AACG Webinar 6.0

Environmental impact of asthma on global health

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sefh
Sociedad Española
de Farmacia Hospitalaria

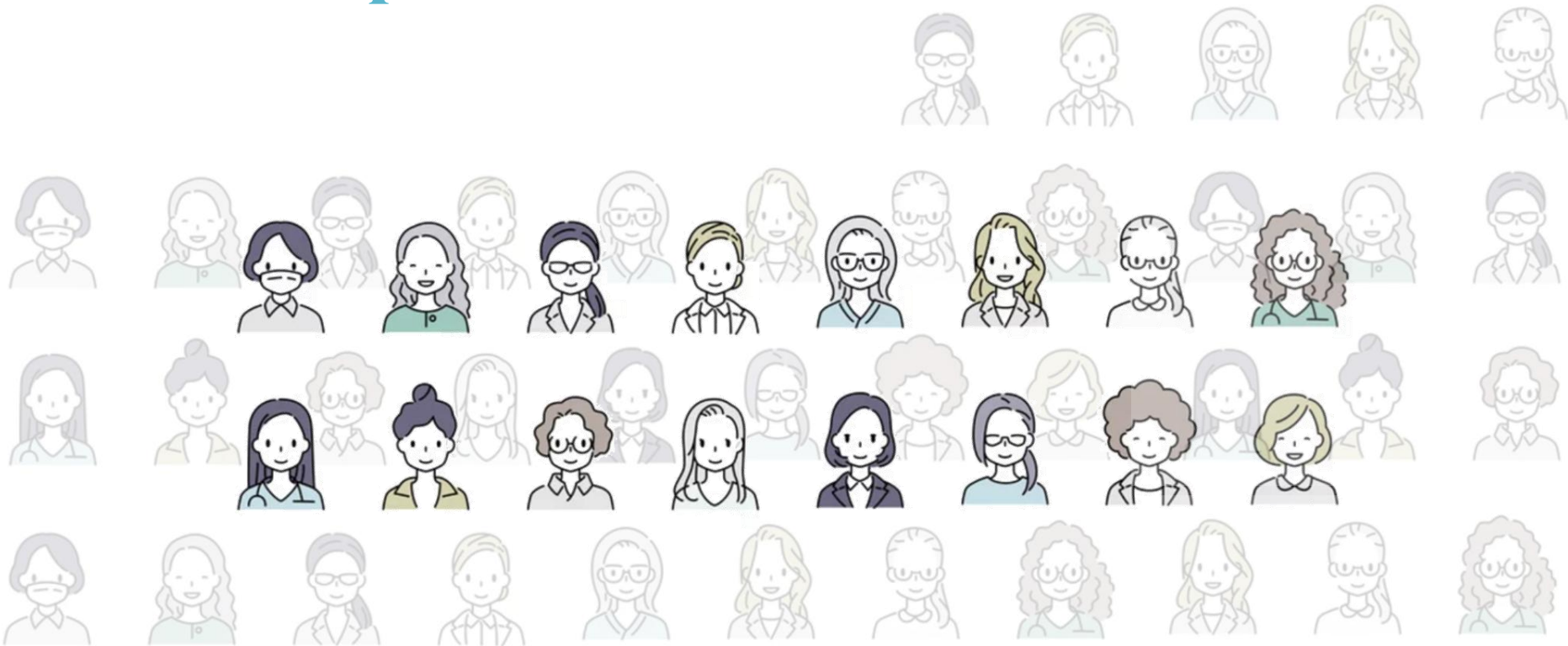
- Context
- Healthcare
- Asthma & inhalers
- Carbon footprint...
- Interventions

Context

Spain & Nigeria

Multidisciplinary work

SUPER-specialization



Environment and health

Does it really affect us?

CONTEXT MATTERS

Mortality

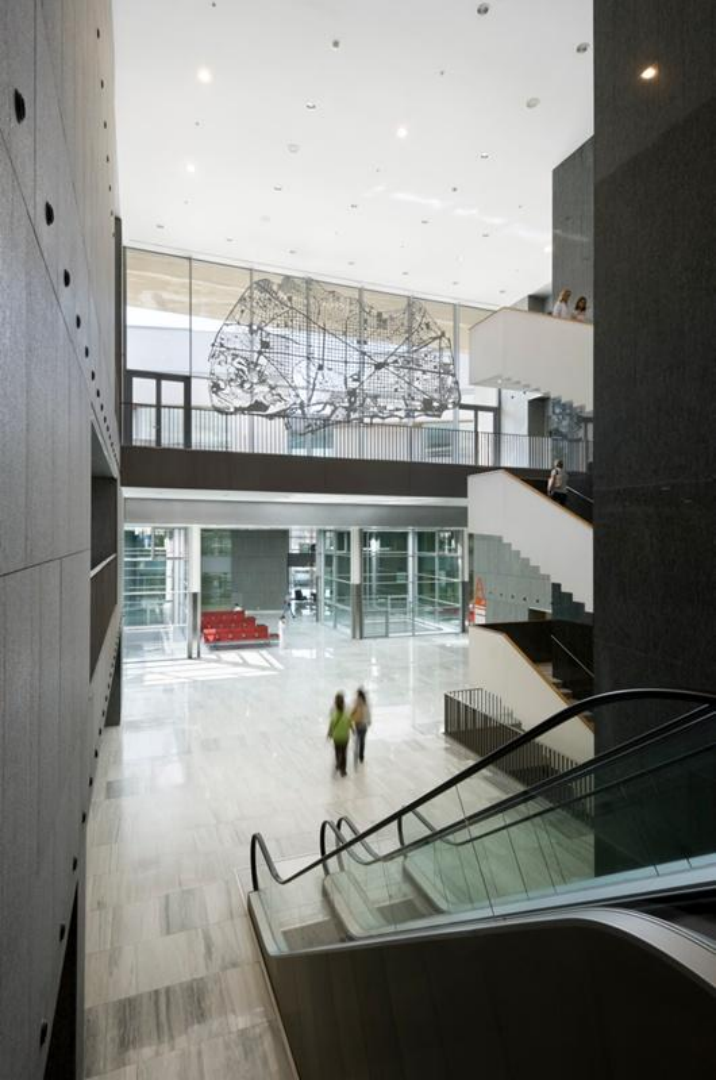
5 CV RF ≈ 20%

DM2, HBP, DLP, BMI, smoking

1. https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health
2. N Engl J Med. 2023 Aug 26;389(14):1273–1285. doi: 10.1056/NEJMoa2206916

Healthcare

Hero or villain?



24/7

FIRST, DO NO HARM

?

Healthcare impact

Carbon footprint

- Global warming
- 5-10% CF

Material supply

Supply chain: 70% consumption E/CO_2

85% non-hazardous

Ex - COVID 20 months
- 87000 tons protective equipment

Waste

AIR
- PM 10: 122 MT
- NO2: 161,9 MT
- SO2: 167,3 MT

SOLID
- Labs: 2% plàstic
- Chemical products
- Paper and cardboard!!

LIQUID
Hospitals: 7% water consumption

Medical vs non medical waste

Energy

- Great consumption
- Ex: refrigeration: 110 coal power plants

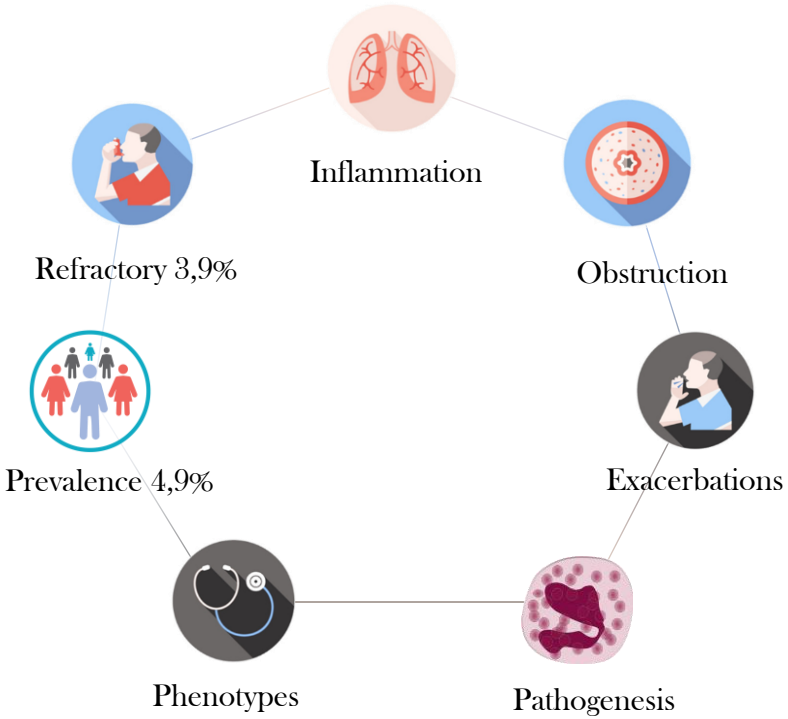
Drugs and hazardous products

- 40% rivers with dangerous drug level concentrations
- Other: acidification, metals, etc.

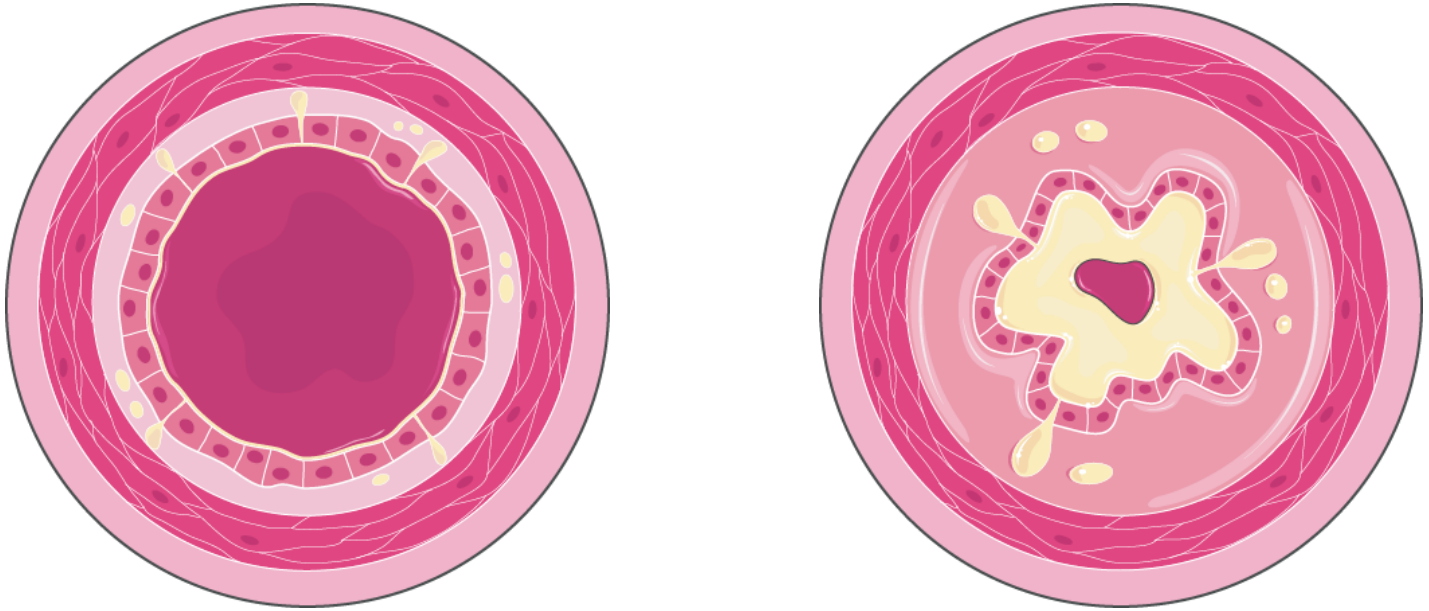
Asthma

What about it?

Asthma


Inflammation
Obstruction
Exacerbations
Pathogenesis
Phenotypes
Prevalence 4,9%
Refractory 3,9%

Reversible airway obstruction



FEV1/CVF <0,7

Image: smart.servier.com

Personalized asthma treatment

Biological drugs, etc.

+ LAMA

↑Medium/high dose ICS

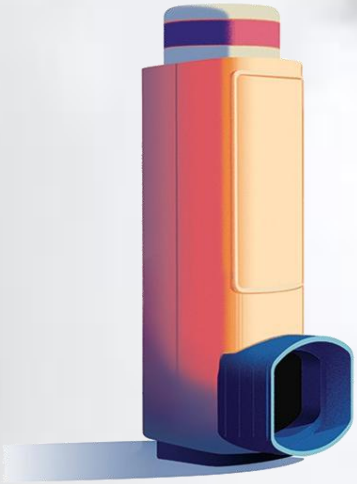
+ LABA

Low dose ICS

RELIEVER : SABA or formoterol +/- ICS

Other medicines for chronic control: montelukast, teofiline, etc.

Inhalers



Pressurized

Dry powder

Soft mist

Nebulized

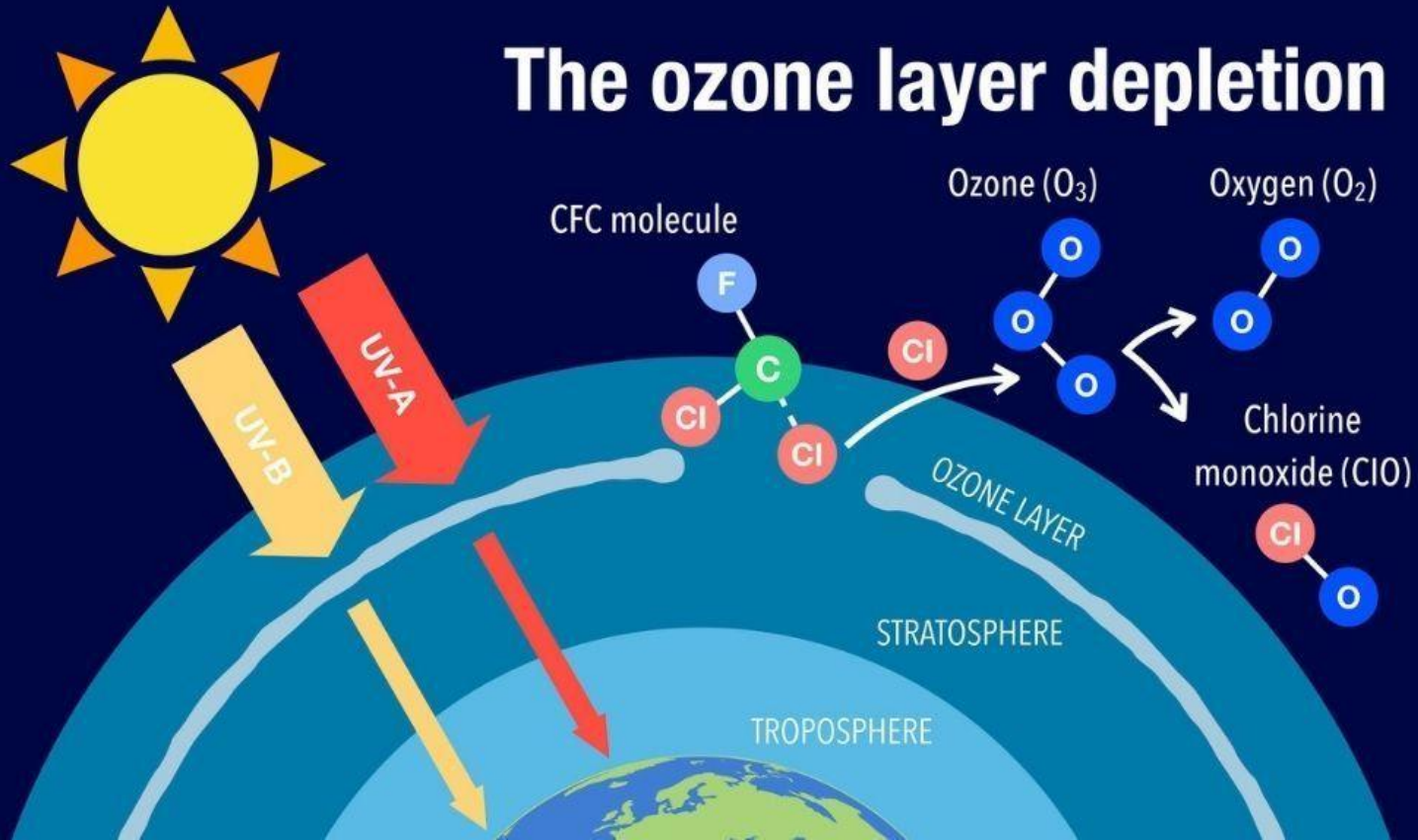
Inhalers

What about them?

