Business context:

The National Health Service (NHS) aims to address missed appointments, known as Did Not Attends (DNAs), to enhance healthcare accessibility, efficiency, and resource utilisation.

With an average estimated cost of £30 per missed appointment (NHS,2019)[1], tackling this problem is key.

As previous research has highlighted, non-attendance at appointments is a highly complex and multifactorial problem at the organisational and individual levels (McLean S, Gee M, Booth A, et al).

This specific analysis will inform decision-making regarding the utilisation trends of each component of the network. In particular, it will focus on two overarching objects:

1. Evaluate whether there has been adequate staff and capacity and if this related to DNAs
2. Determine the resource utilisation across the network

This report will inform decision-making regarding budget allotment, whether to expand capacity or improve utilisation of existing resources within the NHS.

Analytical Approach

Data Ingestion

The report relies on the digestion of 3 primary appointment datasets (AD, NC, NR)[2] and integrates findings with additional FTE data (GP_STATS)[3] to assess the primary care workforce utilisation.
Geographic data have been imported to extract regional and sub-ICB level information, providing keys to merge all datasets using ICB_ons_code or sub_ICB_location.

Within a Jupyter Notebook environment, data validation processes were executed to ensure integrity. This encompassed data examination and checks for duplicate entries and null values across the datasets. Despite previous cleaning efforts,(metadata_nhs) anomaly entries pertained to non-unique combinations of appointments were detected in AR (dup:21604). An example is provided below:

Duplicate Example:

	icb_ons_code	appointment_month	appointment_status	hcp_type	appointment_mode	time_between_book_and_appointment	count_of_appointments
559059	E54000050	2022-06	Unknown	Unknown	Unknown	22 to 28 Days	8
579343	E54000050	2022-06	Unknown	Unknown	Unknown	22 to 28 Days	9
586153	E54000050	2022-06	Unknown	Unknown	Unknown	22 to 28 Days	59
591551	E54000050	2022-06	Unknown	Unknown	Unknown	22 to 28 Days	91
596817	E54000050	2022-06	Unknown	Unknown	Unknown	22 to 28 Days	8

[2] AD stands for Actual Duration, AR stands for Appointment Regional, NC stands for National Categories.
[3] WF_STATS is an extract from the NHS GENERAL PRACTICE STATS. Here, you can see the full bulletin publication: https://digital.nhs.uk/data-and-information/publications/statistical/general-and-personal-medical-services
Note that the data collection methodologies have changed since December 2021. The series are now published monthly and aggregated by Regions and Sub ICB Location instead of quarterly. This version is an extract of the data available with these granularities from December 2021 to June 2022.

To correct this, duplicate rows were aggregated by count_of_appointments, ensuring that essential information was preserved.

It is **crucial** to note that the datasets used in this analysis have varying granularity and data quality levels due to differing appointment management practices and the absence of national data collection standards. Consequently, data quality varies significantly among practices, and assumptions have been made to account for these discrepancies.

The analysis prioritises datasets with the highest frequencies of occurrences to ensure the most comprehensive and presumably more representative data. For example, the AR dataset, which spans from January 2020 to June 2022, is primarily used to capture trends of appointments over time. Therefore, conclusions drawn should be interpreted with caution.

Data Analysis: This has been divided into univariate and bivariate statistics to understand the trend in the variation of appointments and their attributes over time and across networks. We looked at the period June 2020-June 2021 to minimise anomalies caused by Covid-19.

Key Metrics Analysed	Utilisation of Resources	Staff and Capacity
Appointment missed	✓	✓
Waiting times between booking and appointment	✓	✓
FTE (Full Time Equivalent)	✓	✓
Health Professional Provider	✓	
Mode of Appointments	✓	
Average daily Utilisation	✓	✓
DNAs Estimated Costs	✓	✓

Approach and Visualisation

Step 1) Involved understanding the distribution of appointments over time (utilisation of resources), which highlighted seasonal variations with peaks of utilisation in March and October. This also means that demand for primary care is fairly predictable.

