# The Coronavirus Disease Pandemic 2019 [COVID-19]: Impact on NHS England PET-CT Scanning

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# Abstract

**Purpose** To examine the impact of the COVID-19 pandemic on PET-CT scanning activity across England.

**Methods** Monthly PET-CT scanning activity was collected from 41/48 NHS England provider sites. Data from 31/41sites was stratified by non-oncology/oncology and cancer type. Lung cancer and lymphoma activity was split into specific indications. The data was compiled in Excel and analysed using Stata software to assess distribution and statistical significance of variation in activity comparing levels before and during the COVID-19 pandemic.

**Results** In April and May 2020 a 32% and 31% decrease in activity was observed; a larger decrease for non-cancer compared with cancer PET-CT. In June 2020 PET-CT activity started to recover with 6% fewer scans recorded compared with June 2019. Decrease and recovery varied according to cancer types. Of the six most common indications for PET CT, lung and oesophageal cancer had the largest decrease in activity: lung -29%, -45% and oesophagus -43%, -59% in April and May respectively, and slowest recovery, -23%, -26% respectively in June. By contrast, lymphoma and melanoma showed the smallest decrease: lymphoma -14%, -9%; melanoma -16%, +5% in April and May respectively, and fastest recovery +12% lymphoma +14% respectively. Specifically, lung cancer PET-CTs related to initial diagnosis and staging saw the largest fall and slowest recovery compared with PET-CTs for people with known lung cancer.

**Conclusions** There was considerable variation in the rate of decline and recovery in PET-CT scanning across cancer types and specific indications related to the cancer type. The causes for the variation remain to be explained.


# Background

The coronavirus disease has resulted in 21,213,649 million confirmed infections and 760,421 deaths as of August 15th 2020 and the pandemic shows little sign of abating globally [1]. The COVID-19 pandemic has had a substantial impact on health care systems and that includes diagnostic imaging services. A special report of the RSNA COVID-19 task force reported a 40-90% decline of examination volumes in radiology practices [2]. Further, a retrospective review of imaging volumes from the largest health care system in New York state reported a 28% reduction in imaging volume during the COVID-19 pandemic [3]. Several surveys have evaluated the impact of COVID-19 on nuclear medicine services [3,4,5,6,7]. All the surveys showed that COVID-19 had resulted in a significant decline in nuclear medicine scanning across the world, with some centres experiencing a decrease in activity of up to 85% [7]. However, none of these studies were PET-CT focussed and as such do not analyse the variation or magnitude of change in PET-CT imaging volumes during the period using actual real world data.

PET-CT is one of the main diagnostic tests in the investigation of people with cancer [8,9]. It is also used for the assessment of some non-oncological disorders including sarcoidosis, vasculitis, infection, orthopaedics and some neurological and cardiac conditions [8,9]. NHS England commissions PET-CT services across England through a number of NHS Trusts, research institutes, charitable trusts and

independent sector providers with a total of over 130,000 PET-CT scans performed during the calendar year 2019.

Throughout the first wave of the COVID-19 pandemic, NHS England PET-CT centres continued to provide services. Moving out of the first wave, the priority within NHS England, has been to return health care services to as near as possible to pre-COVID levels. With this comes the requirement for diagnostic services, including PET-CT, to meet demand while conforming to new COVID-19 safe measures [10,11]. An accurate and detailed understanding of the changes in PET-CT scanning activity during the first wave, and the extent to which PET-CT services recovered, can contribute to ensuring that management plans for people with cancer are not delayed in the future and that relapse of disease in cancer survivors is detected in a timely fashion. The purpose of this study is to examine the impact of the first wave of the COVID-19 pandemic on PET-CT scanning activity across England, using real world data.

# Methodology

NHS England caters to a population of 55.98 million. A retrospective review of the PET-CT scanning activity within NHS England was undertaken.  PET-CT scanning activity data from January to June 2019 and January to June 2020 was collected from 41 sites out of a total of 48 NHS England provider sites from which data was requested. In total, the data collected accounted for more than 90% of all PET-CT scanning across NHS England. The data provided from each of the sites was aggregated monthly data. Within 31 of the 41 sites the data was further stratified according to non-oncology and oncology. The oncology data included the number of PET-CT scans completed for the six most common indications for PET-CT in England: lymphoma, melanoma, lung, oesophageal, colorectal and head and neck cancer. Lung cancer scanning activity was split between PET-CT for initial diagnosis/staging and PET-CT for subsequent diagnosis of recurrence, surveillance and restaging. Lymphoma PET-CT activity was split between PET-CT for initial staging and PET CT for subsequent management. Analysis of the cancer sub-groups was restricted to the 31 sites that we requested data from.

### STATISTICS

The quantitative data collected was compiled in a database using Excel before being analysed using Stata software to assess the distribution and statistical significance of the variation in monthly PET-CT scanning activity. Data variables were generated to facilitate a comparison of the pre-COVID-19 period [January to June 2019] and COVID period [January to June 2020]. The imaging volumes for each month were summed and descriptive statistical methods were applied to demonstrate the variation and trend in imaging activity for both periods. The variation in activity during January to June 2020 was then compared with the same months in 2019. The percentage change values and mean activity volumes for each month were calculated and independent t-tests were undertaken to assess the statistical significance for p values $< 0.05$.