Use of CFCs as propellant gases

1950s

CFCs and the ozone layer



Replacement of CFCs with HFA

1990s-2000s

HFAs do not deplete the ozone layer

but HFAs contribute to global warming

THE PROBLEM NOW: 2020s

Carbon footprint

The weight of the invisible

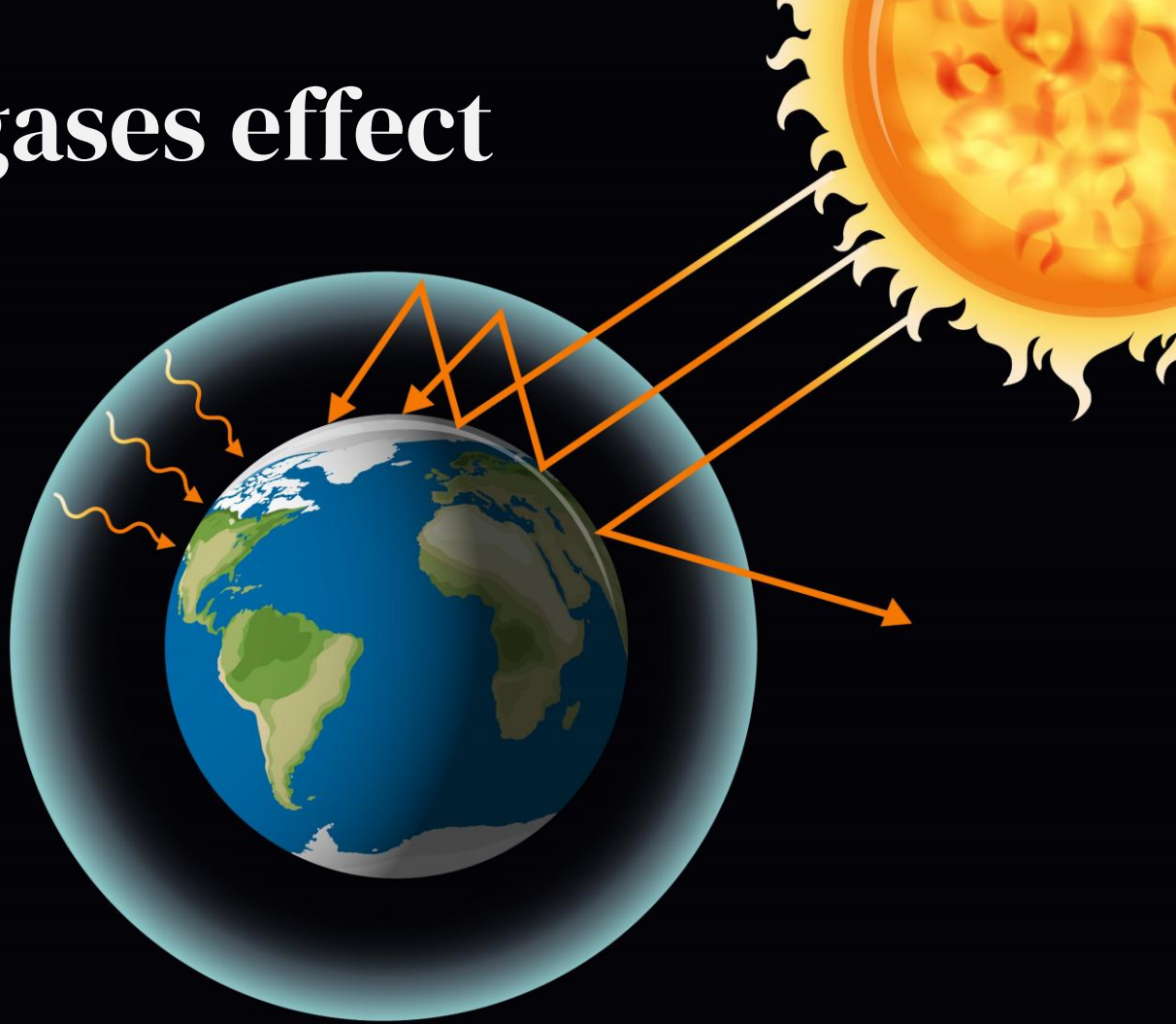
Greenhouse gases effect

CO_2, NO_2

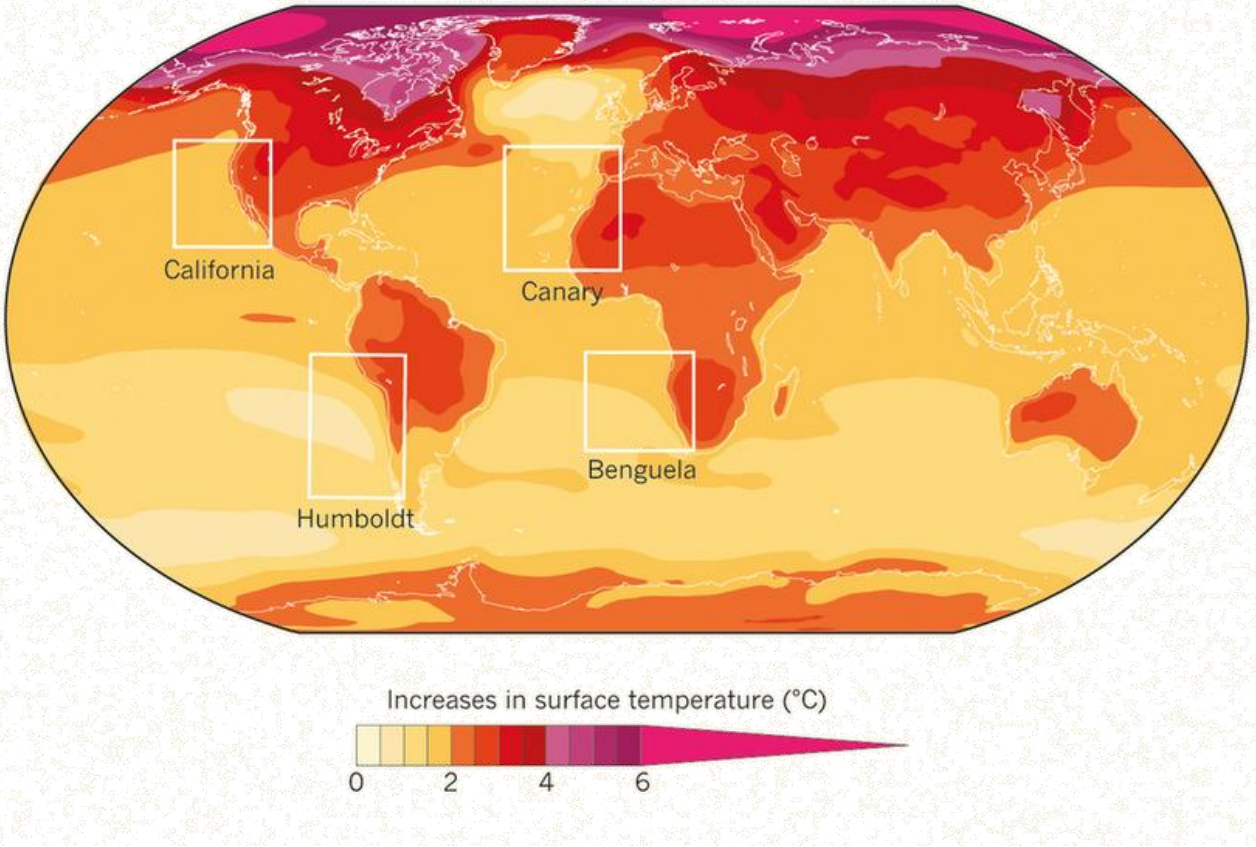
CH_4, O_3

…

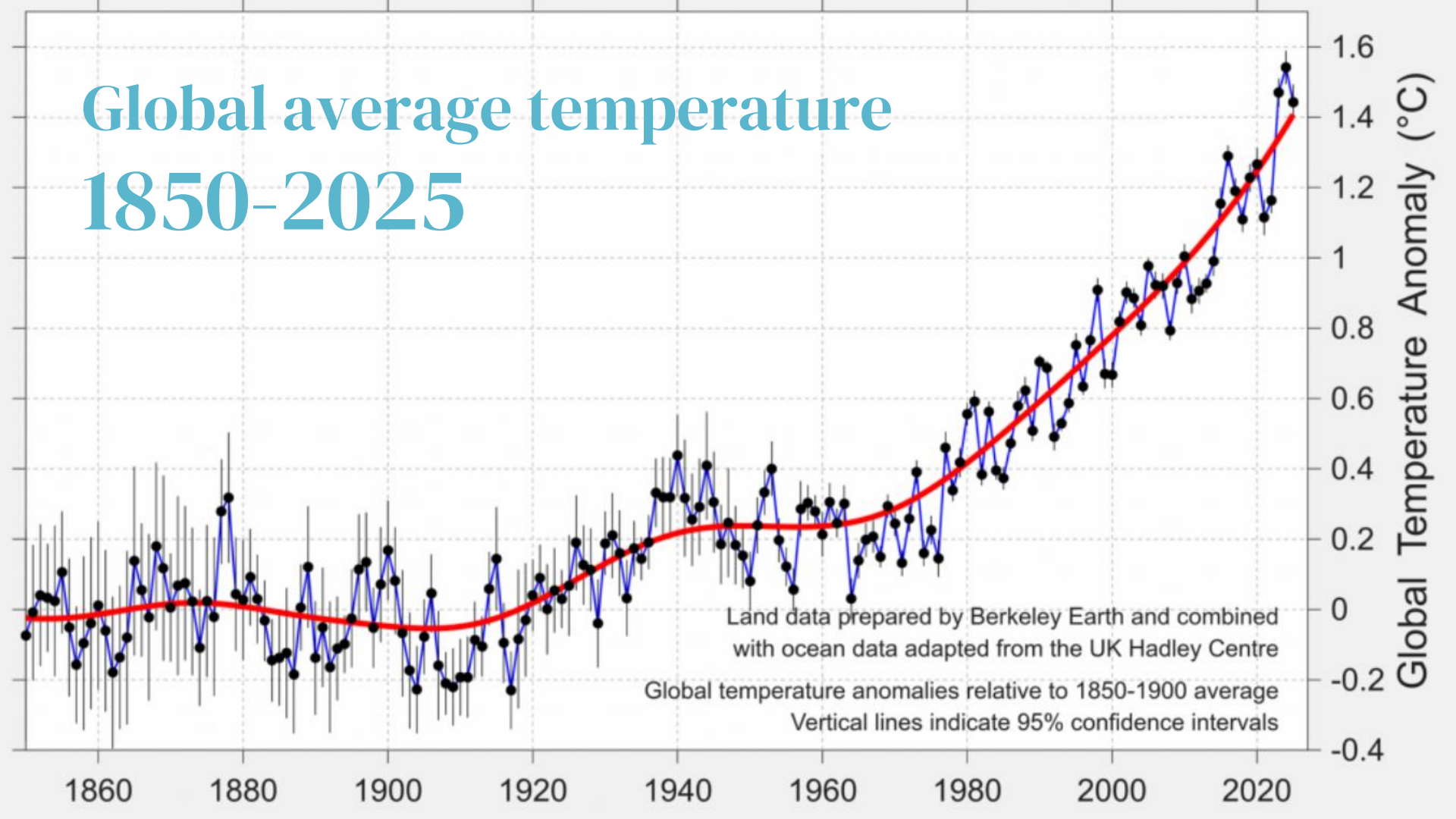
HFAs



Temperature projections for 2050



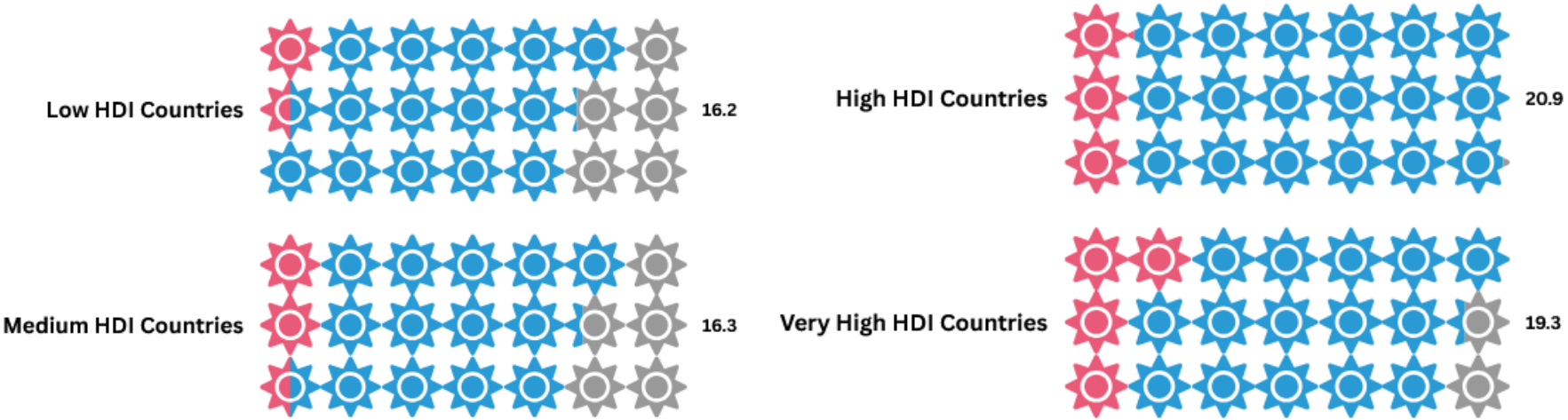
Global average temperature
1850-2025



Average number of heatwave days

Heatwave days expected in a scenario without climate change

Days attributable to the effects of climate change

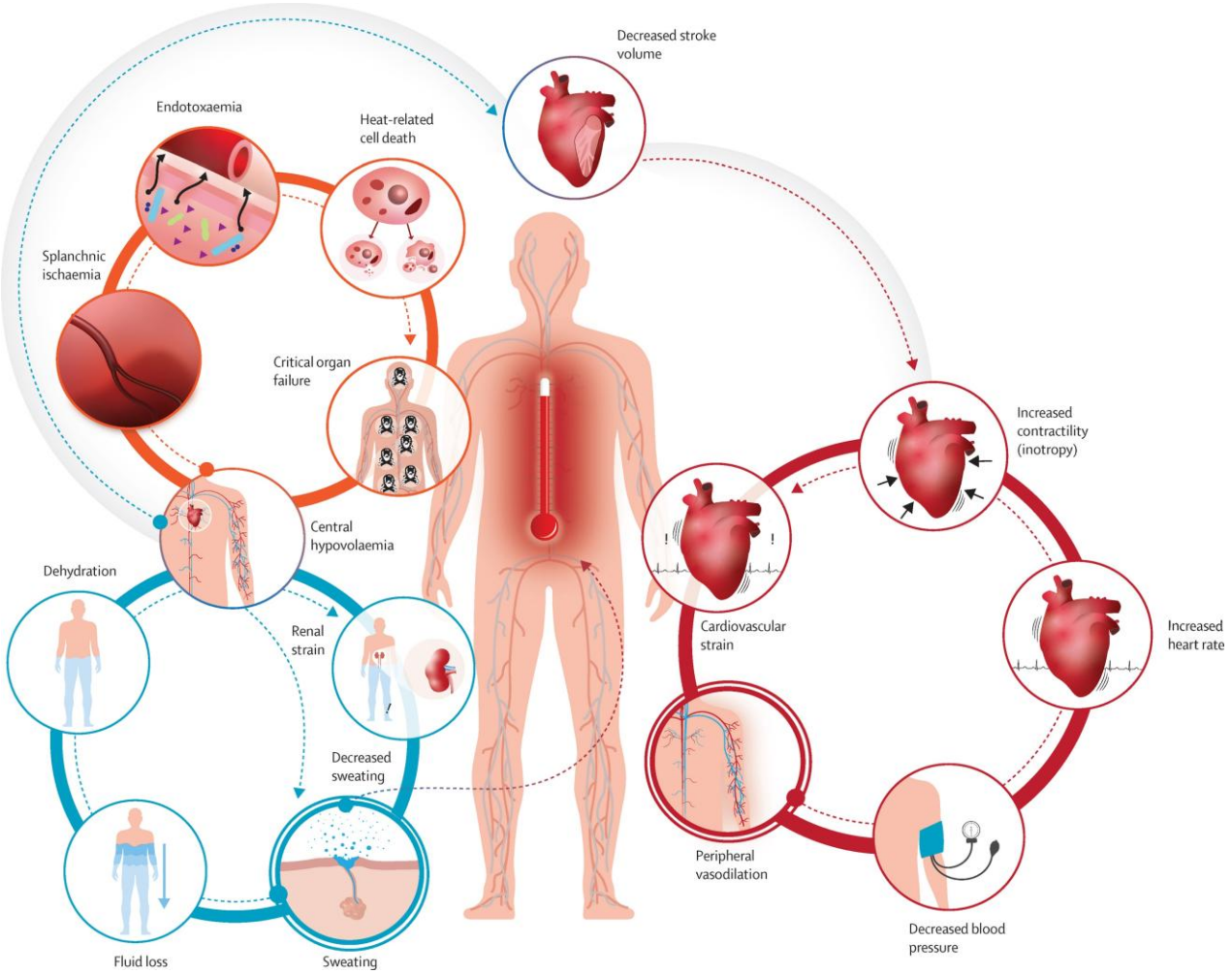


https://lancetcountdown.org/2025-report-visual-summary/

Human development index: HDI

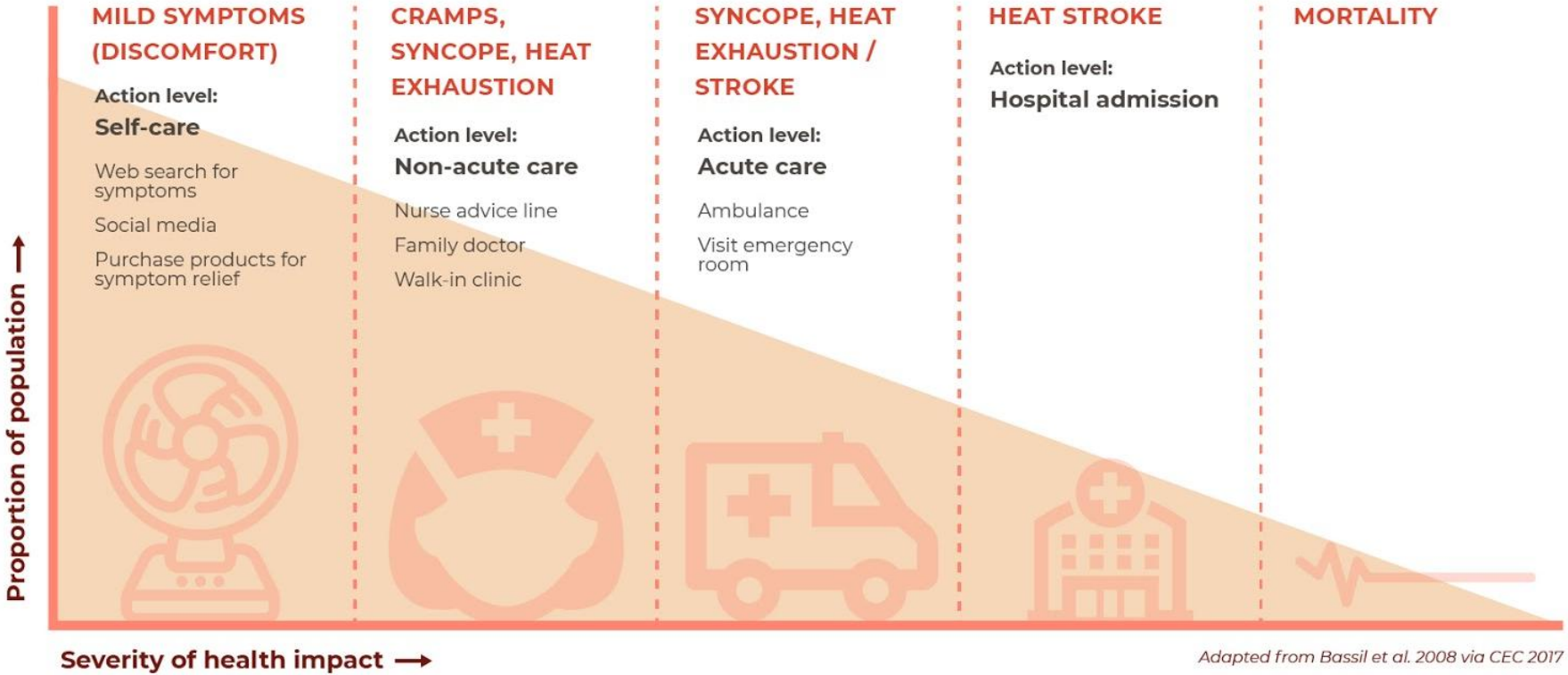
Heat strain

Thermoregulation
Vasodilation
+ sweating
is exceeded



Ebi et al. 2021

Spectrum of heat health outcomes



Adapted from Bassil et al. 2008 via CEC 2017

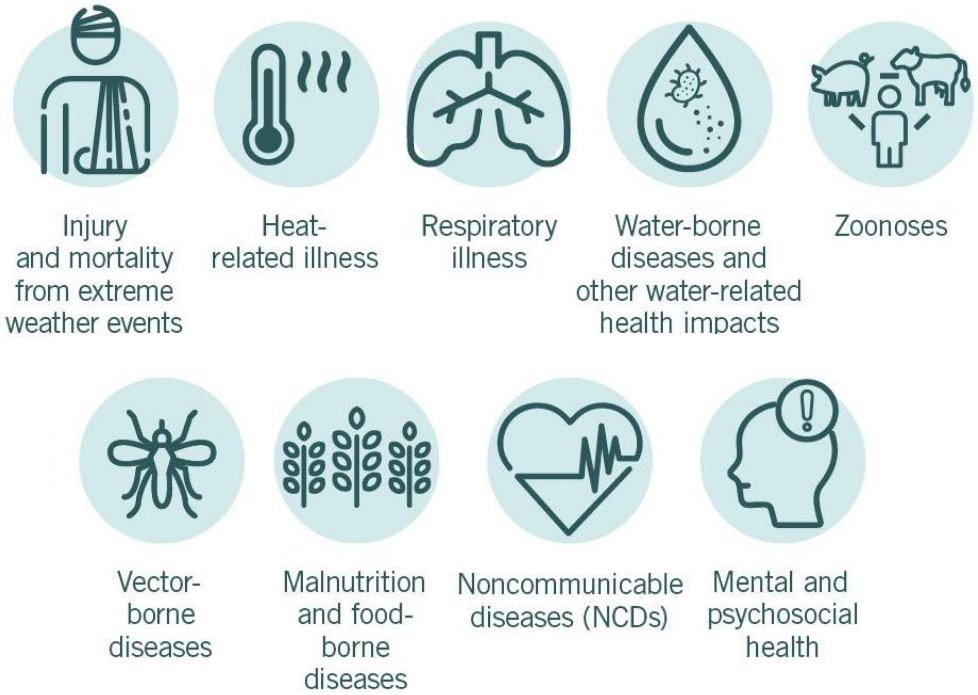
Spectrum of heat health outcomes

Heat Stress vs Heat Stroke

	Heat Stress / Exhaustion	Heat Stroke
Signs	Early warning signs include nausea, light-headedness, fatigue, muscle cramping and dizziness.	In addition to the signs of heat stress, someone experiencing heat stroke may also have a headache, confusion, no sweating, rapid heart rate, nausea or vomiting and may lose consciousness
Response	+ Move to an air-conditioned place + Take a cold shower or use a cold compress + Drink plenty of fluids + Remove tight or extra clothing layers	+ Call for medical help immediately + Use aggressive cooling such as a cold water bath to get temperature down right away + Stop cooling when core temperature of 38 degrees C is reached + Do not give them fluids

https://ghhin.org/in-the-body/

Impact of climate on health



Reference: https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health

Chronic conditions

Atrial fibrillation:
- warfarin
- bisoprolol
- digoxin

Hypothyroidism
- Levothyroxine

Hypertension
- amlodipine
- enalapril
- hydrochlorothiazide

Heart attack
- atorvastatin
- clopidogrel

DM2
- metformin
- empagliflozin
- sitagliptin

Depression
- sertraline

Insomnia
- diphenhydramine
- lorazepam PRN

Which medicines can lead to complications in periods of heat?

Risk assessment

Heart attack
- atorvastatin
- clopidogrel

Atrial fibrillation:
- warfarin
- bisoprolol
- digoxin

DM2
- metformin
- empagliflozin
- sitagliptin

All of them!

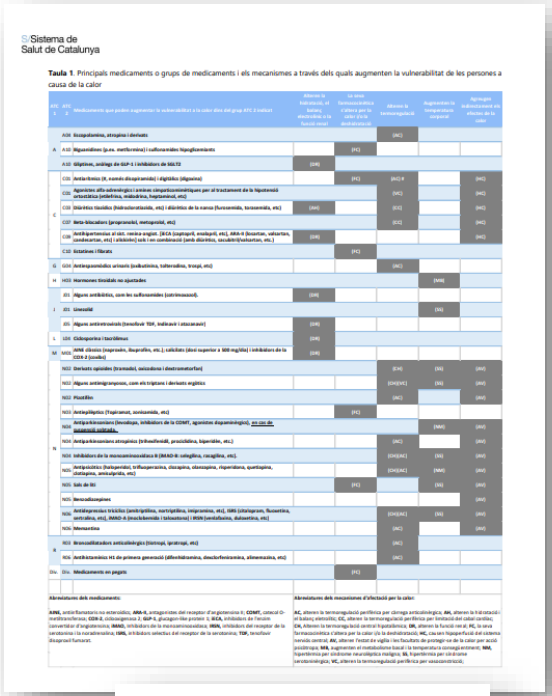
Hypothyroidism
- Levothyroxine

Depression
- sertraline

Hypertension
- amlodipine
- enalapril
- hydrochlorothiazide

Insomnia
- diphenhydramine
- lorazepam PRN

Impact of medicines



Sistema de Salut de Catalunya

Taula 1. Principals medicaments o grups de medicaments i els mecanismes a través dels quals augmenten la vulnerabilitat de les persones a causa de la calor

ATC 1	ATC 2	Medicaments que poden augmentar la vulnerabilitat a la calor dins del grup ATC 2 indicat	Alteren la hidratació, el balanç electrolític o la funció renal	La seva farmacocinètica i cribratge per la calor i/o la deshidratació	Alteren la termoregulació	Augmenten la temperatura corporal	Agreguen radiació/alteren els efectes de la calor
A	A03	Espasmolítics, atropina i derivats			[AC]		
	A10	Hipoglucemiants (p.ex. metformina) i cetoacidosis hipoglucèmiques		[FC]			
	A12	Gliptines, análegs de GLP-1 i inhibidors de SGLT2	[DH]				
C	C01	Antiarítmics (fl, esmolol-disopiramida) i digitàlics (digoxina)		[FC]	[AC]-F		[AC]
	C02	Agonistes alfa-adrenèrgics i amines simpaticomimètiques per al tractament de la hipotensió ortostàtica (midodrina, midodrina, heptaminol, etc)			[VC]		[AC]
	C03	Diürètics tiazídics (hidroclorotiazida, etc) i diürètics de la nansa (furosemida, torasemida, etc)	[DH]		[CC]		[AC]
	C07	Beta-bloquejants (propranolol, metoprolol, etc)			[CC]		[AC]
	C09	Antihipertensius: el cert, renina-angiot. (IECA (captopril, enalapril, etc), ARA-II (losartan, valsartan, candesartan, etc) i aliskiren) sols i en combinació (amb diürètics, sacubitril/valsartan, etc.)	[DH]				[AC]
	C10	Estatines i fibrats		[FC]			
G	G04	Antiespasmòdics urinaris (solifenacina, tolterodina, trospi, etc)			[AC]		
H	H03	Hormones tiroidals no ajustades				[MA]	
J	J01	Alguns antibiòtics, com les sulfonamides (cotrimoxazol).	[DH]				
	J05	Linezolid				[SI]	