Steps 2) We analysed capacity based on the NHS's optimal target for planning purposes of 1.2 million daily appointments. Since appointments from Monday to Friday make up nearly all of the total weekly appointments, we focused on weekdays for our analysis.

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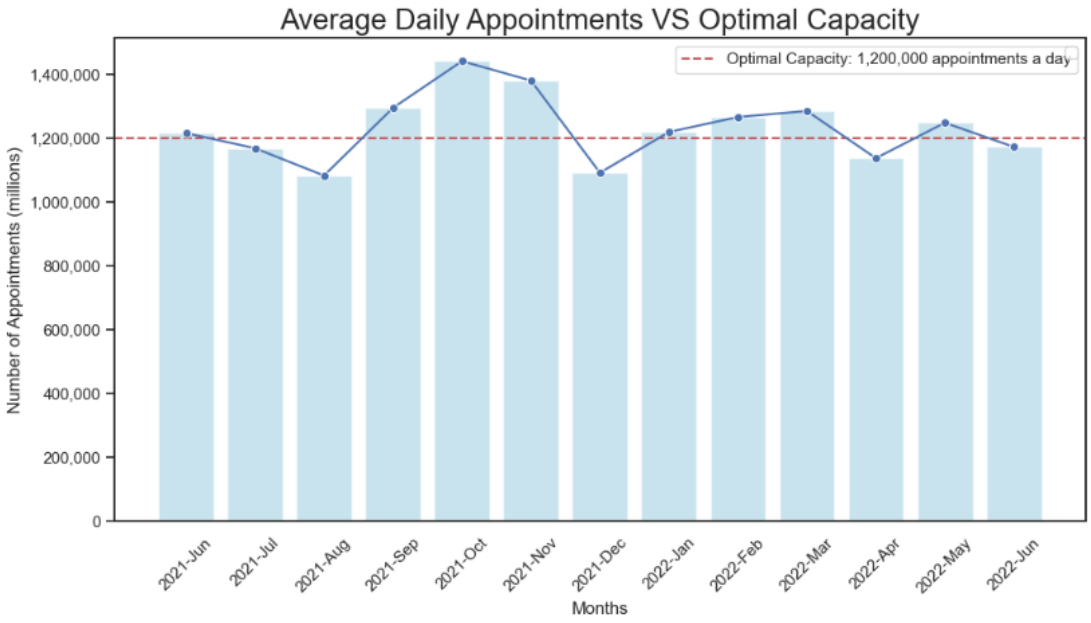
Table 5: Mean estimated number of appointments per weekday (excluding bank holidays), England, January 2020 - June 2022

	Appointment weekday[2]					
Month	Monday	Tuesday	Wednesday	Thursday	Friday	Patient coverage[1]
giu-22	1.420.000	1.340.000	1.240.000	1.240.000	1.190.000	99.7%
mag-22	1.420.000	1.350.000	1.270.000	1.260.000	1.220.000	99.7%
apr-22	1.370.000	1.310.000	1.220.000	1.210.000	1.180.000	99.7%
mar-22	1.410.000	1.330.000	1.250.000	1.230.000	1.200.000	99.8%
feb-22	1.380.000	1.310.000	1.230.000	1.220.000	1.170.000	99.8%
gen-22	1.410.000	1.310.000	1.240.000	1.230.000	1.190.000	99.7%
dic-21	1.380.000	1.300.000	1.190.000	1.150.000	1.020.000	99.7%
nov-21	1.460.000	1.390.000	1.310.000	1.290.000	1.250.000	99.7%
ott-21	1.440.000	1.380.000	1.300.000	1.280.000	1.250.000	99.7%
set-21	1.360.000	1.290.000	1.210.000	1.190.000	1.150.000	99.7%
ago-21	1.230.000	1.190.000	1.110.000	1.080.000	1.040.000	99.6%
lug-21	1.290.000	1.210.000	1.140.000	1.130.000	1.100.000	99.4%
giu-21	1.350.000	1.260.000	1.170.000	1.160.000	1.130.000	99.6%