# Results

The data shows a decrease in the number of PET-CT scans done between January and June 2020 compared with the same period in the previous year. The decrease was mainly due to a lower volume of PET-CT scanning activity between April 2020 and May 2020 [figure 1]. A total of 50,879 PET-CTs were completed between January 2020 and June 2020, compared with 52,460 PET-CTs completed for the same period in 2019. Overall, there was a -32% fall in total volume of PET-CTs performed in April 2020 compared with April 2019 and a fall of -31% in May 2020 compared with May 2019 [table 1,figure 2].

| | Jan | Feb | March | April | May | June |
|---|---|---|---|---|---|---|
| **2019 total no. scans** | 10,421 | 10,244 | 10,168 | 9,927 | 10,471 | 10,229 |
| **2019 Mean** | 254 | 250 | 248 | 242 | 255 | 249 |
| **2020 total no. scans** | 11,744 | 10,810 | 10,672 | 6,778 | 7,323 | 9,652 |
| **2020 Mean** | 286 | 264 | 260 | 165 | 176 | 235 |
| ***P* value** | 0.44 | 0.73 | 0.74 | 0.01* | 0.01* | 0.69 |
| **% change year-on-year** | 13% | 6% | 5% | -32% | -31% | -6% |

*** *P* < 0.05**

**Table 1** Total monthly PET-CT activity and percentage change year-on-year for January - June 2020. P-value reported is based on an independent t-test comparing two means.

In June 2020 PET-CT scanning activity returned to a level of activity that was closer to that of the previous year with an overall percentage decrease of -6% compared with June 2019 [figure 2, table 1]. Out of 41 sites in June 2020, 16 sites showed a percentage increase in activity while 25 sites reported a percentage decrease in activity compared to June 2019. With respect to range, 20 sites were within an interquartile range of between -15% and +6% for percentage change in activity, while 10 sites were below the 25$^{th}$ percentile [marked as red dots in figure 3] and 11 sites reported a percentage change above the 75$^{th}$ percentile [figures 3].

On closer inspection of the data, a more pronounced decrease in activity was observed in non-oncology PET-CT scanning. In 2020, 30,616 oncology scans were completed and 1,817 non-oncology scans were completed compared with 31,845 oncology scans and 1,852 non-oncology scans in 2019. As a percentage, non-oncology PET-CT scanning decreased by -55% and -33% respectively during April and May 2020, compared with a decrease of -23% and -26% respectively for oncology [figure 4].

| Total number of PET-CT scans done | 2019 | 2020 | % change: 2019/20 |
|---|---|---|---|
| Lung cancer | 10,606 | 9,399 | -11% |
| Oesophageal cancer | 1,816 | 1,367 | -25% |
| Melanoma | 1,294 | 1,465 | 13% |
| Head and Neck cancer | 2,525 | 2,452 | -3% |
| Colorectal cancer | 2,376 | 2,332 | -2% |
| Lymphoma | 6,907 | 6,850 | -1% |

**Table 2** Total percentage change [year-on-year over the period January to June 2020] in number of PET-CT scans completed across six cancers

| Cancer | January | February | March | April | May | June |
|---|---|---|---|---|---|---|
| Lung | 15 | 1 | 16 | -29 | -45 | -23 |
| Oesophagus | -9 | -17 | 9 | -43 | -59 | -26 |
| Melanoma | 41 | 16 | 24 | -16 | 5 | 14 |
| Head &Neck | 29 | -3 | 4 | -20 | -22 | -5 |
| Colorectal | 17 | 4 | 9 | -18 | -23 | -3 |
| Lymphoma | 2 | -6 | 10 | -14 | -9 | 12 |

**Table 3** Monthly percentage change [year-on-year for months January - June 2020] in number of PET-CT scans completed across six cancers

Within oncology, a dip in PET-CT scanning activity over April and May 2020 was associated with the type of cancer investigated. In April 2020 the percentage decrease was most marked for oesophageal cancer, followed by lung cancer, head and neck cancer, colorectal cancer and melanoma, with lymphoma showing the smallest dip. A similar trend was observed in May 2020 for oesophageal cancer, lung cancer, colorectal cancer, head and neck cancer and lymphoma. Melanoma however did not show this trend, instead it showed an increase in activity above that of June 2019 (figure 5, table 3).

In June 2020 PET-CT scanning activity related to melanoma and lymphoma returned to their previous year's performance. In addition, scanning activity in colorectal and head and neck cancer returned near to their previous year's performance at -3% and -5% respectively. In contrast, lung and oesophageal cancer reported a -23% and -26% decrease in activity compared with the previous year [figure 5, table 3]. With regard to lung cancer, the level of scanning activity at all 31 sites remained below that of the previous year. At an individual site level, the median level of activity for lung cancer in June 2020 was -26% with an interquartile range of between -33 and -10% [figure 6].

Comparing lymphoma and lung cancer PET-CT scanning activity, scans related to the diagnosis and staging of lung cancer saw a fall in activity of -29% in April 2020, -47% in May 2020 and -26 % in June 2020 compared with -9% in April 2020, -28% in May 2020 and -14 % in June 2020 for lymphoma. PET-CT scanning related to the care of people with lymphoma following their diagnosis showed a fall in activity of -17% in April 2020, +5% in May 2020 and +31% in June 2020 compared with -29% in April 2020, -19% in May 2020 and +2% in June 2020 for PET-CTs for the care of people with lung cancer following their diagnosis.

# Discussion

Our study gives rise to several key findings. (1) Our data shows that PET-CT scanning in England fell significantly during the first wave of the COVID-19 pandemic. (2) PET-CT oncology activity was less affected when compared with non-oncology PET-CT. (3) The pace of recovery post COVID-19 shows that most sites had returned to the previous years' level of activity with the percentage change in non-oncology activity 6% higher than 2019 and oncology -4% lower.

