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The long-run effect of COVID-19 on hospital emergency department attendances:evidence from statistical analysis of hospital data from England

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ABSTRACT

During the COVID-19 pandemic, hospital emergency departments worldwide experienced a pronounced fall in utilisation of emergency care, with a decrease of up to 40% in many countries. Evidence suggests the cause of these changes include both population fear of COVID-19 and the effects of lockdowns and the interaction of these two effects. We analyse a sub-sample of national data on Accident and Emergency (A&E) attendances in England over an extended period from April 2019 to March 2022 for different patient groups, including by age, mental/physical health status, acuity, and common clinical groupings. Our results showed that all patient groups experienced substantial declines in attendances during the first two waves of the pandemic, including high acuity and cardiovascular patients. Mental health patients were the only exception, with a smaller decline in attendances. Our findings suggest that policymakers should recognise the potential harmful effects of lockdowns, public messaging, and changes in health care provision on all patients during health emergencies.

1. Introduction

During the COVID-19 pandemic, hospital emergency departments in England experienced a pronounced fall in utilisation of emergency care [1]. Many studies find a fall in utilisation of around 40% [2–5]. The fall in attendances was particularly large for children [6] and lower severity patients [2,7]. This fall was observed around the world, in the US [3,5], Korea [8], Albania [9], Australia [10] as well as the UK [1,4,11]. Evidence suggests the cause of these changes include both population fear of COVID-19 as well as the effects of lockdowns (e.g. less traffic accidents), and the interaction of these two effects [12]. The decrease in healthcare utilisation during the pandemic has led to concerns of a hidden 'backlog' of patients who delayed or skipped care, which could represent unmet need [13] and even higher mortality for certain groups of patients [14].

We add to this literature by analysing data from a subsample of NHS trusts in England on Accident and Emergency (A&E) attendances over an extended period from April 2019 to March 2022, showing the initial impact of the pandemic in reducing attendances, the temporary recovery in the summer of 2020 and the effect of the second wave (and further two lockdowns) in the winter of 2020/21. Then from spring 2021, we observe the recovery of attendances into 2022.

We investigate how the pandemic differentially impacted groups of patients and potentially identify the factors contributing to the decline in demand and their medium-term consequences, by examining data for several key subgroups. Specifically, we separately analyse the data for patient attendances with mental and physical health conditions, children and older adults, with high and low acuity, and with the three most frequent principal reasons to attend A&E. Given data quality challenges we use a reliable sample with a subset of trusts that has complete information on diagnosis, acuity and chief complaint variables.

Attendances for mental health patients are of interest due to the potential effects of COVID-19 lockdowns on mental health conditions [15,16]. While we know that overall A&E attendances fell during the first year of the pandemic, we test for different effects for mental health A&E attendances. Comparing children and older people is of particular interest because of the stark age gradient in COVID-19 risk [17] and by comparing high and low acuity patients we can test for the trade-off between the effects of lockdown restrictions and COVID-19 risk and the need for urgent non-COVID-19 care. By analysing changes in the volume of the three most common reasons for attending A&E, we can test whether there were any differences in the number of visits due to trauma/musculoskeletal, gastrointestinal, and circulation/chest emergencies that might be more or less affected by lockdown measures and be more or less urgent. Finally, we test if there are differences in the pattern of A&E attendances for patients diagnosed with cardiovascular

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complaints, which are more likely to be directly related to patient mortality.

The timescale of our data allows us to examine not only the initial impact of the onset of the pandemic, but also the period in 2021/22 when A&E attendances returned to previous levels and there was a decline in A&E performance and rise in waiting times [18]. Our data and approach allow us to test if attendances from particular subgroups of patients are associated with the worsening performance in A&E which developed further in later 2022 and 2023 [19].

1.1. Institutional background

The English National Health Service (NHS) is funded by general taxation and is free at the point of use. Patients can seek emergency care directly by calling 999 and requesting an ambulance or by travelling to the Accident & Emergency Department (AED) of the hospital. For urgent but non-life-threatening problems, patients may call the NHS 111 service, which provides advice and triage and may recommend a visit to a hospital ED or GP.