We simplified the calculation by dividing the monthly appointments by the number of weekdays in each month to determine the estimated average of dailiy appointments. This allows us and stakeholders to make

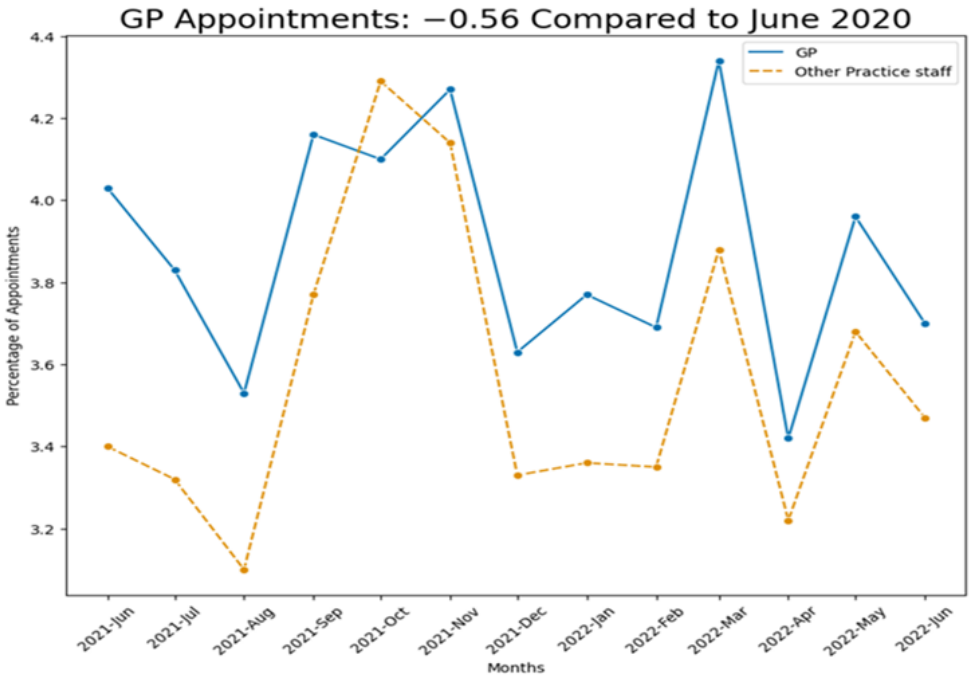
a direct comparison with the optimal target and highlights diminishing appointments compared to the previous. (Fig. 1, below)