The decline observed during the COVID-19 pandemic was most marked between April and May 2020 when a decrease of 32% and 31% respectively was observed when compared to the same months in the previous year. The decrease coincided with the peak of incidence of COVID-19 in England and the period of national lock down [12]. The extent of the decrease in scanning activity confirms the findings from a British Nuclear Medicine Society [BNMS] survey completed by 138 members between March 23$^{rd}$ and mid May 2020. The BNMS members' survey findings reported an average reduction in PET-CT scanning activity of 32%, which exactly matched the activity data from our study [13]. Further, our results also support the findings of a web-based survey by Lutz and his colleagues, which surveyed 434 respondents from 72 countries between 16$^{th}$ April 2020 and 3$^{rd}$ May 2020. Their study found an average decline in PET-CT services of 36% [5].

Second, our data shows that oncology PET-CT activity was less effected when compared with non-oncology PET-CT. This supports the view of four studies into the effect of the COVID-19 pandemic on nuclear medicine which also found that non-cancer nuclear medicine scan activity was more affected when compared with cancer nuclear medicine scans [4,5,13,14]. Specifically, Lutz and colleagues found that while PET-CT cancer scanning activity decreased by an average of 36%, the number of thyroid studies fell by 67%, myocardial studies 66%, bone scans 60%, lung scans 65% and sentinel node procedures by 45%. A web based survey carried out by Fruedenberg et al over 6 days in April 2020 with respondents from Germany, Austria and Switzerland, reported a decline in PET-CT of -14.4% compared with myocardial perfusion imaging -47.2% and radiosynoviothesis of -58.4% [15]. Further, the survey of British Nuclear Medicine Society members reported that the decline in PET-CT was less pronounced than that compared with other nuclear medicine investigations. It reported that 'the most affected area of nuclear medicine in conventional diagnostic nuclear medicine was thyroid, parathyroid and renal imaging, they were all reduced by more than 75%. Oncology PET-CT and some therapies such as SIRT and Ra-233 were the least effected' [13]. Finally, in an Italian single centre study in which 94% of PET-CT scans were for cancer, no statistical significant difference was found in the number of PET-CTs done between February and April 2020 compared with the same period in 2019 [16].

The observed variation in activity between oncology and non-oncology should perhaps not be a surprise. European guidance published at that time advised on the importance of prioritizing essential nuclear medicine procedures over non-essential procedures if possible [11, 17]. In the UK, the British Nuclear Medicine Society recommended prioritizing PET-CT for people with new cancers and sepsis over other PET-CTs if possible [18]. In line with this guidance, many PET-CT centres modified their approach and wrote to referrers to inform them of their change in clinical practice.

The data from this study measures the pace of the recovery of PET-CT services in England after the peak of the first wave of the COVID-19 pandemic. By June 2020, the data shows that most sites had returned to the previous year's level of activity with the percentage change in non-oncology activity 6% higher than 2019 and oncology -4% lower. However, three caveats need to be considered when evaluating the extent of the recovery in PET-CT activity. *First*, the activity data does not take account of any increase in the trend rate of growth in PET-CT activity which pre-COVID-19, was growing at a rate of somewhere between 5-15% per annum. *Second*, a possible backlog of PET-CTs has not been taken into account when considering the recovery in activity in June 2020. According to Cancer Research UK at the start of June 2020 there was an estimated 2.4 million people in the backlog for screening, tests, or treatment. Further, NHS England data from 11$^{th}$ June 2020 shows that the number of urgent GP referrals for cancer dropped by 60% in April compared with the same month in the previous year, and the number of people starting treatment following an urgent GP referral declined by 18% [18]. The *third* caveat concerns the fact that the activity data for June 2020 does not factor in the alternative treatment plans that may have been adopted by clinicians during the peak of the pandemic so as to circumvent the need for a PET-CT scan. In line with national and local guidance, non-surgical treatment was considered in favour of surgery. Systemic treatment and radiotherapy regimens were changed and modified all in an effort to reduce the risk of

spread of Covid-19 infection and to conserve health care resources for COVID-19 patients [19]. In short, the above considerations suggest that any attempt to predict future PET-CT demand maybe challenging as the PET-CT activity data for June 2020 may represent an over or under estimate of real demand.

**The findings from this study add to the literature in two ways.** First, the study shows that variation in reduction and recovery in PET-CT scanning activity during the first wave of the COVID-19 pandemic is related to the type of cancer scanned. Lung and oesophageal cancer showed the biggest fall in activity and also the slowest recovery. By contrast, lymphoma and melanoma showed the smallest fall and fastest recovery. Second, our findings demonstrate that for lung cancer and lymphoma, the specific indication for scanning had an impact in PET-CT scanning activity. Scanning for diagnosis and staging in both tumour groups showed bigger falls in activity and a slower recovery compared with scanning for assessment following initial diagnosis including for detecting recurrence, surveillance and restaging. Delay in diagnosis may contribute to the variation but it does not easily account for the differences seen between lung cancer and lymphoma. Further research into the causes of these variations may provide us with insights into measures that can be taken to address the loss in activity associated with specific subgroups of PET CT patients. This in turn may contribute to improving patient care and outcomes.

# Conclusions

Drawing on activity data from 41 sites across NHS England, this study empirically measures the extent to which the COVID-19 pandemic has impacted on oncology and non-oncology PET-CT activity. The results from this study show that there was considerable variation in the rate of recovery in PET-CT scanning across cancer types and specific indications related to the cancer type. Of the six most common indications for PET CT, lung cancer and oesophageal cancer had the largest percentage decrease in scanning activity and slowest recovery. By contrast, lymphoma and melanoma showed the smallest percentage decrease and fastest recovery. Specifically, lung cancer PET-CTs related to initial diagnosis and staging saw the largest fall and slowest recovery compared with PET-CTs for people with known lung cancer.  The causes for the variation due to cancer type remains to be explained.

