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# The Impact of COVID-19 on Mental Health Services in Scotland, UK

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Abstract. There is a global emergency in relation to mental health (MH) and healthcare. In the UK each year, 1 in 4 people will experience MH problems. Healthcare services are increasingly oversubscribed, and COVID-19 has deepened the healthcare gap. We investigated the effect of COVID-19 on waiting times for MH services in Scotland. We used national registers of MH services provided by Public Health Scotland. The results show that waiting times for adults and children increased drastically during the pandemic. This was seen nationally and across most of the administrative regions of Scotland. We find, however, that child and adolescent services were comparatively less impacted by the pandemic than adult services. This is potentially due to prioritisation of paediatric patients, or due to an increasing demand on adult services triggered by the pandemic itself.

Keywords. Mental Health, COVID-19, Deep Learning, Visualization

#### 1. Introduction

Mental illness (e.g., depression, anxiety, sleep disorders) is a global epidemic placing burdens on individuals, healthcare services, and social-care services. In 2018, mental health (MH) was identified by the Scottish government as a national public health priority (1) and the 2021-22 Scottish Budget included £139 million investment in MH services (2).

The COVID-19 pandemic affected MH both directly and indirectly. For example, through lockdowns, isolation, fear for loved ones and job insecurity, or by limiting access to healthcare services and face-to-face consultations (3). As we recover from the pandemic, it is critical that we understand how MH was affected so that healthcare systems and governments can respond better to such critical events in the future.

Public Health Scotland (PHS) is Scotland's agency for health and wellbeing. PHS works closely with the national government, as well as local authorities, the National Health Service (NHS) and private partners to shape and implement policies to improve public health. PHS has set the NHS in Scotland a number of standards for waiting times, including for MH. The target for Psychological Therapy MH Waiting Times is 18 weeks from referral to treatment (4) for both adult and for Child and Adolescent Mental Health Services (CAMHS).

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In this project we used open-access MH services data provided by PHS (5; 6) to analyse the waiting times of patients referred for psychological therapies MH treatment before, during and emerging from the COVID-19 pandemic.

### 2. Methods

We used national registers of adult and CAMHS data collected by PHS from each NHS Board in Scotland recording the total number of patients referred, on a waiting list ("waiting"), and seen ("seen") for MH issues each month from January 2014 to June 2021 (5; 6). Once patients have had their initial consultation, they are removed from the "waiting" data and recorded as "seen". This means that patients waiting longer than a month for their initial consultation will be counted multiple times in the dataset. Both waiting and seen times are reported in the ranges ≤ 18 weeks, 19-35 weeks, 36-52 weeks and > 52 weeks. We combined data from different health boards (HB) in Scotland and presented monthly waiting times nationally and by HB. For Fife, Greater Glasgow, Lanarkshire and Tayside, the original labels are superseded by newer ones in PHS's records, so we relabel them to be consistent across the full dataset. We analyse the data via clustering, removing HB, month, and year variables prior to the analysis to find unsupervised patterns, such as in geography and time, and the impact of the pandemic.

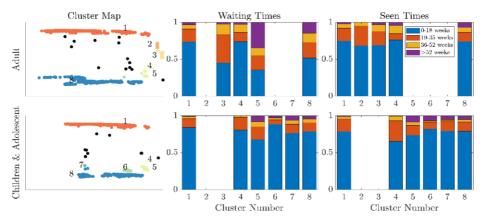
The data are processed so all the values are converted to numerical data as described in (7) where text data are padded with white space, so all elements are the same length. Next, data are converted to numbers using ASCII encoding resulting in 76 variables for each time point. The data are encoded using a deep autoencoder (DAE) to perform data driven analysis and visualize patterns (7). Here we use a DAE with hidden layers of 50, 20, 10 and 2 neurons trained layer-wise for 50,000 epochs. We optimize the parameters in our DAE by running preliminary experiments of 200 parameter combinations for 10,000 epochs selecting the same hyper-parameters for all layers from these experiments, which yield similar results in most cases. We set the lowest dimension of our encoding space as two, allowing visualization of the data as a scatter plot. We cluster the embedding space using the DBSCAN algorithm in MATLAB (8). Combining a DAE and DBSCAN provides a fully unsupervised framework without requiring training labels or a defined number of clusters. We remove HBs S92000003 (country code for Scotland) and SB0803 (NHS24) (9) prior to clustering as they do not represent specific regions.