	J05	Alguns antiretrovirals (tenofovir TDF, indinavir i atazanavir)	[DH]				
L	L04	Ciclosporina i tacrólimus	[DH]				
M	M01	AINE clàssics (naproxèn, ibuprofèn, etc.), calcitats (dosi superior a 600 mg/dia) i inhibidors de la COX-2 (coxibs)	[DH]				
N	N02	Derivats opiàcies (tramadol, oxicodona i dextrometorfan)			[CH]	[SI]	[AV]
	N02	Alguns antimigranyosos, com els triptans i derivats ergòtics			[CH][VC]	[SI]	[AV]
	N02	Pizotifén			[AC]		[AV]
	N03	Antiepilèptics (Topiramat, zonisamida, etc)		[FC]			
	N04	Antiparkinsonians (levodopa, inhibidors de la COMT, agonistes dopaminèrgics), en cas de [illegible]				[MA]	[AV]
	N05	Antipsicòtics atípics (trifluoperazina, clorpina, olanzapina, risperidona, quetiapina, clotiapina, amisulpirida, etc)			[AC]		[AV]
	N05	Inhibidors de la monoaminoxidasa B (MAO-B: selegilina, rasagilina, etc).			[CH][VC]	[SI]	[AV]
	N05	Antipsicòtics (haloperidol, trifluoperazina, clorpina, olanzapina, risperidona, quetiapina, clotiapina, amisulpirida, etc)			[CH][VC]	[MA]	[AV]
	N05	Sals de liti		[FC]		[SI]	[AV]
	N05	Benzodiazepines					[AV]
	N06	Antidepressius tricíclics (amitriptilina, nortriptilina, imipramina, etc), ISRS (citalopram, fluoxetina, sertralina, etc), IMAO-A (moclobemida i tolvaptona) i IRSN (venlafaxina, duloxetina, etc)			[CH][VC]	[SI]	[AV]
	N06	Memantina			[AC]	[SI]	[AV]
R	R03	Broncodilatadors anticolinèrgics (tiotropi, ipratropi, etc)			[AC]		
	R06	Antihistamínics H1 de primera generació (difenhidramina, dexclorfeniramina, alimemazina, etc)			[AC]		
Dis.	Dis.	Medicaments en pegats		[FC]			

Abreviatures dels medicaments:

AINE, antiinflamatoris no esteroïdals; **ARA-II**, antagonistes del receptor d'angiotensina II; **COMT**, catecol O-metiltransferasa; **COX-2**, ciclooxigenasa 2; **GLP-1**, glucagon-like protein 1; **IECA**, inhibidors de l'enzim convertidor d'angiotensina; **IMAO**, inhibidors de la monoaminoxidasa; **IRSN**, inhibidors del receptor de la serotonina i la noradrenalina; **ISRS**, inhibidors selectius del receptor de la serotonina; **TDF**, tenofovir disoproxil fumarat.

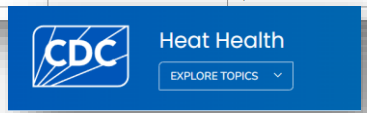
Abreviatures dels mecanismes d'afectació per la calor:

AC, alteren la termoregulació perifèrica per clamuga anticolinèrgica; **AH**, alteren la hidratació i el balanç electrolític; **CC**, alteren la termoregulació perifèrica per limitació del calat cardíac; **CH**, alteren la termoregulació central hipotalàmica; **DH**, alteren la funció renal; **FC**, la seva farmacocinètica s'altera per la calor i/o la deshidratació; **HC**, cau en hipoperfusió del sistema nerviós central; **AV**, alteren l'estat d'alerta i les facultats de protegir-se de la calor per acció psicotrop; **MA**, augmenten el metabolisme basal i la temperatura corporal interna; **NM**, hipertèrmia per síndrome neuroléptica maligna; **SI**, hipertèrmia per síndrome serotoninèrgica; **VC**, alteren la termoregulació perifèrica per vasoconstricció).

Salut/ CSB Consorci Sanitari de Barcelona
Ens públic de la Generalitat de Catalunya i l'Ajuntament de Barcelona

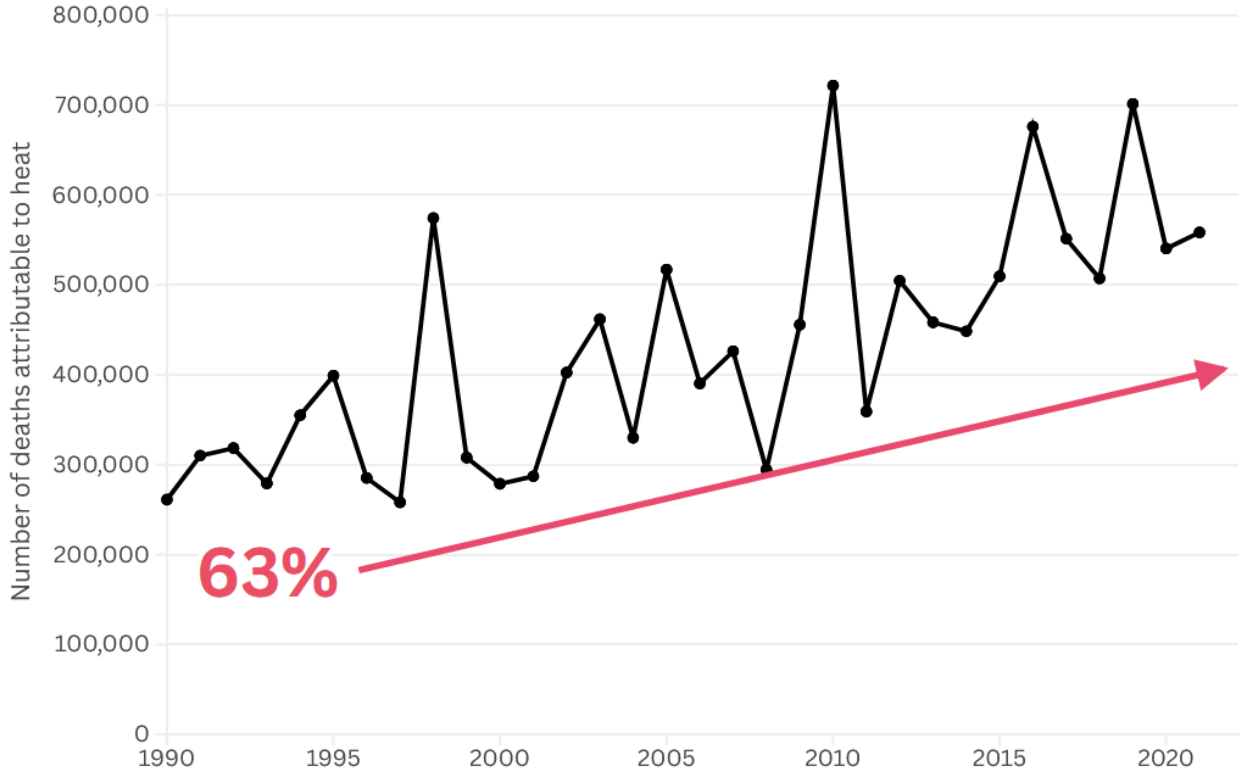
Medications that may increase risk of harm on hot days

Medication Type		Drug Class	Examples	Mechanisms
Cardiovascular medications	Antihypertensives	Diuretics	Furosemide Hydrochlorothiazide Acetazolamide	Electrolyte imbalance Volume depletion, dehydration and increased risk of fainting and falls Reduced thirst sensation
		Beta blockers	Atenolol Metoprolol Propranolol	Reduced superficial vasodilation Decreased sweating Reduced blood pressure, increased risk of fainting and falls
		Calcium channel blocker	Amlodipine Felodipine Nifedipine	Decreased blood pressure, increased risk of fainting and falls Electrolyte imbalance
		Angiotensin Converting Enzyme Inhibitor **(ACEi)** and Angiotensin II Receptor blockers **(ARBs)**	**ACEi:** Enalapril Lisinopril Ramipril **ARB:** Valsartan Losartan	Decreased blood pressure, increased risk of fainting and falls Reduced thirst sensation
		Angiotensin Receptor-Neprilysin Inhibitors **(ARNIs),** combination drug including ARB	Sacubitril/Valsartan	See ARBs
	Anti-platelet medications		Clopidogrel Aspirin	Reduced superficial vasodilation



https://salutintegralbcn.gencat.cat/web/.content/60_actualitat/2023/medicaments-calor/fragilitat-medicaments-calor-bibliografia.pdf
https://www.cdc.gov/heat-health/hcp/clinical-guidance/heat-and-medications-guidance-for-clinicians.html#:~:text=In%20addition%2C%20heat%20exposure%20may,if%20left%20in%20the%20heat.