# Declarations

**Funding** not relevant

**Conflicts of interest/Competing interests** not relevant

**Availability of data and material** raw data available for review

**Code availability** not relevant

**Funding** not relevant

**Ethics approval** not relevant

**Consent to participate** not relevant

**Consent for publication** all co-authors have given permission to publish

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# Figures

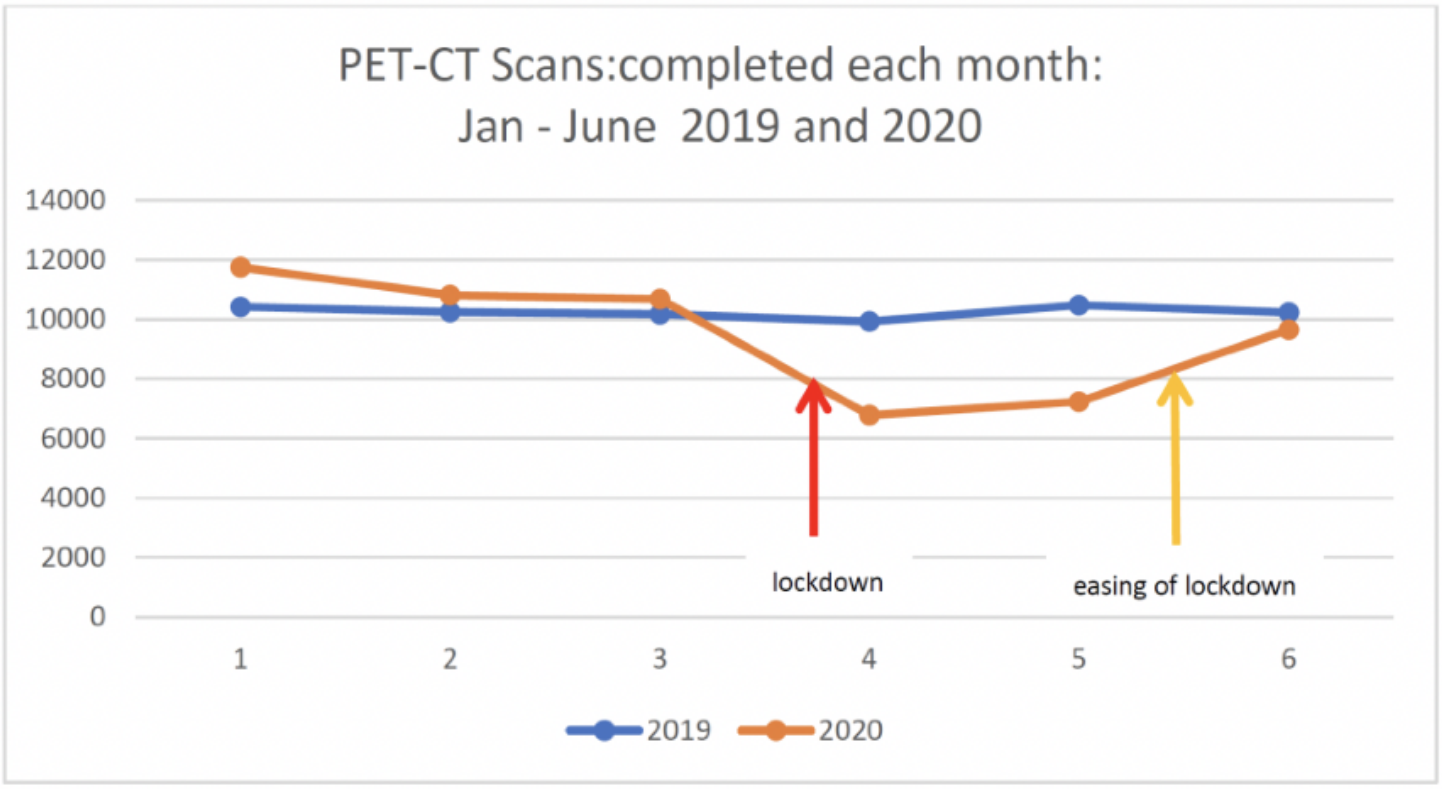


**Figure 1**

Comparison of total volume of PET-CTs completed: January to June for the years 2019 and 2020. 1- January, 2 - February, 3 - March, 4 - April, 5 - May, 6 - June.