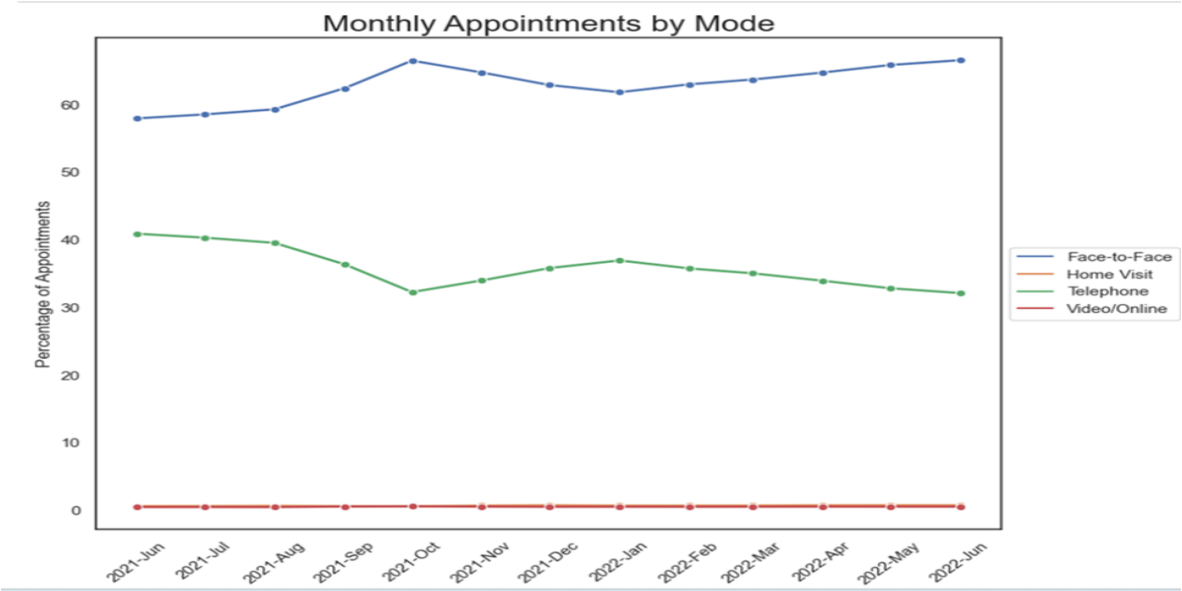
Next, we looked at specific trends and chose a series of line plots to convey information to the user and enhance understanding of the current state of the art.

We narrowed it down by appointments with health professionals (Fig.2) and identified that the diminishing trend is typical of GPs only.

Importantly, we observed significant strain on primary care between October and September 2021. During this period, there was a notable increase in appointments with Other Practice Staff, suggesting a redistribution of the overwhelmed workload from GPs and the presence of backlogs. This trend is comparatively less evident in March, which might suggest a temporary reduction in strain on primary care due to the reduction in demand (see above Fig. 1).