Heat-related mortality

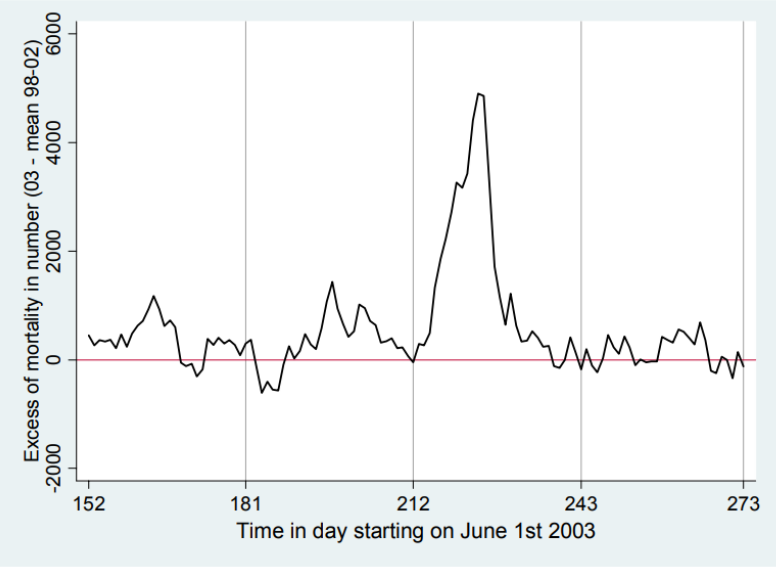


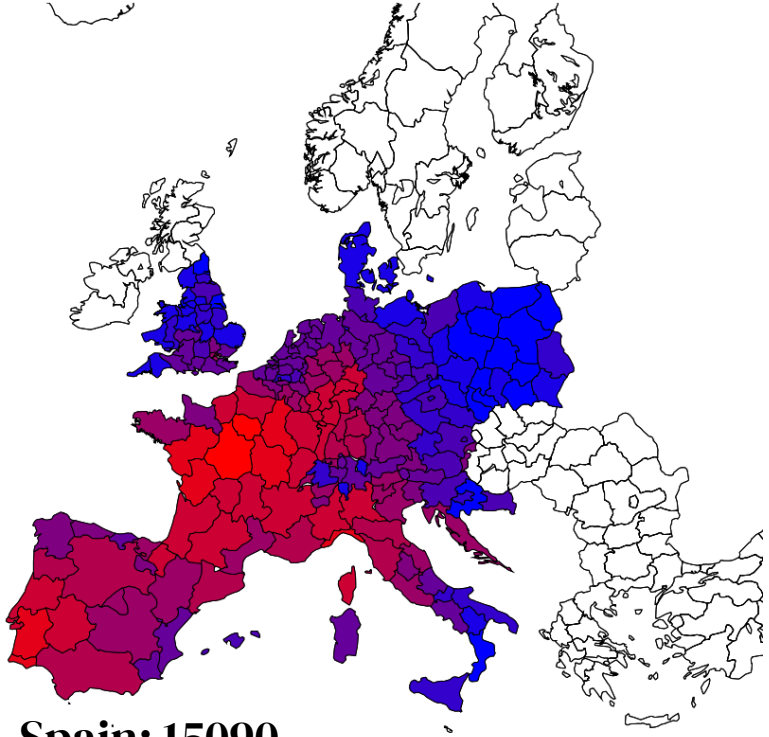
https://lancetcountdown.org/2025-report-visual-summary/

High intensity heatwave events bring high acute mortality

2003 heatwave

70.000 excess deaths in Europe



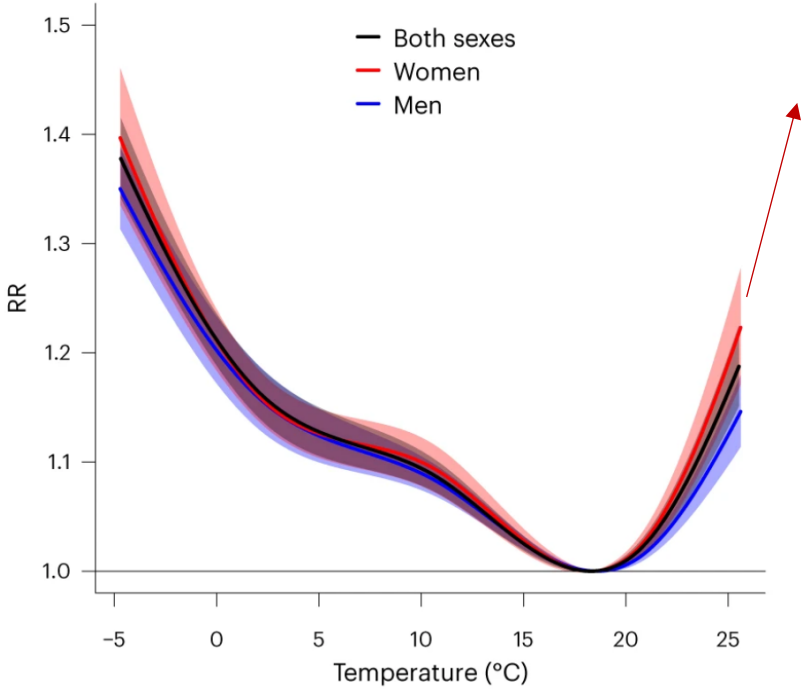


Spain: 15090

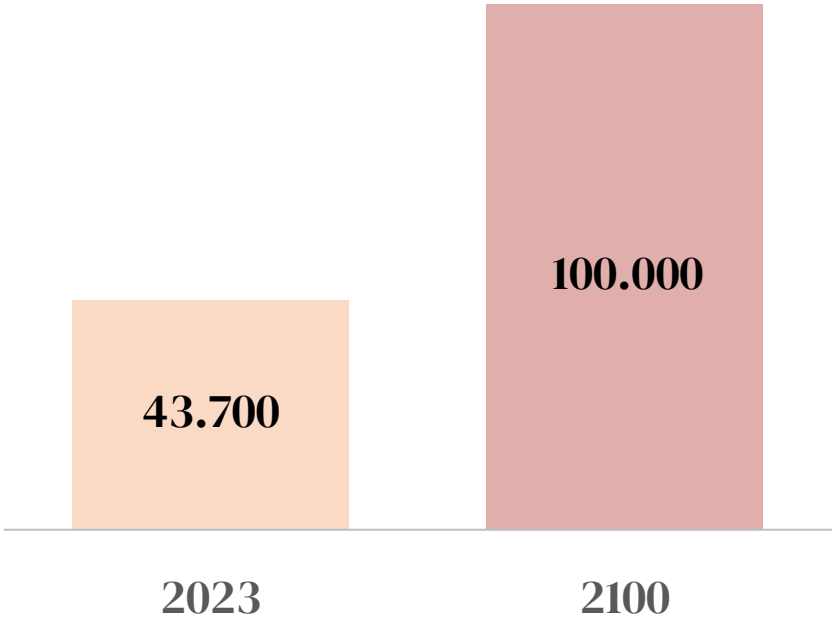
https://ec.europa.eu/health/ph_projects/2005/action1/docs/action1_2005_a2_15_en.pdf

High intensity heatwave events bring high acute mortality

Mortality risk evolution



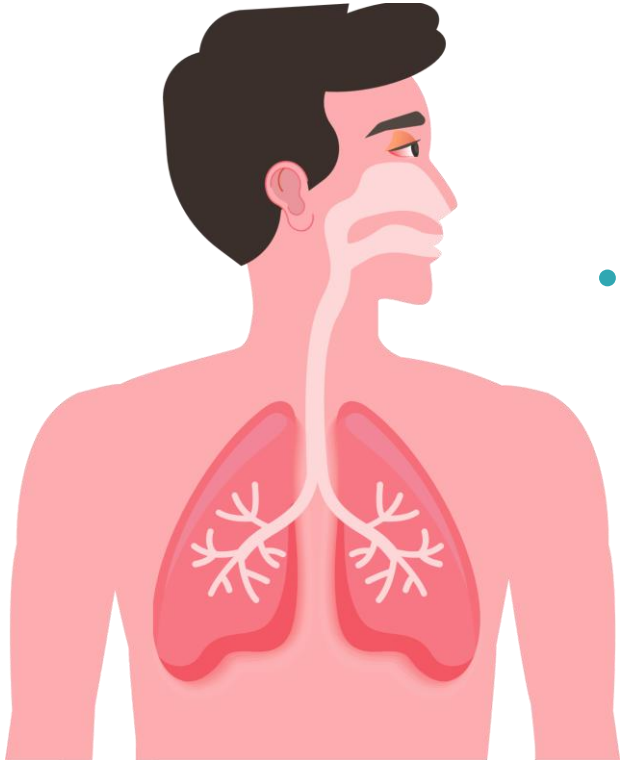
"In northern Europe, summers will be warmer, but not lethal. These regions will become more vulnerable to extreme heat due to ageing population"



García-León 2024

The case of respiratory diseases

- Pneumonia
- ARDS
- ILD
- Lung cancer
- CF



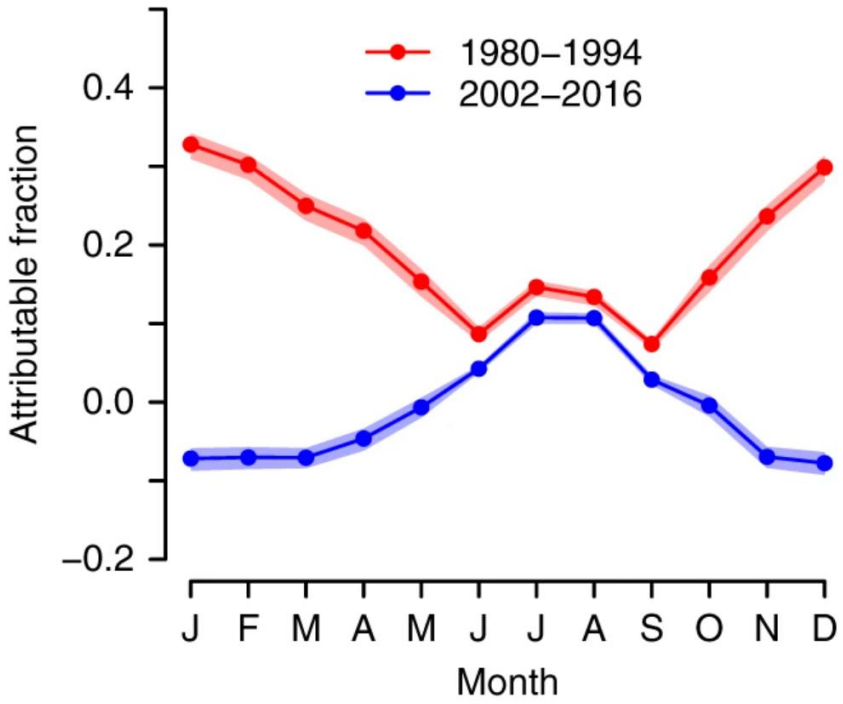
- Asthma
- COPD
- Chronic bronchitis
- Bronchiolitis

Adamkiewicz G *et al*. 2024.

The case of respiratory diseases

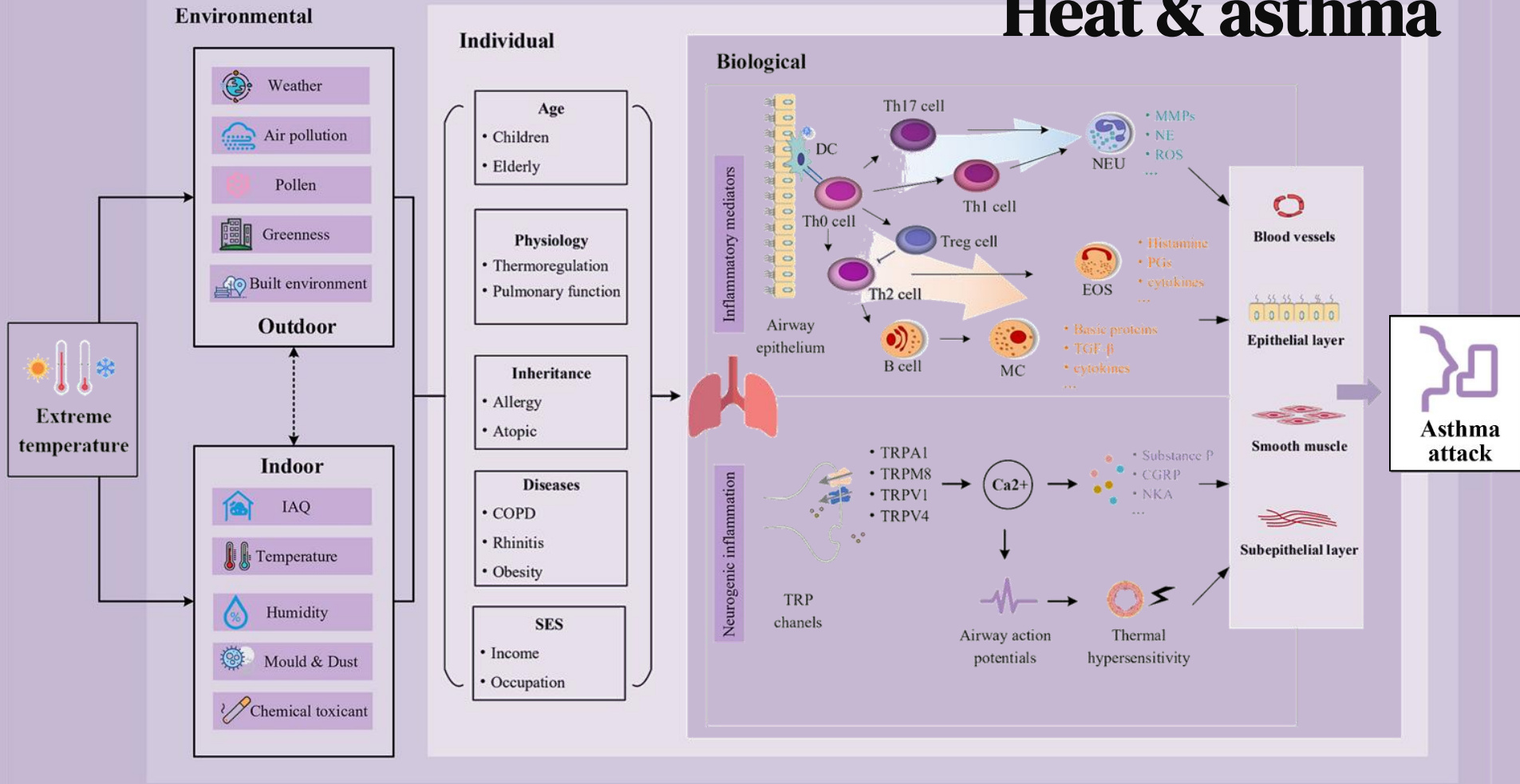
Reversal of the seasonality of mortality from respiratory diseases in Spain

Shift of the maximum monthly incidence from winter to summer



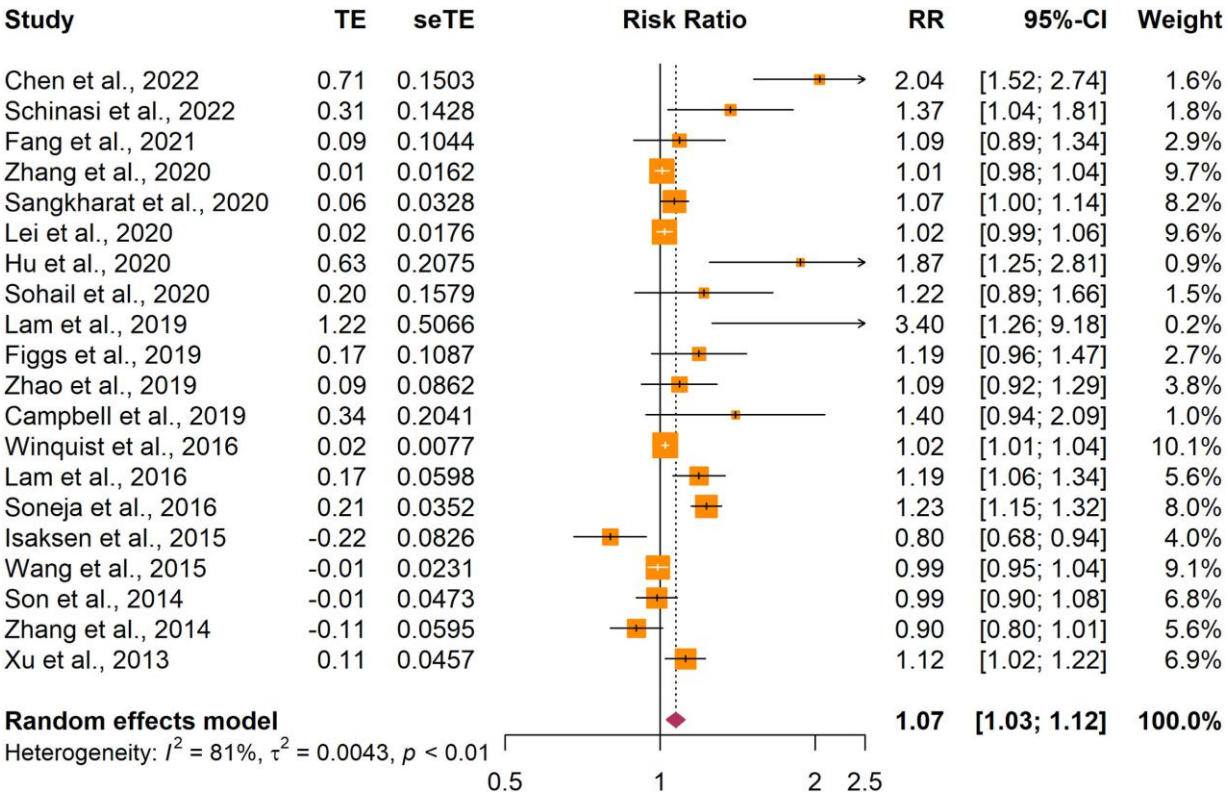
Achebak. 2020.

Heat & asthma



Han et al. 2022.

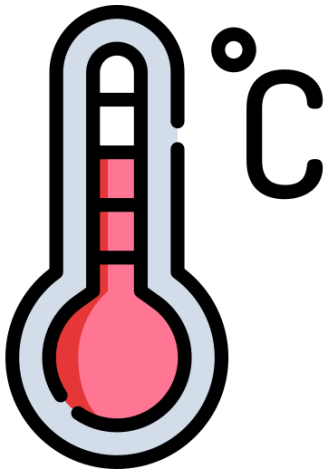
Extreme heat & asthma attacks



Han et al. 2022.