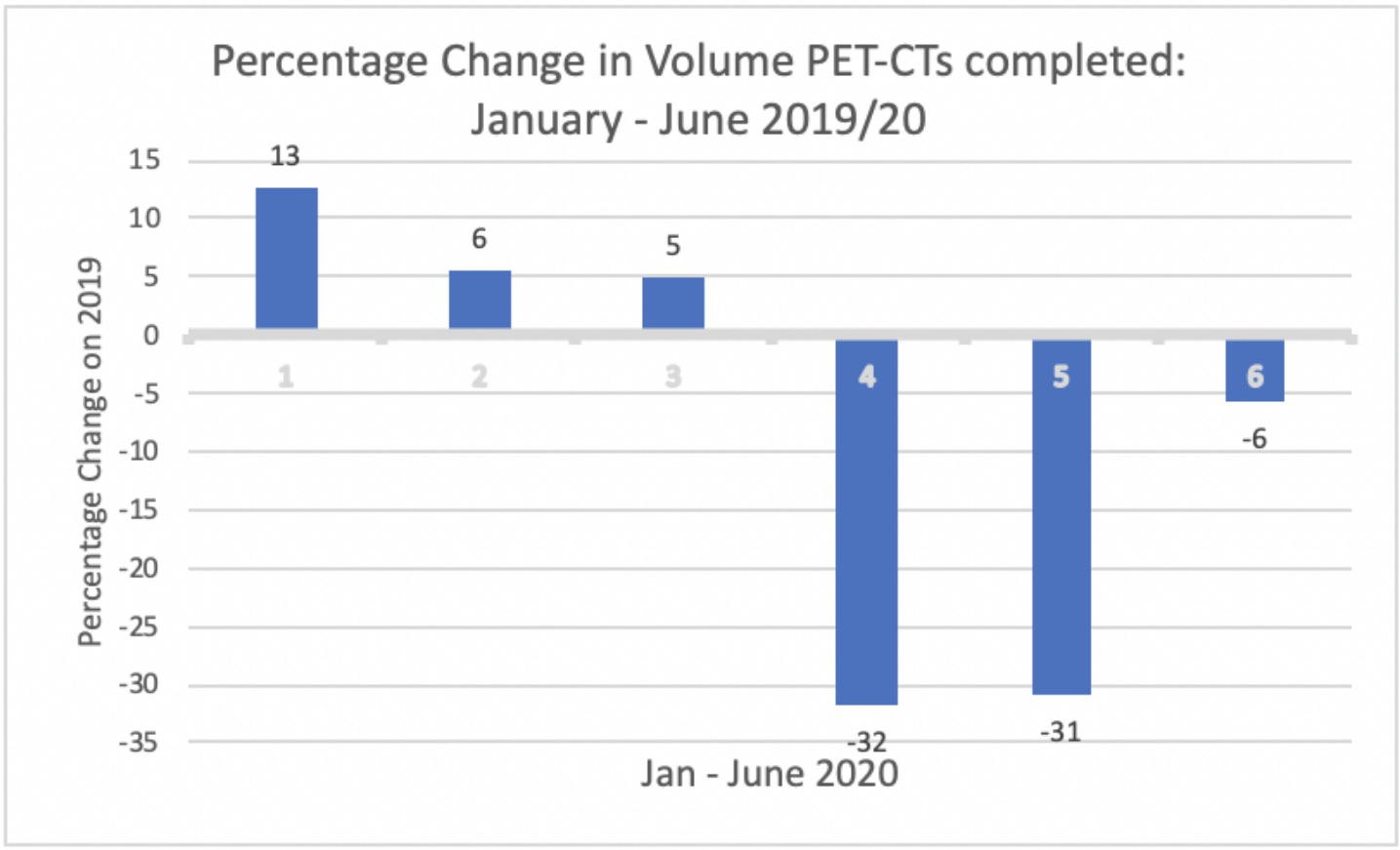


**Figure 2**

Percentage change year-on-year in volume of PET-CTs completed for months January to June 2020. 1- January, 2 - February, 3 - March, 4 - April, 5 - May, 6 - June.

