

# Report on National Health Services resources and capacity utilisation

**National Health Services** (hereafter “NHS”) is a publicly funded healthcare system in England that **is incurring significant avoidable costs due to the large number of patients that miss their medical appointments**. In this report, we focus on potentially existing gaps on NHS’ resources and capacity that affect the ability of patients to attend their appointments. Also, we identify few leads for further exploration on the topic. Mainly, we address:

- **Has there been adequate staff and capacity in the networks?**
- **What was the actual utilisation of resources?**

Data consisted of appointment location, date, duration, type, mode, status, service setting, context type, national category, count of appointments and time between booking and date of the appointment. Pandas and Numpy libraries were used to import, clean and analyse data, Matplotlib for data visualisation and Beautiful soup for data scraping and parsing in Python. Four DataFrames were created for the analysis using “pd.read\_csv/excel()”.

The function “df.dtypes” described data types in the DataFrames, “df.isna().sum()” detected no missing data points and “pd.to\_datetime()” converted date objects into appropriate datetime format. “df.value\_counts()” counted records and “df.groupby().sum()” aggregated sums based on certain criteria, allowing to answer to:

**How many locations, service settings, context types, national categories, and appointment statuses are there? What are the five locations with the highest number of records?**

The dataset includes 106 NHS locations across United Kingdom and the top five locations are below. “df.nlargest(n)” permitted to select only the top five sums in the output.

```
In [25]: location_counts.nlargest(5)
```

NHS North West London ICB - W2U3Z	13007
NHS Kent and Medway ICB - 91Q	12637
NHS Devon ICB - 15N	12526
NHS Hampshire and Isle Of Wight ICB - D9Y0V	12171
NHS North East London ICB - A3A8R	11837

There are four service settings, two context types, 17 national categories and three appointment status. Please note that we consider “Unknown”, “Unmapped” and “Inconsistent mapping” together as “Other”.

```
In [10]: # Determined the number of service settings based on record count in nc DataFrame.
ss_count = nc["service_setting"].value_counts()

print(ss_count)
```

General Practice	359274
Primary Care Network	183790
Other	138789
Extended Access Provision	108122
Unmapped	27419

```
In [16]: # Determined the number of context types based on record count in nc DataFrame.
ct_count = nc["context_type"].value_counts()

print(ct_count)
```

Care Related Encounter	700481
Inconsistent Mapping	89494
Unmapped	27419

```
In [18]: # Determined the number of national categories based on record count in nc DataFrame.
nc_count = nc["national_category"].value_counts()

print(nc_count)
```

Inconsistent Mapping	89494
General Consultation Routine	89329
General Consultation Acute	84874
Planned Clinics	76429
Clinical Triage	74539
Planned Clinical Procedure	59631
Structured Medication Review	44467
Service provided by organisation external to the practice	43095
Home Visit	41850
Unplanned Clinical Activity	40415
Patient contact during Care Home Round	28795
Unmapped	27419
Care Home Visit	26644
Social Prescribing Service	26492
Care Home Needs Assessment & Personalised Care and Support Planning	23505
Non-contractual chargeable work	20896
Walk-in	14179
Group Consultation and Group Education	5341

```
In [20]: # Determine the number of appointment status.
aps_count = ar["appointment_status"].value_counts()

print(aps_count)
```

Attended	232137
Unknown	201324
DNA	163360

**Between what dates were appointments scheduled? Which month had the highest number of appointments and records per month?**

The DataFrames have the period from August 2021 to June 2022 in common and thus this is the focus of the analysis. The months with highest count of appointments and records in the dataset were November 2021 and March 2022 (around 30 and 29 million appointments and 78 and 83 thousand records respectively).

```
In [34]: # Number of appointments per month == sum of count_of_appointments by month.
# Used the groupby() and sort_values() functions
# to obtain the number of appointments per month inn the nc DataFrame.
nc_monthlyap = nc.groupby(nc["appointment_date"].dt.strftime("%Y, %B")).sum().sort_values(["count_of_appointments"],
                                                                                          ascending=False)

print(nc_monthlyap)
```

appointment_date	count_of_appointments
2021, November	30405070
2021, October	30303834
2022, March	29595038
2021, September	28522501
2022, May	27495508
2022, June	25828078
2022, January	25635474
2022, February	25355260
2021, December	25140776
2022, April	23913060
2021, August	23852171

```
In [112]: # Total number of records per month == Count of rows in the Dataframe for each month.
nc["appointment_date"].dt.strftime("%Y, %B").value_counts()
```

```
Out[112]: 2022, March      82822
2021, November      77652
2022, May           77425
2021, September     74922
2022, June          74168
2021, October       74078
2021, December      72651
2022, January       71896
2022, February      71769
2022, April         70012
2021, August        69999
```

Using a line plot, seven graphs were plotted in python to visualise seasonal, monthly and daily trends. Line plots are most appropriate to track changes over periods of time.

