Reusable soft mist inhalers have an improved carbon footprint compared with dry powder inhalers and pressurised metered-dose inhalers

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Background

- Inhalation therapy is the cornerstone of chronic obstructive pulmonary disease (COPD) and asthma management.
- Three therapeutic devices: pressurised metered-dose inhalers (pMDIs), dry powder inhalers (DPIs), and soft mist inhalers (SMIs) are commonly used.[1]
- The carbon footprint, expressed in carbon dioxide equivalent (CO_2e), of pMDIs, DPIs, and SMIs differ, with pMDIs being higher than DPIs or SMIs due to use of hydrofluorocarbon (HFC) propellants.
- HFC propellants are powerful greenhouse gases that have a high global warming potential.
- While pMDIs are only available as single-use inhalers, DPIs and SMIs are also available in reusable forms, further reducing their carbon footprints.
- As pMDIs have a higher carbon footprint than DPIs and SMIs, some national governments and organisations have introduced targets to reduce their use, as part of their efforts in the fight against global warming.[2,3]
- To exemplify the high carbon footprint of pMDIs, it was estimated that using 50% of inhaler devices with a low carbon footprint, such as DPIs and SMIs, would save 288,000 tonnes of CO_2e every year, equivalent to taking more than 61,000 cars off the road.[4]

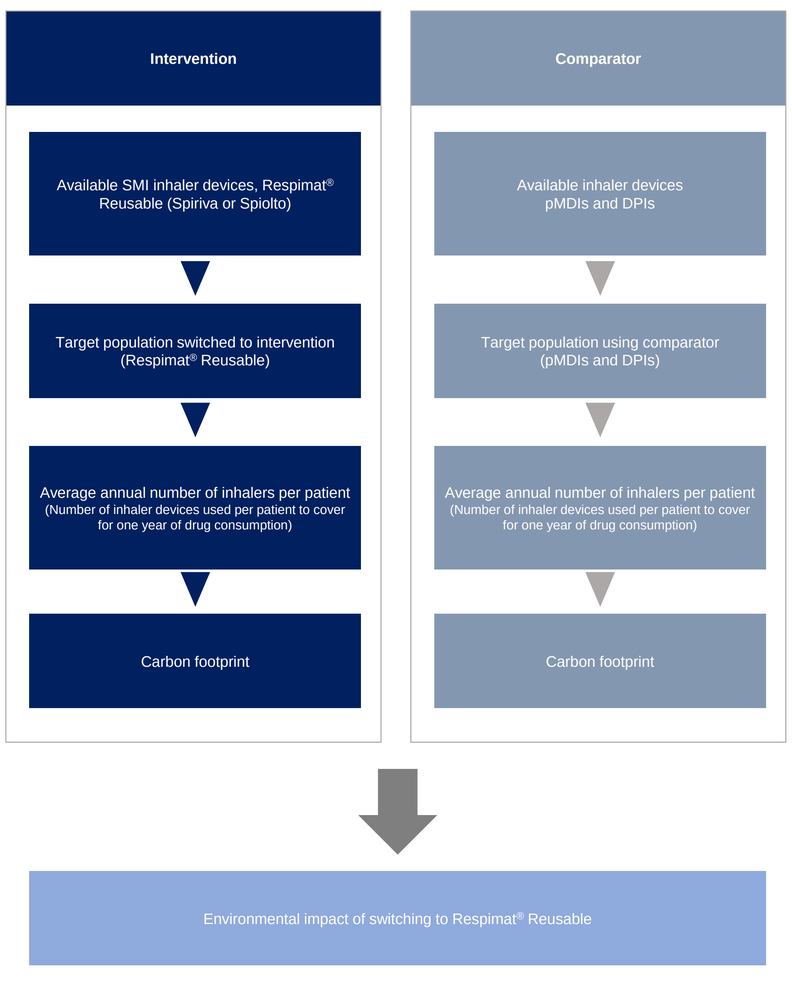
Objective

- As the carbon footprint of SMIs is lower than both pMDIs and DPIs, this study aimed to assess the change in carbon footprint of hypothetically replacing DPIs and/or pMDIs with reusable SMI devices (Respimat® Reusable).

