Supporting Information

Supplementary results

This appendix was part of the submitted manuscript and has been peer reviewed. It is posted as supplied by the authors.

Appendix to: Verlis K, Davies JF, McGain F, et al. Greenhouse gas emissions associated with anaesthetic gases in Australia, 2002–2022: a retrospective descriptive analysis. *Med J Aust* 2025; doi: 10.5694/mja2.00000.

Supplementary results

Table 1. Total carbon dioxide equivalent (CO_2e) emissions and population CO_2e emission rates for anaesthetic gases, Australia, 2002–2022, overall and by anaesthetic gas

	a) Total CO2e emissions (t)				b) CO2e emissions per 100,000 population (t)			
Year	Desflurane	Sevoflurane	Isoflurane	Total	Desflurane	Sevoflurane	Isoflurane	Total
2002	4,872.86	4,699.18	4,977.56	14,549.59	25.00	24.10	25.53	74.63
2003	17,273.10	4,849.66	3,804.33	25,927.09	87.59	24.59	19.29	131.47
2004	26,379.54	5,189.96	3,182.44	34,751.94	132.34	26.04	15.97	174.35
2005	33,286.77	5,914.65	2,453.70	41,655.13	164.98	29.31	12.16	206.45
2006	42,875.85	6,529.56	2,091.05	51,496.46	209.65	31.93	10.22	251.80
2007	52,448.54	6,795.96	1,654.82	60,899.32	251.82	32.63	7.95	292.40
2008	59,810.19	7,412.78	1,414.53	68,637.49	281.47	34.88	6.66	323.01
2009	62,291.69	7,615.39	1,190.16	71,097.25	287.17	35.11	5.49	327.76
2010	63,445.48	7,870.74	1,002.89	72,319.11	287.97	35.72	4.55	328.25
2011	62,696.93	8,140.48	877.91	71,715.31	280.65	36.44	3.93	321.02
2012	65,758.51	8,115.81	733.37	74,607.69	289.26	35.70	3.23	328.18
2013	66,341.33	8,118.32	693.05	75,152.70	286.84	35.10	3.00	324.94
2014	63,790.61	8,373.51	640.44	72,804.56	271.73	35.67	2.73	310.13
2015	64,484.52	8,268.92	604.96	73,358.40	270.76	34.72	2.54	308.02
2016	62,521.17	8,276.63	490.46	71,288.26	258.45	34.21	2.03	294.69
2017	57,104.66	8,145.67	477.56	65,727.90	232.20	33.12	1.94	267.27
2018	49,336.87	8,001.59	429.78	57,768.24	197.64	32.05	1.72	231.41
2019	40,316.94	7,809.80	389.26	48,516.01	159.14	30.83	1.54	191.50
2020	29,868.21	7,043.10	211.46	37,122.78	116.45	27.46	0.82	144.73
2021	22,977.37	7,230.57	200.98	30,408.92	89.46	28.15	0.78	118.39
2022	14,868.08	6,775.83	158.25	21,802.16	56.50	25.75	0.60	82.85

Table 2. Joinpoint trend analysis of carbon dioxide equivalent (CO_2e) emissions associated with anaesthetic gases, Australia, 2002–2022