The first wave of the COVID-19 pandemic affected England between March and May 2020, with high rates of infections, hospitalisations and deaths. During the summer months (June-September 2020), the number of cases dropped considerably with hospitalisations falling below 100 per day [20]. The number of cases, hospitalisations and deaths started rising again in September 2020 and reached a second peak in January 2021, before falling in the spring of 2021.

A series of social restrictions were implemented in 2020 and 2021 to curtail the spread of COVID-19 [21]. The first lockdown was announced on 23 March 2020, closing schools, hospitality, non-essential retail sectors and advising people to work from home. The lockdown was gradually relaxed through May and June 2020 and included limited reopening of schools, shops and hospitality businesses. During the summer and autumn of 2020, a series of localised restrictions were implemented with some areas having more restrictions than others [22]. In October 2020, restrictions increased with many areas having hospitality venues closed again, then in November 2020 there was a second national lockdown with a return to the early 2020 restrictions. In December, there were localised restrictions again, then on 6 January 2021, there was a third national lockdown, which was relaxed gradually from March to May 2021.

In addition to the social restrictions, there were some changes to health care delivery in England during the pandemic. A letter was sent to all NHS organisations in March 2020 outlining plans for the provision of health care during the pandemic, including the postponement of non-urgent elective care [23]. Emergency care was not discontinued, but the "protect the NHS" campaign was widely advertised to limit NHS utilisation [24], including A&E attendances. For suspected COVID-19 cases, patients were advised to call 111 and not to visit general practices or hospital A&E services in the first instance [25]. An official investigation into the 111 service during the pandemic found that patients with COVID-19 symptoms were not always properly clinically assessed and were sometimes recommended to self-care at home when more intensive treatment was appropriate [26].

2. Materials and methods

2.1. Data

Our primary data source is the new Emergency Care Data Set (ECDS) from NHS Digital, which collects information for all attendances to Accident and Emergency Departments run by the English National Health Service. The ECDS includes a wide and rich set of information on attendances, such as diagnosis, treatment, investigations, time and method of arrival and departure and patient characteristics, such as age, sex, and area of residence.

We analyse all non-COVID related A&E attendances to AEDs at English NHS Trusts, from April 2019 to March 2022, for residents in England, for which the commissioner was a Clinical Commissioning Group (CCG). Using the rich set of information provided in the ECDS, we distinguish attendance to an AED based on patient characteristics such as age and key characteristics of attendance, including the acuity of a patient's condition at the time of attendance, the reason for attending the AED (known as the chief complaint), and the patient's diagnosis while in the AED. Our analysis was carried out using the following subgroups.

- Attendance type:
  - *Mental and Physical health:* We define mental or physical health subgroups based on the chief complaint field. The mental health group includes AED attendances where there was drug/alcohol intoxication, self-harm, anxiety, depression, individual exhibited unusual or bizarre behaviour and/or experienced hallucinations or delusions. Physical health includes all other types of complaints such as trauma and musculoskeletal problems, head and neck, eye, skin, or gastrointestinal complaints, breathing or circulatory/chest or neurological problems, and general, minor, or administrative complaints.
  - *High and low acuity:* The acuity field reflects the urgency of the patient's condition at the time of attendance. We create a two subgroups by defining high acuity as AED attendances that required immediate care, very urgent or urgent care, while attendances requiring standard care or low-level care are defined as low acuity.
  - *Three most frequent reasons to attend A&E:* We use the chief complaint field to define subgroups for the three most frequent reasons to attend A&E. These are trauma/musculoskeletal, gastrointestinal and circulation/chest complaints.
  - *Cardiovascular diagnosis:* We define a subgroup for patients with a cardiovascular diagnosis based on the diagnosis field of the ECDS of the heart and circulatory system, which includes cardiac (e.g. myocardial infarction, angina, hypertension); cardiac electrical (atrial fibrillation, any degree of heart block, arrhythmia, cardiac arrest) and neurovascular (stroke, transient ischaemic attack) diagnoses.
- Patient characteristics
  - *Age:* We create two subgroups based on age: children (0–17 years), and older people (65 years and above).