#### 3. Results

The analysis resulted in eight clusters, where clusters 5-8 had worse waiting times than clusters 1-4: in clusters 5-8 there was a larger proportion of patients waiting > 52 weeks for initial assessment and fewer patients waiting less than the target 18 weeks (Figure 1). Map representations of these cluster indices generated using the Python package GeoPandas (10) are shown in Figure 2. Mean dates of each cluster show that clusters 5-8 occur within the pandemic while clusters 1-4 occur pre-pandemic (Figure 2), except for cluster 3 which only contained 0.75 % of the data so may be an outlier. For adults still awaiting initial consultation, the median waiting time in clusters 1-4 was 13.5 weeks and for clusters 5-8 was 17.9 weeks, with median seen (initial consultation) times of 12.4 weeks and 11.5 weeks for clusters 1-4 and 5-8 respectively. For CAMHS, the

median waiting time in clusters 1-4 is 12.8 weeks and for cluster 5-8 was 17.1 weeks, with the median seen times of 13.3 weeks and 13.1 weeks for clusters 1-4 and 5-8 respectively. These values are dominated by clusters 1 (mean date Nov/Dec 2016) and 8 (mean date Jul/Aug 2020) which represent 75 % and 19 % of the data respectively.

Figure 1 shows the proportion of 18 week waiting times reduced in the pandemic (cluster 5-8) in both adult and CAMHS data, increasing the median waiting time by over a month. The proportion of patients seen within 18 weeks was approximately the same before and during the pandemic, resulting in similar median seen times of adults and CAMHS. However, there is a large increase in the proportion of patients in the > 52 weeks category for waiting and seen times in both adult and CAMHS in the pandemic, indicating access to MH services was worse through the pandemic. Figure 2 shows that almost all of Scotland was part of cluster 1 before and part of cluster 8 at some stage during the pandemic, highlighting a systemic issue across the whole of Scotland and not just issues within individual HBs.

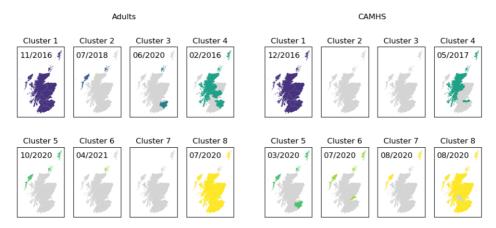


**Figure 1.** Adult (top), child and adolescent mental health services (bottom) data visualized with a DAE and clustered with DBSCAN (left) with a minimum size of 5 and radius of 0.03. Cluster numbers are indicated in the scatter plots with mean waiting (middle) and seen (right) times for each cluster. Note both datasets are processed together but visualized separately for clarity. Outliers are shown in black in the scatter plots. For the adult data, cluster 6 has only one point, waiting times in cluster 2 and seen times in cluster 5 are NaNs so are omitted from the bar plots.

#### 4. Discussion and Conclusions

The proportion of patients seen within 18 weeks remained relatively constant between the pre-pandemic and pandemic clusters for both adult and CAMHS data. The proportion of patients waiting more than 52 weeks, however, increased drastically in clusters 5-8 representing the pandemic period for both adults and CAMHS data. This indicates that demand was growing faster than the capacity for services. This was likely accelerated by the COVID-19 pandemic, with services having to be shut down or delayed (11). Urgency based prioritization of services has been observed for children's services (12). Overall, adult services appeared to be more impacted by the pandemic than children's services for initial assessments, with a lower proportion of adult patients meeting the 18-week target during the pandemic. Both adult and CAMHS waiting times increased by more than four weeks in the pandemic and a greater portion of patients were waiting more than 52 weeks for an initial consultation. This may be due to several factors such as: direct

and indirect lockdown effects; reluctance to use virtual appointments; no access to GP services; redeployment of psychology staff and cancelling of non-essential services. These results indicate that the pandemic was a significant factor in the increase in mental health waiting times. On average, services across the whole of Scotland were affected; all HBs in the adult data and all but one HB (Forth Valley) in the CAMHS data had increased waiting/seen times.



**Figure 2.** Adult and children (CAMHS) clusters represented as geographic maps showing all 14 health boards. If a datapoint from a health board is ever grouped within a given cluster, that health board is coloured on the map. The dates in the top left of each panel indicate the mean average date for all instances of that cluster.

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