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Trends in inhaler use and associated carbon footprint: a sales data-based study in Europe

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ABSTRACT

Background Physicians are being encouraged to favour dry powder inhalers (DPI) over pressurised metered dose inhalers (pMDI) on environmental grounds. The EU is reviewing the F-gas regulation to accelerate emission phase-down targets. Thoughtful use of inhalers can reduce emissions while promoting positive clinical outcomes. We aim to describe the trends of pMDI and DPI use and associated carbon footprint in Europe.

Methods DPI and pMDI sales data between 2011 and 2021 were extracted from IQVIA MIDAS Quarterly 2022 as total sold doses in 10 European countries. Carbon footprint calculations were based on the Medical and Chemicals Technical Options Committee 2022 assessment report.

Results Between 2011 and 2021, the carbon footprint of pMDI-based inhalation therapy increased from 3368 to 3891 kilotons (kt) CO_2 equivalents (CO_2e) because of a 16% increase in the number of sold doses of pMDI. Replacing pMDIs with low-carbon inhalers such as DPIs over this period would have produced 92% lower CO_2 emissions. The UK was the largest source of pMDI-related emissions in 2021 with 1235 kt CO_2e (31% of all emissions) in Europe. Short-acting beta-2 agonist (SABA) dose sales were associated with 1642 kt CO_2e emissions in 2021, 94% from pMDIs.

Conclusions The carbon footprint of inhaler therapy in Europe grew due to an increased use of pMDIs in many European countries. Greater focus on guideline-based controller therapy will potentially improve patient outcomes and decrease SABA over-reliance. Prioritising DPIs or soft mist inhalers when clinically appropriate can lower inhaler greenhouse gas emissions.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Pressurised metered dose inhalers (pMDIs) can have up to 100-fold higher carbon footprint than propellant-free dry powder inhalers (DPIs). Across the European countries, the mean proportion of sold units per inhaler type was 48% for pMDIs, followed by DPIs (40%), and nebulisers (13%) between 2002–2008. In the UK, 70% of all inhalers were sold as pMDIs in 2017. Thus, inhaler use patterns need revision to meet the current treatment recommendations, to improve treatment outcomes in patients with highly prevalent asthma and chronic respiratory pulmonary disease (COPD) and to decrease greenhouse gas (GHG) emissions.

WHAT THIS STUDY ADDS

⇒ The total number of sold pMDI-medication doses increased 16% from 2011 to 2021 in Europe, and the associated pMDI emissions increased from 3368 kt to 3891 kt CO_2e between 2011 and 2021. The UK alone released 1235 kt CO_2e of GHGs in pMDI doses in 2021, while in Sweden, the proportion of sold pMDI doses doubled from 13% to 27% between 2011 and 2021. In 2021, 13.9 billion short-acting beta-2 agonist (SABA) doses were sold in Europe, 94% in pMDIs.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The findings of the study indicated that optimisation of inhalation therapy is necessary to reduce the negative environmental impact of inhaler therapy. Changing the prescription practices of the controller therapy towards propellant-free inhalers for patients with asthma and COPD and considering the significant contribution of SABA over-reliance is recommended.

INTRODUCTION

Climate change impacts health in numerous ways. Globally, approximately 250 000 people, particularly in poor countries, are estimated to die annually due to implications of climate change between 2030 and 2050.[1] Excess emissions of CO_2 and greenhouse gases (GHGs) to the atmosphere absorb energy and slow or prevent the loss of heat to space, causing temperatures to rise.[2] The Intergovernmental Panel on Climate Change and the Paris Agreement stipulated that to avert serious health impacts, the global temperature rise must be limited to 1.5°C.[3 4]

In the Organisation for Economic Co-operation and Development countries, the healthcare sector contributes about 5% to the national carbon footprint.[5] Inhalation therapy, the mainstay of treatment for asthma and chronic respiratory pulmonary disease