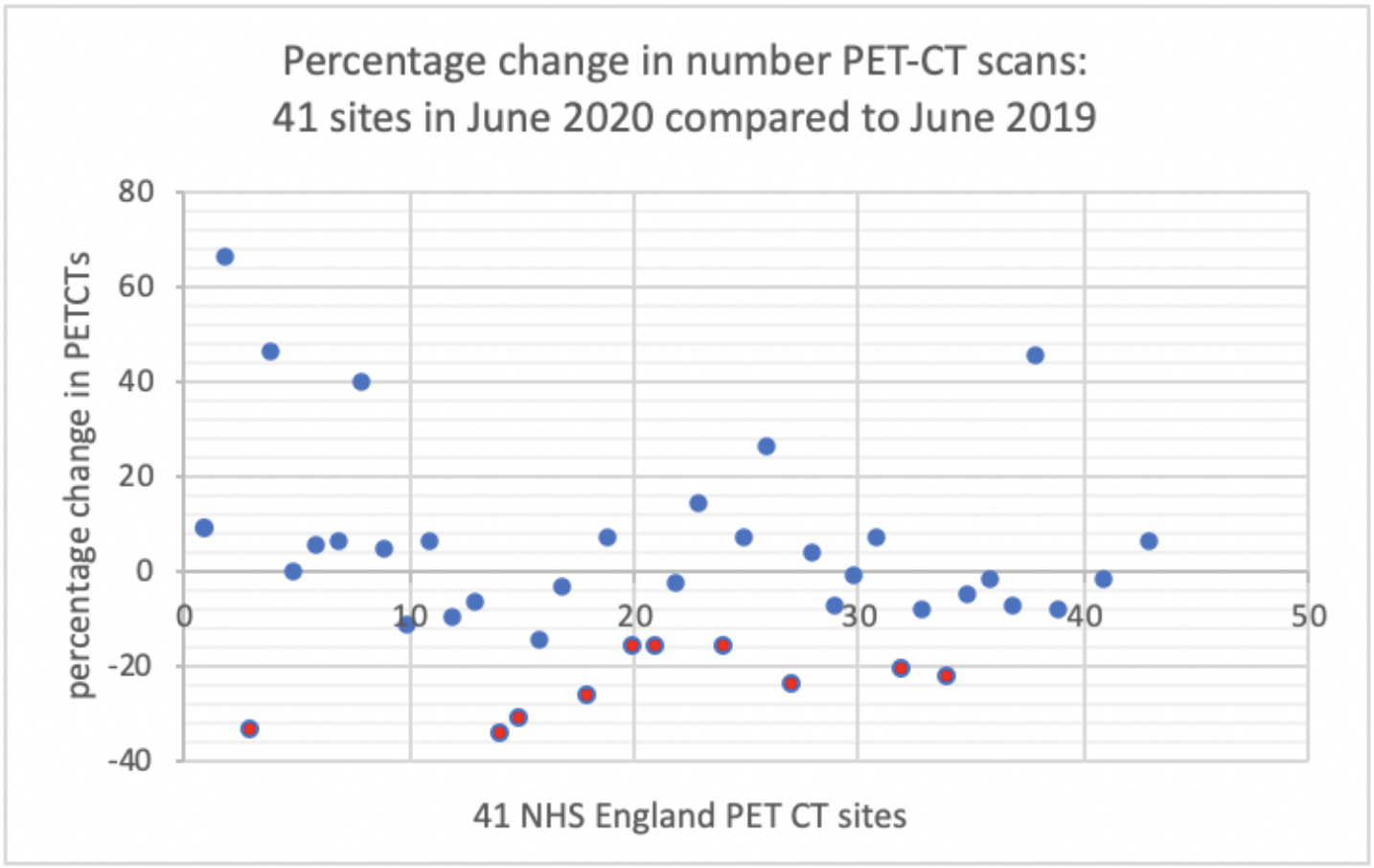


**Figure 3**

Percentage change in PET-CT activity at site level: year-on-year for the month June 2020

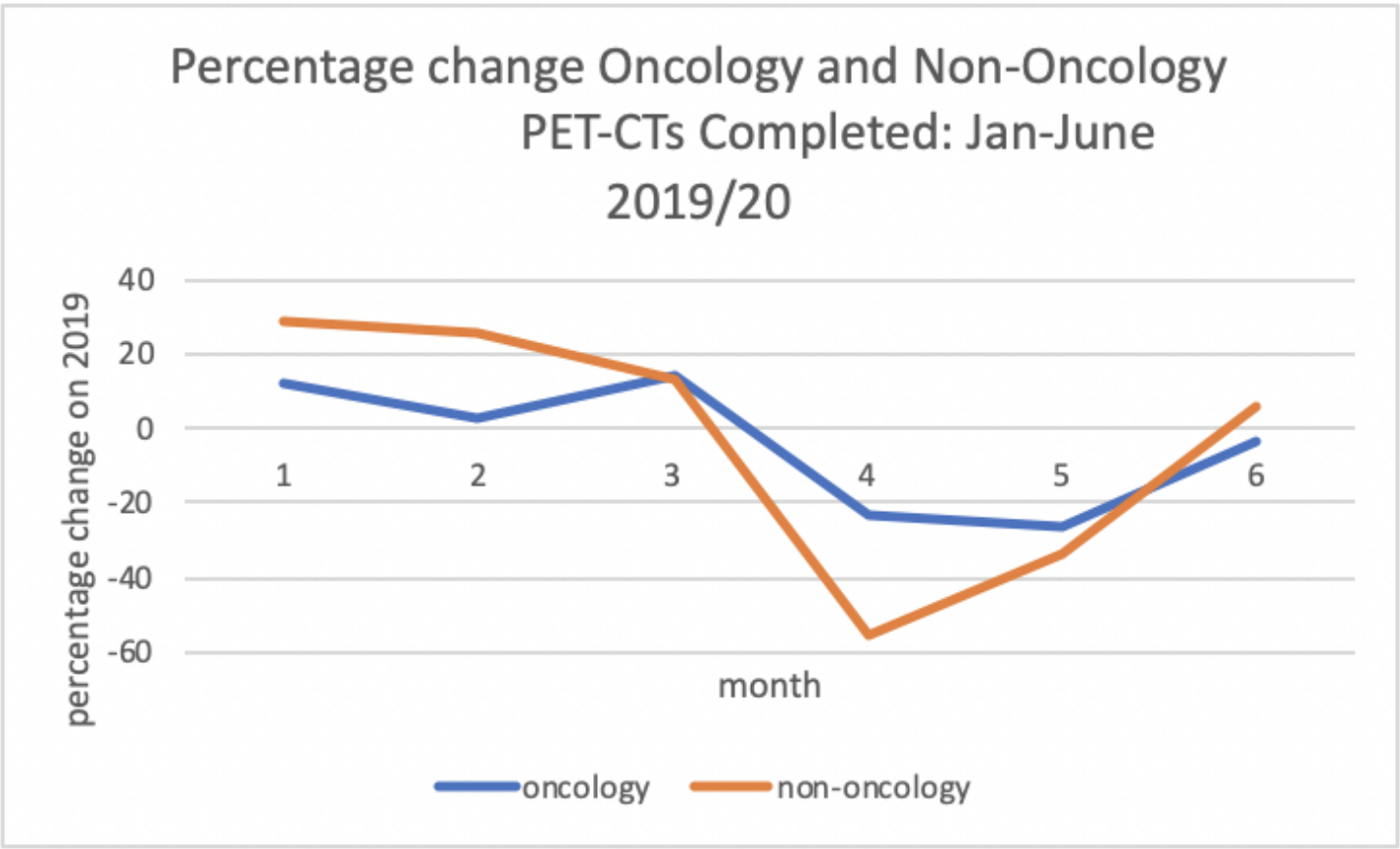


**Figure 4**

Percentage change in volume of oncology and non-oncology PET-CTs completed: year-on-year for the months January-June 2020. 1- January, 2 - February, 3 - March, 4 - April, 5 - May, 6 - June.