Methods

- An environmental impact model was established to assess the change in carbon footprint of replacing different types of pMDIs or DPIs with a reusable SMI, Respimat® Reusable, across 12 European countries and the United States over 5 years (**Figure 1**).

Figure 1: Model structure



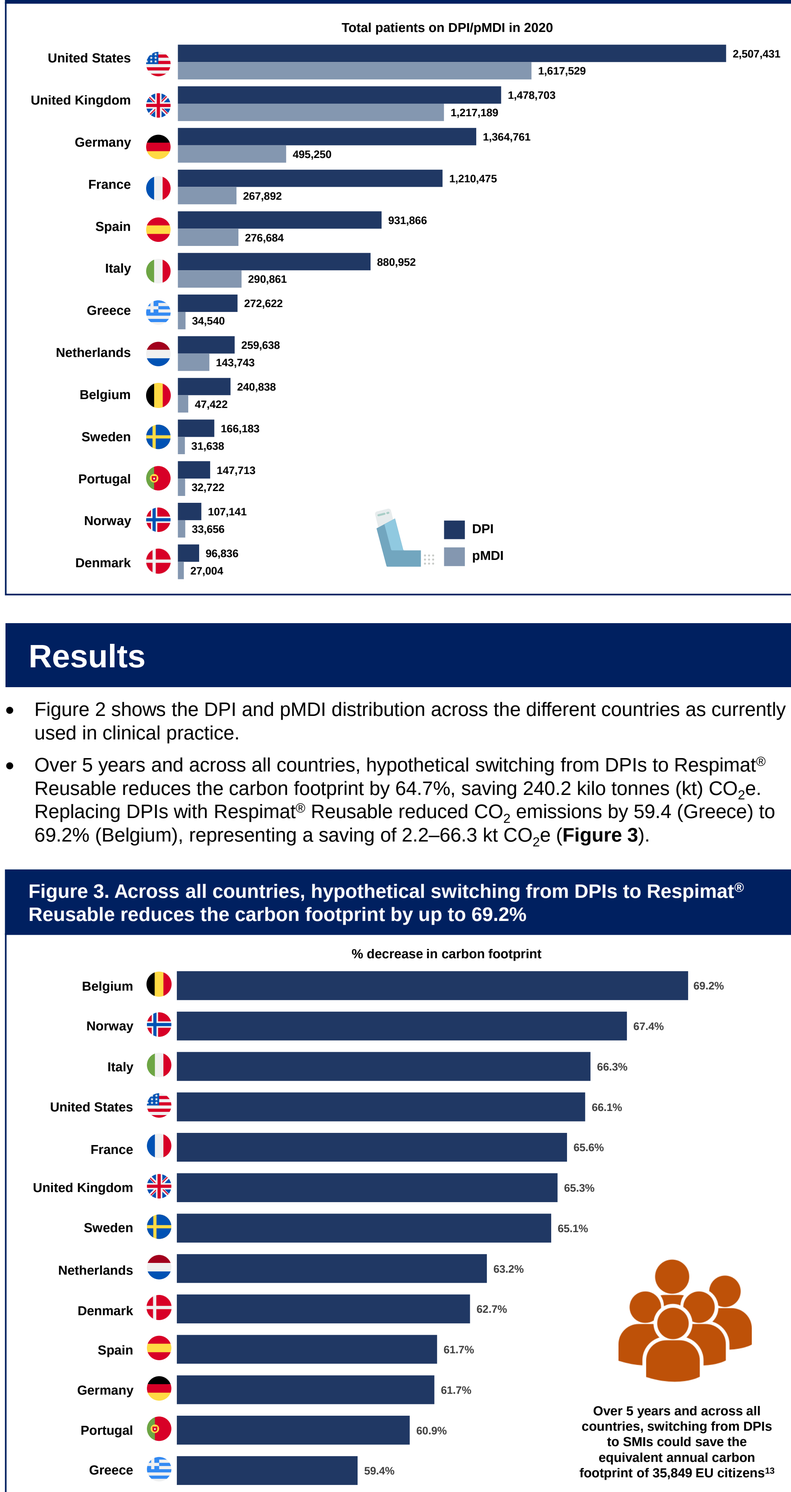
- The model was developed in accordance with ISPOR best practice guidelines for budget impact modelling, deemed to be the most appropriate guidance for model development.[5]
- The eligible population was adults with COPD and asthma on maintenance inhaled therapies.
- Volumes (number of units) and market shares for each inhaler device across all countries were derived from IQVIA MIDAS® international data (2021).[6]
- Inhaler carbon footprints were identified from published sources.[4,7–11] To estimate the carbon footprint of those inhalers with no available data, an average, by inhaler type, was taken between the available estimates and attributed to those inhalers with no available data on carbon footprint (**Table 1**).
- For each country, the size of the eligible population was estimated as the sold yearly dosages based on market share data (**Figure 2**). When switching to SMI, Respimat® Reusable, the optimal use treatment pattern was assumed, of two inhalers per year, each with six refills.
- Sensitivity analyses was carried out to assess the robustness of results.