Year	Australia Emissions tonnes (t) of CO_2e			By state and territory Emissions (tCO_2e) per 100,000 population					By hospital type Emissions (tCO_2e) per 100,000 population			
									Desflurane		Sevoflurane	
	Total	Total per 100,000 population	Total Desflurane	NSW & ACT	QLD	SA & NT	VIC & TAS	WA	Public	Private	Public	Private
Start	2002	2002	2002	2002	2002	2002	2002	2002	2002	2002	2002	2002
	14,550	74	4,873	87	59	84	60	87	10	14	12	12
APC1 (95% CI)	52.8% (38.9 to 64.7%)	51.3% (37.9 to 61.7%)	119.8% (84.4 to 148.2%)	56.4% (47.0 to - 65.6%)	69.3% (49.4 to87.2%)	38.4% (28.1 to 54.2%)	19.8% (15.0 to 29.6%)	76.4% (62.0 to -91.6%)	137.5% (86.0 to - 178.5%)	109.4% (81.3 to 129.6%)	9.9% (8.6 to 12.1%)	5.3% (4.5 to 6.8%)
Joinpoint 1	2004	2004	2004	2004	2004	2005	2004	2004	2004	2004	2006	—
	34,752	173	26,379	220	166	214	88	251	60	71	18	—
APC2 (95% CI)	18.8% (13.2 to 22.4%)	16.7% (11.5 to 20.0%)	21.2% (12.5 to 31.3%)	12.4% (8.7 to15.5%)	18.2% (12.1 to 23.5%)	7.6% (5.1 to 10.4%)	33.2% (-0.2 to 36.9%)*	1.5% (0.5 to 2.6%)	15. 8% (8.6 to 24.0%)	18.8% 11.2 to 27.3%)	3.3% (1.4 to 5.4%)	—
Joinpoint 2	2008	2008	2008	2008	2008	2013	2008	2016	2009	2008	2010	2009
	68,637	320	59,810	355	324	414	266	317	130	150	20	16
APC3 (95% CI)	0.08% (-1.0 to 1.2)*	-1.5% (-2.5 to -0.5%)	0.3% (-2.2 to 2.3%)*	-3.1% (-3.9 to -2.3%)	0.1% (-2.5 to 2.1%)*	-7.6% (-11.6 to -4.3%)	-1.4% (-2.5 to -0.8%)	-16.7% (-26.6 to -5.2%)	-7.5% (-10.4 to -5.1%)	1.2% (-0.9 to 3.1%)*	-1.4% (-2.1 to -0.9%)	0.5% (-1.4 to 2.6%)*
Joinpoint 3	2017	2017	2017	2017	2016	2019	2017	2019	2018	2017	2018	2014
	65,724	265	57,104	263	317	244	233	202	60	154	18	16
APC4 (95% CI)	-20.2% (-21.9 to -18.3%)	-21.1% (-22.6 to -19.6%)	-23.4% (-28.7 to -19.6%)	-19.8% (-21.2 to -18.5%)	-18.5% (-21.0 to -15.9%)	-32.1% (-37.1 to -26.4%)	-18.0 (-19.4 to -16.8%)	-35.6% (-43.9 to -33.2%)	-42.6% (-47.6 to -36.6%)	-19. 8% (-24.5 to -16.7%)	-7.0% (-9.2 to -5.7%)	-3.3% (-4.4 to -2.6%)
End	2022	2022	2022	2022	2022	2022	2022	2022	2022	2022	2022	2022
	21,802	83	14,868	85	90	82	89	48	7	49	13	13

APC = annual percentage change; CI =confidence interval.

* Not statistically significant (95% CI includes 0).

Figure 1. Total number of desflurane, sevoflurane, isoflurane units purchased, Australia, 2002-2022

