

## Background

- **Climate change** is a fundamental threat to human health.<sup>1</sup>
- **Greenhouse gases (GHGs)** – CO<sub>2</sub>, methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O) – are drivers of global warming and climate change.<sup>2,3</sup>
- Current literature suggests that **staff and patient travel** are the largest contributors to adult dentistry's carbon emissions.<sup>4</sup>
- Pharmacological behavioral management techniques in pediatric dentistry are major contributors to dental care-related carbon emissions.<sup>5</sup>
- A 2024 study at a U.S. hospital dental clinic found that **general anesthesia doubled the carbon emissions associated with early childhood caries treatment while N<sub>2</sub>O quadrupled the carbon emissions.**<sup>5</sup>

## Objectives

**Quantify the carbon emissions associated with travel and anesthetic gas(es) used during treatment of caries in pediatric patients at Boston Children's Hospital (BCH).**

## Methods

- Retrospective Epic® chart review of 204 patients of record in the Department of Dentistry.
- **Inclusion criteria:**
  - Between 7 and 8 years of age at the time of treatment completion.
  - Received restorative treatment between June 2024 and December 2025.
  - Patients who **completed at least 3 treatment visits with the use of nitrous oxide** in the outpatient clinic (n=102).
  - Patients who **completed treatment under general anesthesia (GA)** in the operating room (n=102).
- **Outcome measure:**
  - **Kilograms of carbon dioxide equivalents (kgCO<sub>2</sub>e)** associated with emissions from
    - A) Estimated round-trip travel distance (for initial exam and treatment visits)
    - B) Inhaled anesthetic gas(es) used.
  - Patient zip codes were used to estimate round-trip travel distance by using the EPA Greenhouse Gas conversion factor of 0.393 kg CO<sub>2</sub>e/mile for standard gas cars.<sup>6</sup>
  - **Nitrous oxide kgCO<sub>2</sub>e** were calculated using the following equation<sup>5</sup>:
 
$$N_2O \text{ flow rate} \left( \frac{L}{\text{min}} \right) * N_2O \text{ concentration}(\%) * N_2O \text{ density} \left( \frac{kg}{L} \right) * N_2O \text{ GWP} \left( \frac{kgCO_2e}{kgN_2O} \right)$$
  - Emissions for inhaled anesthetic gases used during GA were obtained from Epic® anesthetic gas reports.

## Results

**Table 1. Demographic Description of Study Sample**

Variable	Treatment with nitrous oxide in outpatient clinic (N=102)	Treatment with GA (N=102)	P-value
<b>Age: N (%)</b>			<b>0.016</b>
7	51 (50.00)	68 (66.67)	
8	51 (50.00)	34 (33.33)	
<b>Sex: N (%)</b>			<b>0.159</b>
Male	51 (50.00)	61 (59.80)	
Female	51 (50.00)	41 (40.20)	
<b>Race: N (%)</b>			<b>0.235</b>
Black or African American	20 (19.61)	17 (16.67)	
White	18 (17.65)	33 (32.35)	
Asian	3 (2.94)	3 (2.94)	
American Indian or Alaska Native	0	1 (0.98)	
Bi-racial/multiracial	5 (4.90)	3 (2.94)	
Other/Unknown	48 (47.06)	41 (40.20)	
Choose not to answer	8 (7.84)	4 (3.92)	
<b>Ethnicity: N (%)</b>			<b>0.001</b>
Hispanic, Latino, Latina, Latinx, or Latine	24 (23.53)	25 (24.51)	
Not Hispanic, Latino, Latina, Latinx, or Latine	65 (63.73)	43 (42.16)	
Unknown	9 (8.82)	31 (30.39)	
Choose not to answer	4 (3.92)	3 (2.94)	

**Table 1.** Demographic description of study groups. The significance level was set at 0.05.

## Conclusions

Nitrous oxide is a major inhaled anesthetic gas used for pediatric dental treatment in the outpatient clinic and under general anesthesia at BCH. **Completion of pediatric dental treatment in the outpatient clinic with nitrous oxide released nearly triple the carbon emissions released from completion of equivalent treatment under general anesthesia.** Therefore, it is critical to acknowledge and mitigate the environmental burden of caries management in the pediatric population.

**Table 2. Total distance traveled and duration of use of inhaled anesthetics associated with completion of treatment**

		Treatment with nitrous oxide in outpatient clinic	Treatment with GA	P-value
<b>Round-trip distance (miles)</b>	Mean ± SD	143.30 ± 176.75	108.32 ± 81.61	0.428
	Median (IQR)	70.64 (155.27)	84.36 (82.29)	
<b>Duration of use of inhaled anesthetic (minutes)</b>	Mean ± SD	<b>89.42 ± 26.96</b>	<b>95.75 ± 32.52</b>	<b>0.042</b>
	Median (IQR)	85 (30)	94.5 (44)	

**Table 2.** The total distance traveled and duration of use of inhaled anesthetics associated with the completion of caries treatment. The significance level was set at 0.05.

**Table 3. Total carbon emissions from travel and anesthetic gases (kgCO<sub>2</sub>e)**

		Treatment with nitrous oxide in outpatient clinic	Treatment with GA	P-value
<b>Travel emissions</b>	Mean ± SD	56.32 ± 69.46	42.57 ± 32.07	0.428
	Median (IQR, range)	27.76 (61.02, 3.09 - 334.45)	33.15 (32.34, 11.99 - 148.68)	
<b>Nitrous oxide emissions</b>	Mean ± SD	145.70 ± 46.84	41.78 ± 87.84	
	Median (IQR, range)	139.43 (48.14, 55.18 - 334.62)	11.03 (21.64, 0.76 - 435.94)	
<b>General anesthesia emissions</b>	Mean ± SD	-	29.01 ± 69.87	
	Median (IQR, range)	-	10.39 (11.09, 1.62 - 470.09)	
<b>Total emissions</b>	Mean ± SD	<b>202.02 ± 84.98</b>	<b>71.58 ± 82.01</b>	<b>&lt;0.001</b>
	Median (IQR, range)	177.94 (77.94, 72.42 - 522.28)	49.49 (37.96, 16.37 - 520.64)	

**Table 3.** Total carbon emissions generated from travel and anesthetic gases used during treatment. The significance level was set at 0.05.

## References

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**Acknowledgements:** The authors would like to acknowledge Madison Waple for their support on this project.