We calculate the monthly number of A&E attendances per Clinical Commissioning Group. We use the patient's CCG of residence and map the 2019 and 2020 CCGs to the 106 CCGs in effect as of 2021. This allows us to take into account unobserved time-invariant heterogeneity across the CCGs.

Our primary outcome variable is the total number of A&E attendances by individuals who reside in one of the 106 CCGs between 1 April 2019 and 31 March 2022. When defining the analysis subgroups, we encountered the presence of missing data in key ECDS fields, and this missingness varied over time, generally with improvements (reducing missingness) over time. We analyse the variation over time in attendances in specific subgroups, so changes over time in the missingness of the variables which define the subgroups will lead to misleading results. We therefore decided to use a restricted sample of AEDs with less than 3% missing data in acuity and chief complaint variables to mitigate the potential biases introduced by missing data and ensure more robust results.

The missing data problem is likely due to the ECDS being a recent dataset since it replaced the Hospital Episode Statistics (HES) Accident and Emergency Commissioning Data Set in April 2020. Phased rollout of the ECDS data set started in October 2017 and was completed during the 2019-20 reporting period, which means that all activity within the 2020-21 financial year was reported in the ECDS format. However, the completeness of the fields was not the same across 2020-21. Please see

Tables 3 and 4 in Appendix B for time-varying missingness in the acuity and chief complaint variables.

There were 61,159,515 A&E attendances from April 2019 to March 2022, as shown in Table 1 in Appendix A. We only keep attendances from NHS trusts and exclude those from independent sector providers. Furthermore, we keep only attendances from providers that had less than 3% missing on the acuity and chief complaint variables, which leads to a sample of 18,221,183 A&E attendances. Of these, 18,128,101 attendances were non-COVID related and 17.9 million were attendances from English CCG patients and assigned to the 106 CCGs in 2021. Therefore, we analyse data on 17.9 million attendances across the 3816 monthly observations, that is, 36 months over the 106 CCGs.

Tables 5–7 in Appendix B report that there were no significant differences between the providers included and excluded from the analysis based on the total volume of attendances, or volume by female, male, children, adults, elderly, or the volume of attendances from the most deprived patients.

2.2. Methods

We run a linear regression model where the dependent variable is the logarithm of A&E attendances in different subgroups per CCG per month. As explanatory variables we include month-specific (fixed) effects and CCG-specific fixed effects. The CCG effects allow us to control for unobserved constant differences between CCGs that might affect A&E attendances. However the CCG fixed effects do not allow for variations over time in the local COVID-19 risk. The month-specific effects enable us to capture the temporal variation and examine the trends before, during and after the waves of COVID-19 infections and associated lockdowns in England. By using both sets of fixed effects, we can effectively disentangle the impact of time-invariant heterogeneity among CCGs and the changes that occur over different months, providing a comprehensive understanding of the effects of the lockdowns and COVID-19 waves on A&E attendances. We use the formula % $change \approx \left(e^{\beta} - 1\right) * 100$ to convert estimates of regression coefficients β and their standard errors for the month effects to approximate percentage changes to present in the results plots.

3. Results

Figs. 1–4, 5 and 6 present plots of approximate percentage changes in attendances for each month from May 2019 to March 2022 compared to April 2019 as the reference case for different subgroups of the data. These figures are presented for the restricted sample of providers that has less than 3% missing in the acuity and chief complaint variables. Appendix C provides detailed regression coefficients.

We start by analysing total A&E attendances before, during and after COVID-19 infection waves and lockdowns. Fig. 1 shows approximate percentage changes in the total number of non-COVID-19 attendances at English AEDs from 1 April 2019 to 31 March 2022. The dashed vertical lines mark the months when lockdowns were introduced in England.

We observe the greatest drop in the total number of A&E attendance during the first wave of COVID-19 and associated lockdown which affected the UK in March and April 2020. The attendance levels recover near to previous levels during the summer of 2020 and then drop for a second time during the second COVID-19 wave, and the second and third lockdowns. From the spring of 2021, attendances rose back to around pre-COVID levels. Table 2 in Appendix A shows detailed descriptive statistics.

