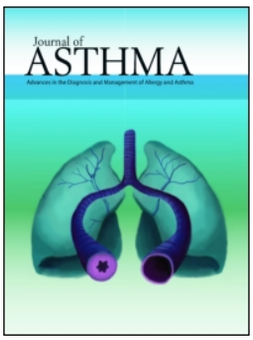

Journal of Asthma

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ijas20

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To cite this article: Marco Contoli, Sara Barile, Elena Nudo, Daniele Guastalla & Fulvio Braido (2021): Exploring quality of life and satisfaction with treatment in asthmatic patients receiving dry powder inhalers: a multinational survey, Journal of Asthma, DOI: 10.1080/02770903.2021.1923739

To link to this article: https://doi.org/10.1080/02770903.2021.1923739

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JOURNAL OF ASTHMA
https://doi.org/10.1080/02770903.2021.1923739

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Exploring quality of life and satisfaction with treatment in asthmatic patients receiving dry powder inhalers: a multinational survey

Marco Contoli, MD, PhD[a], Sara Barile, MSc[b], Elena Nudo, MSc[b], Daniele Guastalla, BSc[b] and Fulvio Braido, MD, PhD[c]

[a]Respiratory Section, Department of Translational Medicine, University of Ferrara, Ferrara, Italy; [b]Global Medical Affairs, Chiesi Farmaceutici S.p.A, Parma, Italy; [c]Department of Internal Medicine (DiMI), Respiratory Unit for Continuity of Care, IRCCS, Ospedale Policlinico San Martino, University of Genova, Genova, Italy

ABSTRACT

Introduction: The quality of life (QoL) and device needs have not been characterized in asthmatic patients treated via dry powder inhalers (DPIs). The aim of this study was to assess the impact of asthma on health-related QoL, device satisfaction, and preference in adult asthmatic patients using DPI devices, and to identify any DPI-associated unmet needs.

Methods: An online survey was conducted between November and December 2019 on eligible patients from the Cint consumer panel across Europe. Newly designed, as well as validated questionnaires were used to collect data on QoL and inhaler satisfaction.

Results: A total of 1063 asthmatic patient took part in the survey; 66% of the patients reported medium or high impact of asthma on the overall QoL. The majority of patients (61%) reported high level of satisfaction with their current device. The patients with medium-to-high impact of asthma on QoL were significantly less likely to be satisfied with their current device (55%) than those who reported low-to-medium impact of asthma on QoL (67%; *p*-value < 0.001). "Higher number of available doses," "usability," "clear dose counter," and "feedback on correct inhalation" were the attributes mostly requested from a new device. The demand for user-friendly devices that provide feedback on correct drug administration was identified as an unmet need.

Conclusions and clinical relevance: In asthmatic patients with medium to high impact of asthma on the overall QoL, the satisfaction with the device is highly affected.

ARTICLE HISTORY
Received 9 March 2021
Revised 22 April 2021
Accepted 26 April 2021

KEYWORDS
QoL; asthma impact on life; DPI; device satisfaction; device preference

Introduction

Asthma is a common and heterogeneous chronic respiratory disease that comes in a range of severity: from mild and occasional clinical manifestations managed by relieve treatment only to severe and/or persistent respiratory symptoms requiring up to a high dose of inhaled corticosteroids (ICS), long acting bronchodilators and, in selected patients, biologic therapies (1). For patients, living with asthma means dealing with recurring respiratory symptoms (including wheezing, shortness of breath, chest tightness, and cough) and chronic use of inhaled medications. All these aspects can impact negatively their motivation, physical activity, career opportunities, social life, and relationships (2–4). Clearly, the quality of life (QoL) defined as individual's satisfaction and happiness with one's life is compromised by all of the above factors (5). The severity of the clinical manifestation of asthma is a strong predictor of asthma-specific QoL (6), but QoL is also known to be influenced by the level of satisfaction with treatment (5) and patients' expectations of pharmacological regimens (7).

The goals of asthma therapy are to control symptoms, improve the patient's QoL and to reduce the risk of future disease progression mainly through the prevention of potentially life-threatening events characterized by worsening of respiratory manifestations called exacerbations. (1). Inhalation treatment is the standard of care for asthmatic patients. This route of drug delivery enhances the benefit of a treatment while minimizing its adverse events (8). To ensure the benefits of the inhaled route, good adherence to treatment and good quality and easy to use devices are of paramount importance (9). Several types of inhalers are available on the market. Choosing the

CONTACT Fulvio Braido fulvio.braido@unige.it Department of Internal Medicine (DiMI), Respiratory Unit for Continuity of Care, IRCCS, Ospedale Policlinico San Martino, University of Genova, Genova, Italy.