(COPD), has been globally recognised as one possibility for action.[6–8] Inhalers widely used are pressurised metered dose inhalers (pMDIs) containing very potent GHGs hydrofluorocarbon (HFC) propellants, propellant-free dry powder inhalers (DPIs), and in a smaller scale soft mist inhalers (SMI) and nebulisers.[9 10] Due to their content in HFC propellants, pMDIs contribute approximately 0.03% of yearly global GHG emissions and can have up to 100-fold higher carbon footprint than DPIs.[11 12]

The phase-out of propellant gases is being evaluated at the EU level, with F-gas (fluorinated GHG) emission targets set to reaching 55% of reductions by 2030 (compared with 2015) and carbon neutrality by 2050.[8] Inhaler use has a wide geographical variation in Europe: in the UK, 70% of all inhalers were sold as pMDIs in 2017 (3.1% of the carbon footprint of the National Health System England was due to pMDI alone),[13] in contrast with 13% in Sweden.[14] Short-acting beta-2 agonist (SABA) relievers contribute substantially to pMDI sales and emissions in the UK.[14 15] In Europe, the mean proportion of sold units per inhaler type was 47.5% for pMDIs, followed by DPIs (39.5%), and nebulisers (13%) between 2002 and 2008.[15]

Both pMDIs and DPIs are equally safe and effective when used as instructed, and the choice of inhaler should be primarily based on the patient's needs and preferences.[6] The Global Initiative for Asthma (GINA) guidelines were recently updated (2023 report) to include environmental considerations for inhaler choices, and national guidelines such as the British, Finnish, German and Swedish guidelines recommend the use of DPI or SMI in asthma treatment over other inhalers with high emissions.[6 7 16–19] Inhaler use patterns need revision to meet recommendations stated in the current treatment guidelines, to improve treatment outcomes and control highly prevalent asthma and COPD.[6 7] Moreover, despite extensive discussion about the global warming potential (GWP) of propellants and their contribution to climate change over the past decades, insufficient actions have been undertaken to increase the use of propellant-free inhalers. The primary aim of this study was to describe the current use of pMDI and DPI in 10 representative European countries based on sales data and associated carbon footprint. Due to the geographical variations, our secondary aim was to describe pMDI and DPI use and associated carbon footprint in the UK and Sweden, as well as the use and associated carbon footprint of SABA relievers.

MATERIALS AND METHODS

Sales data and sources

IQVIA MIDAS Quarterly data 2022 was analysed for retrospective sales data for pMDIs and DPIs as total sold doses in Europe by country. SMI and nebuliser devices were outside the scope of this study due to low sales, and therefore were not accounted for in the data analysis. Sufficiently accurate data for 11 years (2011–2021) were available from the European countries of Denmark, Finland, France, Germany, Italy, Norway, Poland, Spain, Sweden and the UK. Countries included in the data accounted for a total of 389 million people, representing approximately 75% of the total population in Europe.[20 21] IQVIA MIDAS data were also analysed for SABA (sales by different devices and formulations). SABA sales data were available for the year 2021 from the following countries: Denmark, Finland, France, Germany, Italy, Norway, Spain, Sweden and the UK. The SABA molecules considered in this study included salbutamol, fenoterol and terbutaline monoinhalers. For calculating the ratio of SABA/controller medication use for the UK and for Sweden, controller medication use was calculated by the sum of all sold doses of inhaled corticosteroids (ICS), ICS combinations (ICS+long-acting beta-agonists (LABA), ICS+LABA+long-acting muscarinic antagonists (LAMA)) and LABA+LAMA combinations. The controller medication molecules considered were aclidinium bromide+formoterol, beclomethasone, beclomethasone+formoterol, beclomethasone+formoterol+glycopyrronium, beclomethasone+salbutamol, budesonide, budesonide+formoterol, budesonide+formoterol +glycopyrronium, ciclesonide, fluticasone+fluticasone furoate+umeclidinium bromide+vilanterol, fluticasone furoate+vilanterol, fluticasone+formoterol, fluticasone+salmeterol, formoterol+glycopyrronium, glycopyrronium+indacaterol, glycopyrronium+indacaterol+mometasone, indacaterol, indacaterol+mometasone, mometasone, and umeclidinium bromide+vilanterol.

