Centre for Sustainable Delivery

NHS SCOTLAND

National Green Theatres Programme

Pròram Nàiseanta Lannsaireachd Uaine

Defining Health Miles

A Carbon Metric for Patient Travel to NHS Scotland Appointments

2026

1. Summary

Patient travel to healthcare appointments represents a significant source of carbon emissions within NHS Scotland, particularly in regions where private transport is the dominant mode.

This study introduces the concept of Health Miles – a standardised carbon metric which quantifies greenhouse gas emissions in terms of carbon dioxide equivalence, per mile travelled by patients attending NHS appointments. Using aggregated data on transport mode usage and recognised emission factors, we calculated an estimated average Health Miles value of **0.17597** kg CO_2e per mile, excluding air and ferry travel.

The analysis highlights regional variation in emissions, with rural and island communities exhibiting higher per-mile emissions due to longer travel distances and limited public transport options. Modest shifts in transport behaviour or increased uptake of virtual appointments could yield significant carbon savings from patient travel.

By defining and applying the Health Miles metric, this study provides NHS Scotland with a scalable framework for integrating patient travel emissions into climate action planning, supporting more sustainable and equitable models of care delivery.

As more electric vehicles (EVs) are used and the electricity grid continues to decarbonise, emissions will keep falling in the coming years. To reflect this, the health miles emission factor should be updated each year. For example, using the 2024 emission factors would give a value of 0.20722 kg CO_2e.

2. Background

NHS Scotland has committed to becoming a net-zero health service by 2040, in alignment with the Scottish Government's broader climate targets. The NHS Scotland Climate Emergency and Sustainability Strategy 2022–2026 [i]outlines a comprehensive approach to reducing emissions across clinical care, estates, procurement and travel.

While significant progress has been made in decarbonising buildings and energy use, indirect emissions - particularly those associated with patient travel - remain a critical and under-addressed component of the healthcare carbon footprint relating to Scope 3 emissions.

Patient travel to appointments contributes substantially to NHS-related emissions, especially in a geographically diverse country like Scotland, where rurality, island communities and transport infrastructure shape travel behaviours.

Despite this, emissions from patient journeys are not consistently measured or reported, limiting the ability of health boards to target interventions or evaluate the impact of service redesigns, such as virtual consultations or community-based care.

Similar challenges have been identified internationally. A 2025 study published in JAMA Network Open quantified patient travel emissions across the United States of America, estimating an average of 424 g CO_2e per mile, and highlighting the disproportionate burden on rural populations. Likewise, a 2024 British Medical Journal (BMJ) Open systematic review emphasised the need for standardised carbon metrics in healthcare, noting that healthcare systems contribute an average of 4.9% of national emissions. These findings underscore the importance of developing consistent, scalable tools - such as Health Miles - to support national and regional planning.

To address this gap, we propose the concept of Health Miles: a carbon metric that standardises the emissions associated with patient travel per mile at a national level. By combining data from different types of transport and applying recognised emission factors, Health Miles offers a scalable and policy-relevant tool for estimating travel-related emissions. This metric supports NHS Scotland's strategic aims by enabling more accurate carbon accounting, informing sustainable service planning, and promoting low-carbon models of care that are equitable and accessible across all regions.

3. Introduction

The transition to a net-zero health service is a central pillar of NHS Scotland's climate response. While efforts to decarbonise estates, procurement, and clinical care are well underway, emissions associated with patient travel remain a significant and under-quantified contributor to the overall carbon footprint of healthcare delivery.

Patient journeys to and from appointments are shaped by a complex interplay of geography, transport infrastructure, service configuration and individual circumstances. In Scotland, where rurality and island communities present unique challenges, travel-related emissions can vary widely across regions and populations. Despite this, there is currently no standardised method for estimating or reporting the carbon impact of patient travel across NHS Scotland at a national level or a local level.

The aim of this desktop study is to define and calculate the Health Miles metric for NHS Scotland, explore regional and modal variations. By doing so, we seek to support NHS Scotland's strategic goals and provide a practical tool for integrating patient travel emissions into climate-conscious healthcare delivery.

4. Methods

4.1 Overview

The Health Miles metric is derived from aggregated travel data and transport mode emission factors, enabling a standardised approach to estimating the environmental impact of patient travel across the healthcare system.

4.2 Data Sources – Transport Modal Split

An accurate, population-wide estimate for transport modes used by patients to attend appointments in Scotland is not available from public surveys like the Scottish Household Survey (SHS).