Extreme heat: a trigger for exacerbations

Above 32,5°C

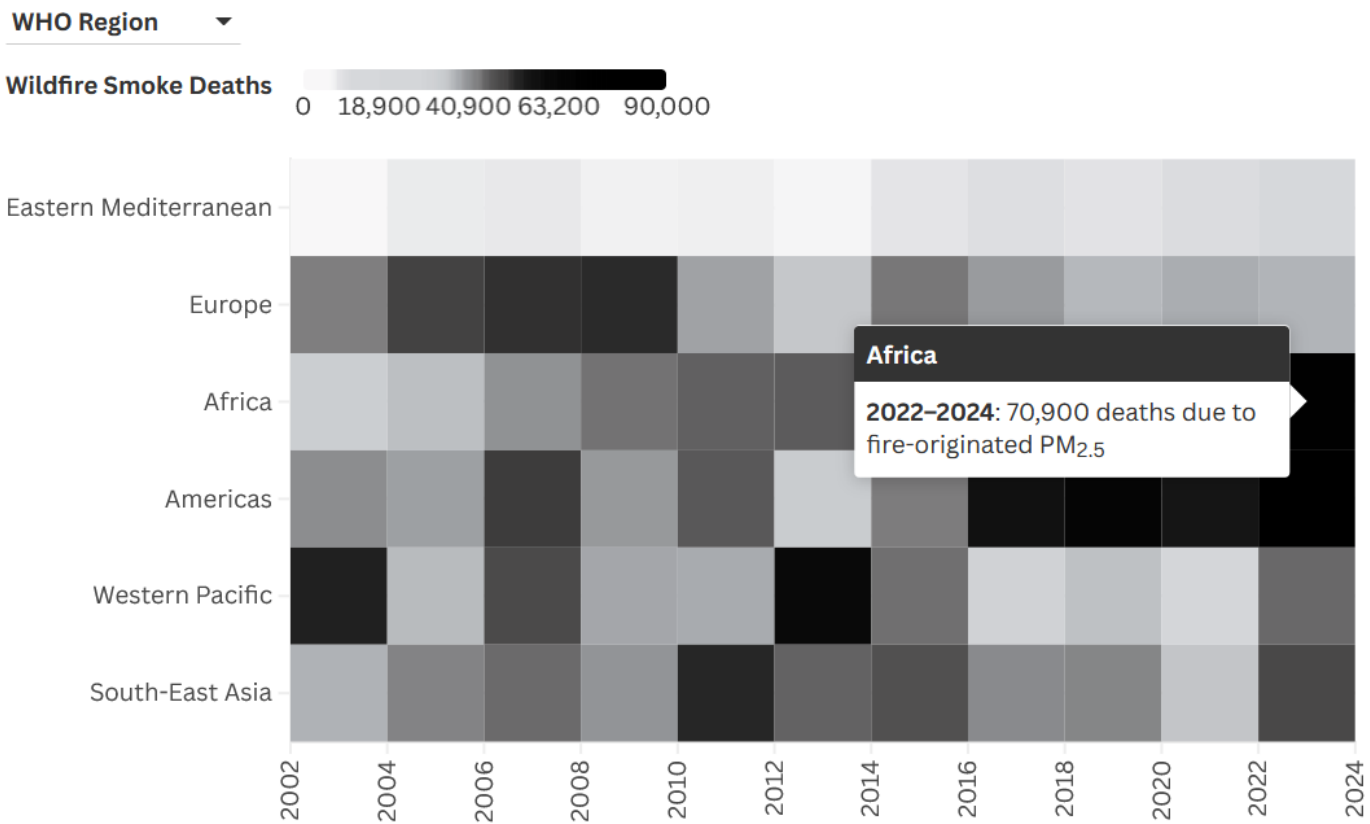


each 1°C rise

20-40% increase
in asthma exacerbations

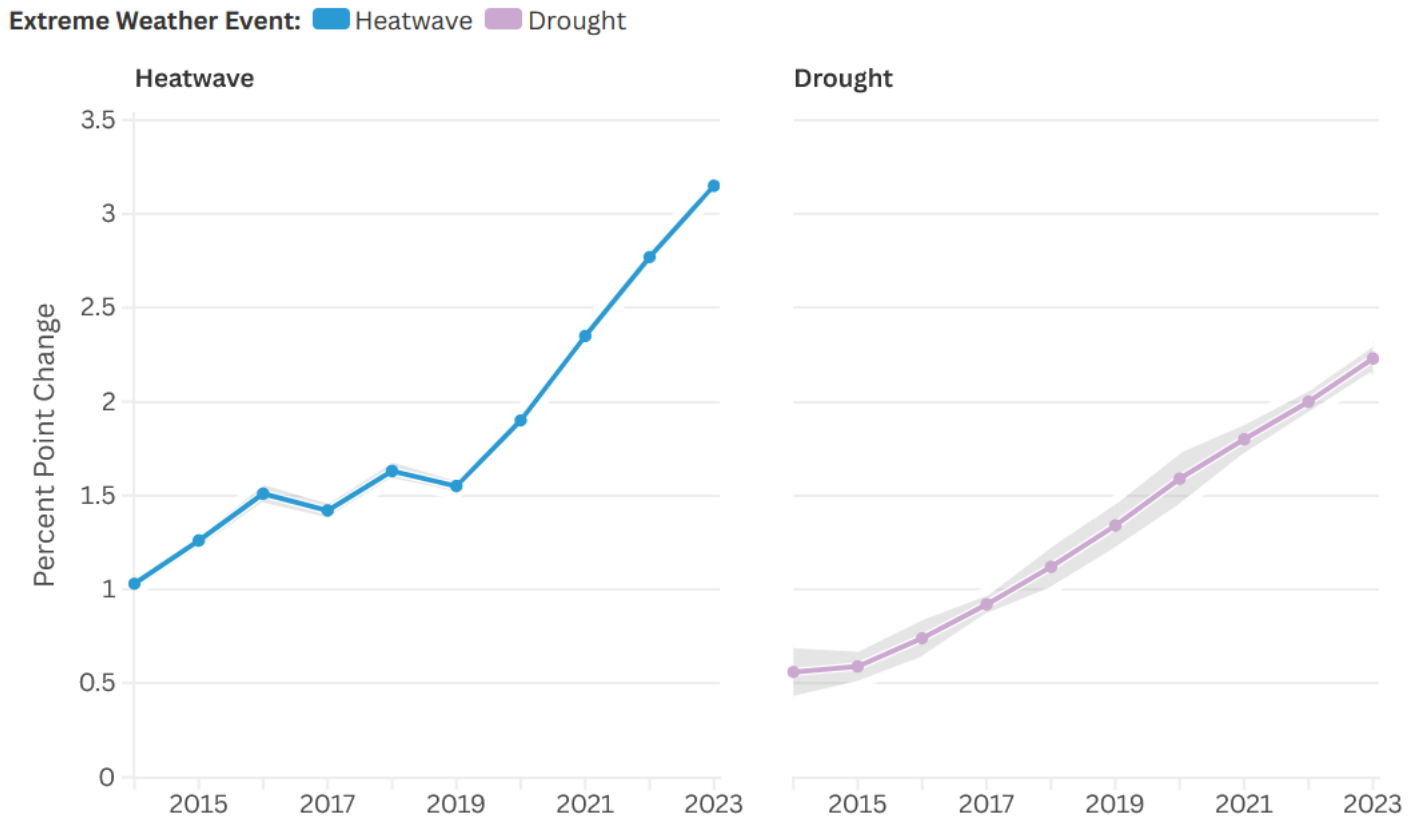
Direct effects & indirect effects

Mortality from Wildfire Smoke Exposure



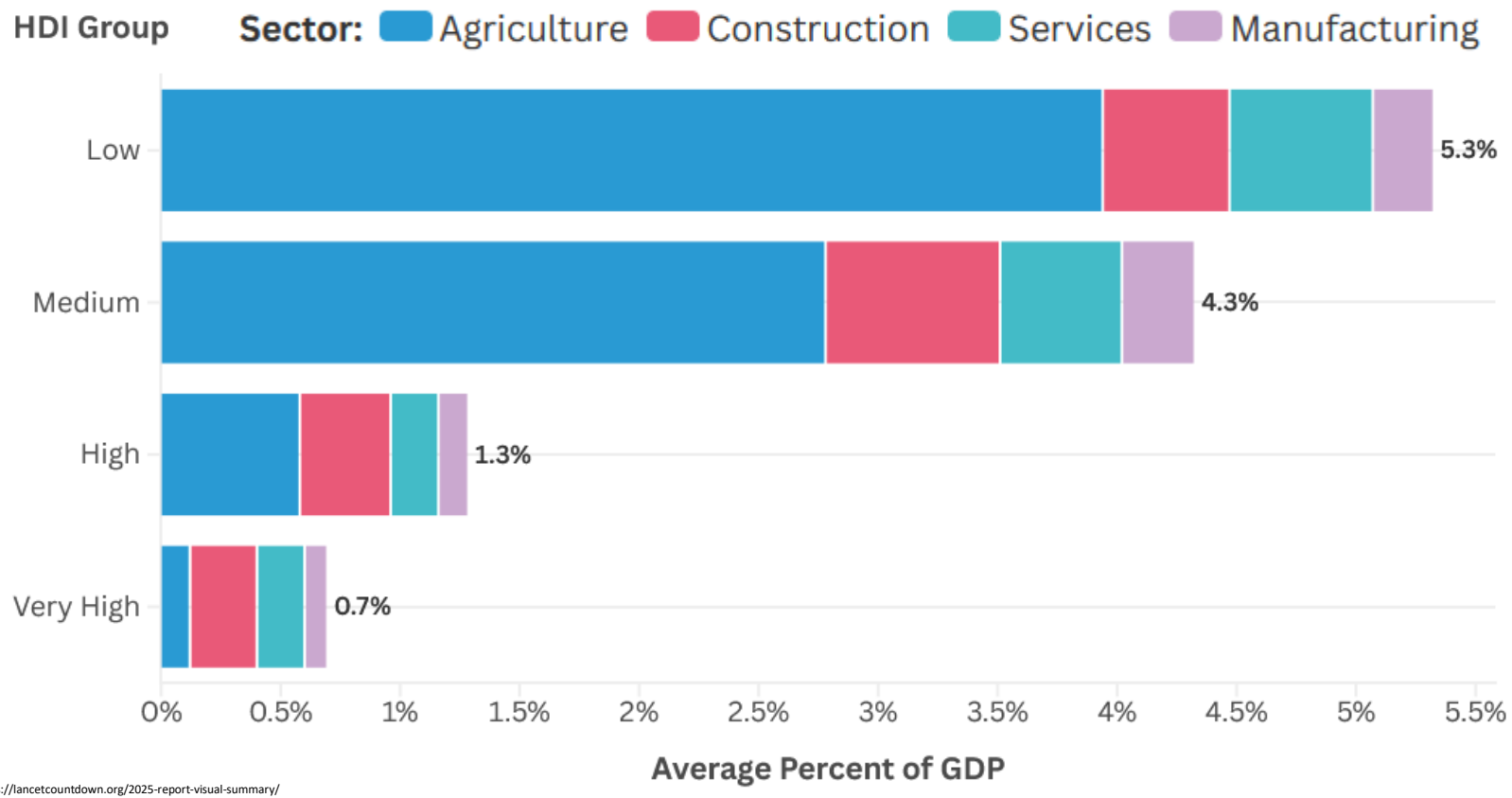
https://lancetcountdown.org/2025-report-visual-summary/

Impact of Extreme Weather on Food Insecurity



https://lancetcountdown.org/2025-report-visual-summary/

Earnings Lost due to Heat-Related Reduction in Labour Capacity



https://lancetcountdown.org/2025-report-visual-summary/

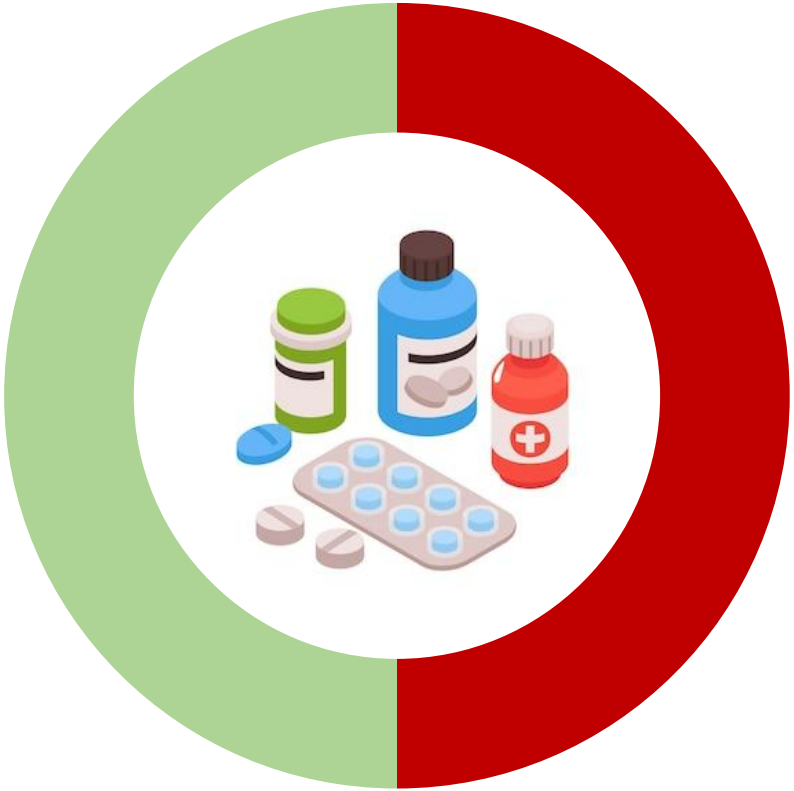
Healthcare

Medicines & inhalers

Carbon footprint & healthcare

- 5-10% of the total
- Global top: 5th country

Bosurgi. 2019



Carbon footprint of drugs and MDs

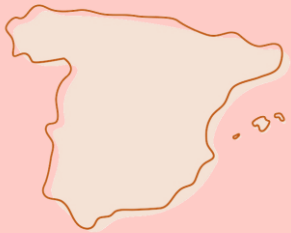
25-50% healthcare

Marraud. 2023

Pressurized metered-dose inhalers (pMDIs)

Impact of propellant gases (HFA): 1300 – 3350 eq. CO_2

30 kg CO_2 =  = **300 km** 



- 52% of inhalers are pMDI
- 15 million units are dispensed per year
- 400.000 tonnes of CO_2 equivalent per year

What can we do?

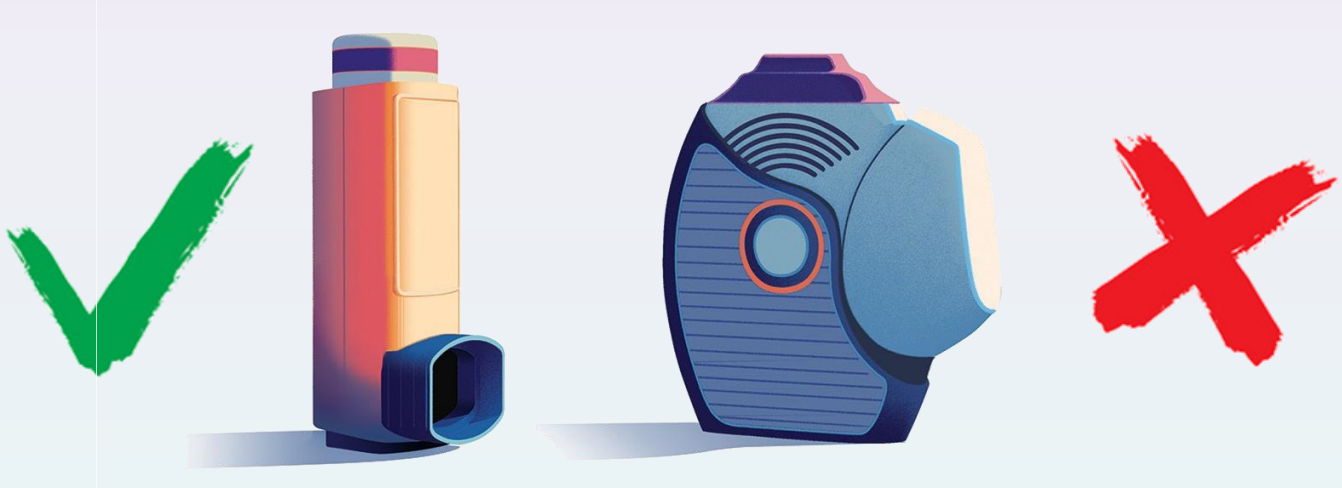
¿Should we switch inhalers?

Pressurized Dry powder Soft mist Nebulized

Not as a general recommendation...

1. DPI requires an inspiratory flow >30 L/min

Patients with severe airflow limitation



Not as a general recommendation...

1. DPI requires an inspiratory flow >30 L/min
2. Technique is an important factor

Correct technique in 1/3 of cases

- Consider coordination + patient preferences
- Review periodically

Correct adherence in 50% of cases

- ↓ adherence: ↑morbimortality + ↑ use of healthcare services
- Assess at each visit: TAI and/or medication dispensing records

TAI 10 ítems

Nivel de adhesión

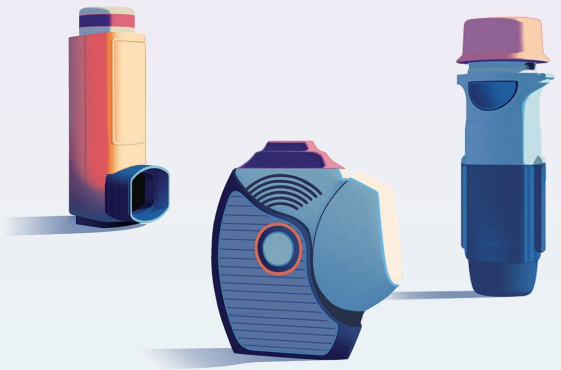
PUNTUACIÓN		INTERPRETACIÓN
=50 puntos	➤	Buena adhesión
Entre 46 y 49 puntos	➤	Adhesión intermedia
≤ 45 puntos	➤	Mala adhesión

1. Sanchis, J.; Gich, I.; Pedersen, S. Systematic Review of Errors in Inhaler Use Has Patient Technique Improved Over Time? *Chest* **2016**, *150*, 394–406; 2. https://www.taitest.com/ 3. Garin et al. Clinical Impact of Electronic Monitoring Devices of Inhalers in Adults with Asthma or COPD: A Systematic Review and Meta-Analysis. Pharmaceuticals 2023, 16(3), 414;

Not as a general recommendation…

1. DPI requires an inspiratory flow >30 L/min
2. Technique is an important factor
3. Some patients prefer / achieve better control with pMDIs

- Variability in preferences
- Inhaler tailored to the patient:
  - Better control
  - Reduced exacerbations
  - Lower corticosteroid use
  - Improved adherence



1. Nakanishi Y, Iwamoto H, Miyamoto S, Nakao S, Higaki N, Yamaguchi K, Sakamoto S, Horimasu Y, Masuda T, Matsumoto N, Nakashima T, Onari Y, Fujitaka K, Haruta Y, Hamada H, Hozawa S, Hattori N. Association Between Patient Preference for Inhaler Medications and Asthma Outcomes. *J Asthma Allergy*. 2022;15:1539-1547
2. Schreiber, J., Sonnenburg, T. & Luecke, E. Inhaler devices in asthma and COPD patients – a prospective cross-sectional study on inhaler preferences and error rates. BMC Pulm Med 20, 222 (2020). https://doi.org/10.1186/s12890-020-01246-z
3. Navaie M, Dembek C, Cho-Reyes S, Yeh K, Celli BR. Inhaler device feature preferences among patients with obstructive lung diseases: a systematic review and meta-analysis. Medicine. 2020;99:25(e20718).