Data analysis

Sales data and associated carbon footprint were analysed using descriptive statistics. The pMDI and DPI sales were reported as a unit of one sold dose. All calculations on carbon footprint were based on the Montreal protocol Medical and Chemical Technical Options Committee assessment report. For calculations of pMDI emissions, it was assumed that the devices included the more common propellant gas hydrofluoroalkane (HFA)-134a and the average carbon footprint per dose was 125 g CO_2e.[9 10 22 23] For DPIs, an average carbon footprint per dose of 10 g CO_2e was used.[10 22] These estimations consider different components of the life cycle of pMDI and DPI devices such as raw materials, ancillary materials, energy, production and purification of HFCs, production of the devices, clinical usage and end-of-life.[10]

Patient and public involvement

Patients and the public were not involved in the design of this study.

RESULTS

Inhaler use and associated emissions

Overall, the number of DPI and pMDI sold doses has increased between 2011 (37.7 billion) and 2021 (41.6 billion) in the selected European countries. The total number of sold doses of pMDI-administered medications

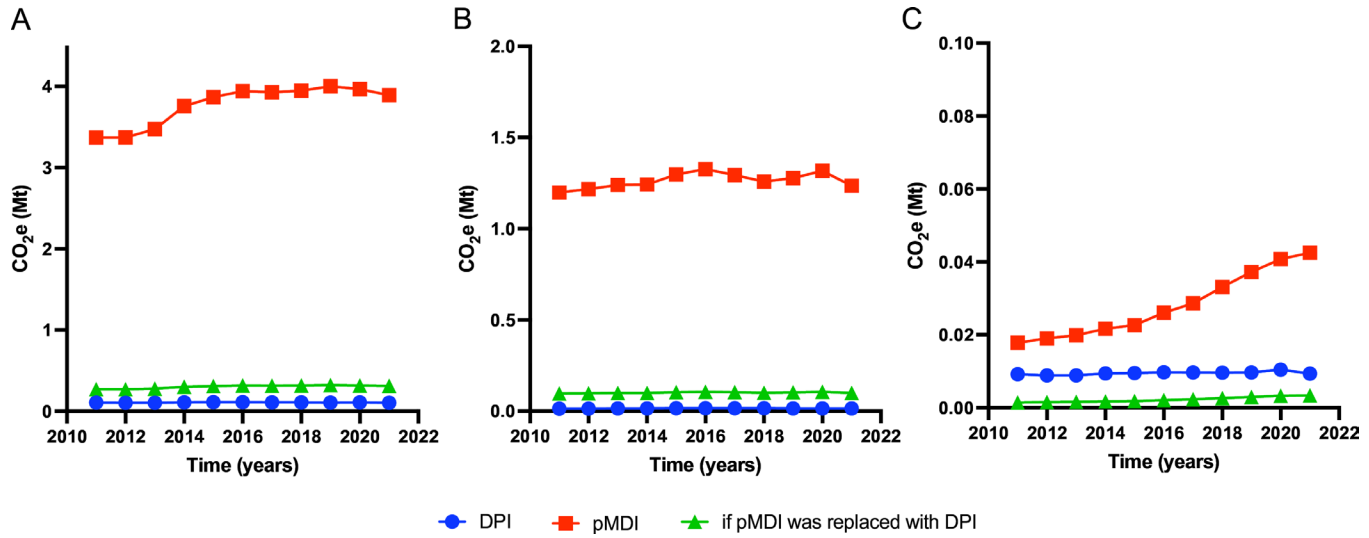

Figure 1 Carbon footprint of inhaler treatment. Global warming potential of inhalers presented as mean CO_2e kt (A) from selected countries Denmark, Finland, France, Germany, Italy, Norway, Poland, Spain, Sweden and the UK; (B) in the UK and (C) in Sweden. Based on IQVIA MIDAS Quarterly sales data for the year 2021, reflecting estimates of real-world activity. Copyright IQVIA. All rights reserved. CO_2e, carbon dioxide equivalent; DPI, dry powder inhaler; kt, metric kilotons; pMDI, pressurised metered dose inhaler.