The SHS provides statistics on how people travel, showing the share of different transport modes used for commuting and for all types of journeys. Commuting statistics are based on a survey question that asks respondents about their usual main way of travelling to work. Statistics on all type of journeys are based on travel diaries, where respondents describe every trip they made on the day before the survey interview. This includes journeys for any purpose, such as shopping, visiting friends or family, or travelling to hospital and other health-related appointments.

The latest SHS (2024) estimates that 2.2% of trips are related to hospital and other health-related reasons, but does not provide a share breakdown for these (likely due to the data limitations). In the absence of detailed data on travel for health reasons in Scotland, we use the SHS to estimate the modal split for appointments.

We use the data for all trips (travel diary data) as it relies on actual trips taken and can capture the multiple purposes why someone would, and modes to, make a trip (unlike the commuting data, which only captures one main mode of travel to work). These data also provide a mode split by urban-rural classification, which is useful to explore regional variations across health boards.

Assumptions:

- Travel behaviour patterns remain broadly consistent to historical trends, which may not reflect recent policy interventions (e.g. active travel promotion). Additionally, data from the Census and Labour Force Survey indicate that there has been little change in the share of different transport modes over the past ten years.[1]
- Transport provided by health boards for patient travel by ambulances and NHS transport were not included as these are reported by Health Boards directly under Scope 2 emissions.

The SHS reports an aggregated "Other" travel mode category, which may include motorcycles, ferry, or other less frequently used modes - its share is redistributed proportionally across the remaining modes.

Limitations:

- Travel diary records trips made the previous day, which can vary across the week.
- Lack of real-time national survey data introduces uncertainty as it relies on respondents remembering all trips they made.
- Regional and socioeconomic variations may not be fully captured.

4.3 Estimated Transport Modal Split

The results of the estimates of modal split are detailed in table 1 below. To simplify the model, private car and taxi journeys were combined into a single category.

Transport Mode	Adjusted Proportion (%)
Private Car + taxi	64.4
Public bus	6.6
Train/Rail	2.4
Walking/cycling (active travel)	26.6
Total	**100.0**

Table 1: Adjusted proportions based on Scottish Household Survey Table TD2

[1] Transport Scotland (2025) Scottish Transport Statistics 2024: Chapter 11 – Personal and Cross-modal. Edinburgh: Transport Scotland. Available at: https://www.transport.gov.scot/publication/scottish-transport-statistics-2024/chapter-11-personal-and-cross-modal/

4.4 Emission Factors

Emission Factors: Mode-specific carbon emission factors were obtained from the UK Government's Greenhouse Gas Conversion Factors for Company Reporting (2025).[ii] The emission factors, which can be directly taken from the published data set, are detailed in table 2 below these have been converted to kg CO_2e per mile for consistency.

Transport Mode	Emission Factor (kg CO_2e/mile)
Public Bus	0.16713
Train	0.0571
Walking/Cycling	0.0000

Source: UK Government Greenhouse Gas Conversion Factors for Company Reporting (2025).

Table 2

As there is no average published emission factors for the average private cars, in order to establish an emission factor for this we have calculated this using the published UK government data as follows.

To create a single representative car emission number, we need to weight emissions by the share of different fuel types in the UK registered cars by using the UK department of Transport and Driver Vehicle Licensing Agency (DVLA), Vehicle licensing statistics data table VEH1111: Licensed vehicles at the end of the year by body type, fuel type and year of first use: Great Britain and United Kingdom[iii], which identifies all licensed vehicles at the end of 2024 by year of first registration.

In order to calculate the number of cars by fuel type we extracted all vehicles designated as cars. Sorted these by fuel type, there were a number of fuel types that represented less than 1% of the total cars, which have been excluded from the comparison these were Fuel Cell Electric (0.0003%), Gas (0.078%), other fuel type (0.007%).

In addition to this, we have included numbers for Hybrid Electric (Diesel) in numbers for Hybrid Electric (Petrol), numbers for plug-in Hybrid (Diesel), plug-in Hybrid (Petrol) and Extend Battery Electric in Battery Electric.The UK Government's Greenhouse Gas Conversion Factors for Company Reporting (2025) does not differentiate between these fuel types.

The remaining fuel types were then adjusted to 100%. The weighted emission factor for the average car was then calculated by multiplying the proportion of fuel type by the published emission factor for the average car of that fuel type. The results of this calculation are shown in table 3.