### **What trends are evident, based on the number of appointments for service settings, context types, and national categories?**

Firstly, we look at monthly trends (see appendix 1 to 3). The most demanded service is general practitioner (hereafter “GP”) (around 2.1 to 2.8 million appointments per month). Care related encounters are the preferred context of patients over other types (around two to 2.6 million appointments per month). Clearly, the most used category (by total number of appointments) is general consultation routine (varying between 0.8 to one million appointments per month), peaks were in November and March and lows in August and April. Following, patients use general consultation acute and clinical triage, which have a more homogeneous trend during the year peaking only in March. Similarly, home visits, non-contractual chargeable work and planned clinical procedures are the third group of categories used most by patients and have a homogeneous trend throughout the year only peaking in November. Other categories are not very significant.

Secondly, seasonal daily trends. For the seasonal analysis we created a graph for each season (see appendix 4 to 7) (August 2021 = Summer, October 2021 = Autumn, January 2022 = Winter, April 2022 = Spring). We consider that NHS has a maximum capacity to accommodate 1,200,000 appointments per day and we compare the daily activity during Autumn and Spring (one high and low season respectively). Both graphs show that during the week, appointments flow is much higher than on weekends (almost zero). Also, the peak of appointments is reached on Monday decreasing until Friday. In Autumn we see that current NHS’ capacity is not enough to cover the Monday to Wednesday flow (which reaches almost 1.4 million appointments) while in Spring only Mondays are not fully covered by current capacity.

In summary, despite seasonal daily fluctuations the monthly average utilisation rate of NHS’ services is below 1 indicating an underutilisation (see appendix 10). Attended appointments follow the overall trend and represent around 90% of the total average appointments per month. Face-to-face appointments seem to be preferred by patients (around 60% of total average appointments per month), while telephone appointments are around 30%. Same day bookings of appointments seem to have the highest preference among patients (around 40% of total average utilisation per month), followed by up to 1 week (around 20%) and up to 2 weeks (around 10%).

### **What are the top trending hashtags (#) on Twitter related to healthcare in the UK?**

Additionally, we analyse around one thousand healthcare related posts on twitter. We filtered tweets for all hashtags used (around 4.3 thousand). Hashtags were grouped based on similarity of words and filtered per relevance to the healthcare topic. Only words used at least 10 times were considered (see appendix 8 and 9). “#healthcare” was the hashtag most used, almost 800 times. Following, we see “#medic”, “#health”, “#tech” and “#covid” the most.

Hashtags (“#”) in twitter index words and sentences. Businesses can use hashtags to identify, understand and respond to issues since customers often tweet to complain about services. (Driver, 2023).

In conclusion, **NHS has adequate staff in the networks.** However, especially in busy seasons such as October and March, **NHS’s capacity is unbalanced.** There is overutilisation of services from Monday to Wednesday and underutilisation on the remaining days of the week. Thus, **NHS does not have to hire more staff, but rather build a more efficient staff allocation model that is flexible to appointments flow instead of fixed.** Increasing

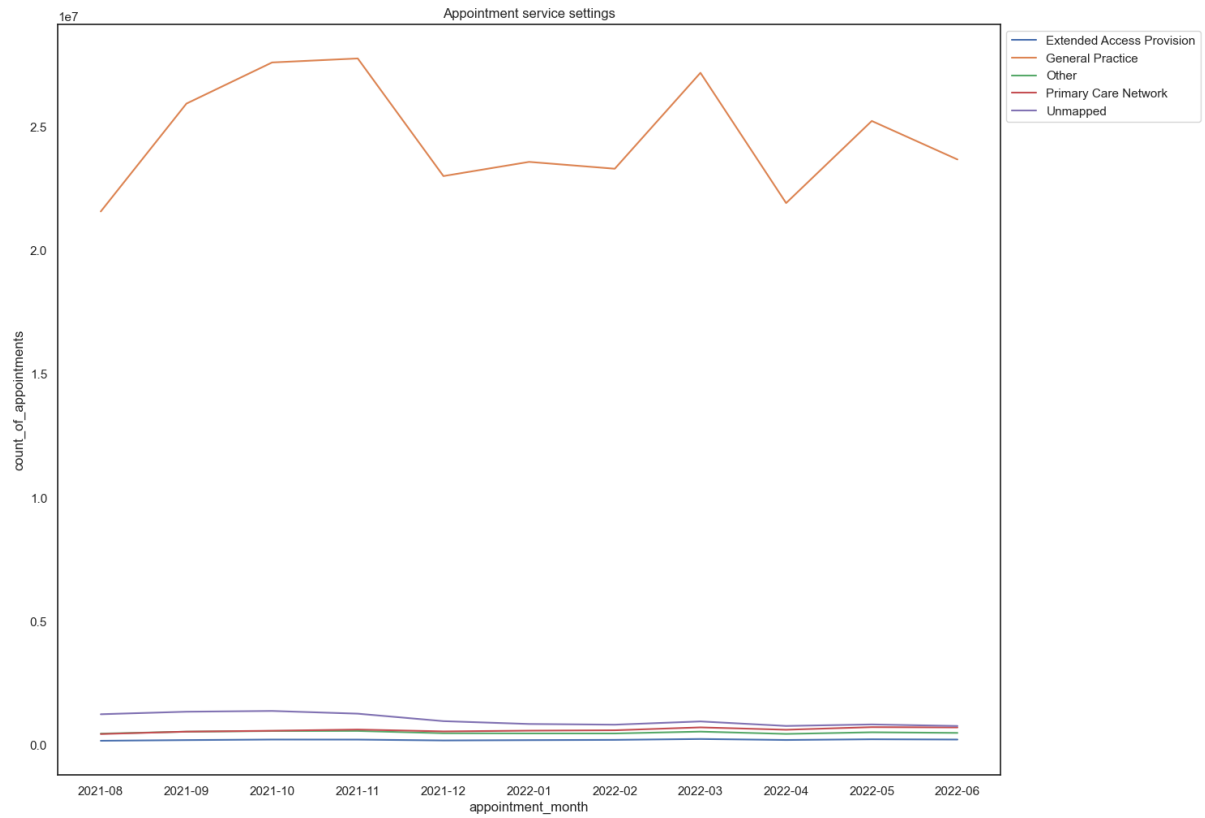
**capacity in busier days and reducing it otherwise.** Most importantly is to **manage well the GP service** which is the most sought by patients and is the most unbalanced. Further, NHS could **explore the #healthcare hashtag on twitter to identify patient complaints related to services' malfunction or demand for other services not currently provided.** Finally, NHS could discover other reasons for the 10% non-attended appointments (e.g. inaccessibility to NHS locations, booking system efficiency).