increased 16% from 2011 (26.9 billion) to 2021 (31.1 billion), whereas the number of sold doses of DPI-administered medications slightly decreased (10.7 billion in 2011 vs 10.4 billion in 2021, a 2.7% decrease). The associated net emissions were approximately 3368 and 3891 kilotons (kt) CO_2e for pMDIs in 2011 and 2021, respectively, while DPI-associated emissions in the same period remained stable at 103–112 kt CO_2e (figure 1A). When extrapolated to the population of Europe, the corresponding emissions from the use of pMDIs were approximately 5186 kt CO_2e in 2021. Replacing pMDIs with low-carbon inhalers such as DPIs would have resulted in approximately 92% lower net emissions, with a speculative scenario of 269–320 kt CO_2e/year for our dataset during the period of 2011–2021. SMI and nebuliser sales were not accounted for in the analysis of sold inhaler doses and associated emissions.

On a country level, the UK had the highest number of sold pMDI doses in 2021 (9.9 billion), with associated emissions of 1235 megatons (Mt) CO_2e, comprising 31% of the pMDI-associated total emissions in the selected countries (figure 1B). The emissions were 3.1% higher in 2021 than in 2011 (1198 kt CO_2e, table 1). The number of DPI sold doses in the UK was 1.4 billion in 2021, with associated emissions of 14 kt CO_2e (0.35% of total emissions). The proportions of sold pMDI (87–88% of all sold doses, figure 2) and DPI (12–13%, online supplemental figure 1) doses did not change in the UK during 2011–2021.

In Sweden, the number of sold DPI doses increased from 921 million in 2011 to 938 million in 2021. Yet, the corresponding proportions of DPI of all sold inhaler doses decreased from 87% to 73% (online supplemental figure 1), with associated emissions below 10 kt CO_2e per year. In the same period, the pMDI sold doses more than doubled from 142 (13%) in 2011 to 340 (27%) million doses in 2021 (figure 2), with associated emissions reaching over 43 kt CO_2e in 2021 (table 1, figure 1C).

Speculative net emissions between 96 and 106 kt CO_2e for the UK (figure 1B) and between 1 and 3 kt CO_2e for Sweden (figure 1C) would have been observed if the equivalent treatment was administered using DPIs. Sales data and associated emissions for each country in 2011 and 2021 are stated in table 1.

Contribution of SABA relievers

In 2021, a total of 13.9 billion SABA doses (pMDIs+DPIs) were sold in nine countries (data for Poland was unavailable). Approximately 94% (13.1 billion) doses of SABA were sold in pMDIs, and the associated emissions were estimated at 1633 kt CO_2e (table 2).

In the UK, the number of sold SABA doses was 6.4 billion in 2021, representing 57% of all sold doses in the UK in 2021 (table 3). Approximately 96% (6.2 billion) of these SABA doses were sold in pMDIs, with emissions of 771 kt CO_2e in that period. In Sweden, the corresponding numbers were 236 million SABA doses (18% of all sold pMDI and DPI doses in 2021 in Sweden). Nearly 72 million (30%) were sold in pMDI devices, with corresponding emissions of 9 kt CO_2e. In 2021, the emissions associated with SABA relievers administered using pMDIs alone were 13 times higher in the UK compared with Sweden, estimated to be 1.15 kt CO_2e per 100 000 of population for the UK versus 0.09 kt CO_2e per 100 000 of population for Sweden. The ratio between the use of SABA and controller inhalation therapy (ICS alone, ICS combinations and LABA+LAMA combinations) for the UK was 1.4, while for Sweden the same ratio was 0.7.