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right inhaler for the right patient is still a challenging issue. Indeed, while several flow charts have been proposed to help the clinician in the selection of the device (10,11), no standardized procedure has been validated. Dry powder inhalers (DPIs) are a type of devices that dispatch therapeutic agents in the form of a powder (12). DPI design continues to evolve and they are an important category of devices not least due to their environmental friendliness (13). DPIs have variable design characteristics in terms of drug storage (single capsules, foil blisters/multiple capsules, or drug reservoir) and construction (mouthpiece configuration and length, powder impaction angle with the device, and air inlet size) (14); they can be single-use or reusable. The importance of all of the DPI construction features to patients' satisfaction and adherence to treatment has not been completely determined and each type of inhaler devices comes with its own advantages and limitations (11,15). Many asthmatic patients are noncompliant with their treatment regimens (16–20). Several factors have been claimed to cause poor adherence to treatment in asthma including: the complexity of the therapeutic regimens (21), patients' awareness/perception of the disease, inappropriate expectations of the treatment (22), and also poor satisfaction with and/or misuse of inhaler devices (23). Poor adherence to medication establishes a vicious circle associated with negative disease outcomes including poor asthma control, increased exacerbation rates that require further treatment or hospitalization, decreased QoL, and lifestyle limitations for the patient (24). Understanding the patients' prospective on asthma impact on QoL, and their satisfaction with and expectations of devices can provide clinically valuable data to improve disease management and outcomes.

Here we present the results of this multinational survey conducted in adult asthmatic patients treated with any DPI device available in 7 European countries. Aims of the study were: (1) to understand the impact of asthma on patients' QoL and (2) to analyze patients' satisfaction with DPI devices and their device preference, and identify any unmet needs associated with them. With the scope of focusing mainly on the effect of a specific device type and generating data on as uniform and large patient population as possible, we included asthmatic patients treated with inhaled corticosteroid/long-acting beta$_2$-agonist (ICS/LABA) via a DPI device only.

Methods

Survey population

The study population consisted of asthmatic patients (aged 25–60) treated with ICS/LABA via a DPI device. They were recruited between November and December 2019 from a consumer panel, hereafter referred to as the database, owned by Cint Barcelona, Spain. Asthmatic patients from seven countries (Austria: 50, France: 177, Germany: 200, Italy: 200, Netherlands: 49, Spain: 200, United Kingdom: 187 participants) were selected and contacted by email. Individuals, who had more than two chronic conditions (such as Alzheimer's disease, ankylosing spondylitis, cardiovascular disease, chronic obstructive pulmonary disease, Crohn's disease, cystic fibrosis, diabetes, epilepsy, HIV/AIDS, multiple sclerosis, myasthenia gravis, Parkinson's disease, psoriasis, rheumatoid arthritis, systemic lupus erythematosus), were not treated with DPI or were also treated with tiotropium bromide, were excluded (Figure 1). Participants were assigned an ID to prevent them from completing the survey more than once.

Given the strictly online character of the study, we excluded patients over the age of 60 to avoid bias related to poor computer literacy and limited access to the necessary technology, the key elements for the correct completion of the online survey. Moreover, in order to focus on a cohort of asthmatic patients as uniform as possible and to reduce the confounding factors related to different inhaled regimens, only patients on ICS/LABA were included in the analysis. Combination ICS/LABA inhaled therapy is the core of asthma treatment (1). Patients to whom ICS/LABA therapy is prescribed are theoretically daily users of the devices. This

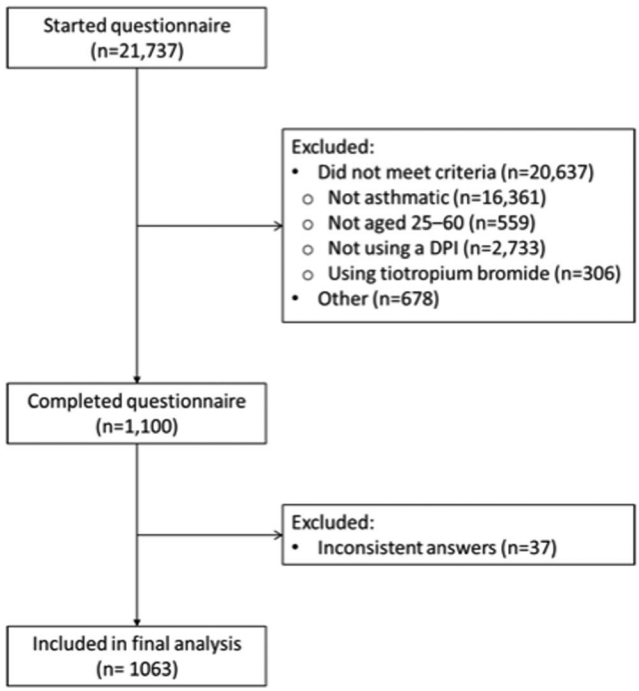

Figure 1. Survey design. DPI, dry powder inhaler.

increases burden of therapy on the QoL and makes them the right interlocutors of whom to ask questions regarding the satisfaction and preferences for the devices. Furthermore, the study was not designed to compare patient-reported outcomes and treatment satisfaction with available DPI devices. Thus, the analysis was performed on the entire population of asthmatic patients irrespective of the specific DPI used.

Objectives

The survey was designed to gain further insights into the effects of asthma on QoL in patients treated with ICS/LABA delivered via DPI, to evaluate their satisfaction with the devices and device preference, and to identify any unmet needs associated with their use.

Design

The survey was developed with the help of an independent market research agency (ELMA Research, Milan, Italy) and included, amongst others, three previously published questionnaires: the 27-item Modified and Short Version of Living with Asthma questionnaire (ms-LWAQ) (25), the 14-item Patient Satisfaction and Preference Questionnaire for Inhalation Devices (PASAPQ) (26), and the 10-item Test of Adherence to Inhaler—TAI (27).