**References:**

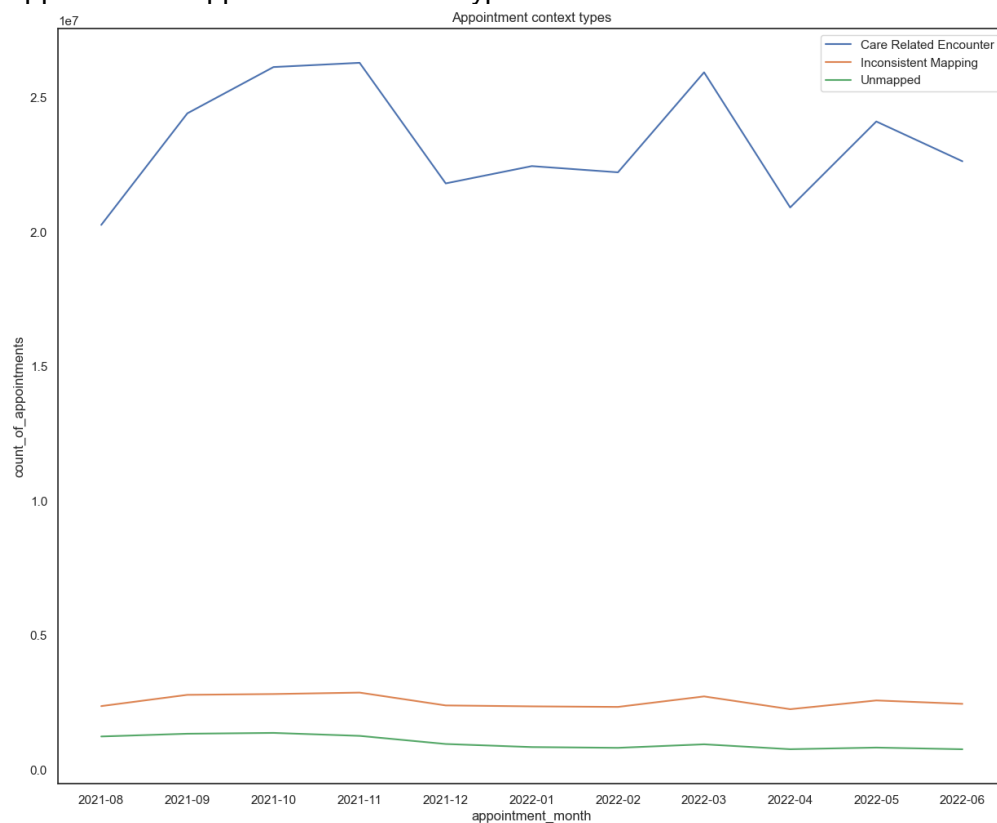
Driver, S. (2023). Twitter for Business: Everything You Need to Know. *Business News Daily*.

