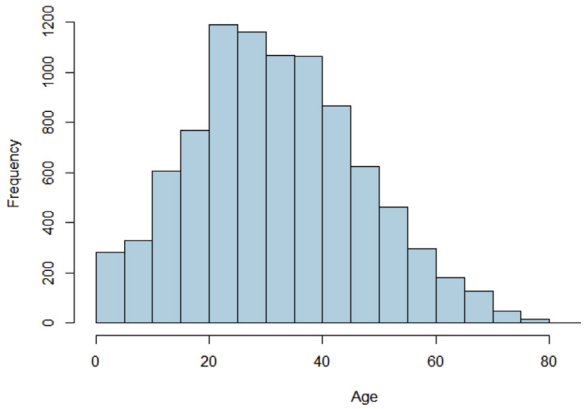

FIG E3. Age distribution.

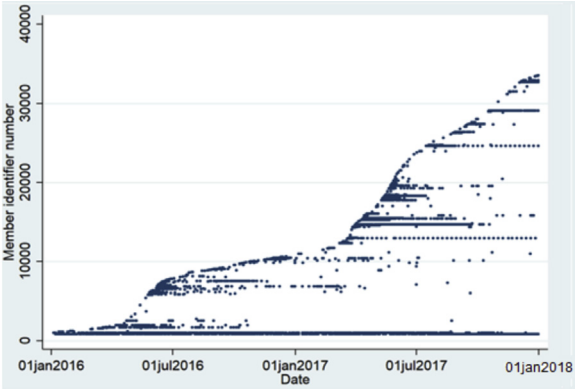

FIG E4. VAS scores reporting trajectories in French users (n = 520 users, 3,114 days).

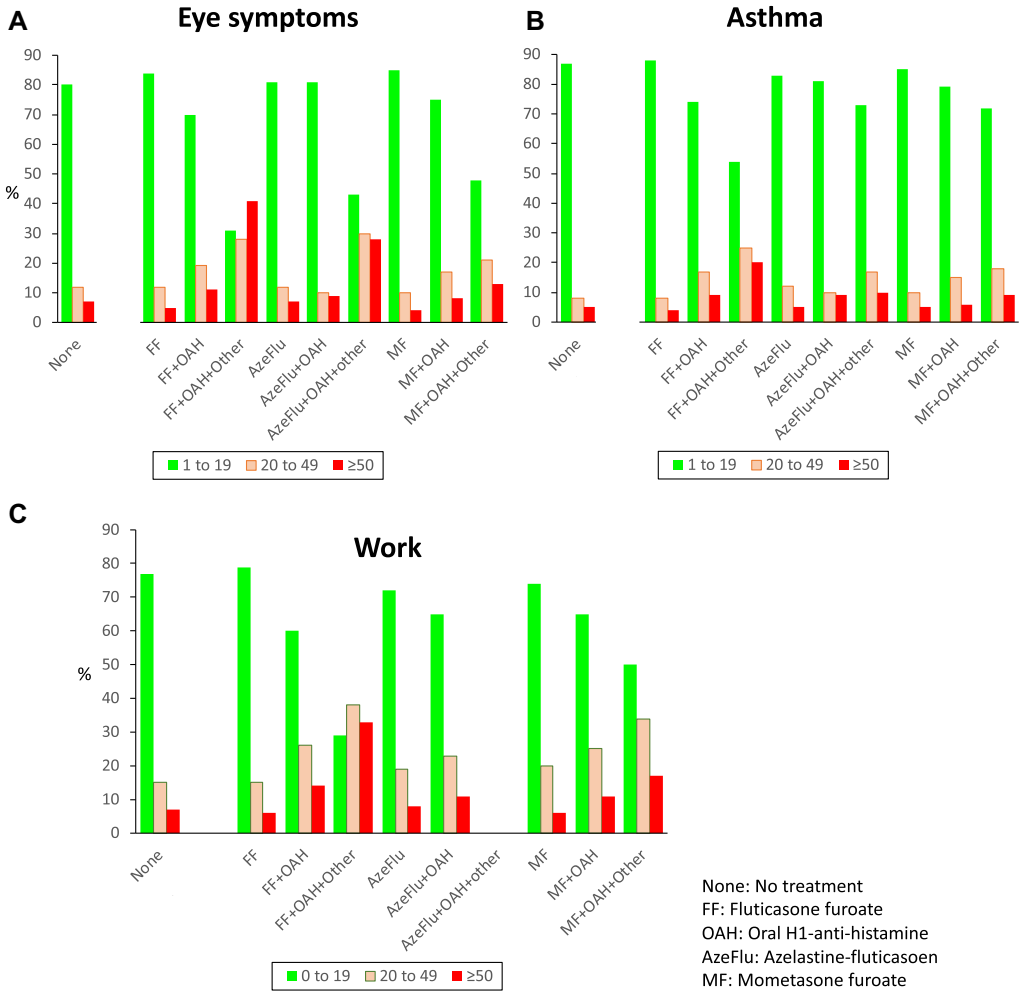

FIG E5. Percentage of days in each category of treatment for VAS scores for eye symptoms **(A)**, asthma **(B)**, and work productivity (**C**; full data set).

TABLE E1. Variations in VAS global scores within the same day

Days with >1 VAS score	No. of days	VAS global score, median (p25-p75)		*P* value*
		First entry	Second entry	First vs second entry
All days	1576	18 (4-45)	22 (6-50)	.01
Days without treatment	866	14 (0-36)	17 (3-42)	.005
Days with AzeFlu treatment	140	13 (4-41.5)	14 (4.5-53)	.58
Days with other INCS treatment	177	29 (8-51)	25 (9-54)	.90

*Statistical analysis was performed with Wilcoxon and Mann-Whitney tests.