The survey was divided into three sections: (1) patients' demographic and disease characteristics, (2) patients' experience with the disease, that is, the impact of asthma on 10 aspects of daily life, and the health-related QoL assessment using ms-LWAQ, and (3) patient-reported evaluation of DPI devices. In particular, in the third section, patients were asked to report: (i) the level of satisfaction with the current inhaler using PASAPQ; (ii) the importance of chosen DPI attributes; (iii) current limitations (if any) and desirable new technological features for next generation DPIs; (iv) willingness to continue using the current device; (v) history of device switching (the reason for switching, who suggested it, and how the new device was presented). Finally, patients' treatment adherence was examined using the TAI questionnaire. Full survey content is provided in the Supplementary Material.

The impact of asthma on daily life was measured on a 1–7 scale for each question (1 = does not impact at all, 7 = impacts a lot). A score of 4–7 indicated medium-to-high and 1–3 low-to-medium impact. In the ms-LWAQ, individual questions scored 0–2 (0 = not at all true, 1 = somewhat true, 2 = very true) as originally described (25). The satisfaction with the device for each item of the PASAPQ tool was assessed on a 1–7 scale (1 = non satisfied, 7 = very satisfied). A score of 6–7 indicated high satisfaction, 3–5 indicated medium satisfaction, and 1–2 indicated low satisfaction with a DPI. Willingness to continue using the current device was assessed on a 1–7 scale (1 = not at all likely, 7 = very likely). In the 10-item TAI questionnaire, each item was evaluated on a 1–5 scale (1 = worst adherence, 5 = best adherence). The adherence was considered good for the score of 50, intermediate—for scores in the range 46–49 and poor—for scores <46 points.

The survey was provided in local languages and designed to take approximately 20 min to complete. It complied with the European Pharmaceutical Market Research Association (EphMRA) Code of Conduct and was registered in accordance with the Data Protection Act. Informed patient consent was obtained at the beginning of the survey.

Statistical analysis

A necessary sample size was determined on the basis of the approximate relative prevalence of ICS/LABA DPI use in the countries included, estimated on ICS/LABA DPI sales data and compared to their usage prevalence in the CINT database, with the aim of maximizing the number of interviews achievable. We aimed to recruit 200 participants per country for France, Germany, Italy, Spain and the UK, and 50 participants each for Austria and the Netherlands.

Survey results were analyzed using descriptive statistics for the total population. For selected questions, data were stratified according to the impact of asthma on the overall QoL (medium-to-high vs low-to-medium impact) and history of switching devices (switched vs never switched) and analyzed using the two-tailed t-test. All statistical calculations were performed using SPSS Statistics software, version 26.0 (IBM, Armonk, New York, US).

Results

Of the 21,737 people invited to participate in the study, 4276 asthmatic patients were identified. Among them, 1063 patients (DPI users) met the inclusion criteria and completed the survey (Figure 1). Detailed patients' demographics and characteristics are shown in Table 1. Mean asthma duration in this series was of 20.2 ± 13.6 years. Patients had been using their current device for a mean of 28 ± 28.2 months.

Table 1. Patient demographics and characteristics.

Characteristic	*N* = **1063**
Female	532 (50.0)
Age	
Mean, years (± SD)	45 (± 11.6)
≤38 years	325 (31)
39–50 years	371 (35)
>50 years	367 (35)
Country	
Austria	50 (4.7)
France	177 (16.7)
Germany	200 (18.8)
Italy	200 (18.8)
Netherlands	49 (4.6)
Spain	200 (18.8)
United Kingdom	187 (17.6)
Age at asthma diagnosis	
Mean, years (±SD)	25 (± 16.2)
≤10 years	263 (25)
11–20 years	242 (23)
21–30 years	185 (17)
31–40 years	166 (16)
>40 years	207 (19)
Smoking status	
Current smoker	237 (22)
Ex-smoker	344 (32)
Never smoked	481 (45)
Sports participation	
Regular	269 (25)
Occasional	318 (30)
None	
Personal choice	317 (30)
Because of asthma	159 (15)
Current ICS/LABA DPI (main)	
Budesonide/formoterol Turbuhaler®	310 (29)
Fluticasone/salmeterol Diskus®	147 (14)
Beclometasone/formoterol Nexthaler®	141 (13)
Fluticasone/vilanterol Ellipta®	104 (9)
Fluticasone/salmeterol Diskus®	78 (7)
Budesonide/formoterol Spiromax®	46 (4)
Budesonide/formoterol Easyhaler®	14 (1)
Other	223 (23)
Length of time using current device	
Mean, months (± SD)	28 (± 28.2)
≤6 months	244 (23)
7–12 months	170 (16)
13–24 months	213 (20)
25–36 months	149 (14)
37–60 months	149 (14)
61–120 months	138 (13)

All values are presented as number of patients (%), unless otherwise stated.

DPI, dry powder inhaler; ICS, inhaled corticosteroid; LABA, long-acting beta$_2$-agonist; SD, standard deviation.