Not as a general recommendation…

1. DPI requires an inspiratory flow >30 L/min
2. Technique is an important factor
3. Some patients prefer / achieve better control with pMDIs
4. Rescue medication: pMDI

Solutions?

1. Prevention

Smoking

- Production accounts for 0.2% of global CF
- Inhaler use and other issues

COPD

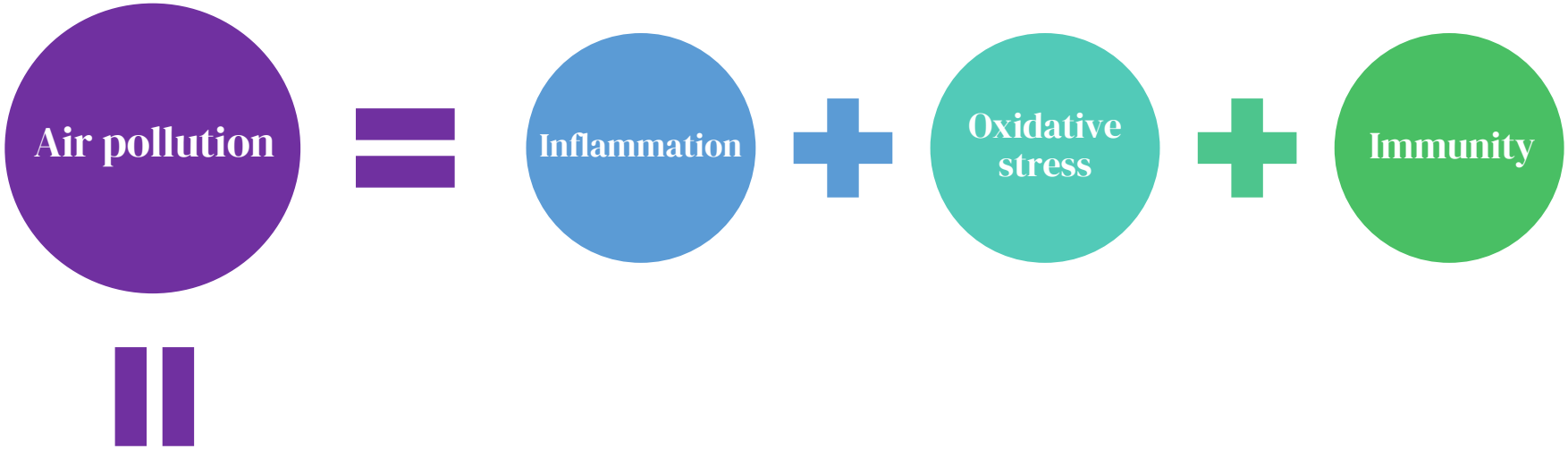
Main cause
Poorer control
Main prognostic factor
Frequency of exacerbations

Asthma

Risk factor
Worse control
Risk factor for exacerbations
Poorer disease progression

Guía GEMA 5.5. 2024; Guia GOLD 2024

Pollution



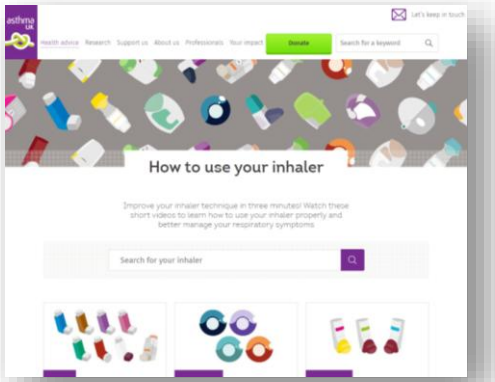
- ↑ **Prevalence, ↓control, ↑ symptoms and mortality**
- ↑ **Use of inhalers**

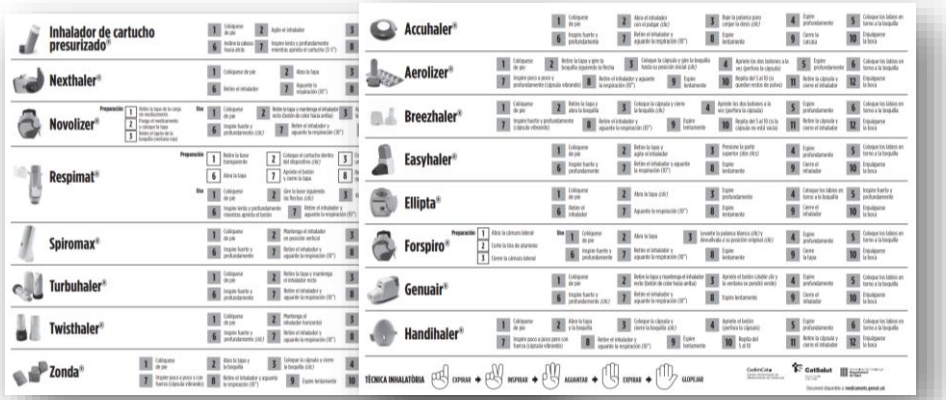
Huan Minh Tra, 2023

2. Asthma management

Inhaler technique

- Correct technique: 1/3 patients
- Consider: coordination, lung capacity, types, chambers, etc.
- Education + individualization +/- chambers





1. https://www.asthma.org.uk/advice/inhaler-videos/ 2. http://medicaments.gencat.cat/web/.content/minisite/medicaments/ciutadania/tractaments/Inhaladors/checklist_inhaladors_ESP.pdf

Adherence to inhalers

What are we talking about?

- 50% approx.
- 37% of prescriptions are not collected

Assessment:

- TAI: inhaler adherence test
- Nº dispensations, other.

		Puntuación
1.	En los últimos 7 días ¿cuántas veces olvidó tomar sus inhaladores habituales? ☐1. Todas ☐2. Más de la mitad ☐3. Aprox. la mitad ☐4. Menos de la mitad ☐5. Ninguna	
2.	Se olvida de tomar los inhaladores: ☐1.Siempre ☐2. Casi siempre ☐3. A veces ☐4. Casi nunca ☐5. Nunca	
3.	Cuando se encuentra bien de su enfermedad, deja de tomar sus inhaladores: ☐1.Siempre ☐2. Casi siempre ☐3. A veces ☐4. Casi nunca ☐5. Nunca	
4.	Cuando está de vacaciones o de fin de semana, deja de tomar sus inhaladores: ☐1.Siempre ☐2. Casi siempre ☐3. A veces ☐4. Casi nunca ☐5. Nunca	
5.	Cuando está nervioso/a o triste, deja de tomar sus inhaladores: ☐1.Siempre ☐2. Casi siempre ☐3. A veces ☐4. Casi nunca ☐5. Nunca	
6.	Deja de tomar sus inhaladores por miedo a posibles efectos secundarios: ☐1.Siempre ☐2. Casi siempre ☐3. A veces ☐4. Casi nunca ☐5. Nunca	
7.	Deja de tomar sus inhaladores por considerar que son de poca ayuda para tratar su enfermedad: ☐1.Siempre ☐2. Casi siempre ☐3. A veces ☐4. Casi nunca ☐5. Nunca	
8.	Toma menos inhalaciones de las que su médico le prescribió: ☐1.Siempre ☐2. Casi siempre ☐3. A veces ☐4. Casi nunca ☐5. Nunca	
9.	Deja de tomar sus inhaladores porque considera que interfieren con su vida cotidiana o laboral: ☐1.Siempre ☐2. Casi siempre ☐3. A veces ☐4. Casi nunca ☐5. Nunca	
10.	Deja de tomar sus inhaladores porque tiene dificultad para pagarlos: ☐1.Siempre ☐2. Casi siempre ☐3. A veces ☐4. Casi nunca ☐5. Nunca	

Las dos siguientes preguntas las deberá responder el profesional sanitario responsable del paciente según los datos que figuran en su historial clínico (pregunta 11) y tras comprobar su técnica de inhalación (pregunta 12)

11.	¿Conoce o recuerda el paciente la pauta (dosis y frecuencia) que se le prescribió? ☐1. No ☐2. Sí	
12.	La técnica de inhalación del dispositivo del paciente es: ☐1. Con errores críticos ☐2. Sin errores críticos o correcta	
	PUNTUACIÓN TOTAL	

Relationship with disease control (use of inhalers)

SABAs pMDI in Italy, Spain, France, Germany and the UK: 1.791.312 T CO2-eq/year

1. Wilkinson, 2021; 2. https://www.taitest.com/

OTHER: improve diagnosis, follow-up…

3. Reducing the impact of inhalers

Switching propellants

HFA	GWP	$t_{1/2}$
HFC-227ea	3350	34,2 years
HFC-134a	1300	14 years
HFC-152a	138	1,5 years
HFO-1234ze(E)	<1	18 days

1. Woodcock, 2022; 2. De Boer 2024.

BUT…

PFAS: Per- and polyfluoroalkyl substances

HFC-152a

- Still some CF
- Capacity to transform into PFA in the environment?

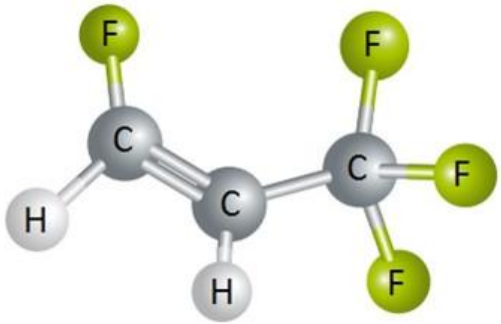
HFO-1234ze(E)

- Chemically PFAs

FOREVER CHEMICHALS

with potential harmful health effects

Need of more information?



If the propellant were inert, would it still be a problem?


YES!


NO.


YES!

Not only carbon footprint…

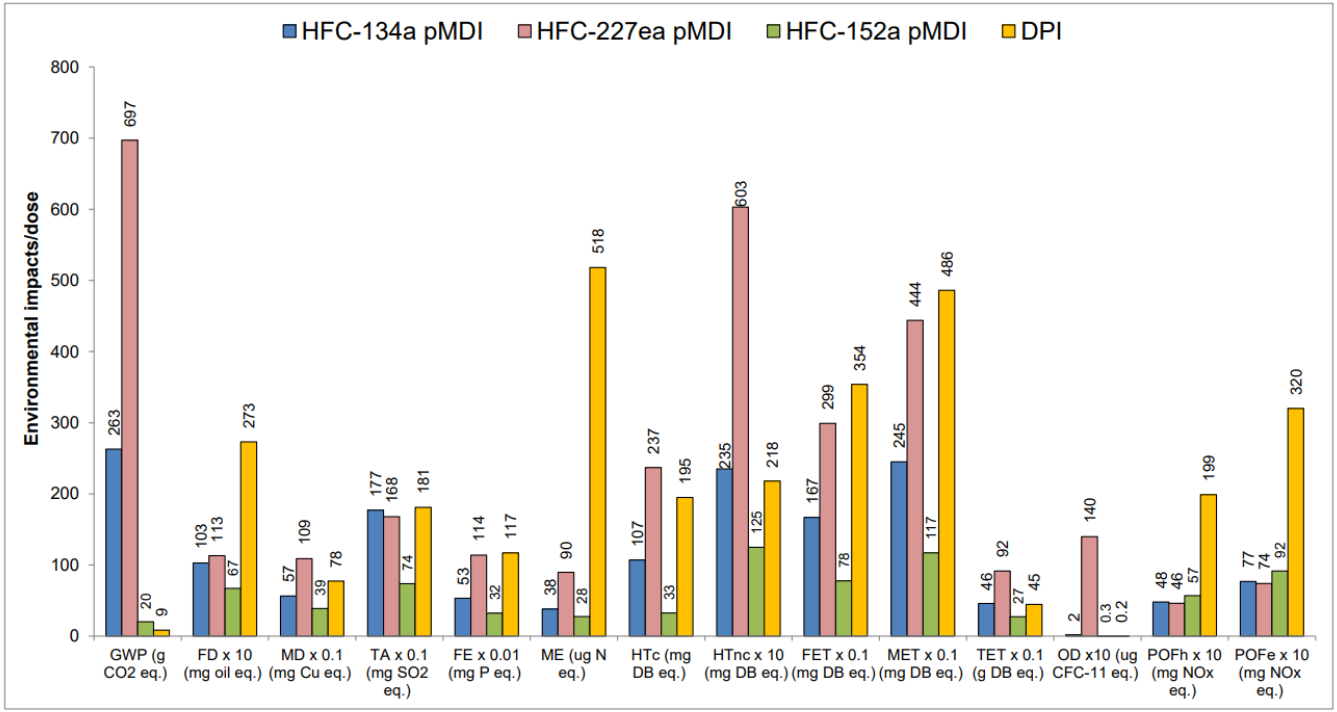
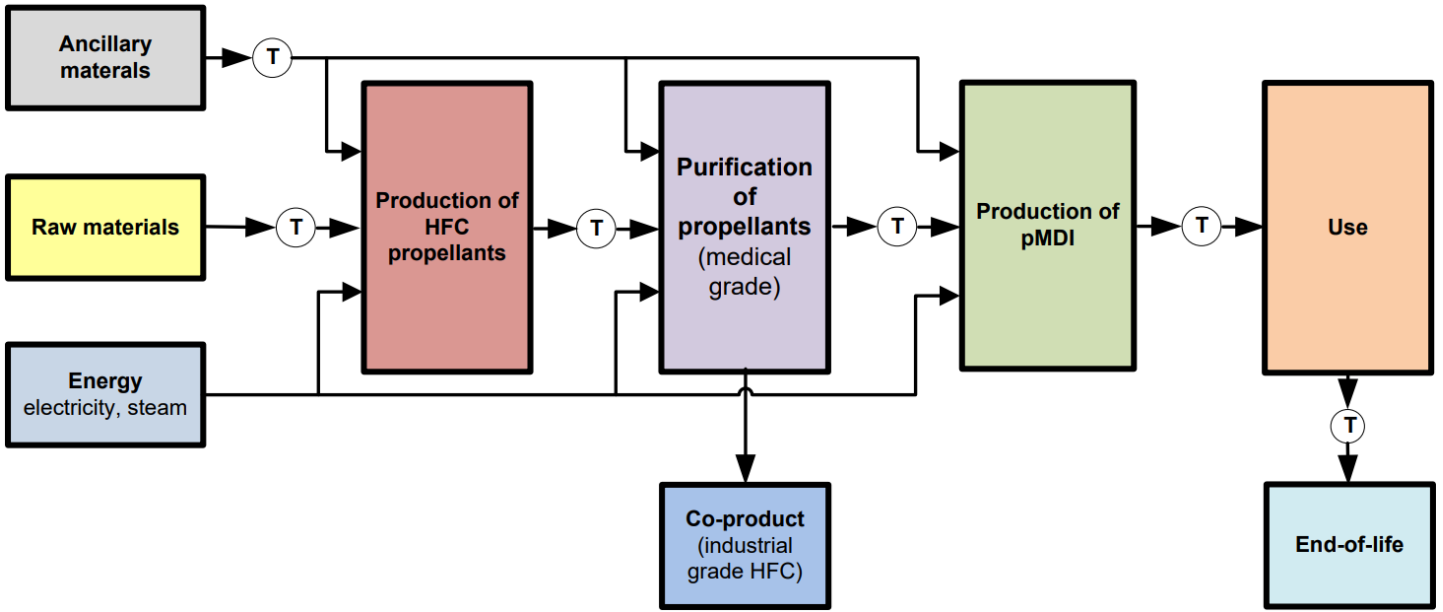


Figure 3 Life cycle environmental impacts of inhalers

[pMDI: pressurised metered-dose inhaler. DPI: dry powder inhaler. GWP: global warming potential; FD: fossil depletion; MD: metal depletion; TA: terrestrial acidification; FE: freshwater eutrophication; ME: marine eutrophication; HTc: human toxicity cancer; ; HTnc: human toxicity non-cancer FET: freshwater ecotoxicity; MET: marine ecotoxicity; TET: terrestrial ecotoxicity; OD: ozone depletion; POFh: photochemical oxidants formation – human health; POFe: photochemical oxidants formation - ecosystem. Some impacts have been scaled to fit and should be multiplied by the factor shown on the x-axis to obtain the original values.]