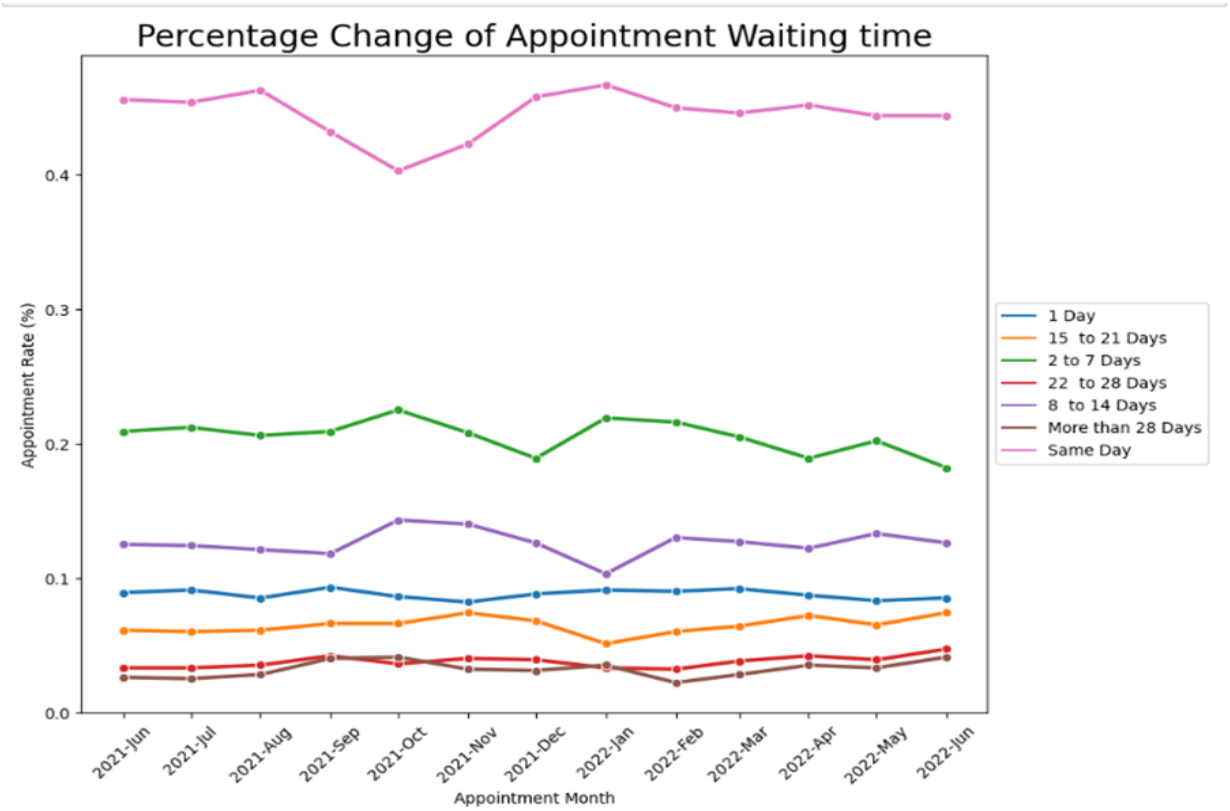


Analysis of Appointment Modes, DNAs, and Waiting Times served as key performance indicators. They further confirmed the presence of backlogs and strain on primary care, as highlighted in Fig.3 below. The share of face-to-face appointments did not mirror seasonal variations, suggesting suppressed demand from previous months.