Table 1. Carbon footprint of the different types and classes of inhaler used as model inputs

Device Type	Therapeutic Class	Product	Reusable?	CF-Inhaler*,†	CF-Refill*,†	Reference
pMDI	LABA/ICS	Symbicort	No	25.3		Janson et al. (2020);[6] Panigone et al. (2020);[8] Wilkinson et al. (2019),[4] NICE[10]
		Crivanil Plus	No	25.3		Janson et al. (2020);[6] Panigone et al. (2020);[8] Wilkinson et al. (2019),[4] NICE[10]
		Seretide	No	25.3		Janson et al. (2020);[6] Panigone et al. (2020);[8] Wilkinson et al. (2019),[4] NICE[10]
		Sirdupla	No	25.3		Janson et al. (2020);[6] Panigone et al. (2020);[8] Wilkinson et al. (2019),[4] NICE[10]
		Aliflus	No	25.3		Janson et al. (2020);[6] Panigone et al. (2020);[8] Wilkinson et al. (2019),[4] NICE[10]
		Dulera	No	25.3		Janson et al. (2020);[6] Panigone et al. (2020);[8] Wilkinson et al. (2019),[4] NICE[10]
		Foster	No	11.5		Panigone et al. (2020)[8]
		Flutiform	No	35.9		Wilkinson et al. (2019)[4]
	LAMA/LABA	Bevespi Aerosphere	No	25.3		Janson et al. (2020);[6] Panigone et al. (2020);[8] Wilkinson et al. (2019),[4] NICE[10]
	Triple FDC	Trimbow	No	14.5		Panigone et al. (2020)[8]
		Breztri Aerosphere	No	25.3		Janson et al. (2020);[6] Panigone et al. (2020);[8] Wilkinson et al. (2019),[4] NICE[10]
DPI	LABA/ICS	Symbicort	No	0.9		Janson et al. (2020)[6]
		Breo Ellipta	No	0.8		Janson et al. (2020)[6]
		Revinty Ellipta	No	0.8		Janson et al. (2020)[6]
		Seretide	No	0.9		Janson et al. (2020)[6]
		Aliflus	No	0.9		Janson et al. (2020)[6]
		Crivanil Plus	No	0.8		Janson et al. (2020);[6] Panigone et al. (2020);[8] Novartis (2021)[9]
		Duoresp	No	0.8		Janson et al. (2020);[6] Panigone et al. (2020);[8] Novartis (2021)[9]
		Gibiter	No	0.8		Janson et al. (2020);[6] Panigone et al. (2020);[8] Novartis (2021)[9]
		Bufomix Easyhaler	No	0.8		Janson et al. (2020);[6] Panigone et al. (2020);[8] Novartis (2021)[9]
		Rolenium	Yes	0.6	0.1	Janson et al. (2020);[6] Panigone et al. (2020);[8] Novartis (2021)[9]
		Pulmoton	Yes	0.6	0.1	Janson et al. (2020);[6] Panigone et al. (2020);[8] Novartis (2021)[9]
		Flutic/ Salmet Pras	Yes	0.6	0.1	Janson et al. (2020);[6] Panigone et al. (2020);[8] Novartis (2021)[9]
		Foster	No	0.9		Panigone et al. (2020)[8]