## Appendix:

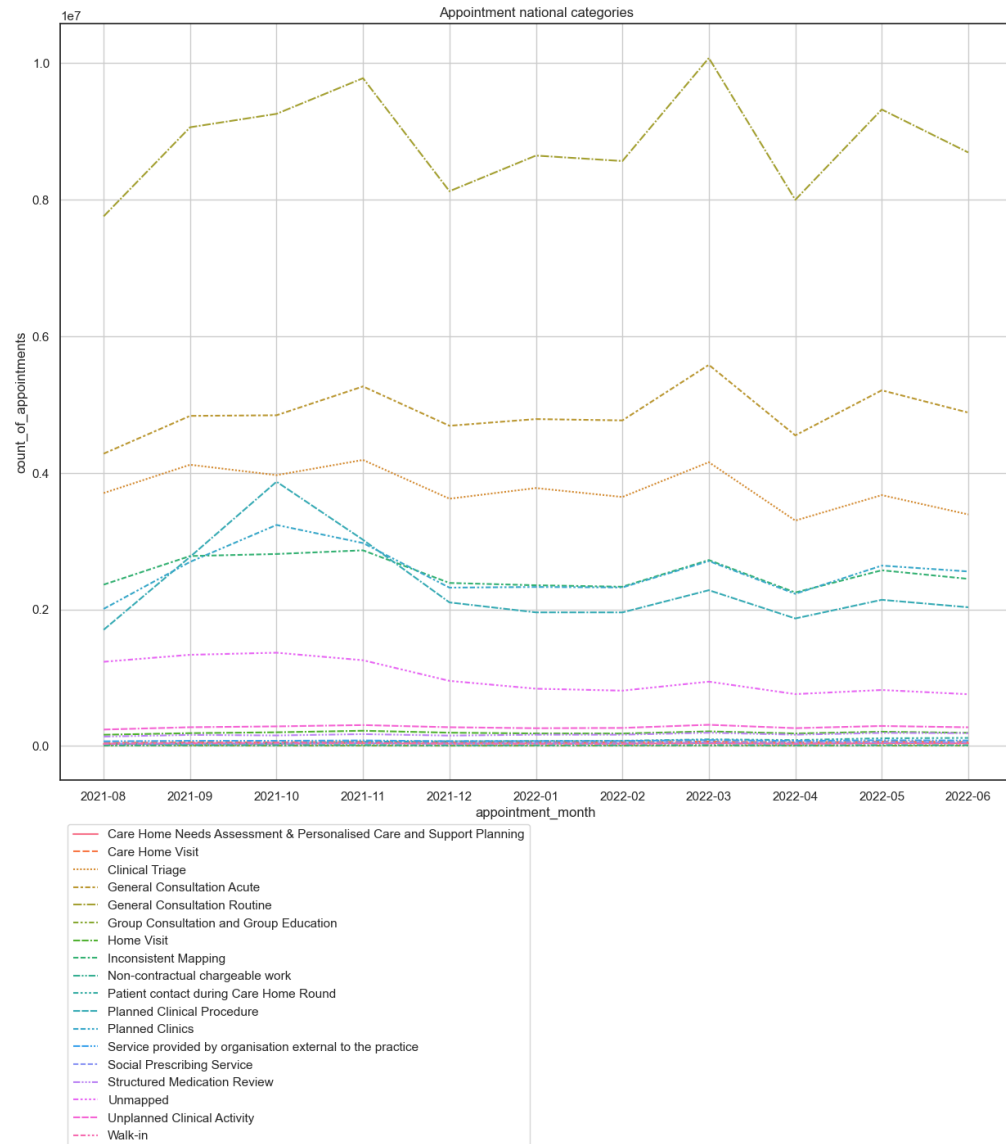
### Appendix 1: "Appointment service settings"



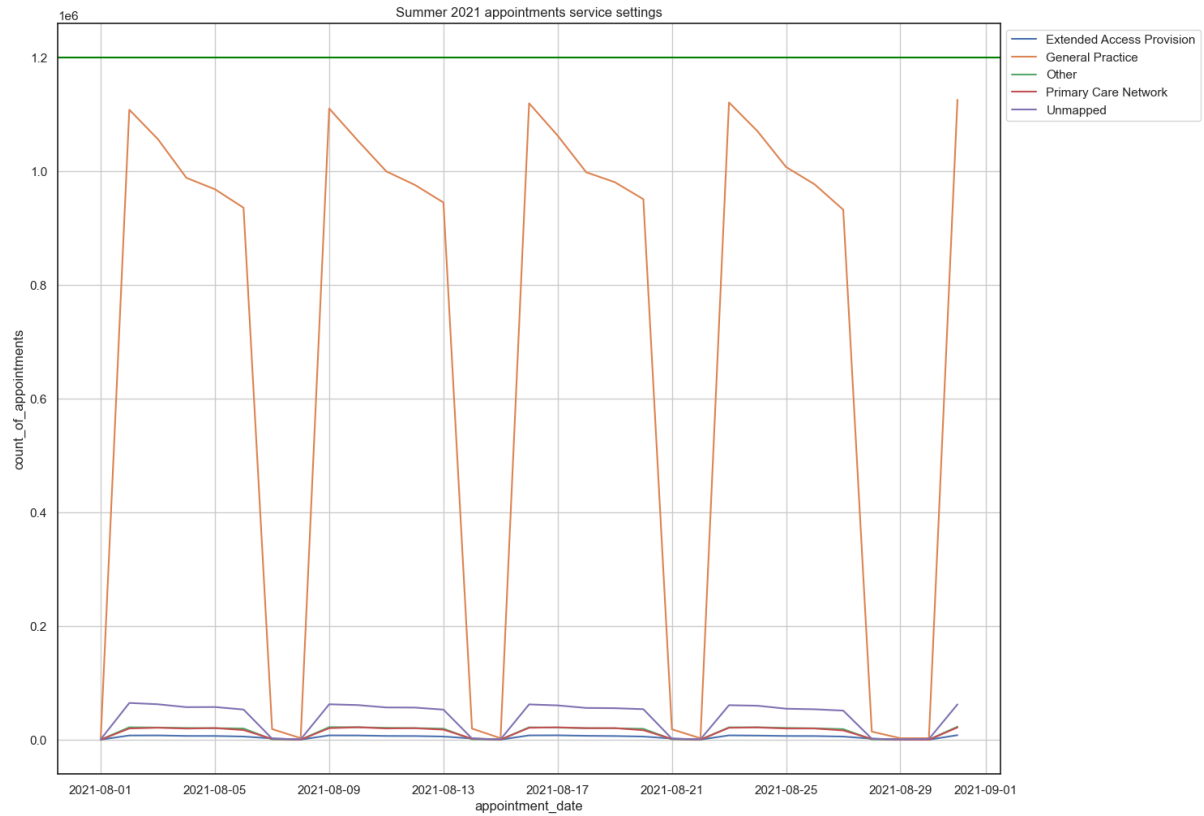
### Appendix 2: "Appointment context types"