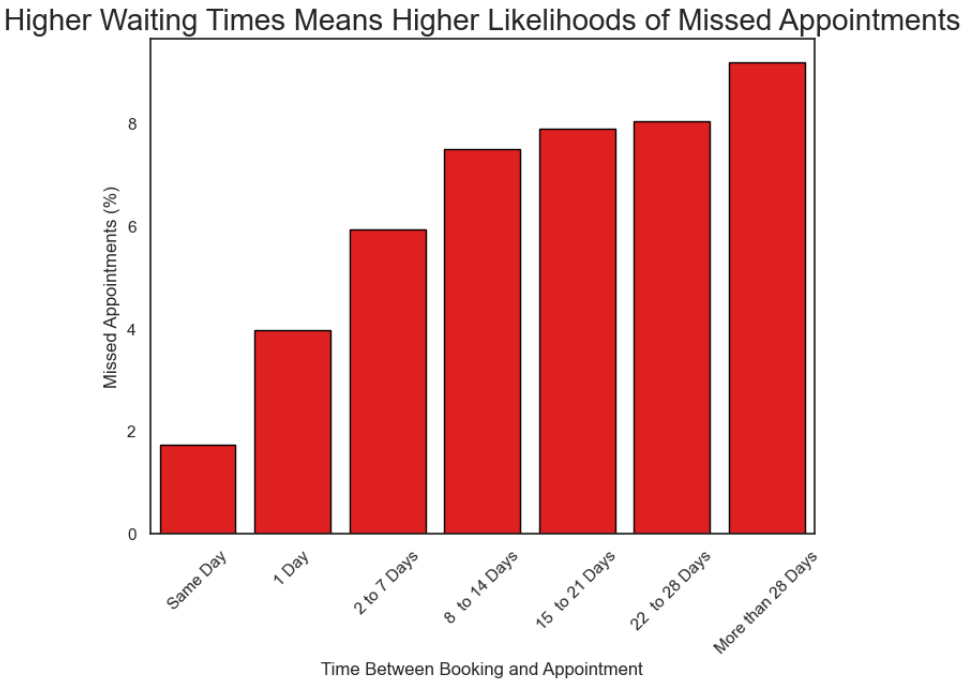


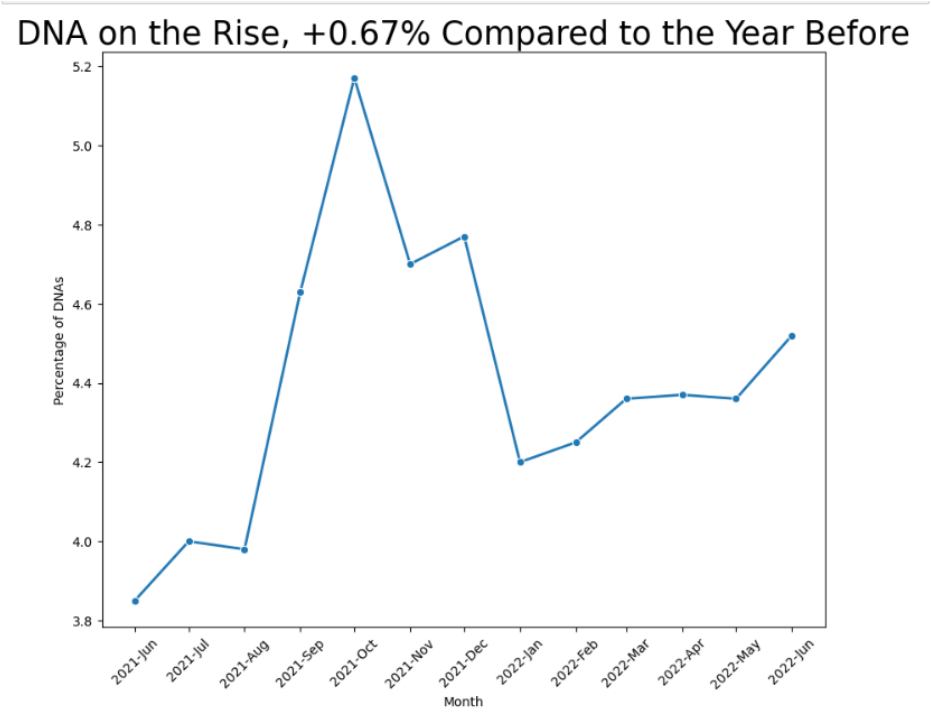
(Fig. 3)

Figs.4 below depicts increased waiting times and reduced capacity of same-day appointments. During busy periods, such as October, the share of same-day and one-day appointments falls drastically, showing GP facilities struggle to meet immediate or urgent patient needs.

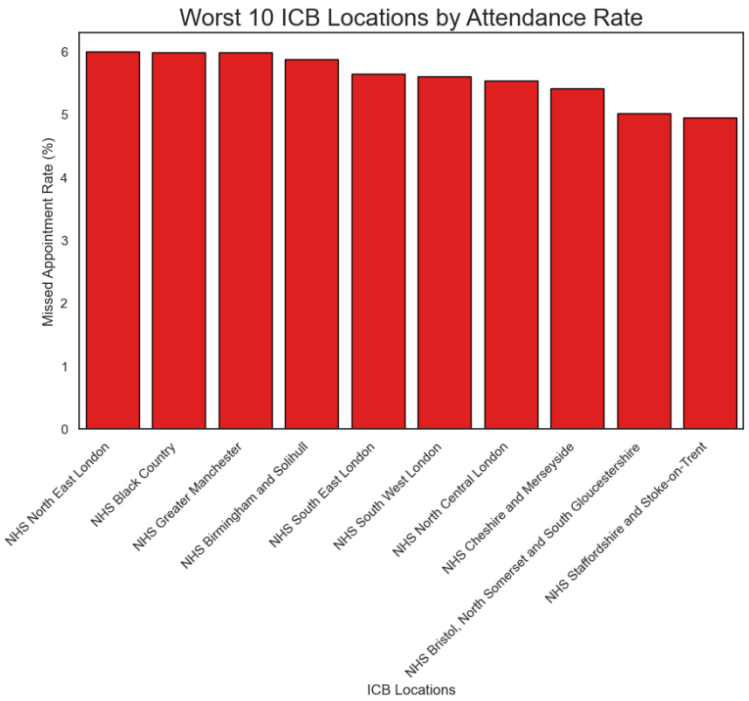


DNas rates have been found to be increasing and linked to waiting times (Fig. 5) and explain the increase in missed appointments (Fig.6). DNA rate variation by location has also been found (fig 7).