Fig. 2 shows the monthly effects on mental health and physical health attendances. Attendances for physical health show a relatively stable pattern through 2019/20, a fall of 26% in March, with an even larger fall of 59% in April 2020, associated with the onset of the pandemic. Physical health attendances then recovered to near-normal levels in the summer of 2020 and suffered a second large fall (43%) during the winter of 2020/2021, before gradually recovering to near-normal levels. Attendances for mental health display a more volatile pattern in the months prior to the pandemic, with a decrease of roughly 47% in April 2020 and a quick recovery to pre-pandemic levels in summer 2020 followed by a further drop in winter 2020/21.

Fig. 3 shows the monthly effects for children and older people. The graph shows a similar pattern between the two groups, with a slightly bigger drop in attendances for children of 73% in April 2020 compared to older individuals (drop of 63%). Both groups had a similar recovery in the summer of 2020 and a second, slightly smaller fall in attendances in winter 2020/21.

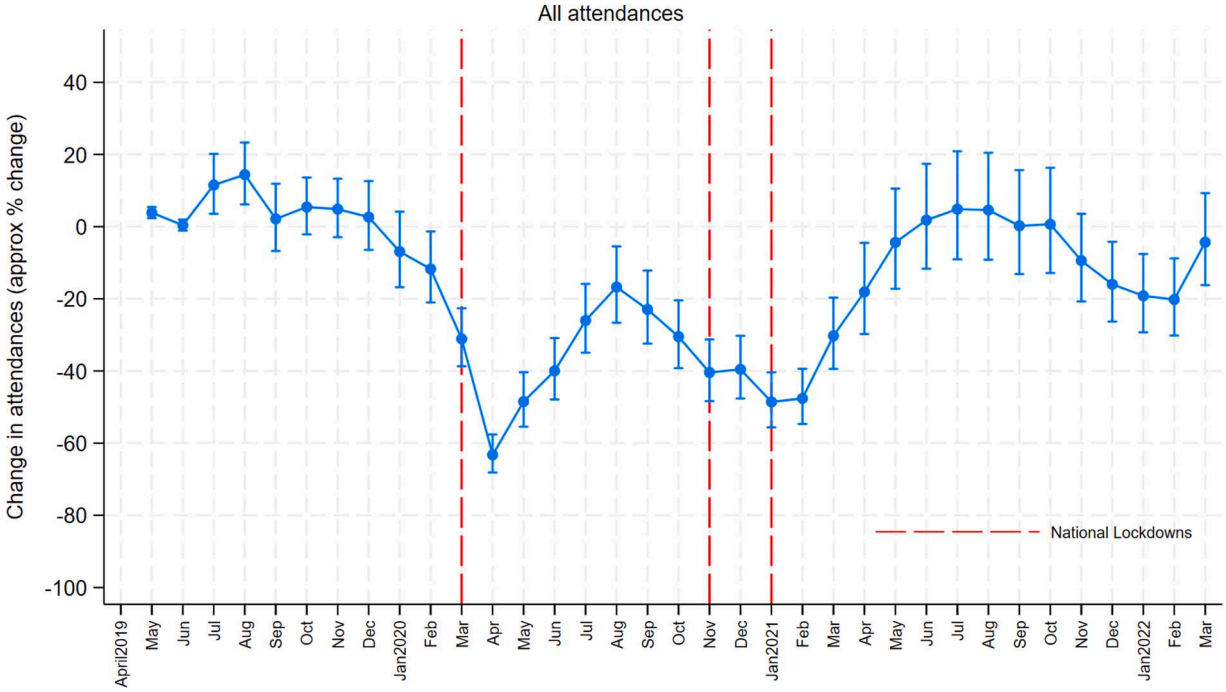

Fig. 1. Estimated approximate % changes in A&E attendances for a subsample of trusts in England April 2019 to March 2022 (compared to April 2019).