Impact of asthma on daily life

The overall impact of asthma on daily life was perceived as high in 14% of patients, medium in 53% and low in 34% when asked to evaluate it on a scale of 1–7 (Figure 2A). The aspect of daily life most negatively impacted by asthma was that of "ability to play sports" with more than a quarter (26%) of patients reporting a high impact of the disease on this activity. "Quality of sleep" and "leisure activities" turned out to be the second and third most affected aspects, to which 17 and 15% of patients, respectively, attributed high impact. On the other hand, the least impacted life spheres were those of "feeling of inadequacy" and the person's "working life" for which more than half of the respondents, that is, 55% and 54%, respectively, reported a low impact of asthma.

Using the ms-LWAQ tool to gauge the domains most heavily compromised by the disease, the highest score of 1.2 was obtained for the perception of severity that is the "seriousness" domain, then 0.75 for the "drugs" domain that probes into the impact of therapy and the use of an inhaler on QoL, 0.68 for both "consequences" and "leisure" domains, while the "affect" domain that encompasses the emotional impact and self-perception scored the lowest, that is, 0.55 (Figure 2B). The overall mean ms-LWAQ score in this cohort was 0.75.

Patients' experience with DPI devices

According to the PASAPQ questionnaire results, the overall satisfaction with the current device was high for 61%, medium for 36% and low for 3% of patients. To establish if patient's perceived impact of asthma on general QoL influences their level of satisfaction with the device, PASAPQ score was assessed in patients with reported medium-to-high vs low-to-medium impact of asthma on QoL. The analysis showed that significantly lower proportion of asthmatic patients expressed high satisfaction with their current device in patients with medium-to-high vs low-to-medium impact of asthma on the overall QoL (55% vs. 67%, p values < 0.001, respectively; Table 2). This finding was consistent for all of the 13 specific devise features that were investigated (Table 2).

In addition to determining patients' satisfaction with the devise, we also investigated their self-declared treatment adherence to inhalers deploying the TAI questionnaire. The results showed that 20% of patients obtained scores corresponding to good adherence, whilst more than half of the respondents (53%) gave answers compatible with poor inhaled treatment adherence.

Patients' expectation of devices

Next, the respondents were asked to choose the two most important and the two least relevant inhaler attributes. The query resulted in the following feature importance rating: "inhaled dose goes to lungs" (selected by 27% of patients), "works reliably" (26%), "knowing how much medication is left" (19%), "usability of inhaler" (19%), "ease of inhaling a dose" (18%), "overall feeling of inhaling" (14%), and "speed medicine comes out" (11%) (Figure 3A).

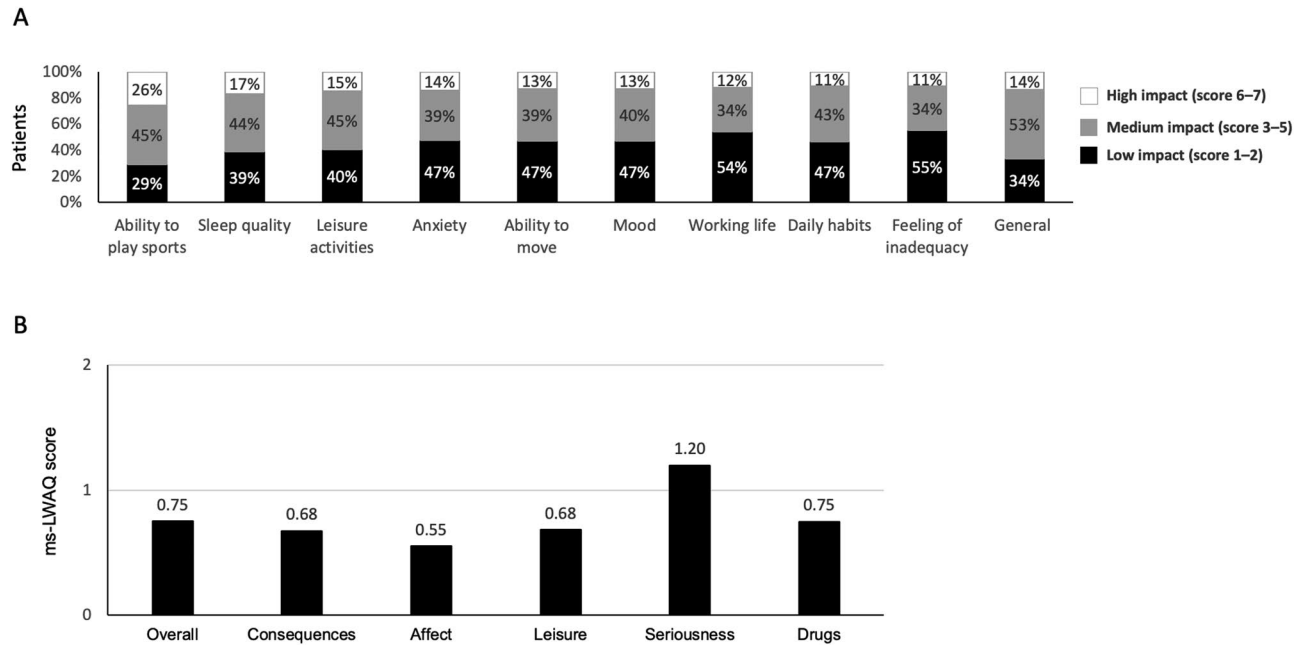

Figure 2. Impact of asthma on patient quality of life (QoL) in the entire patient population: (A) impact on various aspects of daily life, measured on a scale of 1–7 where 1 = doesn't impact at all and 7 = impacts a lot; (B) mean modified and shortened version of Living with Asthma Questionnaire (ms-LWAQ) score.