### Appendix 3: "Appointment national categories"



#### Appendix 4: “Summer 2021 appointments service setting”

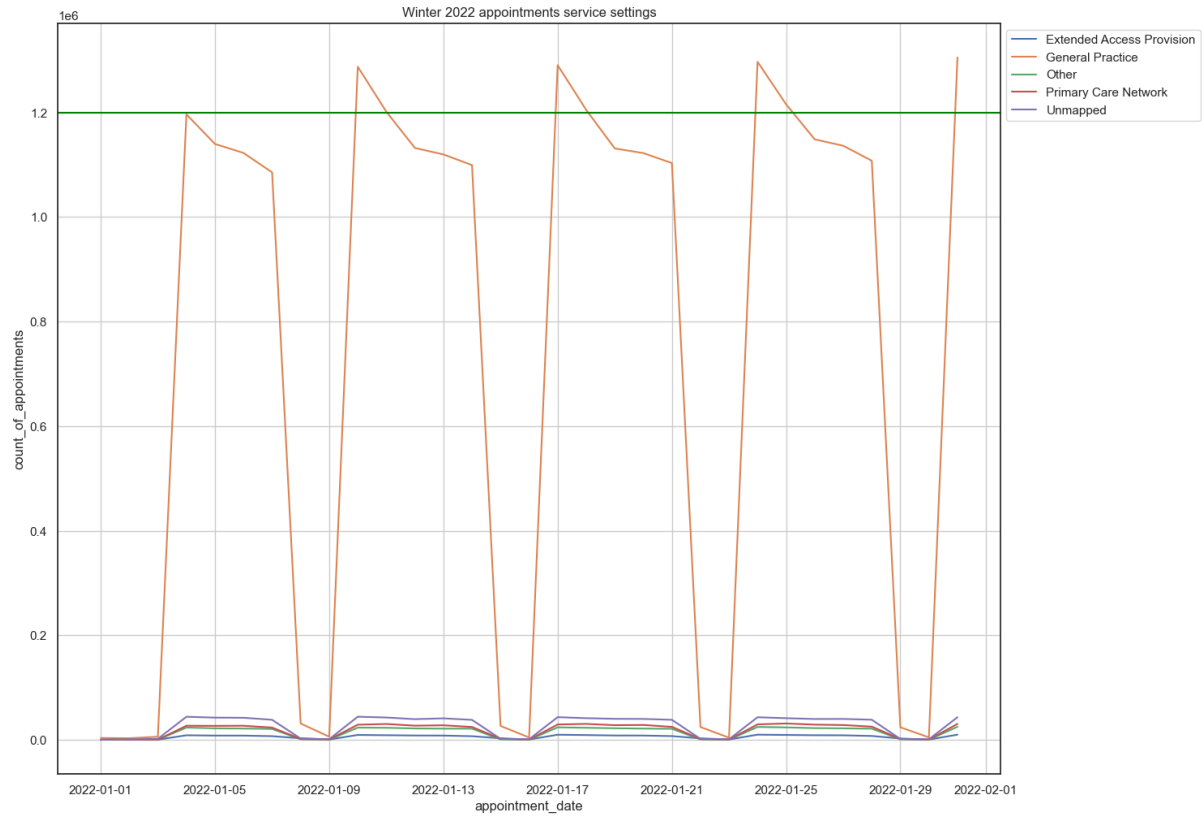