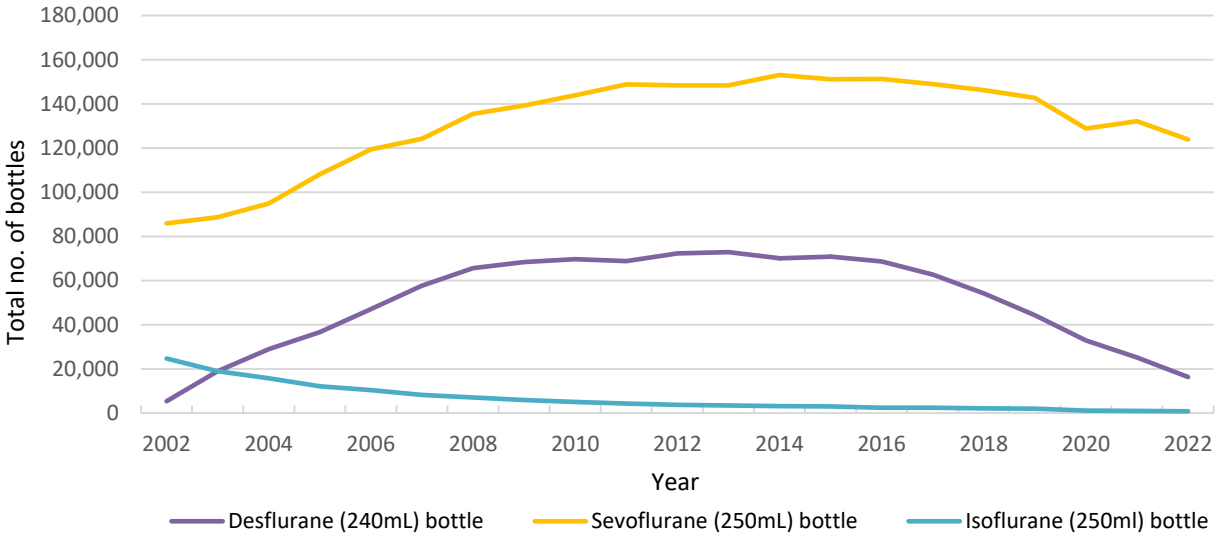


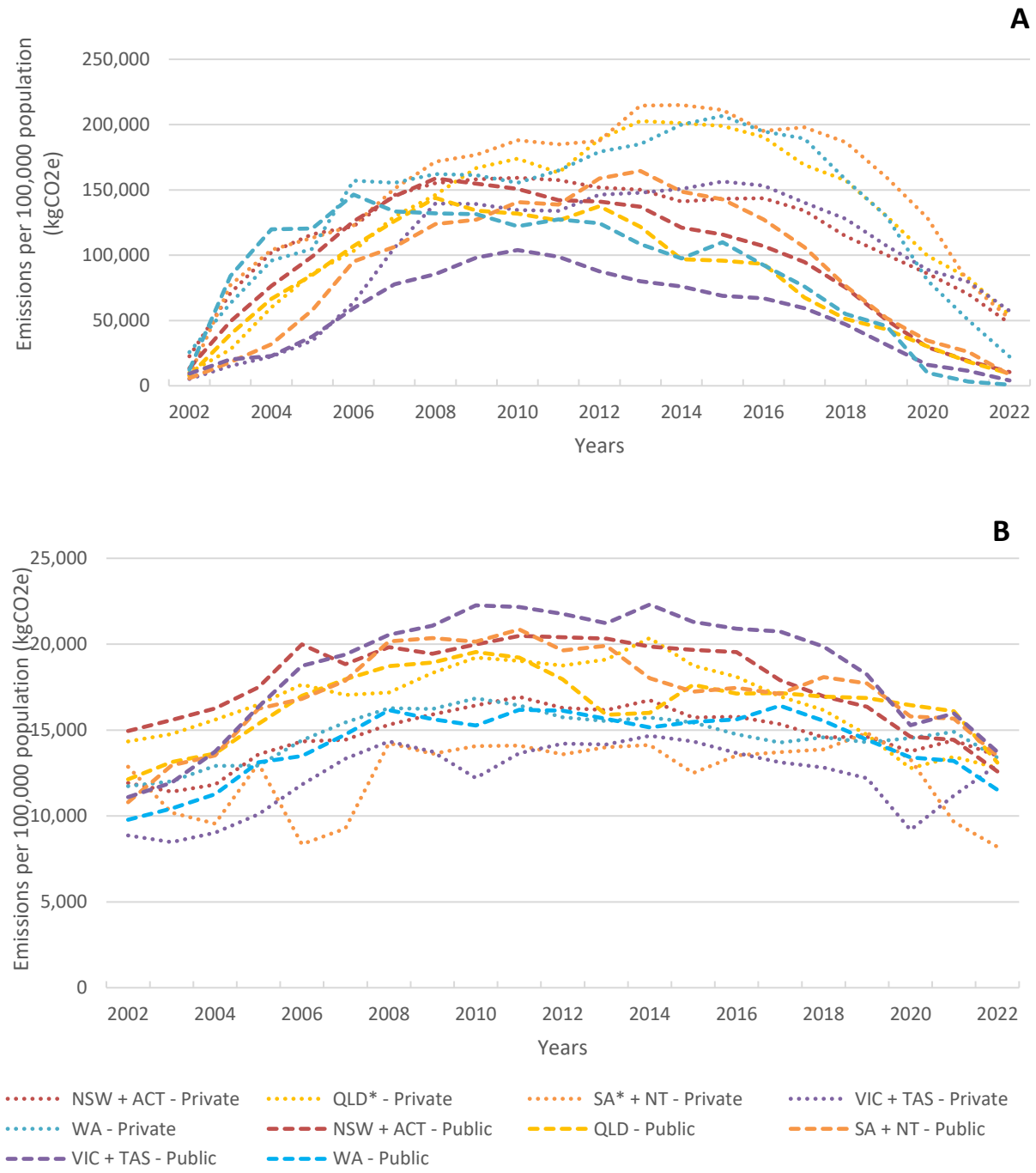
Table 3. Population carbon dioxide equivalent (CO_2e) emission rates for anaesthetic gases, Australia, 2002–2022, by state and territory*