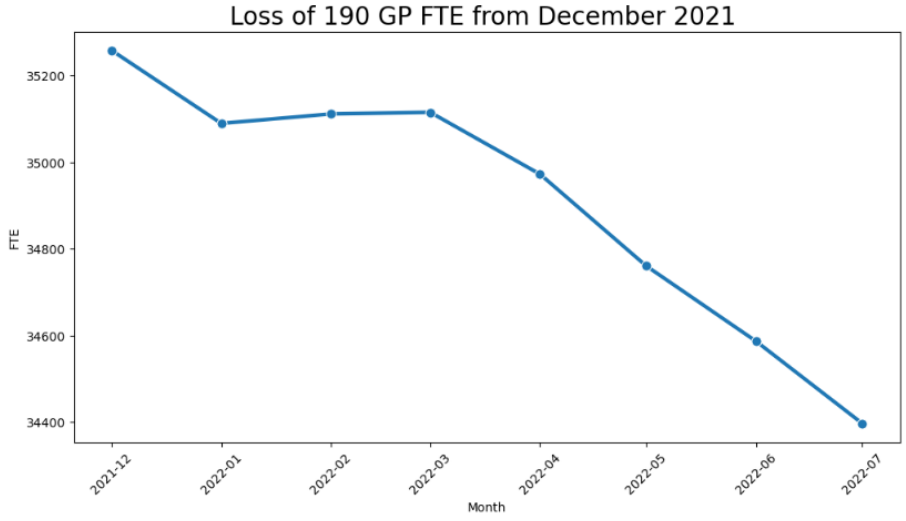
(Fig. 6 above)



(Fig. 7)

DNAs were then multiplied by the average cost for missed appointments, 30£[4], and financial impacts were estimated to present stakeholders with the locations more impacted. This comparison will be shown with bar charts[5].

Supply shortage has been validated with analysis of GP workforce FTE over time, which showed diminished during the period observed (Fig. 7). A positive correlation between DNA and FTE GP retainers has been found. The results of this last one need further exploration and won't be reported.