Table 2. Results from the Patient Satisfaction and Preference Questionnaire for Inhalation Devices (PASAPQ): proportion of highly satisfied patients (Scores 6 and 7 on a 7-point scale) with their current device in the study population and in groups of patients with low to medium or medium to high impact of asthma on the general quality of life (QoL).

		Impact of asthma on overall QoL Patient number (%)		
Device characteristic	**Total ($N = 1063$)** Patient number (%)	**Low to medium ($n = 563$)**	**Medium to high ($n = 500$)**	Chi-square, p-value*
Overall satisfaction with device	653 (61)	377 (67)	276 (55)	<0.001
Device works reliably	664 (62)	395 (70)	269 (54)	<0.001
Confidence about correct inhalation				
Overall feeling of inhaling	573 (54)	338 (60)	235 (47)	<0.001
Inhaled dose goes to lungs	547 (51)	326 (58)	221 (44)	<0.001
Knowledge of the amount of medication left	510 (48)	300 (53)	210 (42)	<0.001
Ease of administration				
Inhaler usability	642 (60)	367 (65)	275 (55)	0.001
Ease of inhaling a dose	659 (62)	390 (69)	268 (54)	<0.001
Speed medication comes out	606 (57)	355 (63)	252 (50)	<0.001
Convenience of device				
Convenience of carrying	578 (54)	333 (59)	244 (49)	0.001
Durability	628 (59)	358 (64)	270 (54)	0.002
Ease of holding during use	682 (64)	392 (70)	290 (58)	<0.001
Instructions for use	634 (60)	367 (65)	268 (54)	<0.001
Size of inhaler	567 (53)	327 (58)	240 (48)	0.001
Ease of cleaning inhaler	515 (56)	300 (53)	215 (43)	0.001

*Comparison between patients for whom asthma had a low impact and those for whom asthma had a high impact on general QoL.

In order to understand patients' expectations of devices, the participants were subsequently asked to select design features that they would like to see on a new device. The most desirable features comprised "higher number of doses" (selected by 36% of patients) and "greater ease of use" (30%). On the contrary, inhaler's robustness was the least desirable feature (11%; Figure 3B, Table 3). Patients with reported low-to-medium compared to medium-to-high impact of asthma on QoL were significantly more likely to report as desirable features: "feedback on correct inhalation" (33% vs. 18%, respectively) and "more convenient mouthpiece" (30% vs. 16%, respectively) (p values < 0.05 for both; Figure 3B, Table 3).

Decision to switch devices

We then investigated the patients' reported willingness to switch to a different inhaler. Twenty-three percent of patients admitted to having considered changing