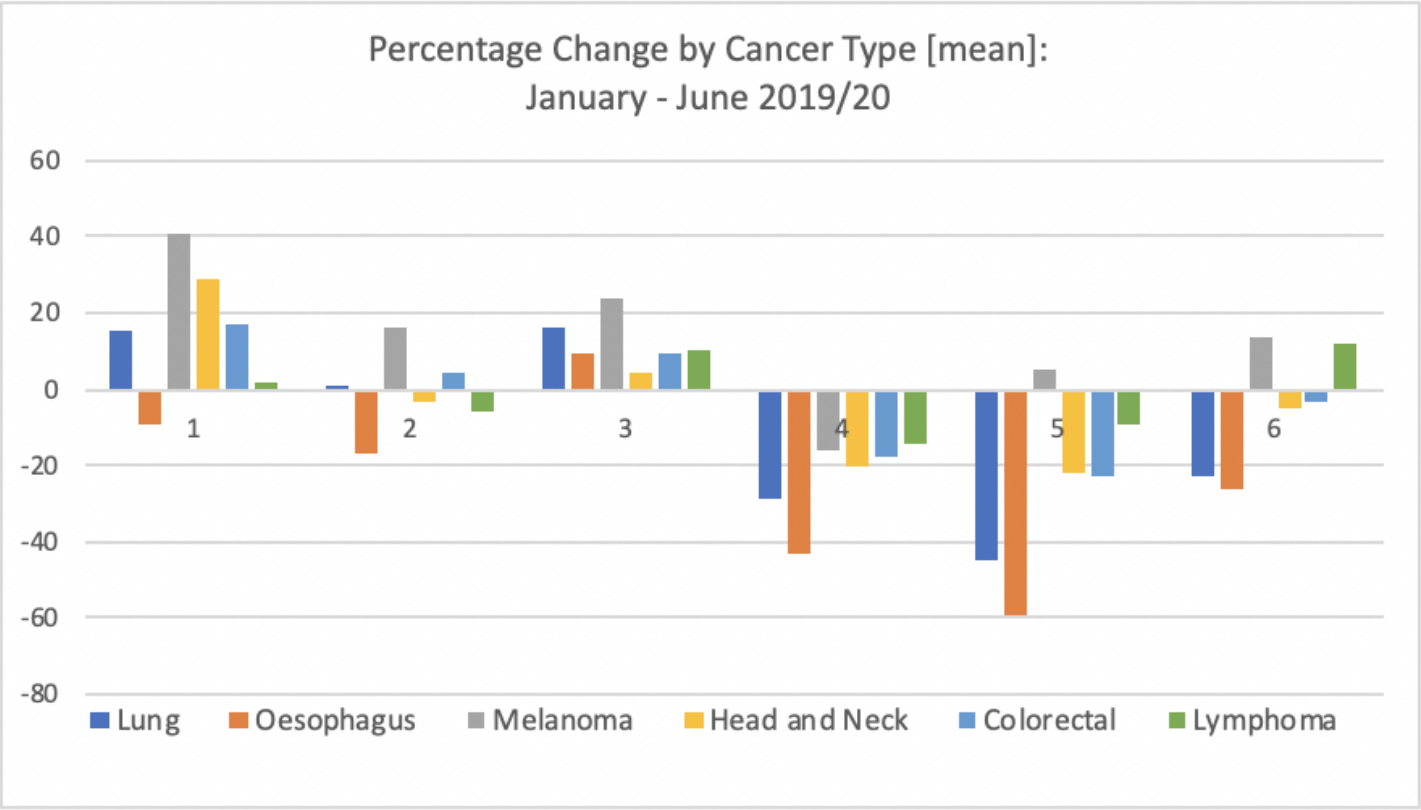


**Figure 5**

Percentage change year-on-year for the months January - June 2020 in global FDG PET-CT scanning activity related to indications for PET- CT. 1- January, 2 - February, 3 - March, 4 - April, 5 - May, 6 - June.