Table 1 Number of doses sold, percentages and carbon footprint associated with the prescription/use of pMDIs and DPIs†

	pMDIs		DPIs	
	Number of doses sold (million)†	Carbon footprint (kt CO_2e)	Number of doses sold (million)*	Carbon footprint (kt CO_2e)
2011				
Denmark	199	24.9	495	5.0
Finland	97	12.2	224	2.2
France	3167	395.9	1307	13.1
Germany	6475	809.4	3019	30.2
Italy	1774	221.8	505	5.0
Norway	144	18.1	191	1.9
Poland	970	121.3	669	6.7
Spain	4387	548.4	2069	20.7
Sweden	142	17.8	921	9.2
UK	9586	1198.2	1321	13.2
Total	**26 941**	**3367.8**	**10 721**	**107.2**
Total (pMDI+DPI)	**37 665 million doses**		**3.48 Mt CO_2e**	
2021				
Denmark	309	38.6	429	4.3
Finland	168	21.0	219	2.2
France	3595	449.3	1167	11.7
Germany	7589	948.7	2738	27.4
Italy	2735	341.9	1123	11.2
Norway	228	28.5	148	1.5
Poland	1167	145.8	485	4.9
Spain	5115	639.4	1774	17.7
Sweden	340	42.5	938	9.4
UK	9880	1235.0	1412	14.1
Total	**31 126**	**3890.8**	**10 433**	**104.3**
Total (pMDI+DPI)	**41 559 million doses**		**4.00 Mt CO_2e**	

*Numbers reflect rounding.
†Based on IQVIA MIDAS Quarterly sales data for the period 2011 to 2021, reflecting estimates of real-world activity. Copyright IQVIA. All rights reserved. Soft mist inhaler and nebuliser sales are not included in the analysis.
CO_2e, carbon dioxide equivalents; DPIs, dry powder inhalers; kt, metric kilotons; Mt, megatons; pMDIs, pressurised metered dose inhalers.

DISCUSSION

Here, we describe current trends of pMDI and DPI use in 10 representative European countries based on sales data, as well as the associated carbon footprint. Despite evidence of the harmful environmental effects and the high GWP of propellant gases used in pMDIs,[22] our results showed that the use of these devices is increasing in Europe. Between 2011 and 2021, an increase of 16% in sold pMDI-administered and a 2.7% decrease in DPI-administered medications was observed in the selected European countries. This resulted in estimated emissions of 3891 kt CO_2e for pMDIs and 104 kt CO_2e for DPIs for the year 2021. In 2021, 1642 kt CO_2e emissions were associated with SABA use, 94% coming from pMDIs.

Our observations show a considerable difference in prescription practices among European countries, as previously reported.[15 24] Here, we showed a slightly higher proportion of pMDI sold doses (88% of all sold doses) for the UK compared with previous reports showing 70–80% pMDI sold units.[14 15 25] This could be partially because many pMDIs contain more doses per device than DPIs. However, despite the wide use of DPI devices for the treatment of respiratory diseases in Sweden, the sales and carbon footprint of pMDI doses more than doubled in 2021 (340 million) compared with 2011 (142 million).

Environmentally, pMDIs are considered the largest single contributors to the pharmaceutical-related GHG emissions (Sustainable Development Unit,