#### Appendix 5: “Autumn 2021 appointments service setting”

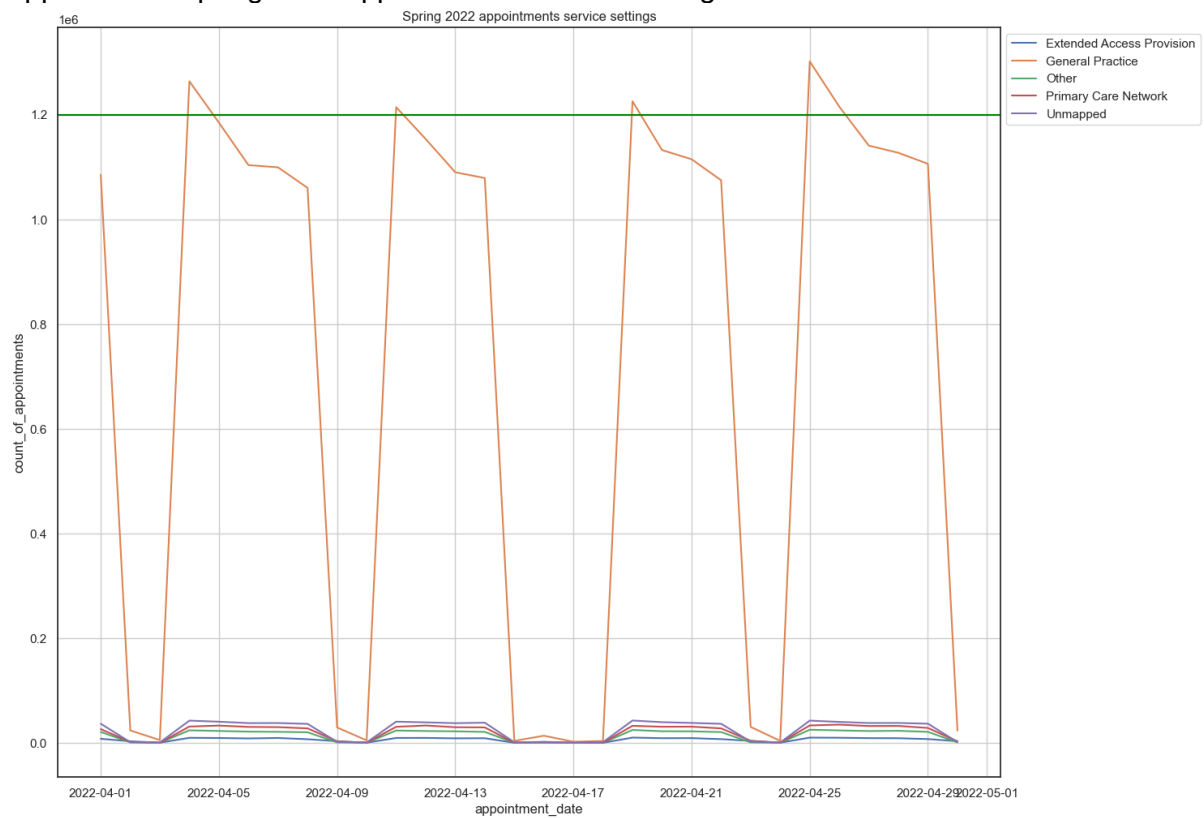




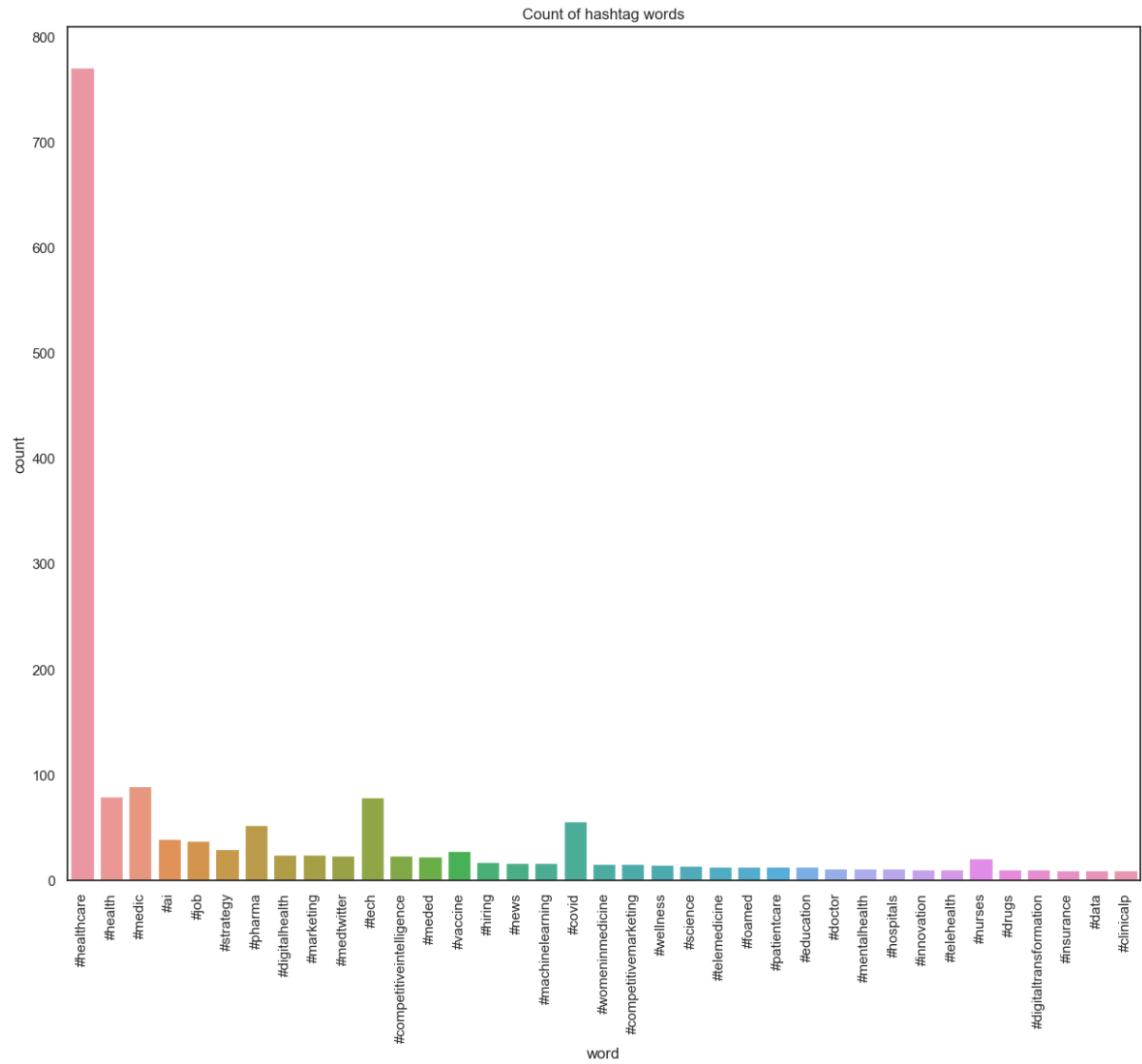
## Appendix 6: “Winter 2022 appointments service setting”