Fuel Type	No. of Vehicles	Adjusted proportion %	Emission Factor (kg CO_2e/mile)	weighted kg CO_2e/mile
Battery Electric	1,275,992.00	3.83%	0.06512	0.00249
Diesel	10,459,315.00	31.40%	0.27849	0.08744
Hybrid electric (petrol/diesel)	2,217,034.00	6.66%	0.20639	0.01374
Petrol	18,695,620.00	56.12%	0.26187	0.14697
Plug-in hybrid electric (petrol/diesel)	664,015.00	1.99%	0.16834	0.00336
Total	**33,311,976.00**	**100.00%**		**0.25400**

Table 3

Based on the calculations above, the emission factors used to calculate health miles are stated below. These represent the average kilograms of CO_2 equivalent emitted per mile for each transport mode, including both **tailpipe emissions** and **well-to-tank (WTT)** emissions.

- **Private Car (0.254 kg CO_2e/mile)**:
  This weighted figure includes direct fuel combustion and upstream emissions from fuel production and distribution, based on the average UK car fleet composition.
- **Public Bus (0.16713 kg CO_2e/mile)**:
  Reflects diesel-powered buses with average occupancy assumptions.
- **Train (0.0571 kg CO_2e/mile)**:
  Weighted across electric and diesel services, accounting for electricity generation and fuel supply chains.
- **Walking/Cycling (0.0000 kg CO_2e/mile)**:
  Considered zero-emission modes for this analysis.

4.5 Calculation of Health Miles

The Health Miles metric was calculated using the following steps:

1. **Mode-Specific emissions**: For each transport mode, the carbon emissions per mile were multiplied by the proportion of patients using that mode:

   $$E_m = \sum_{i=1}^{n} (P_i \times EF_i)$$

   Where:
   Em= Emissions per Health Mile (kg CO_2e/mile) Pi = Proportion of patients using transport mode EFi = Emission factor for transport mode

2. **Weighted average**: The resulting values were aggregated to produce a weighted average carbon emission per mile travelled by patients.

5. Results

5.1 Aggregate Health Miles Emissions

Using the modal split and calculated emission factors, the average carbon emissions per Health Mile were calculated as:

Transport Mode	Split	Emissions/km (kgCO2e)	Emissions/mile (kgCO2e)	Weighted/mile (kgCO2e)
Private car	64.6%		0.2540	0.16357
Public bus	8.6%	0.10385	0.16713	0.01103
Train	2.4%	0.03546	0.05707	0.00137
Active travel	26.6%		0	0
Weighted total				**0.17597**

Table 4

For the purpose of national reporting in the absence of detailed travel surveys the figure for a national Health Mile of **0.17597** $kgCO_2e$ per patient mile can be used to estimate the carbon emissions avoided.

5.2 Regional Variation

It is recognised there is significant regional variation in how patients travel to NHS appointments across Scotland, reflecting differences in geography, infrastructure, and transport availability.

Urban health boards, such as NHS Lothian, benefit from dense public transport networks and active travel infrastructure, resulting in higher shares of walking, cycling, and public transport use.

In contrast, rural boards like NHS Highland exhibit strong reliance on private vehicles due to dispersed populations and limited public transport options. These disparities have implications for health equity, carbon emissions, and accessibility, underscoring the need for tailored interventions that account for local context in the future.

Using the SHS Travel Diary breakdown by urban-rural classification, we have estimated the modal split for NHS Lothian (assuming large urban area classification) and NHS Highland (assuming mix of accessible small town and rural classification).

Transport Mode	NHS Scotland	NHS Lothian	NHS Highland
Private Car + Taxi	64.4	52.0	69.6
Public Bus	6.6	11.2	3.0
Train/Rail	2.4	4.1	0.7
Walking/Cycling (active travel)	26.6	32.7	27.7

Table 5: Adjusted proportions based on SHS Travel Diary Table TD2d

Based on this estimated regional transport modal split and same calculation used to estimate the weighted Health Miles emission factor, the Local emission factors would be 0.1818 kgCO_2e per patient mile for NHS Highland, and 0.1531 kgCO_2e per patient mile for NHS Lothian.

6. Conclusion

This study defines and applies the Health Miles metric to estimate carbon emissions from patient travel to NHS Scotland appointments. With an average value of **0.17597 kg CO_2e per mile**, the metric provides a robust baseline for assessing and managing travel-related emissions. Health Miles can be used to support NHS Scotland's net-zero ambitions, guide service redesign, and promote more sustainable models of care.

The Health Miles approach aligns with international best practices, while the Health Miles metric offers a practical and scalable approach to quantifying patient travel emissions across NHS Scotland. By combining transport mode data with standardised emission factors, the metric enables health boards to better understand the environmental impact of service delivery and identify opportunities for carbon reduction.

7. References

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