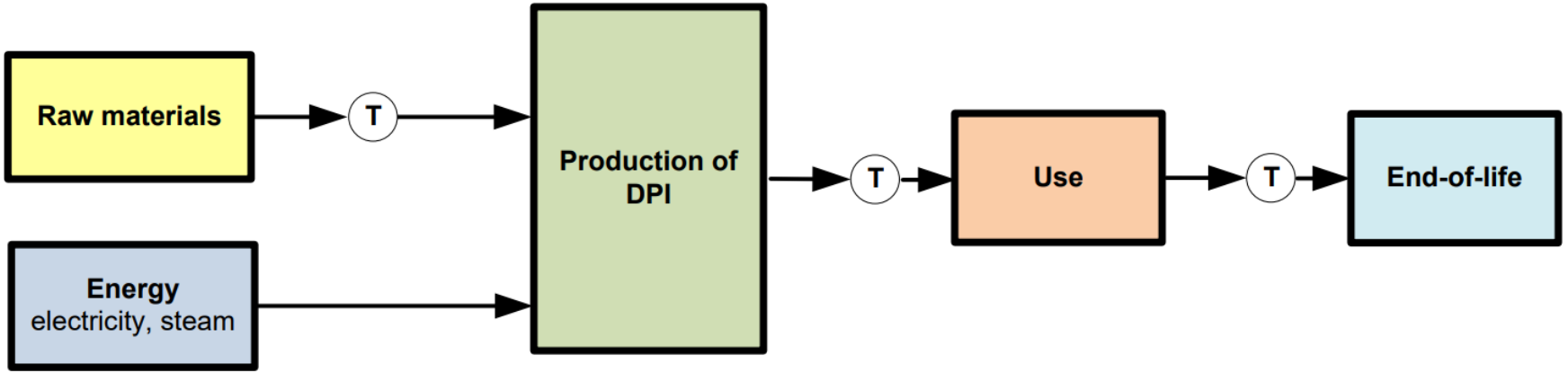
Jeswani. 2019

pMDI manufacturing



Jeswani. 2019

DPI manufacturing



Jeswani. 2019

Example: materials

Table 1 Inventory data for raw materials for the production of inhaler devices

Size	pMDI 100 doses (200 actuations) [a]	DPI 60 doses [a]
Aluminium	7.6 g	20 g
Teflon (for coating)	0.004 g	-
Polypropylene	14 g	1.3 g
Polyoxymethylene	0.4 g	7.7 g
Polymethylmethacrylate	0.006 g	-
Acrylonitrile-butadiene-styrene copolymer	-	35.6 g
Nylon	-	5 g
Polycarbonate	-	2.4 g
Polyvinylchloride	-	5 g

[a] pMDI: Pressurised metered-dose inhaler. DPI: dry powder inhaler (blister-based Diskus). The number of doses are based on a typical size of devices in the UK.

Jeswani. 2019

Other ways of reducing the impact:

Lower dose pMDI for tests

Reusable inhalers

4. Waste management

Propellants and more…

Plastic

Health effects
Slow degradation

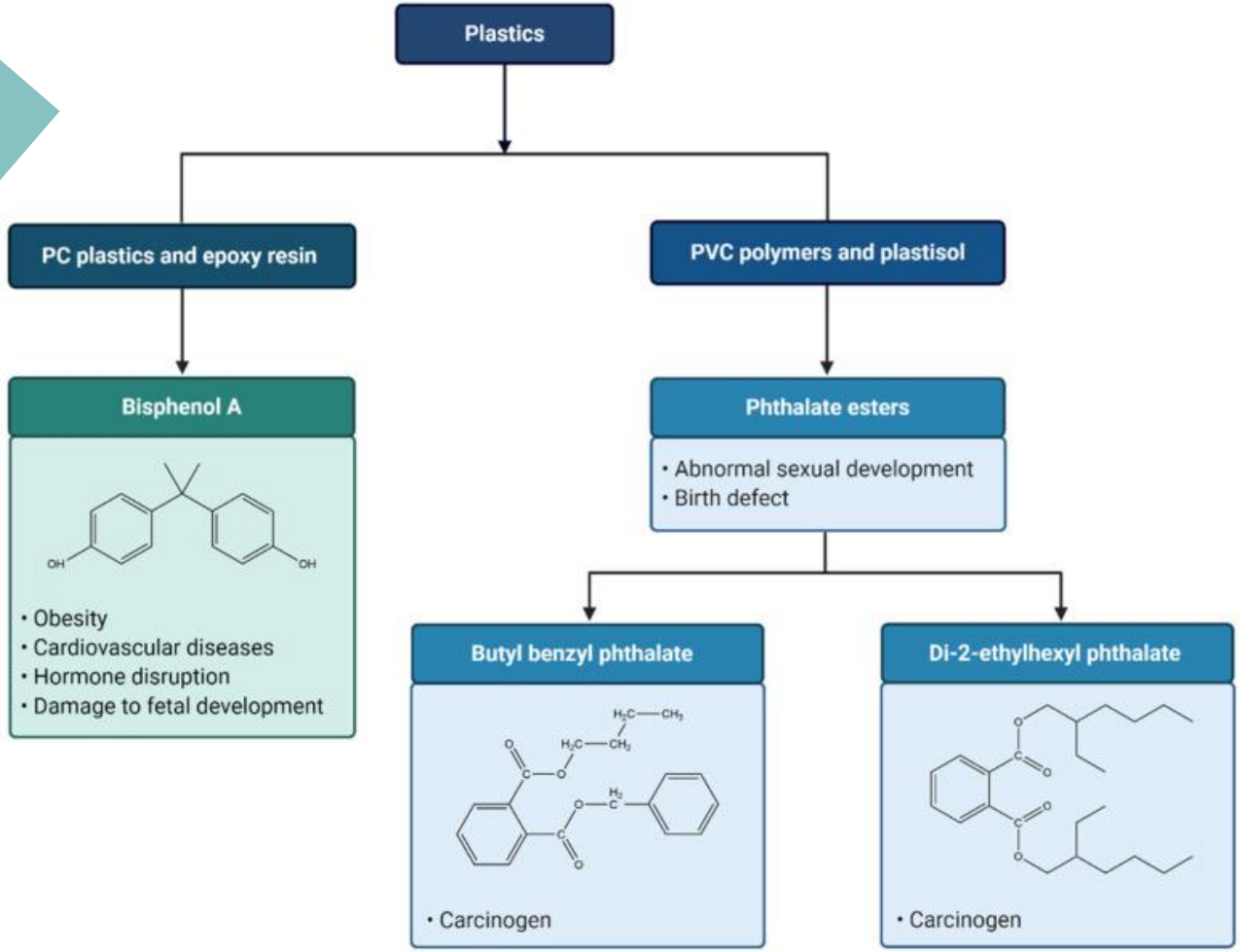
Metal

Energy consumption

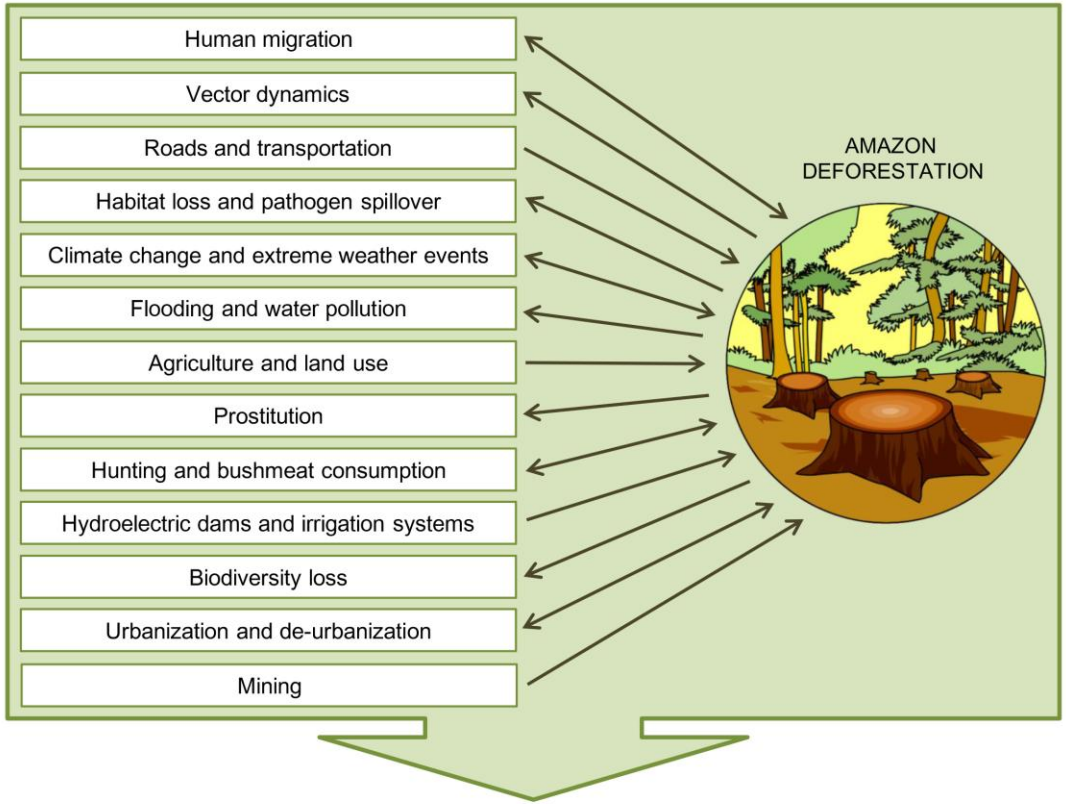
Paper-carboard

Deforestation

Impact of plastics



Effects of deforestation

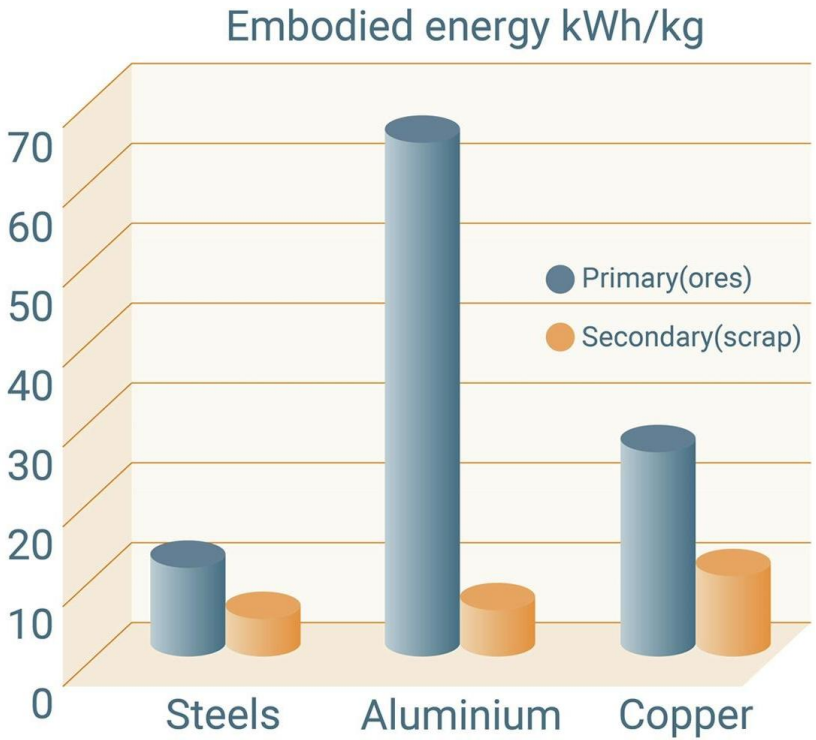


"PERFECT STORM" OF INFECTIOUS DISEASES

Ellwanger et al. 2020.

Metals

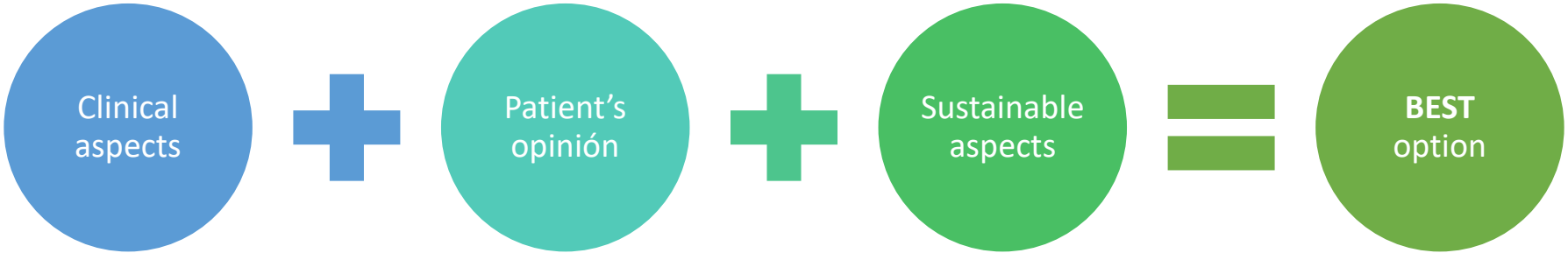
Recycling Aluminium reduces energy consumption and GHG emissions by > 90%



Raabe et al 2022.

5. Sustainable prescription

Sustainable prescripton



6. Regulatory aspects

INTERNATIONAL OBJECTIVE:

Limit global warming to 1.5°C

↓ fluorinated gas emissions by 90% by 2050 compared with 2015 levels

https://eur-lex.europa.eu/resource.html?uri=cellar:ecf2b875-b59f-11ec-b6f4-01aa75ed71a1.0016.02/DOC_1&format=PDF

REGULATION (EU) 2024/573

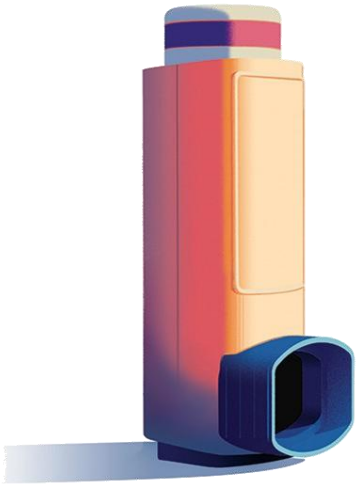
(20) La fabricación de inhaladores dosificadores para la administración de ingredientes farmacéuticos usa una proporción no desdeñable de todos los HFC que se consumen actualmente en la Unión. Existen opciones alternativas, como los inhaladores dosificadores que usan como propulsores gases fluorados de efecto invernadero con menor PCG, que han sido desarrolladas recientemente por la industria. El presente Reglamento incluye el sector de los inhaladores dosificadores en el sistema de cuotas de HFC, creando así un incentivo para que la industria siga avanzando hacia alternativas más limpias. Para permitir una transición sin trabas, el mecanismo de cuotas previsto para el sector de los inhaladores dosificadores garantizará una cuota completa, correspondiente a la cuota de mercado más reciente de dicho sector, para el período de 2025 a 2026, y alcanzará la tasa de reducción completa de los demás sectores comprendidos en el sistema de cuotas únicamente en 2030. Los HFC usados como propulsores en inhaladores dosificadores son esenciales para la salud de los pacientes que padecen afecciones respiratorias, como el asma y la enfermedad pulmonar obstructiva crónica. Los inhaladores dosificadores son medicamentos sujetos a evaluaciones rigurosas, incluidos estudios clínicos, a fin de garantizar la seguridad de los pacientes. La cooperación entre la Comisión, las autoridades competentes de los Estados miembros y la Agencia Europea de Medicamentos debe facilitar un proceso sencillo de aprobación de los inhaladores dosificadores que usen gases fluorados de efecto invernadero de bajo PCG y alternativas a los gases fluorados de efecto invernadero, y de ese modo asegurar la transición hacia soluciones más limpias.

https://www.boe.es/doue/2024/573/L00001-00067.pdf

Alternatives

… not always clinical alternatives

… all have potential environmental impact



Pressurized

Dry powder

Soft mist

Nebulitzed

OUR INITIATIVES

Gestión del impacto ambiental de los inhaladores desde la Farmacia Hospitalaria

PROYECTO GIMAFH 360

Sustainable use of inhalers

Sustainable prescription

Patient participation

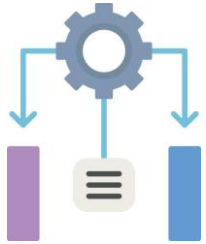
Healthcare management

Sustainable prescription

Aimed to develop a resource that supports sustainable prescribing

- **Database of environmental impact of inhalers in Spain**
- **Decision-making algorithm based on patient characteristics**
- **Scenarios — projections**

Environmental impact database of inhalers in Spain



- Carbon footprint
  - Total
  - Life-cycle stages
- Other variables (n=9)