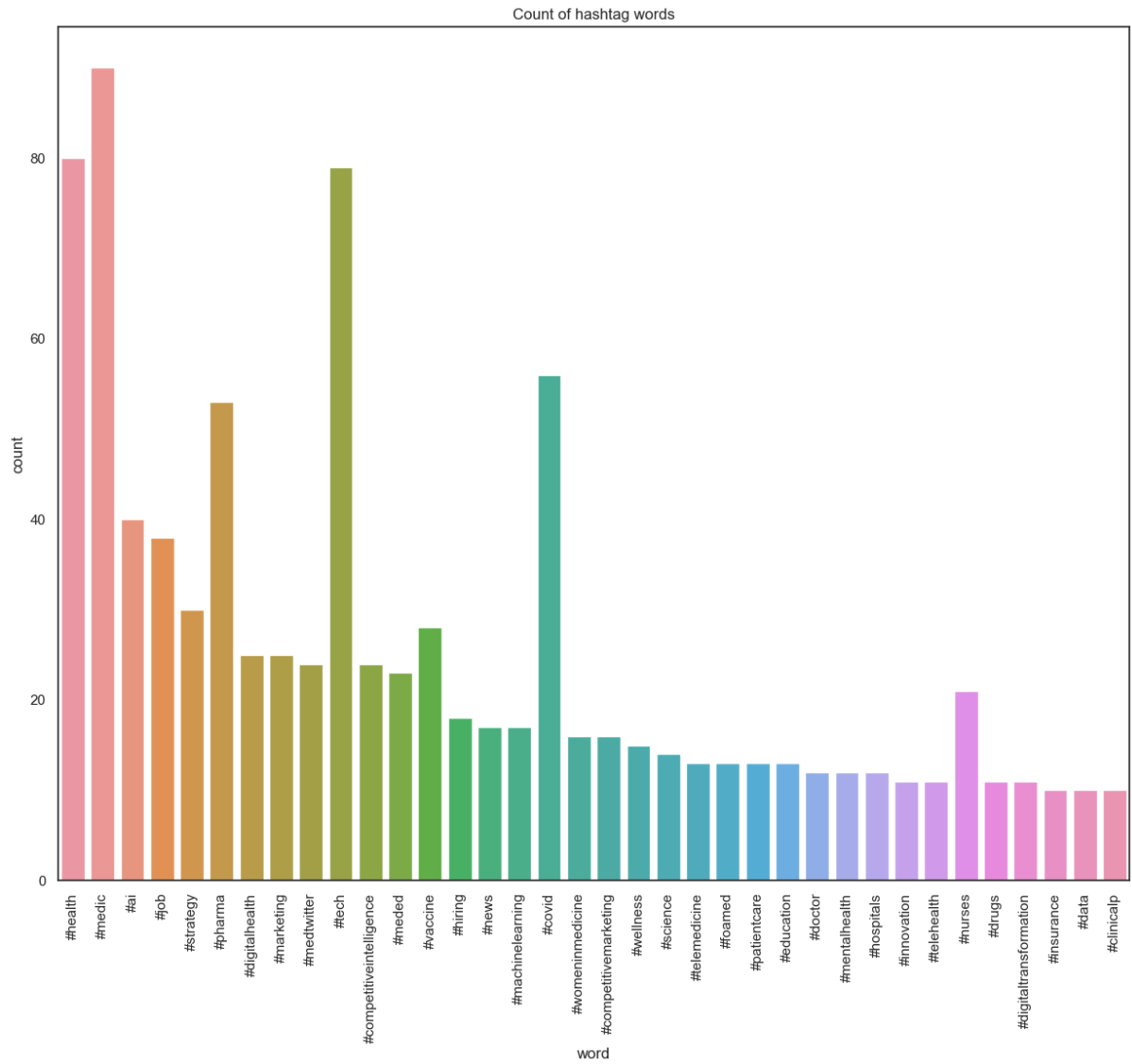
## Appendix 7: “Spring 2022 appointments service setting”