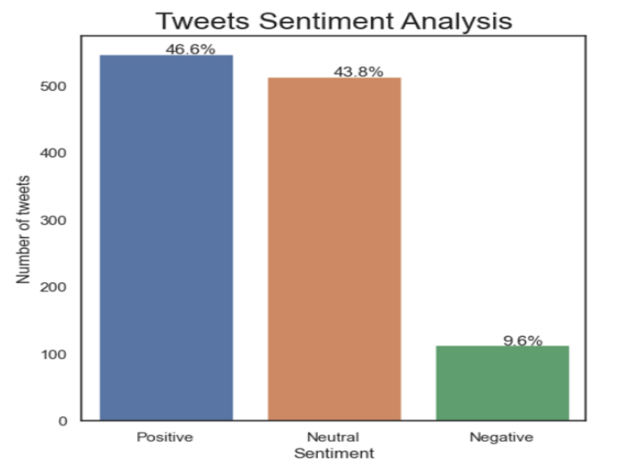


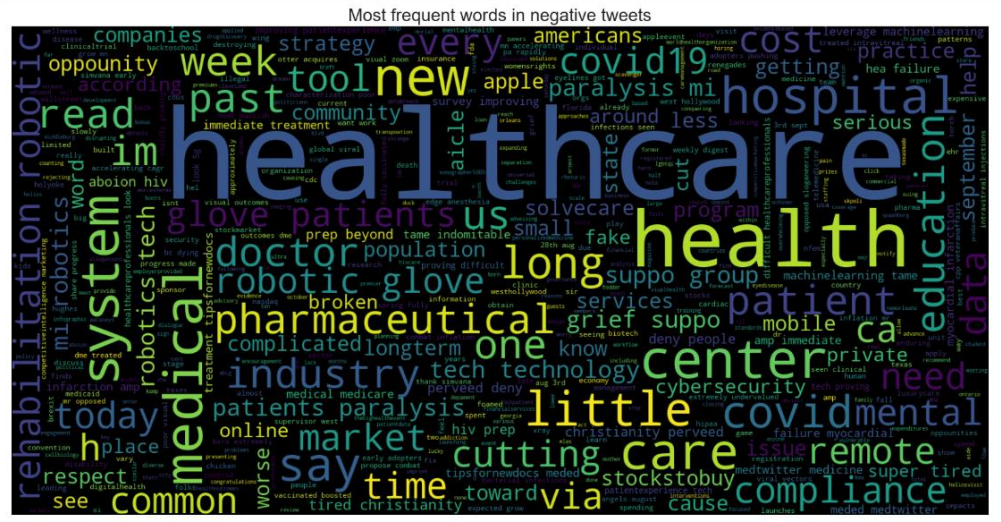
[4] NHS(2019). To adjust to current inflation.

[5] These insights are not presented in the report but will be shared exclusively with stakeholders

Finally, we leveraged pre-scraped Twitter data to understand the view of the general public toward NHS services. This was performed through the TEXTBLOB python library for NLP. Due to the limited dataset size (1175 tweets), we used TEXTBLOB for its simplicity; however, for future analyses, we recommend using VADER or RoBERTa models, which are optimised for social media and can detect nuanced sentiments more accurately. Hence, outputs might be underestimated.

A bar chart has been used to compare the distribution of sentiment tweets, and a word cloud will display the negative tweets for topic analysis. Words like "healthcare," "cutting," "costs," "less," "long," "doctors," and suggest potential inefficiencies, issues, or criticisms related to the NHS. These findings may be linked to perceptions of the (dis)benefits of attending appointments and require future investigation.





Conclusions and Recommendations

- Whilst the NHS has met the monthly appointment targets, the primary care system is treating fewer patients and not working at the optimal capacity compared to June 2021
- Resource allocation in October(Staff) has not been adequate to meet the demand and required task-shifting with ‘Other practice staff’.
- Waiting times have increased, and the percentage of face-to-face appointments has not grown compared to peak demand, highlighting capacity issues.

- If we want to reduce missed appointments (inefficiencies), we strongly recommend reducing waiting times and increasing GP workforce. Also, I greatly recommend deploying strategies to send reminders at critical times since DNA is linked with waiting times.
- Some locations perform worse than others, requiring further investigation.
- While sentiment analysis has provided insights, conducting opinion mining over time is crucial. Perceived disbenefits from appointments are key contributors to DNA appointments. To this end, we recommend enhancing Twitter API Access. Real-time insights will help the NHS stay responsive to the public. This approach is recommended and will outweigh the costs.

References

1. NHS England Missed GP appointments costing NHS millions. 2019. https://www.england.nhs.uk/2019/01/missed-gp-appointments-costing-nhs-millions/2019/
2. NHS drive to reduce 'no shows' to help tackle long waits for care. https://www.england.nhs.uk/2023/01/nhs-drive-to-reduce-no-shows-to-help-tackle-long-waits-for-care/
3. McLean S, Gee M, Booth A, et al. Targeting the Use of Reminders and Notifications for Uptake by Populations (TURNUP): a systematic review and evidence synthesis. Southampton (UK): NIHR Journals Library; 2014 Oct. (Health Services and Delivery Research, No. 2.34.) Chapter 5, Patterns and influences on health-care attendance behaviour: a narrative overview of key themes and issues. Available from: https://www.ncbi.nlm.nih.gov/books/NBK260108/