	LAMA/LABA	Anoro Ellipta	No	0.8		Janson et al. (2020) [6]
		Laventair	No	0.8		Janson et al. (2020) [6]
		Duaklir Genuair	No	0.8		Janson et al. (2020);[6] Panigone et al. (2020);[8] Novartis (2021)[9]
		Brimica Genuair	No	0.8		Janson et al. (2020);[6] Panigone et al. (2020);[8] Novartis (2021)[9]
		Ultibro	Yes	0.4	0.1	Novartis (2021)[9]
		Xoterna Breezhaler	Yes	0.4	0.1	Novartis (2021)[9]
		Ulunar Breezhaler	Yes	0.4	0.1	Novartis (2021)[9]
	LAMA	Incruse Ellipta	No	0.8		Janson et al. (2020)[6]
		Rolufta	No	0.8		Janson et al. (2020)[6]
		Spiriva	Yes	0.6	0.1	Janson et al. (2020);[6] Panigone et al. (2020);[8] Novartis (2021)[9]
		Braltus	Yes	0.6	0.1	Janson et al. (2020);[6] Panigone et al. (2020);[8] Novartis (2021)[9]
		Bretaris Genuair	No	0.8		Janson et al. (2020);[6] Panigone et al. (2020);[8] Novartis (2021)[9]
		Eklira Genuair	No	0.8		Janson et al. (2020);[6] Panigone et al. (2020);[8] Novartis (2021)[9]
		Tiotropium br vtrs	Yes	0.6	0.1	Janson et al. (2020);[6] Panigone et al. (2020);[8] Novartis (2021)[9]
		Gregal	Yes	0.6	0.1	Janson et al. (2020);[6] Panigone et al. (2020);[8] Novartis (2021)[9]
		Seebri	Yes	0.4	0.1	Novartis (2021)[9]
		Tovanor Breezhaler	Yes	0.4	0.1	Novartis (2021)[9]
		Enurev Breezhaler	Yes	0.4	0.1	Novartis (2021)[9]
	Triple FDC	Trelegy Ellipta	No	0.8		Janson et al. (2020)[6]
		Elebrato Ellipta	No	0.8		Janson et al. (2020)[6]
		Enerzair	Yes	0.4	0.1	Novartis (2021)[9]
SMI	LAMA/LABA	Spiolto Respimat® Reusable	Yes	0.7	0.1	Hänsel et al. (2019)[7]
	LAMA	Spiriva Respimat® Reusable	Yes	0.7	0.1	Hänsel et al. (2019)[7]

*The proportion of CF (~17%) attributed to the refill was based on the proportion of active pharmaceutical ingredients and distribution as the total carbon footprint per package in Janson et al.(2020)[6] with the exception of SMIs (in which case Hänsel et al. 2019[7] provided this data); † for products/inhalers with no available CF-estimate, an average of all available evidence was used. CF, carbon footprint; DPI, dry powder inhaler; FDC, fixed dose combination; ICS, inhaled corticosteroid; LABA; long-acting beta-agonists; LAMA, long-acting muscarinic antagonist; pMDI, pressurised metered dose inhaler; SMI, soft mist inhaler.