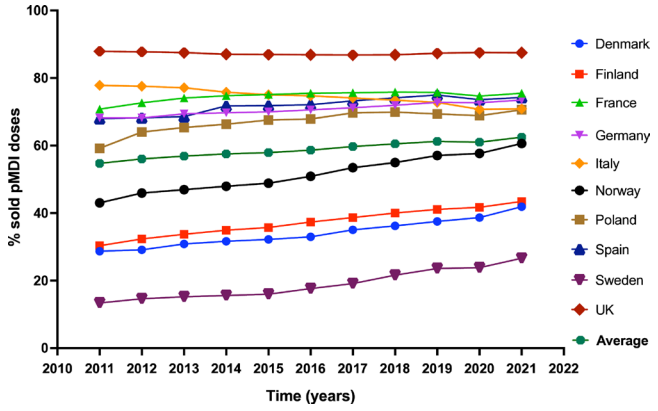

Figure 2 The percentage of pMDI sold doses over time between 2011 and 2021 in the selected European countries. Based on IQVIA MIDAS Quarterly sales data for the period 2011 to 2021, reflecting estimates of real-world activity. Copyright IQVIA. All rights reserved. pMDI, pressurised metered dose inhaler.

2016).[10] In 2021, we estimated emissions due to pMDI use at 3.9 Mt CO_2e in the selected European countries, approximately 24% of the 16.4 Mt CO_2e global emissions of pMDI use reported in 2022.[22] Extrapolation to the European population suggests that almost one-third (32%) of the global pMDI-associated emissions came from Europe alone. The pMDI-associated emissions in the UK were 1.24 Mt CO_2e in 2021, in line with the previously reported 1.34 Mt CO_2e pMDI-associated annual emissions for the UK.[10] Changing fully to green inhalers such as DPI-administered or SMI-administered medication could theoretically result in a 92% decrease in pMDI-related emissions among all analysed countries (from 1235 to 99 kt CO_2e for the UK, and from 43 to 3 kt CO_2e for Sweden). However, this would not be clinically possible, since a proportion of patient still need pMDIs. A previous study demonstrated that in 2017, 70% of all inhalers sold in England were pMDIs versus 13% in Sweden, and that an annual reduction of 550 kt CO_2e would be achieved if the same proportions of DPIs and pMDIs observed in Sweden would be used in England,[14] contributing towards the UN Montreal Protocol target of decreasing F-gas emissions by up to 90% by 2050 globally compared with 2015.[8] Considering the total GHG emissions at the country level,[26 27] the use of pMDIs alone contributes to approximately 0.32% in GHG emissions for the UK and 0.09% for Sweden.

The contribution of SABA, typically available in pMDI devices, has a significant impact in the wide use of pMDIs observed in the treatment of respiratory diseases and carbon footprint of inhaler therapy. About 94% of sold inhaler doses in countries with available SABA sales data were sold in pMDIs, in line with previous reports.[14 25 28] In the UK and Sweden, 57% and 18% of all inhaler doses sold in 2021 were SABA, a finding corroborated by the ratio between SABA and ICS (and ICS combinations) use of 1.5 in the UK versus 0.7 in Sweden. Furthermore, we found that the associated carbon footprint of SABA medication in pMDI was 13 times higher for the UK versus Sweden per 100 000 of population. Likewise, two-thirds of asthma patients in the UK had a treatment regime dominated by salbutamol pMDI: 34% of patients are prescribed a SABA-only regime, and 31% are prescribed ICS and SABA in separate inhalers but with poor compliance with ICS therapy.[9] The prevalence of SABA overuse was found to be 38% across Europe in the SABINA study.[28]

In asthma, switching to a DPI combination of LABA/ICS (GINA track 1) can substantially reduce pMDI emissions and maintain or improve asthma control.[29 30] The high prescription of SABA does not follow the current recommendations[6] and is associated with worse disease control, asthma deaths and hospitalisation.[28 31 32] Prescription of propellant-free inhalation therapy should be adopted when disease management or treatment efficacy with a prescribed pMDI is suboptimal, as well as in treatment initiation of newly diagnosed patients.[23]

Moreover, critical handling errors, especially in the elderly, are more frequent with pMDIs compared with

Table 2 SABA contribution to sold pMDI and DPI doses in selected European countries§ in 2021

	Number of sold doses (million)*	Carbon footprint (kt CO_2e)
Total inhaler (pMDI+DPI) doses sold, 2021†	41 559	3995
SABA (pMDI+DPI)‡	13 887	1642
SABA (pMDI)	13 067	1633
SABA (DPI)	820	8