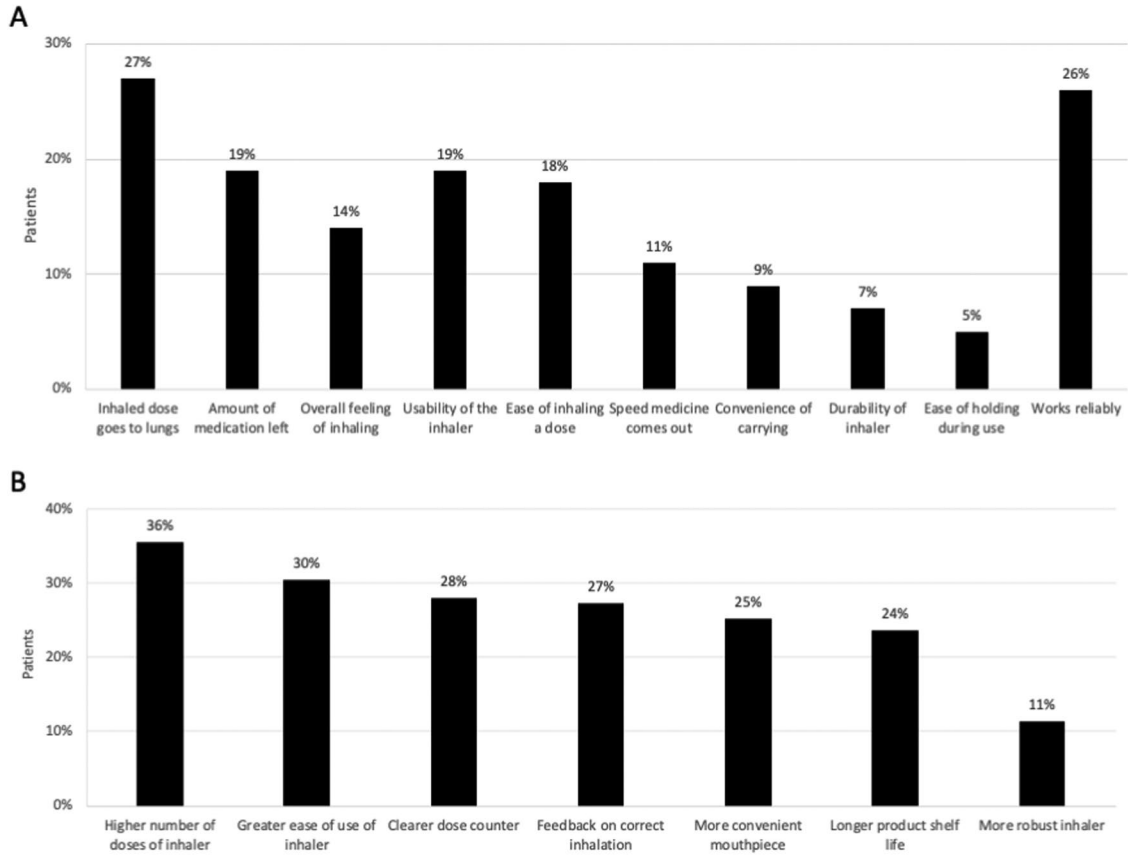

Figure 3. Patients' expectations of DPI devices. (A) feature importance rating based on the selection by the respondents of the two most and the two least important features in DPIs; (B) rating of desirable design features in a new device.

Table 3. Features patients who had considered switching their device would like to see in a new inhaler. Data are shown for the entire subpopulation, and grouped according to the impact of asthma on their general quality of life (QoL).

		Impact of asthma on overall QoL Patient number (%)		
Desired device characteristic[a]	**Total (*N* = 247)** Patient number (%)	**Low to medium (*n* = 87)**	**Medium to high (*n* = 160)**	Chi-square, *p*-value
Higher number of doses	88 (36)	27 (31)	61 (38)	0.210
Greater ease of use	75 (30)	24 (27)	51 (32)	0.299
Clearer dose counter	69 (28)	24 (27)	45 (28)	0.343
Feedback on correct inhalation	68 (27)	16 (18)	52 (33)	0.010
More convenient mouthpiece	62 (25)	14 (16)	48 (30)	0.012
Longer product shelf life	58 (24)	15 (17)	43 (27)	0.042
Robust inhaler	28 (11)	6 (7)	22 (14)	0.243

[a]Patients could choose more than one desired characteristic.

their device. Interestingly, the proportion of asthmatic patient who considered switching devices at some point was higher in patients with medium-to-high vs low-to-medium impact of asthma on QoL (32% vs. 15% of patients, *p* values = 0.003, respectively; Table 4).

The actual switch of the inhaler occurred in 583 patients (55%; Table 4). For 75% of these patients, the switch was recommended by the patient's healthcare provider, whilst 18% of respondents asked the physician to change their device without requesting an exact model and further 7% proposed an inhaler to try. The characteristics of the new device were explained by a healthcare professional to 78% of patients. The new device was shown to 34% of patients, whereas it was described only verbally to 58% of patients. Printed information was used in 6% of patients receiving the new device and videos in 1%.

Patients who had never switched devices, compared to patients who had previously done so, had a higher msLWAQ score (indicating higher impact of asthma on QoL—0.83 vs. 0.69, *p* values = 0.014, respectively) and lower mean PASAPQ score (indicating lower level of satisfaction with the current DPI—5.5 vs. 5.7, *p* values = 0.042, respectively) (Table 5). Amongst

Table 4. Patients who had previously switched inhaler devices.

	n = **583**
Key reason for switch, n (%)	
Need to change medicine	433 (74)
Need to change device	150 (26)
Considered switching device vs impact of asthma of the overall QoL, n (%)	
Low to medium (1–3)	86 (15)
Medium to high (4–7)	160 (32)
Switch recommended by, n (%)	
Doctor/nurse	437 (75)
Patient asked for change, did not specify device	107 (18)
Patient proposed new device	39 (7)
New device characteristics explained by physician, n (%)	456 (78)
New device presented to patient, n (%)	
Verbally only	265 (58)
With the support of the device	156 (34)
With the support of printed material	29 (6)
With the support of a video	6 (1)

Table 5. Satisfaction with current device for patients who had previously switched devices, versus those who had never switched devices.

	Previously switched devices n (%)		
	Yes	No	*p*-value
Patients	583 (55)	480 (45)	
Willingness to continue using current device, score			
Mean	6.2	6.0	0.140*
1–2 (unlikely)	10 (2)	14 (3)	
3–5	103 (18)	101 (21)	
6–7 (very likely)	470 (81)	365 (76)	
Patient has considered asking to change from current device, n (%)	102 (17)	155 (32)	0.035*
Impact of asthma on overall QoL			
Mean	3.1	3.8	0.011*
Low to medium (1–3)	309 (53)	202 (42)	
Medium to high (4–7)	274 (47)	278 (58)	
msLWA, score			
Mean	0.69	0.83	0.014*
Satisfaction with current device, mean PASAPQ score**			
Overall	5.7	5.5	0.042
Works reliably	5.8	5.5	0.001
Inhaled dose goes to lungs	5.4	5.3	0.371
Knowledge of amount of medication left	5.3	5.2	0.183
Overall feeling of inhaling	5.4	5.3	0.030
Device usability	5.7	5.5	0.010
Ease of inhaling a dose	5.7	5.5	0.011
Speed medicine comes out	5.6	5.4	0.004
Convenience of carrying device	5.5	5.4	0.547
Durability of inhaler	5.6	5.4	0.044
Ease of holding during use	5.8	5.5	0.001
Instructions for use	5.7	5.5	0.023
Size of inhaler	5.4	5.4	0.733
Ease of cleaning inhaler	5.3	5.1	0.012
TAI, score			
Poor adherence	299 (51)	278 (58)	0.022**

msLWA, modified and shortened Living with Asthma questionnaire; PASAPQ, Patient Satisfaction and Preference Questionnaire for Inhalation Devices; TAI, Test of Adherence to Inhaler.
*t-test; **Chi-Square.