## Appendix 8: “Count of hashtag words”



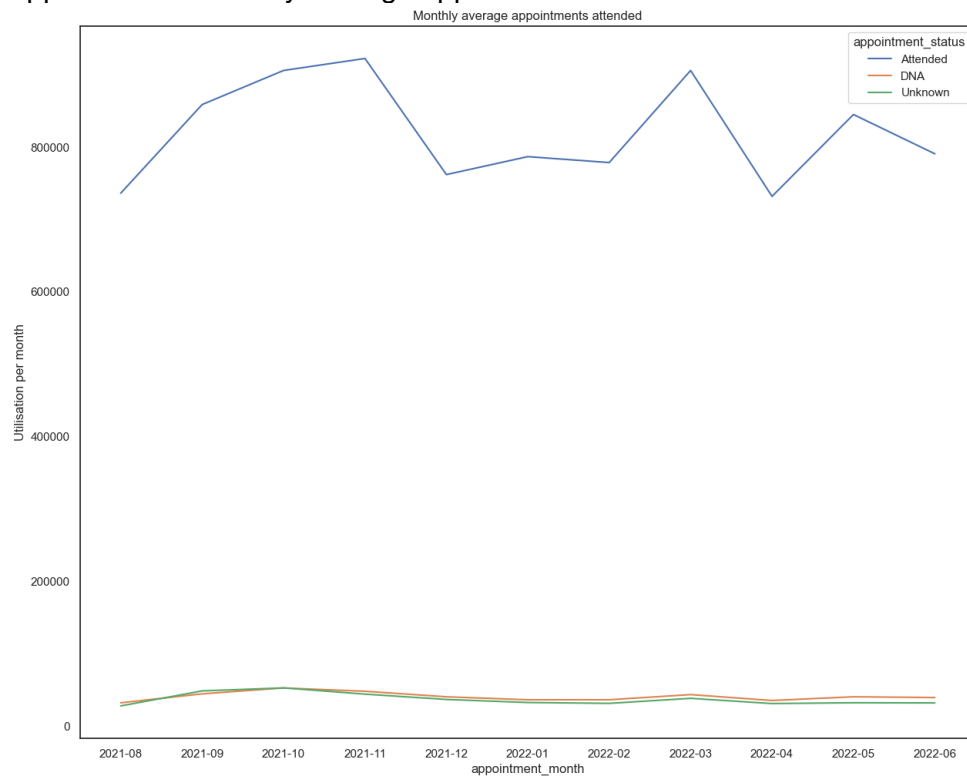
## Appendix 9: “Count of hashtag words – without #healthcare”



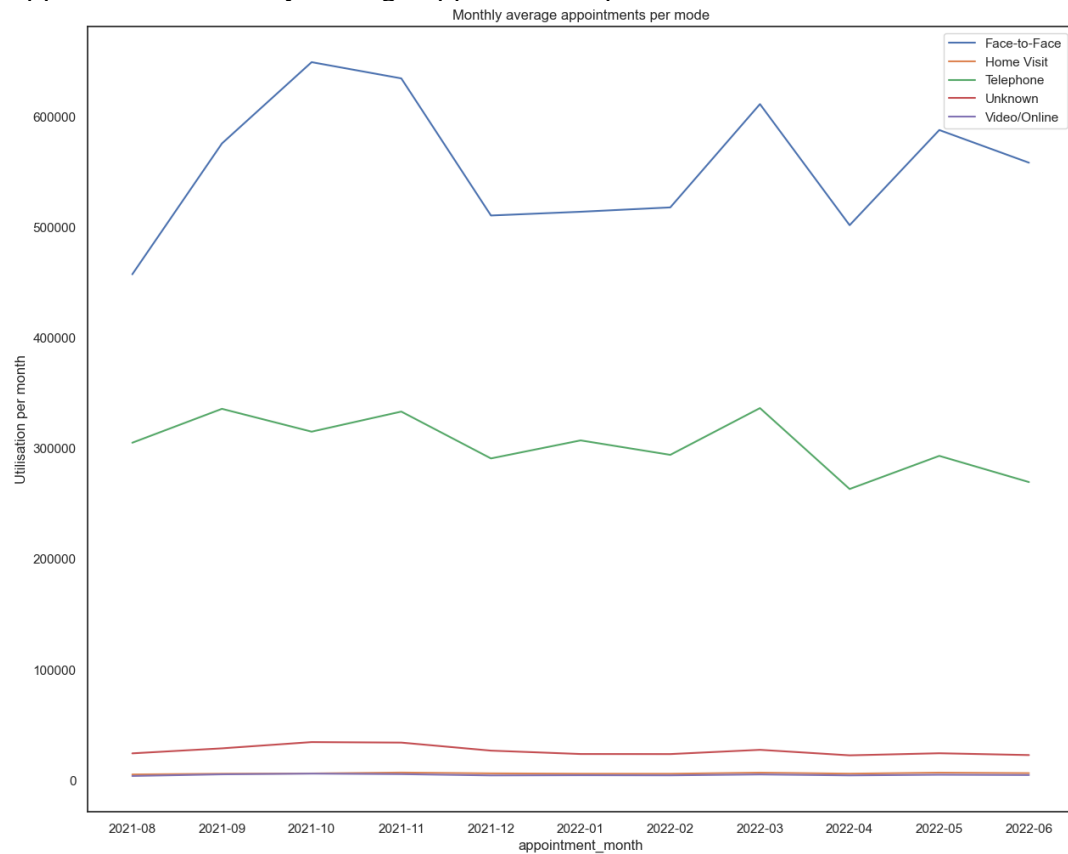
## Appendix 10: “Monthly average NHS’ services utilisation”



## Appendix 11: “Monthly average appointments attended”



## Appendix 12: “Monthly average appointments per mode”



## Appendix 13: “Monthly average demand for Healthcare professionals by type”



## “Appendix 14: “Monthly appointments with time span between book and appointment per groups”