Figure 2. Size of the target population that are eligible to switch to Respimat® Reusable



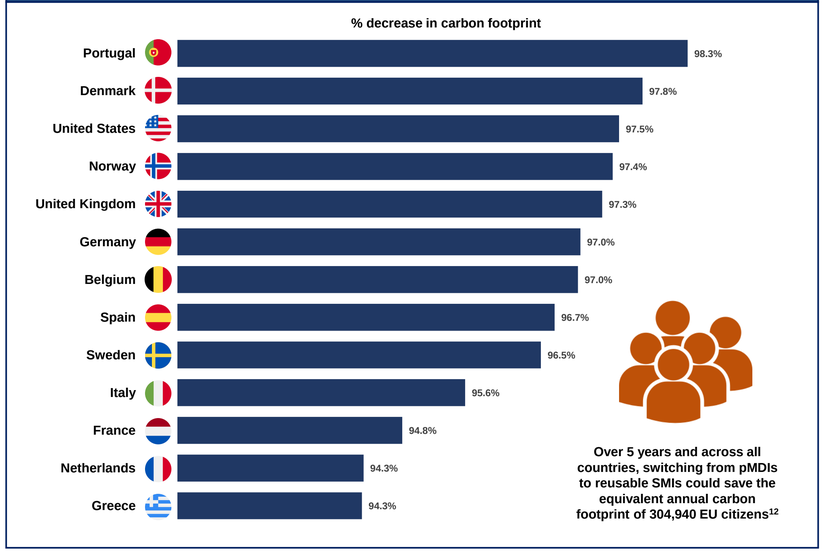
Results

- Figure 2 shows the DPI and pMDI distribution across the different countries as currently used in clinical practice.
- Over 5 years and across all countries, hypothetical switching from DPIs to Respimat® Reusable reduces the carbon footprint by 64.7%, saving 240.2 kilo tonnes (kt) CO_2e. Replacing DPIs with Respimat® Reusable reduced CO_2 emissions by 59.4 (Greece) to 69.2% (Belgium), representing a saving of 2.2–66.3 kt CO_2e (**Figure 3**).

Figure 3. Across all countries, hypothetical switching from DPIs to Respimat® Reusable reduces the carbon footprint by up to 69.2%

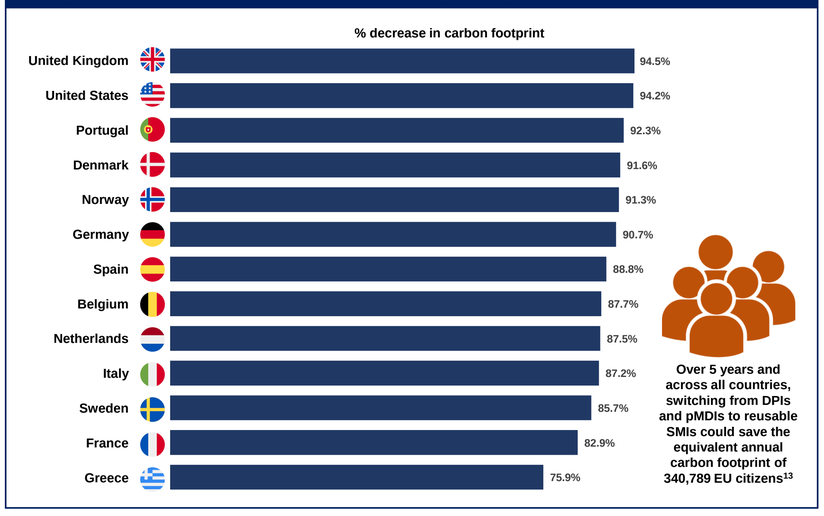
- Over 5 years and across all countries, hypothetical switching from pMDIs to Respimat® Reusable reduces the carbon footprint by 97.1%, saving 2,043.1 kt CO_2e. Replacing pMDIs with Respimat® Reusable reduced CO_2 emissions by 94.3 (Greece) to 98.3% (Portugal), saving 7.7–847.2 kt CO_2e (**Figure 4**).