*Numbers reflect rounding.
†Soft mist inhaler and nebuliser sales are not included in the analysis.
‡The SABA molecules considered included salbutamol, fenoterol and terbutaline.
§Selected European countries include Denmark, Finland, France, Germany, Italy, Norway, Spain, Sweden and the UK. SABA sales data from Poland were not available. Based on IQVIA MIDAS Quarterly sales data for the year 2021, reflecting estimates of real-world activity. Copyright IQVIA. All rights reserved.
CO_2e, carbon dioxide equivalents; DPI, dry powder inhaler; kt, metric kilotons; pMDI, pressurised metered dose inhaler; SABA, short-acting beta-2 agonist.

Table 3 SABA contribution to sold pMDI and DPI doses and associated carbon footprint in Sweden and in the UK in 2021*

	Number of sold doses (million)†	Carbon footprint (kt CO_2e)	Carbon footprint/100 000 population (kt CO_2e)
UK, 2021‡			
SABA (pMDI+DPI)§	6419	774	
SABA (pMDI)	6168	771	1.150
SABA (DPI)	250	3	0.004
Total (pMDI+DPI sales)	11 174		
Proportion SABA/national inhaler sales (%)	57%		
Sweden, 2021‡			
SABA (pMDI+DPI)§	236	11	
SABA (pMDI)	72	9	0.086
SABA (DPI)	164	2	0.016
Total (pMDI+DPI sales)	1260		
Proportion SABA/national inhaler sales (%)	18%		

*Based on IQVIA MIDAS Quarterly sales data for the year 2021, reflecting estimates of real-world activity. Copyright IQVIA. All rights reserved.
†Numbers reflect rounding.
‡Soft mist inhaler and nebuliser sales are not included in the analysis.
§The SABA molecules considered included salbutamol, fenoterol and terbutaline.
CO_2e, carbon dioxide equivalents; DPI, dry powder inhaler; kt, metric kilotons; pMDI, pressurised metered dose inhaler; SABA, short-acting beta-2 agonist.

DPIs and may lead to worse asthma control.[33–36] For example, as many as 30% of patients inhale too fast while using pMDI devices despite repeated training by healthcare professionals (HCPs).[23 36] DPIs are more appropriate for people who have a tendency to inhale fast and hard (the correct technique for a DPI) or who have trouble coordinating their breath with a pMDI, and most patients can generate sufficient peak inspiratory flow rate to activate a range of DPIs, regardless of internal resistance.[36] Positive treatment outcomes can be achieved with the predominant use of DPI, as seen by the superior treatment results observed in Sweden compared with the UK (leader in pMDI use): the UK registered a particular increase in asthma death rates (21%) between 2011 and 2015, while in Sweden, asthma death rates have generally decreased between 2000 and 2018.[37 38] The mortality rate for the UK was almost double that of Sweden in 2015 due to COPD alone (61 vs 31/100 000).[39]