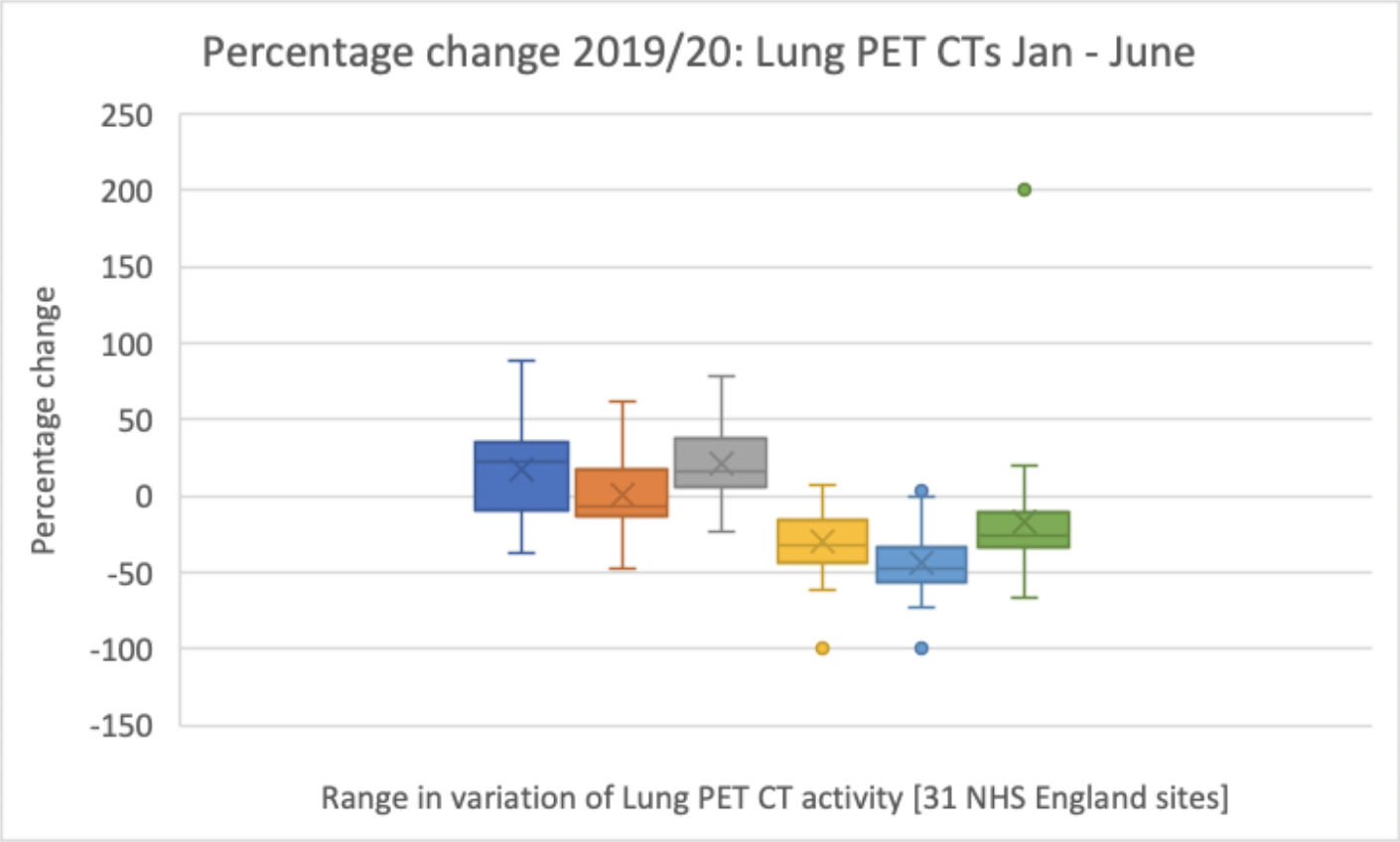


**Figure 6**

Monthly percentage change [year-on-year for the months January - June 2020] in PET-CT lung cancer activity across 31 NHS England sites.

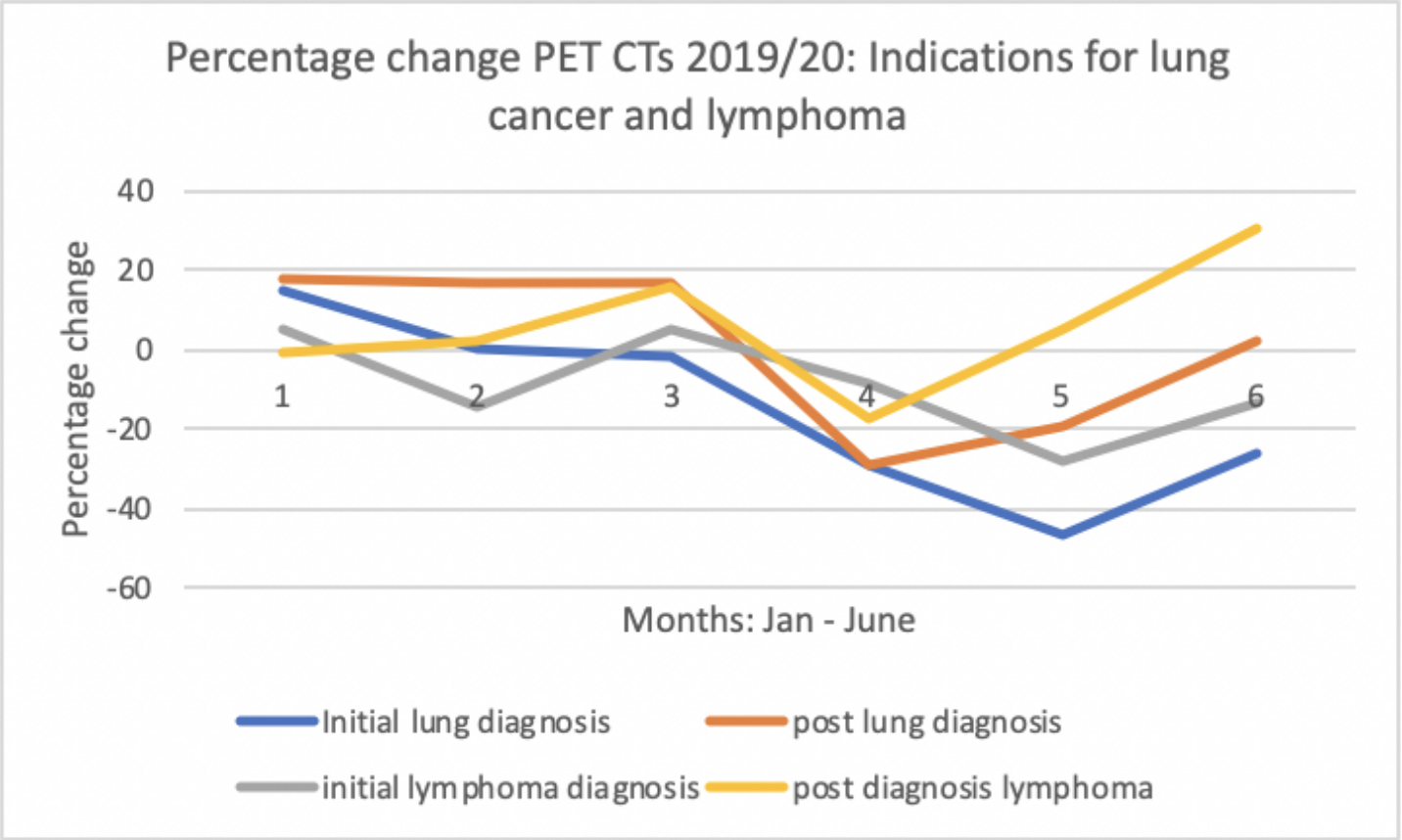


**Figure 7**

Monthly percentage change [year-on-year for the months January - June 2020] in PET CT related to specific indications for lung cancer and lymphoma.1- January, 2 - February, 3 - March, 4 - April, 5 - May, 6 - June.