Figure 4. Across all countries, hypothetical switching from pMDIs to Respimat® Reusable reduces the carbon footprint by up to 98.3%



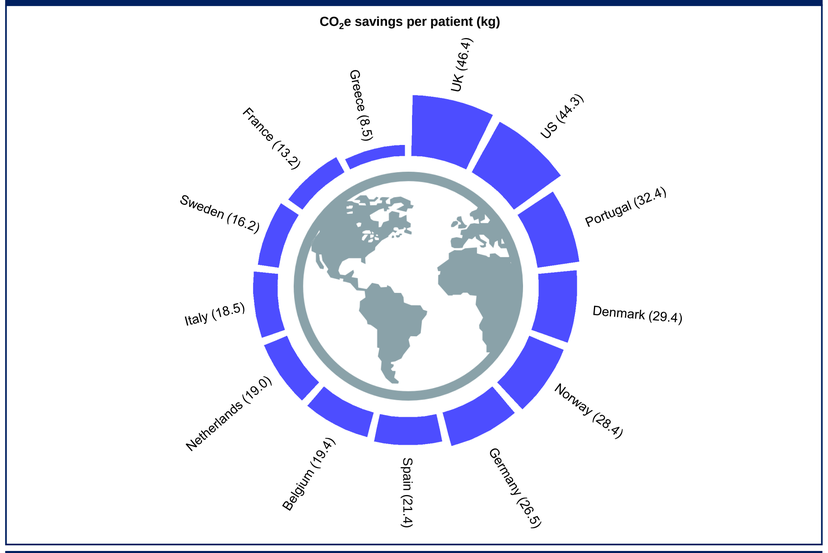
- Over 5 years and across all countries, hypothetical switching from both DPIs and pMDIs reduces the carbon footprint by 92.2%, saving 2,283.3 kt CO_2e. Replacing both DPI and pMDI devices to Respimat® Reusable reduced CO_2 emissions by 75.9 (Greece) to 94.5% (UK), saving 13.1–913.6 kt CO_2e (**Figure 5**).

Figure 5. Across all countries, hypothetical switching from DPIs and pMDIs to Respimat® Reusable reduces the carbon footprint by up to 94.5%



- The annual per patient CO_2e savings across the different countries if all DPIs and pMDIs were switched to Respimat® Reusable is shown in **Figure 6**.
- Sensitivity analyses were performed for all countries and showed that the base case results were robust to changes in parameters including varying assumptions around the number of Respimat® Reusable inhalers used in clinical practice, changes in carbon footprint per inhaler, market shares for devices, and the extent of inhaler replacement.

Figure 6. Annual per patient CO_2e savings across the different countries if all DPIs and pMDIs were switched to Respimat® Reusable



Conclusions

- Hypothetical replacement of pMDIs and DPIs with Respimat® Reusable, an SMI, used at its full refill potential (two inhalers per year, each with six refills), could result in substantial reductions in the carbon footprint, supporting global environmental goals.
- The countries that would benefit most from implementing changes to inhaler use based on their carbon footprint are the United Kingdom, the United States, and Germany, which is aligned with these countries having the highest prevalence of COPD/asthma and the highest ratio of pMDI prescribed.
- This study was a theoretical exercise, and patients should continue to use DPIs and pMDIs based on clinical need. As per ERS recommendations, patients should not be switched between devices purely for environmental reasons.[12]
- However, when considering a switch for clinical need, clinicians should first pick the appropriate treatment (class), and in case of equal preference, they should also consider the carbon footprint of the device and prioritise those with smallest carbon footprint.

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Conflict of interest statement

CJ has received honoraria for educational activities and lectures from AstraZeneca, Boehringer Ingelheim, Chiesi, GlaxoSmithKline, Novartis, Orion and TEVA, and has served on advisory boards arranged by AstraZeneca, Boehringer Ingelheim, GlaxoSmithKline, Novartis, Orion, Sanofi, and TEVA. LN and SL received consulting fees from Boehringer Ingelheim. JHP, SS, and ESHG are employees of Boehringer Ingelheim.

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