patients who had switched devices, a smaller proportion of patients reported poor treatment adherence according to the TAI score.

Discussion

This multinational online survey conducted on a large sample of asthmatic patients treated with ICS/LABA via a DPI device explored, for the first time, the relationship between QoL, inhaler satisfaction, treatment adherence and patients' satisfaction with devices and their properties.

Our results confirmed that asthma constitutes a significant burden on daily life for most patients. More than 50% of patients reported a medium or high impact of asthma on their general QoL, as well as on 7/9 specific life areas assessed, mostly: the ability to enjoy sports, sleep quality and leisure activities. In

particular, 26% of patients reported heavy impact of the disease on their ability to play sports, 15% of them stated to be incapacitated to exercise, whilst 30% declared no interest in sport participation.

Our data validate the results of other studies assessing QoL with the ms-LWAQ tool, showing that asthma, considered by the patients a serious problem, has a negative impact on patients' QoL (7,28,29).

The evaluation of asthma-related QoL comprises the relationship between the patient and their medication, albeit the appraisal of therapeutic interventions is not the main point in the QoL analysis. For example, the domain "drugs" in the ms-LWAQ tool consists of just two questions: one regarding the nuisance of having to use an inhaler and another on concerns regarding long-term medication effect on health. In order to obtain a more detailed picture of patients' experience with inhalers, patients' satisfaction with their DPI devices has been explored. More than 60% percent of patients expressed high overall satisfaction with the current device (61%), especially in terms of "reliability" (62%) and "usability" (64%). When we stratified the patients according to the impact of the disease on QoL, we found that medium-to-high impact was strongly associated with the level of satisfaction with the device: patients with medium-to-high impact of asthma on QoL were significantly less likely to be satisfied with the current inhaler in terms of overall satisfaction, device reliability, and confidence about correct inhalation and drug delivery to lung. This data supports the existence of a negative interplay between device satisfaction and the impact of asthma on the overall QoL. The DPI attributes in current devices that reached the lowest percentage of scores corresponding to high satisfaction were "knowledge of how much medication is left," "size of inhaler," and "inhaled dose goes to the lung." Whether or not directly related to the level of satisfaction with the device, 53% of patients who participated in this survey, obtained a poor treatment adherence score. Although, it is a worrisome result, this study was not designed to address the question of the noncompliance in detail. Given that a personalized approach to the selection of an appropriate device for any given patient enhances persistence with device adherence (11), studies like this one, that probe into patients' experience and expectations, will ultimately help to increase treatment compliance. In the future, artificial intelligence-based solutions for contactless at-home assessment of patient's inhaler handling will help to monitor and improve treatment adherence through reminders and instant feedback on use, with healthcare professionals having access to such records for an objective measure of treatment adherence (30).

Several tools for gauging the level of satisfaction with an inhaler devise exist and the research questions vary amongst them. This study opted for the PASAPQ tool that allows the assessment of both convenience—and performance-related features of the devices that contribute to patients' satisfaction and preference. Hantulik and colleagues, who used a 7-item own questionnaire, found that an inhaler that was easy to teach, was also easy to use by the patients resulting in high level of satisfaction in comparison to that obtained for other devices (31).

Our patients selected most frequently "inhaled dose goes to lungs" and "works reliably" as inhaler features of top importance. Asthmatic patients from the Hawken series, placed most value on an inhaler that required one step for dose preparation rather than four steps, that is, was easy to use, gave a confirmation of the dose being taken, and could be used during episodes of breathing difficulties (15). Schreiber et al. acknowledged that patients may vary in their inhaler preferences and established that the ease of handling, followed by short inhalation time and low inhalation resistance were the most important device features according to the patients included in their study (32). On the other hand, a recent study found that the fast relief of symptom and the reduction of exacerbation rate were considered the most important characteristics for asthma maintenance inhaler while ICS safety and device convenience were not identified as priority characteristic showing that patients put clinical efficacy in the first position (33).

In addition to evaluating their current device characteristics, we also asked patients about inhaler features that they would like to see improved in new devices. We showed that patients would appreciate inhalers capable of dispensing "higher number of doses" and "easy to use," whilst asthmatic patients with medium to high impact or their disease on QoL were significantly more likely to choose "feedback on correct inhalation" and "more convenient mouthpiece" as the desirable features. These data highlight an unmet need in people with poor asthma-related QoL who seek user-friendly devices with clear feedback on correct drug administration. Our results, together with the findings of Hawken et al. (15) and Schreiber et al. (32), emphasize the need to improve the convenience, user-friendliness, and reliability of inhaler devices used to treat asthmatic patients.