Significant actions should be implemented to mitigate pMDI-related emissions and optimise treatment outcomes and disease control. These include changes in health policy, updating national guidelines to harmonise asthma management approaches in accordance with the most updated standard of care guidance, and education and increase of disease awareness among HCPs. An optimal patient follow-up and disease management are crucial to improve disease control, which affects the total environmental impact not only in the form of lower GHG emissions from pMDI use but also by decreasing hospitalisation rates. From the patient perspective, actions, such as (1) involving patients in disease management by establishing treatment targets, regular treatment assessment and education on inhaler handling technique; (2) discussing together the option to switch to greener inhalers and (3) considering patient preference, beliefs and concerns about their medication, shall be considered for achieving positive treatment outcomes and minimising emissions.[6 7 15 24] Reasons for patient non-adherence or discontinuation of ICS after a short period often are that ICS were 'not effective' and 'contain steroids',[40] thus the need to constantly involve the patients in their treatment. Moreover, 60% of pMDI users would consider changing device for environmental reasons in the UK.[41] There are tools to aid patient decision-making regarding options for inhaler devices with their HCP, considering carbon footprint among other factors.[42] For patients who benefit from their pMDI-based medication and/or need to recur to SABA, substantial carbon savings can be made by using small volume HFA134a MDIs (<10 kg CO_2e per inhaler), instead of large volume HFA134a MDIs (>25 kg CO_2e/inhaler) or those containing HFA227ea (with higher GWP) as a propellant gas.[23] Moreover, DPI delivery of SABA therapy was found to be equally effective as SABA delivery via pMDI.[29] Also, new-generation pMDI inhalers with sustainable propellant gases (eg, HFC-152a, with a GWP 10 times lower than that of HFC-134a) are being developed,[43] which would bring a substantial reduction of pMDI emissions of 90–92% according to Jeswani and Azapagic.[10] Additionally, other strategies can be implemented to reduce the

carbon footprint of pMDI inhaler therapy, such as reducing propellant usage in pMDIs, recovering propellants from used pMDIs, use of HFC-134a in all pMDIs (replacement of HFC-227ea with HFC-134a pMDIs), or a combination of the different strategies.[10] Finally, the use of SMI and nebulisers is a viable option to reduce inhaler carbon footprint.

Switching from pMDI to DPI may also bring considerable cost savings. Wilkinson *et al*[23] reported that if pMDIs using HFA propellant are replaced with the cheapest equivalent DPI, for every 10% of pMDIs changed to DPIs, drug costs would decrease by £8.2 million annually, and 58 kt CO_2e could be saved annually in England. In the Netherlands, replacing pMDIs with propellant-free inhalers in eligible patients could reduce GHG emissions by 63 kt CO_2e and save €49.1 million/year.[44] Besides the clinical and environmental benefits, showing evidence on cost savings represents a strong motive to propose changes in health policies at the national level.

The strengths of this study are inclusion of data from several European countries for 11 years. We report doses sold rather than devices sold, which can introduce misunderstanding as inhalers can contain a variable number of doses. Clinical relevance relies on data from reliable nationwide statistics. Regarding limitations, since this is a sales data-based study and patient adherence to treatment may not be 100%, the number of sold doses may not correspond to the real inhaler use. SABA sales data were available for 2021 for the group of countries selected, and country-level data were only available for the UK and Sweden. Due to a lack of clinical data, it is not possible to directly estimate the burden of disease control. Additionally, the reported emissions may be underestimated, as we did not include SMI and nebuliser use.

In this study, we observed a generalised increase in pMDI sales accompanied by a slight decrease in DPI sales in Europe, with a consequent substantial increase in GHG emissions. Inhaler therapy is a considerable source of GHG emissions globally, but this can be mitigated by using green inhalers such as DPI, SMI or nebulisers. However, the challenge of inhalation therapy is bigger than just GHG emissions. It is not enough to focus on and change the prescription practices of the controller therapy towards propellant-free inhalers for asthma and COPD patients, but requires also taking into consideration the significant contribution of SABA over-reliance not only in the environmental context but also especially in the context of disease control.[23 44] Current prescribing practices do not follow the guidelines recommending reducing over-reliance on SABAs and prioritise long-term, controller therapy. This results in higher than necessary death rates, sick leave and early retirements due to uncontrolled chronic respiratory diseases. In the future, it would be of importance to understand how the type of inhaler is associated with disease outcomes and healthcare resource utilisation, for example, hospitalisation rates, in asthma and COPD in different countries. Broader actions such as tackling air pollution, tobacco control and non-pharmacological treatments such as pulmonary rehabilitation are also vital for improving lung health and reducing GHG emissions from clinical care. The optimisation of inhalation therapy towards increased controller medication prescription in greener inhalers brings opportunities to reduce carbon footprint while maintaining or improving disease control.

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