Search
ATC R03

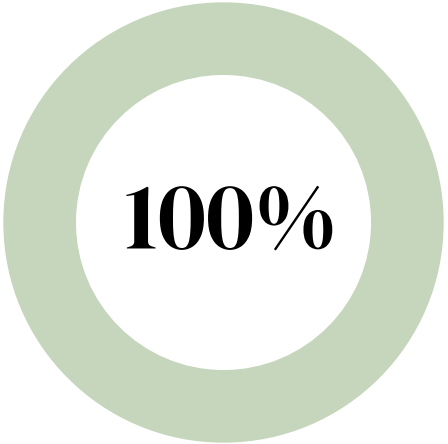
Database
190 inhalers

Contact to
24 laboratoris

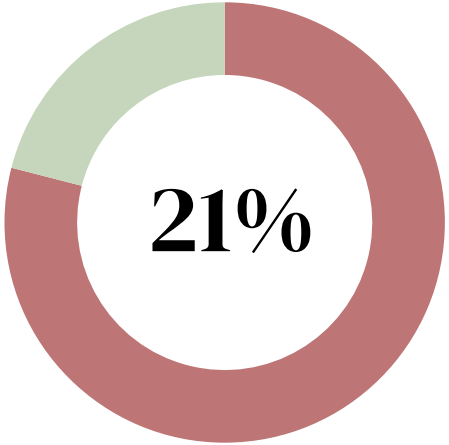
Algorithm for
additional data

Environmental impact database of inhalers in Spain

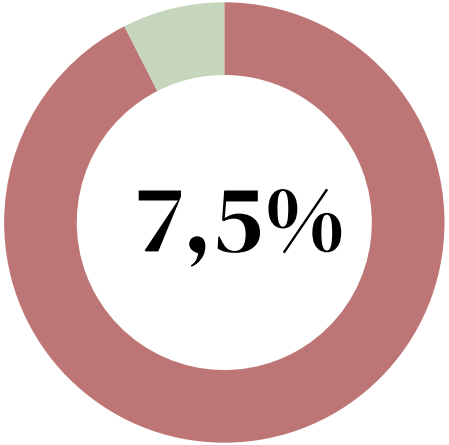
Total carbon footprint



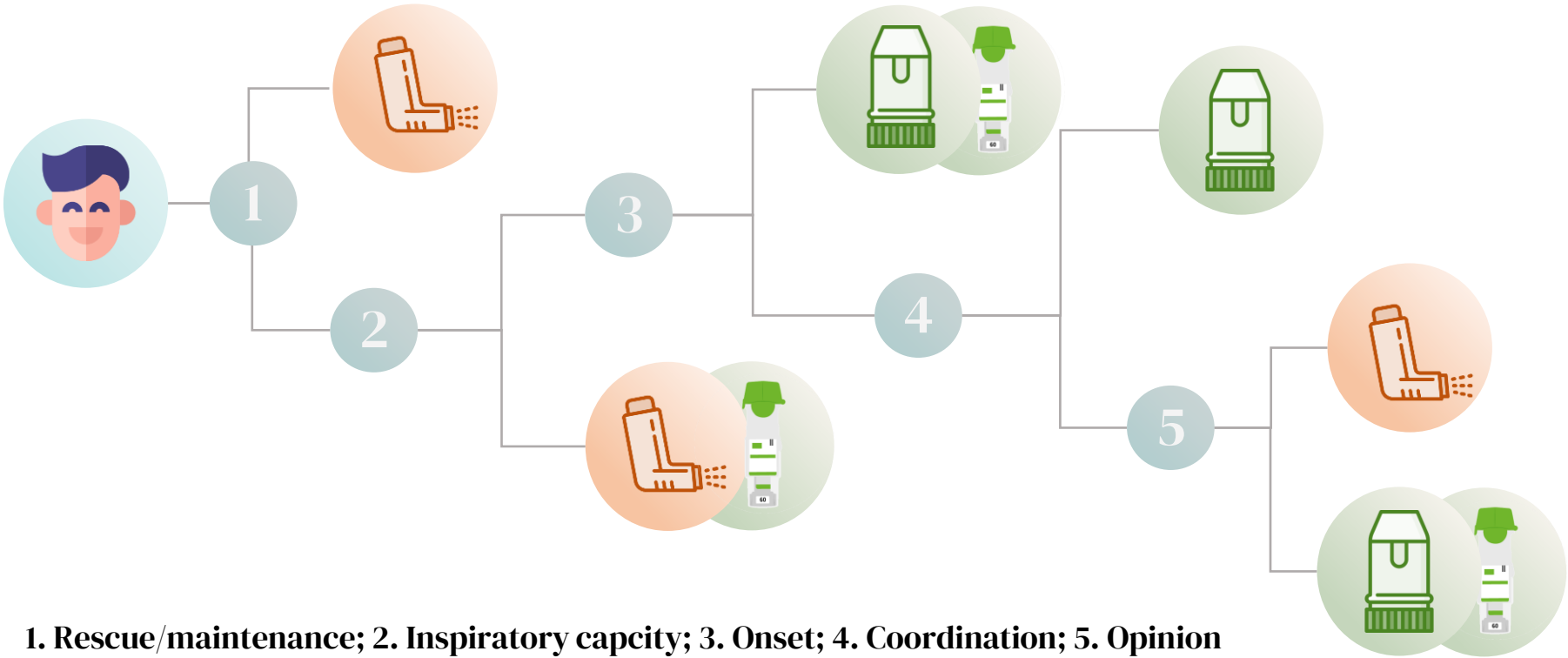
Life-cycle stages CF



Other variables



Decision-making algorithm for sustainable prescribing



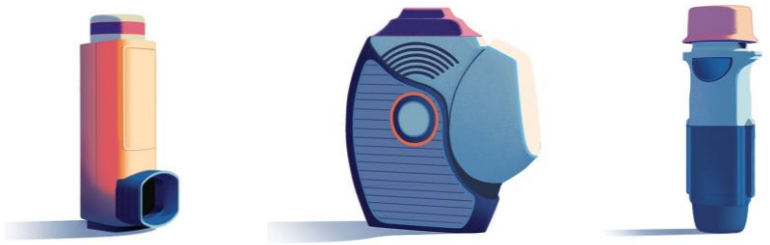
1. Rescue/maintenance; 2. Inspiratory capcity; 3. Onset; 4. Coordination; 5. Opinion

Decision-making algorithm for sustainable prescribing

In clinically appropriate cases and in agreement with the patient:

Switch pMDI → DPI/SMI does not affect asthma control

Avoid changes without patient agreement



Woodcock 2022

Scenario projections

Table 1 Projections of CO_2 emission savings in different scenario projections

Scenario projections	CO_2e Savings
National projections in Spain	
10% shift from pMDIs to DPIs	40 000 tonnes CO_2e/year
50% shift from pMDIs to DPIs	200 000 tonnes CO_2e/year
Individual patient projections	
Switching salbutamol from pMDI to DPI	27.42 kg CO_2e/inhaler
Switching salbutamol pMDI to ipratropium bromide pMDI	13.41 kg CO_2e/inhaler
Consolidating LABA/LAMA/IC triple therapy (2 pMDIs into a single DPI)	664.08 kg CO_2e/patient/year
Environmental sustainability practices	
pMDI waste management vs prescribing DPIs	17.97 kg CO_2e/inhaler

CO_2e, carbon dioxide equivalent; DPI, dry-powder inhaler; IC, inhaled corticosteroids; LABA, long-acting beta-agonists; LAMA, long-acting muscarinic antagonists; pMDI, pressurised metered-dose inhalers.

Framework for sustainable prescription practices in Spain

Original research

The environmental impact of inhalers: a framework for sustainable prescription practices in Spain

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► Additional supplemental material is published online only. To view, please visit the journal online (https://doi.org/10.1136/ejhpharm-2024-004402).

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Received 29 October 2024
Accepted 23 December 2024

EAHP Statement 4: Clinical Pharmacy Services.

Check for updates

To cite: Garin N, Zarate-Tamames B, Lertxundi U, *et al*. *Eur J Hosp Pharm* Epub ahead of print: [please include Day Month Year]. doi:10.1136/ejhpharm-2024-004402

ABSTRACT

Background The healthcare sector contributes significantly to global greenhouse emissions, with inhalers being major contributors.

Objective To develop a framework for reducing the environmental footprint of inhalers in Spain by implementing greener prescription practices.

Methods A multidisciplinary working group was formed, including hospital pharmacists, pulmonologists, and environmental experts. We created a comprehensive database on the environmental impact of inhalers marketed in Spain, incorporating product specifications and environmental data from the Spanish Agency of Medicines and Medical Devices and pharmaceutical companies. We developed a decision-making algorithm integrating clinical and environmental criteria and performed scenario projections to estimate potential benefits of transitioning from pressurised metered-dose inhalers (pMDIs) to dry powder inhalers (DPIs) and other eco-friendly alternatives. Scenarios included global and individual projections, as well as comparisons between sustainable prescriptions and waste-management strategies.

Results The national database revealed significant variability in the carbon footprint across inhaler types, with pMDIs showing the highest emissions. A shift of 10% from pMDIs to DPIs could reduce CO_2 emissions by approximately 40 000 tonnes/year, and a 50% shift by up to 200 000 tonnes. The decision-making algorithm effectively combined clinical and environmental considerations, facilitating the selection of more sustainable inhalers.

Conclusion The study highlights the importance of incorporating environmental criteria into inhaler prescribing choices to reduce healthcare's carbon footprint. Transitioning from pMDIs to DPIs when clinically indicated offers considerable environmental benefits without compromising patient health. The developed decision-making algorithm provides a practical tool for healthcare professionals, balancing clinical efficacy with sustainability. Future research should refine these practices and explore their application in other medical devices.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Medicines, including inhalers, contribute significantly to environmental degradation, with pressurised metered-dose inhalers emitting large amounts of greenhouse gases owing to hydrofluoroalkane propellants.

WHAT THIS STUDY ADDS

⇒ This study establishes a carbon footprint database and an algorithm to guide environmentally sustainable prescribing choices for inhaler prescriptions in Spain. Also, individual and global estimated projections highlight the substantial benefits of switching inhalers when clinically indicated.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE, OR POLICY

⇒ This framework supports eco-conscious prescribing. The results of our study may help clinicians to minimise the impact of inhalers considering clinical and environmental aspects, as well as to promote the implementation of sustainable practices in future clinical guidelines and policies.

INTRODUCTION

The healthcare sector is a significant contributor to environmental degradation at multiple levels. It accounts for 5.5% of global carbon footprint, reaching up to 10% in some countries.[1] If considered a country, healthcare would rank fifth in terms of carbon emissions. Energy consumption is a major driver of this impact, with healthcare facilities responsible for over 10% of total energy use. However, material supply is the largest contributor to the healthcare sector's carbon footprint, accounting for 71%.[2] The impact of the manufacturing, distribution and use of supplies goes beyond greenhouse gases, involving air pollutants (PM10, NO_x, SO_x), solid waste such as chemicals and plastics, significant water consumption, deforestation (more than half of waste being paper/cardboard), river contamination by pharmaceuticals, and excessive water use.

These factors collectively threaten global health and well-being. In fact, 24% of global deaths are linked to the environment.[3] WHO estimates that between 2030 and 2050, climate change will cause an additional 250 000 deaths annually.[4] Health risks encompass injuries, respiratory diseases, water-borne diseases, malnutrition, vector-borne diseases, zoonosis, non-communicable diseases or mental conditions arising from the coexistence of vulnerability factors, climate-related hazards and exposure pathways. Specifically, for respiratory diseases, each degree Celsius increase above 29°C correlates with a 7% increase in mortality rates and a 4% increase in respiratory-related hospital admissions.[5] Thus, these negative health effects undermine the sustainability of healthcare systems

GIMAFH project: 40 hospitals

Aimed at contributing to the management of inhalers in order to minimize their environmental impact through:

- Exploring the prevalence of correct disposal at the SIGRE collection point
- Evaluating the factors related to better waste management
- Improving patient management and assessing results
- Empowering healthcare professionals

Waste management

Need of patients' participation

Waste processing

SIGRE

How do we achieve this?

What we did

Multicenter, multidisciplinary, prospective project in patients with AGNC

Phase 1

Inclusion
+ EHR variables

Questionnaire

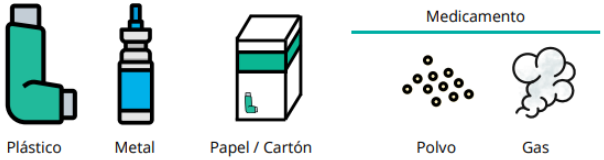
Education

Phase 2

Environmental
re-assessment

TU INHALADOR Y LA SALUD DEL PLANETA

¿Sabías que los inhaladores están formados por varios componentes?



¿Sabías que estos componentes pueden afectar al medio ambiente?

Los **gases** "hidrofluoroalcanos" contribuyen al **efecto invernadero**

El **plástico** tarda hasta 400 años en desintegrarse

Los **metales** requieren altas energías para su fabricación

El uso desmedido de **papel** y **cartón** favorece la deforestación

¿Conoces la huella de carbono de los inhaladores?

La huella de carbono mide el efecto invernadero en forma de kg de CO_2

1 inhalador* = 30 kg CO_2 = 300 km de emisiones de un coche

*variable según el tipo de inhalador

neumo sefh

TU INHALADOR Y LA SALUD DEL PLANETA

¿Qué podemos hacer para minimizar el impacto?

Los medicamentos se deben desechar en el **punto SIGRE** de tu oficina de farmacia

Puedes acudir a tu farmacia **sin ningún coste** y ayudar al planeta

¿Qué medicamentos se pueden depositar en el punto SIGRE?

Inhaladores **caducados**

Envases **vacíos y cajas de medicamentos**

Medicamentos que **no vayas a usar**

RECUERDA: también se deben desechar otros medicamentos

Recuerda:

- Es muy importante que utilices tus inhaladores **como te aconseje tu médico o farmacéutico**
- Los inhaladores tienen un **impacto importante en la salud del planeta**
- Un **correcto manejo de sus residuos** minimizan el impacto ya que se pueden reciclar o tratar adecuadamente
- Para ello, deposita tus medicamentos en el **punto SIGRE de la farmacia**

neumo sefh

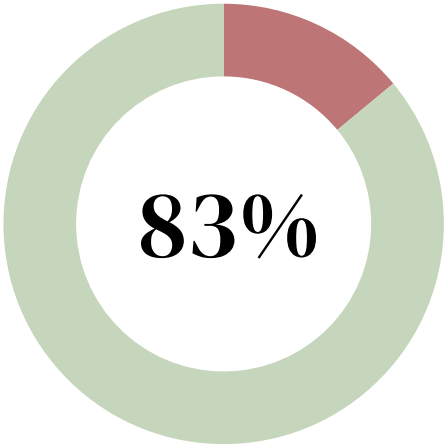
Results (preliminary data)

>50%

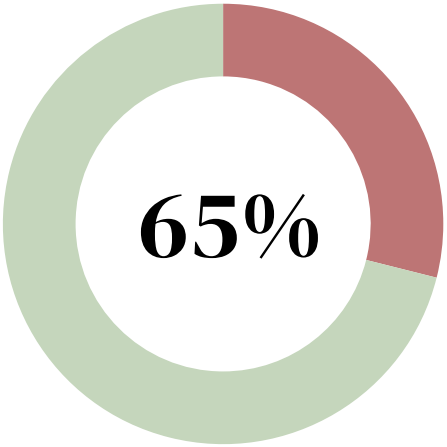
pacients believe inhalers have less impact than other medicines

Results (preliminary data)

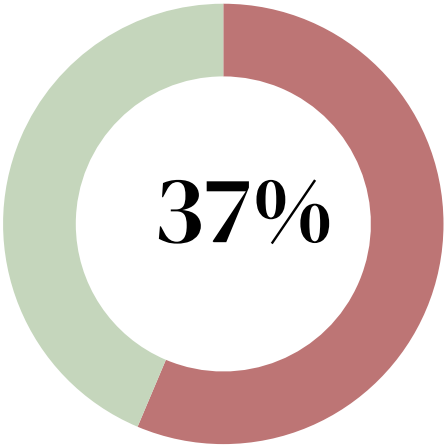
Awareness of medication disposal programme



Medicines disposal at pharmacy collection points



Inhaler disposal at pharmacy collection points



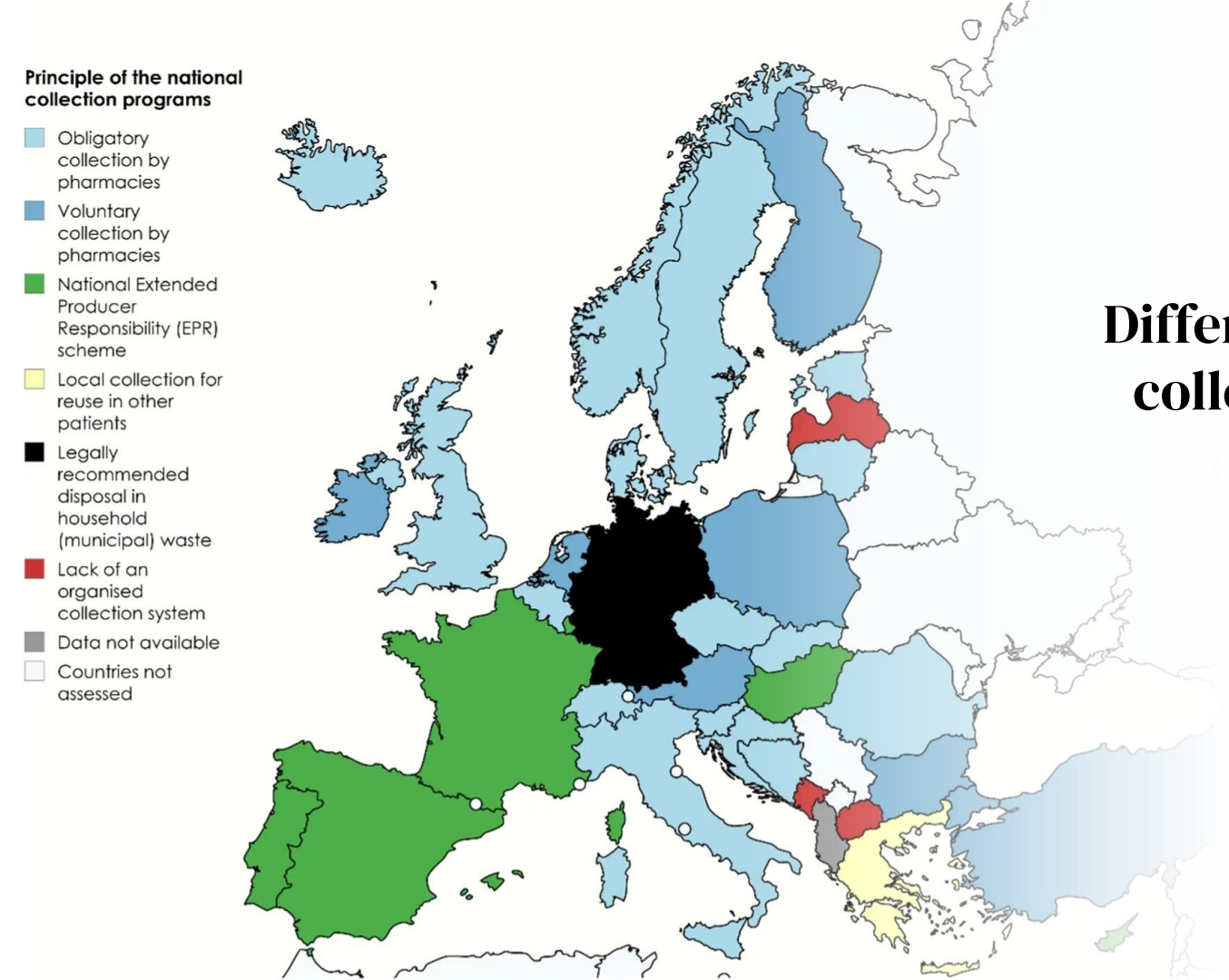
Results (preliminary data)

After the education intervention...

ALL environmental behaviours improved

Context

Differences in national collection programs



Kardas et al. 2026.

GIMAFH project: pilot project

Aimed at lowering emissions due to intra-hospitalary waste

- Assessing yearly emissions due to inhalers used in the hospital
- Evaluating possible improvements in a multidisciplinary team
- Implementing a hospital-level inhaler waste management system
- Reducing hydrofluorocarbon emissions generated in the hospital

Single-hospital pilot project

Spirometries and other tests:

- Discarded inhalers after 1-4 puffs

Emergency/admitted patients

- Discarded after improvement

Single-hospital pilot project

NEW workflows

Hospital-generated waste

341 T CO_2/year

emissions prevented

Conclusions

(Some) conclusions

- Inhalers have a major impact on the environment
- Products need to be adapted, including HFAs, manufacturing, etc.
- A selection algorithm based on clinical criteria is essential
- Selection has a greater impact and complements recycling
- Multilevel approach: prevention, management, legislation, etc.

Thank you