	Total CO2e emissions per 100,000 population (t)				
Year	**NSW & ACT**	**QLD**	**SA & NT**	**VIC & TAS**	**WA**
2002	87.23	60.15	83.93	60.61	87.27
2003	164.88	108.31	144.56	79.56	187.92
2004	221.07	167.78	180.02	88.43	252.37
2005	257.83	210.13	215.00	115.25	260.93
2006	293.77	250.68	253.09	167.32	337.03
2007	333.68	295.39	290.62	226.09	325.51
2008	357.87	327.98	336.18	268.61	329.92
2009	355.77	339.88	342.77	278.21	329.84
2010	353.32	346.11	366.14	277.42	313.95
2011	342.43	328.91	363.09	272.49	328.68
2012	333.61	364.53	383.10	273.59	338.79
2013	327.97	360.46	415.72	266.51	327.23
2014	302.15	335.56	398.11	267.06	330.03
2015	297.72	331.92	386.42	264.10	348.91
2016	288.44	319.76	356.24	257.31	318.29
2017	265.04	271.46	337.06	235.50	297.46
2018	223.95	242.01	297.51	209.39	243.71
2019	183.97	205.02	245.25	170.76	204.53
2020	145.03	159.08	192.61	130.33	118.85
2021	119.30	130.88	130.94	118.85	81.52
2022	85.30	89.79	81.65	88.74	47.98

Table 4. Population carbon dioxide equivalent (CO_2e) emission rates for desflurane and sevoflurane, Australia, 2002–2022, by hospital type

	CO_2e emissions per 100,000 population (t)			
	Public hospitals		Private hospitals	
Year	Desflurane	Sevoflurane	Desflurane	Sevoflurane
2002	10.46	12.50	14.54	11.61
2003	40.21	13.39	47.38	11.20
2004	60.46	14.34	71.88	11.70
2005	78.21	16.22	86.76	13.09
2006	103.55	18.13	106.10	13.80
2007	118.53	18.32	133.29	14.31
2008	130.22	19.46	151.25	15.43
2009	130.54	19.47	156.63	15.64
2010	130.44	20.03	157.54	15.69
2011	125.37	20.26	155.28	16.17
2012	125.59	19.76	163.67	15.94
2013	117.68	19.14	169.17	15.96
2014	103.61	19.09	168.12	16.58
2015	100.42	19.06	170.34	15.66
2016	93.24	18.85	165.20	15.36
2017	78.48	18.32	153.73	14.81
2018	60.49	17.71	137.15	14.35
2019	43.20	16.89	115.94	13.94
2020	24.16	15.13	92.28	12.33
2021	15.57	15.16	73.88	12.99
2022	7.26	12.97	49.24	12.78

Figure 2. Carbon dioxide equivalent (CO_2e) emissions per 100,000 population by jurisdiction and hospital type for volatile anaesthetic agents: (A) desflurane and (B) sevoflurane



REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement—checklist of items

Note: The page numbers in this checklist refer to the submitted manuscript, not to the published article or its Supporting Information file

	Item No	STROBE items	RECORD items	Page No.
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	4 (abstract)
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported		5 (Introduction)
Objectives	3	State specific objectives, including any prespecified hypotheses		5-6 (Introduction)
Methods				
Study design	4	Present key elements of study design early in the paper		6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection		6,7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants (*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow	n/a

			diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	6,7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group		6
Bias	9	Describe any efforts to address potential sources of bias		12 (Limitations)
Study size	10	Explain how the study size was arrived at		n/a (all available records were included)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why		8 (covariates and outcomes)
Statistical methods	12	*(a)* Describe all statistical methods, including those used to control for confounding *(b)* Describe any methods used to examine subgroups and interactions *(c)* Explain how missing data were addressed *(d)* *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching ofcases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy *(e)* Describe any sensitivity analyses		8,9 (outcomes and data analysis)
Data access and cleaning methods		..	RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population.	8 (Data source)

			RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	
Linkage			RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	n/a
Results				
Participants	13	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	RECORD 13.1: Describe in detail the selection of the persons included in the study (i.e., study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	n/a
Descriptive data	14	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders		n/a
		(b) Indicate number of participants with missing data for each variable of interest		n/a
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		n/a
Outcome data	15	*Cohort study*—Report numbers of outcome events or summary measures over time		n/a
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		n/a
		Cross-sectional study—Report numbers of outcome events or summary measures		n/a
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included		7-9 (national trends)

		(*b*) Report category boundaries when continuous variables were categorized		n/a
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses		8,9 (Trends by jurisdiction, Trends by hospital type)
Discussion				
Key results	18	Summarise key results with reference to study objectives		9,10 (principal findings)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	12 (Strengths and limitations)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence		1(Findings in relation to other research)
Generalisability	21	Discuss the generalisability (external validity) of the study results		11-12 (Implications for policy, practice & research)
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based		See Acknowledgements and competing interest statements
Accessibility of protocol, raw data, and programming code			RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	Supplementary files (Table S1, Figures S1, S2A,B), See Data sharing statement

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, et al. (2015) The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Med 12(10): e1001885. doi:10.1371/journal.pmed.1001885.*