When asked whether they had ever considered switching devices, 23% of patients in this series gave an affirmative answer. Patients medium to highly

impacted by their asthma were more likely to consider switching to a new device. Fifty-five percent of patients did change their inhaler at some stage of their disease. The switch was usually recommended by the healthcare practitioner, albeit a quarter of the patients asked for it themselves, sometimes indicating their specific inhaler preference. A concerning finding is that 22% of patients received no training on the new inhaler, and, to most patients who had switched, the new device was presented only verbally, without the support of the actual device, or of printed information or videos. The effectiveness of asthma devices hinges on the optimal delivery of drug to the lungs, and is, therefore, user-dependent (34) and an incorrect inhaler technique was found to be associated with poorer disease control (35) or lower QoL (36). As different devices function distinctly, it is vital that operating procedures are carefully explained upon device switch.

Our study shows that patients who had switched devices reported less severe impact of asthma on the overall QoL, lower msLWAQ scores and were more satisfied with their current device than patients who never had. Moreover, amongst patients who switched devices in this population, there were significantly less reports of poor treatment adherence. These patients were also significantly less likely to consider asking to change again, and significantly more satisfied with several characteristics of the current device, including reliability and usability. This suggests that changing devices or medication, when appropriate, can lead to an improved patient satisfaction and treatment adherence. However, switching is a delicate process that should involve the patient and follow a number of steps summarized by the UR-RADAR (UncontRolled asthma/UnaffoRdable device-Review, Assess the technique, Discuss options, Allow patient's input, Re-educate) mnemonic. Patient's input, such as device preference and shared decision making with a healthcare professional, is very important in this process (37).

There are some limitations to this study: the study contains exclusively patient-reported outcomes and was not designed to acquire clinical asthma outcome data such as pulmonary function tests and asthma control. Such a design makes it impossible to draw conclusions on treatment efficacy. Likewise, no direct comparisons between DPI devices can be made based on information gathered. In addition, as a patient-reported survey, data accuracy is highly reliant on individual perception, opinion or recall, which may be subjective or inaccurate, and what is more, the responses cannot be verified. Lastly, study participants may not be representative of the overall population of asthmatic patients, as the age of respondents was restricted to 25–60 years as explained in the Methods section. Children and the elderly asthmatics may have greater difficulties with the use of inhaler devices, and, as a result, their responses may have been different to those observed in our study population. Although, this study identified a specific need in patients with medium to high impact of their disease on QoL, the exploration of the relationship between QoL, treatment satisfaction and adherence and the quest for the development of an "ideal inhaler" warrants more work.

The importance of the current study lies also in the fact that it was conducted remotely using the Internet. In this way, we have been able to accrue a very big number of patients from several countries in just two months. Such an approach has a very big potential, not least at the time of the pandemic.

Conclusions

This multinational survey collected patient-reported data regarding the impact of asthma on QoL, device satisfaction, device attribute ranking, treatment adherence, and device switching preference for 1063 patients receiving treatment with ICS/LABA via a DPI device. Our findings confirm that asthma has a negative impact on general QoL. We showed that most patients were satisfied with their DPI devices; although, those highly impacted by asthma reported lower DPI satisfaction than patients with low impact of asthma of QoL. Switching devices was associated with reporting lower impact of asthma on QoL, better mean msLWAQ score and increased satisfaction with treatment. Amongst patients who switched, less respondents owned up to poor treatment adherence. Most importantly, this study identified the demand for user-friendly devices that provide feedback on correct drug administration as a clear unmet need in asthmatic patients and poor general QoL.

Acknowledgements

Writing assistance was provided by Toni Dando and Alicja M. Gruszka, of Springer Healthcare Communications. The medical writing assistance was funded by Elma Research.

Author contributions

MC and FB supervised the questionnaire preparation. SB, DG, EN planned the research and implemented the survey. All authors analyzed and interpreted data, developed, revised, and approved the manuscript.

Declaration of interest

MC received grants, personal fees, and non-financial support from Chiesi, personal fees and non-financial support from AstraZeneca, personal fees and non-financial support from Boehringer Ingelheim, personal fees and non-financial support from Alk-Abello, grants, personal fees and non-financial support from GlaxoSmithKline, personal fees and non-financial support from Novartis, personal fees and non-financial support from Zambon outside the submitted work. SB, EN, and DG are employees of Chiesi Farmaceutici S.p.A. In the last 5 years, FB received honoraria for speaking and/or consulting from AstraZeneca, Biofutura, Boehringer Ingelheim, Chiesi Farmaceutici, GlaxoSmithKline, Lallemand pharma, Menarini, Novartis, Levante pharma, Zambon. Dompè, Malesci/Guidotti as well as institutional support for research from Chiesi Farmaceutici and Vitaliare.

Funding

The survey and the development of the manuscript were carried out by the research company, Elma Research and funded by the pharmaceutical company, Chiesi Farmaceutici S.p.A.

ORCID

Marco Contoli http://orcid.org/0000-0002-2731-5809
Fulvio Braido http://orcid.org/0000-0003-2460-4709

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