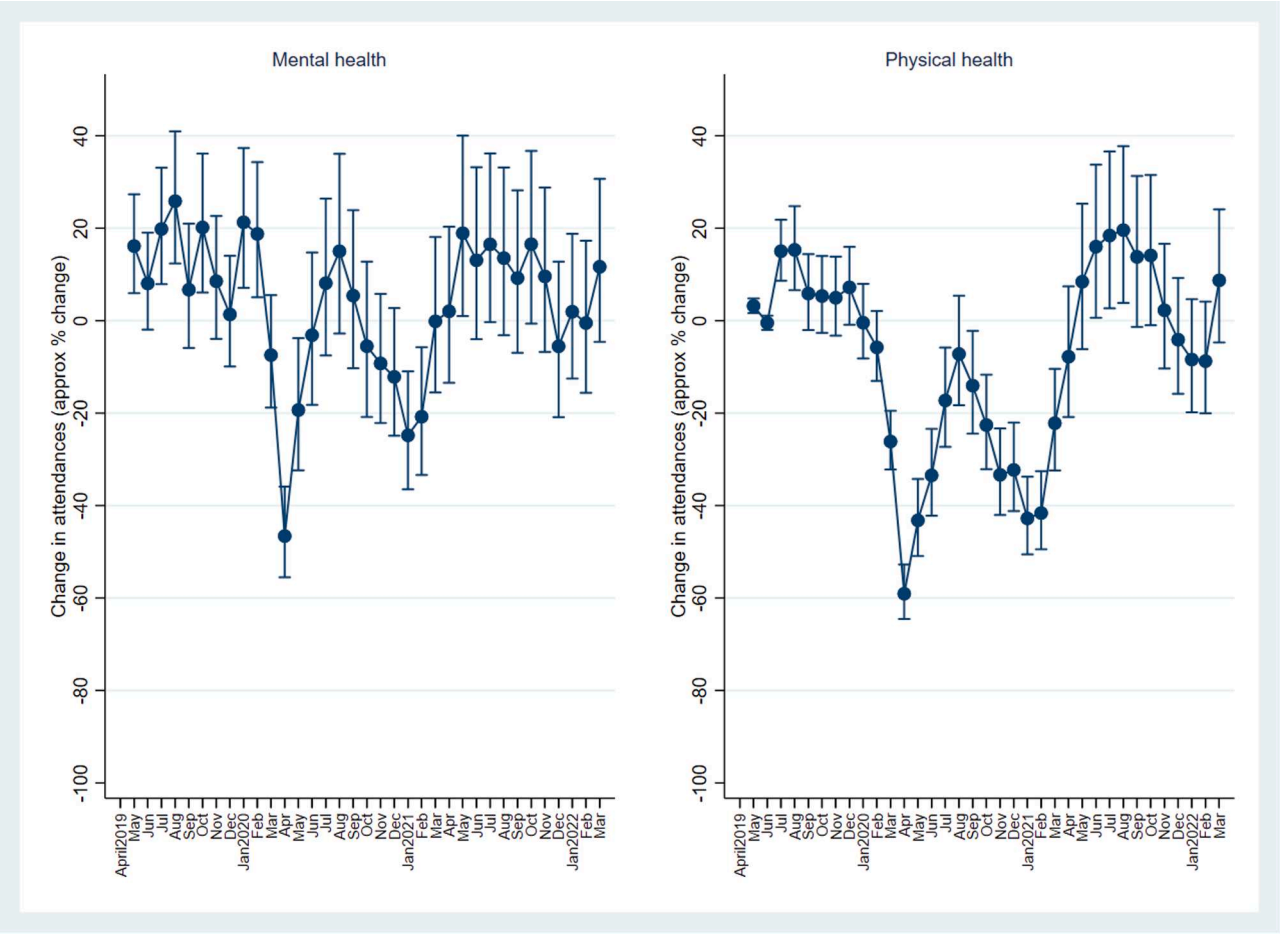

Fig. 2. Estimated approximate % changes in physical and mental health attendances for months from May 2019 to March 2022 (compared to April 2019) for a subsample of trusts in England.

Fig. 4 shows the monthly effects for high and low acuity patients. The results show a similar pattern to overall attendances in Fig. 1. Low acuity attendances have a slightly larger fall in April 2020 (down 67% from April 2019 levels) compared to high acuity attendances (down by 57%) but by the summer of 2020 both high and low acuity attendances, although lower than in April 2019, are not significantly different from each other. With the second wave of COVID-19 in winter 2020/21 again the low acuity patients have a slightly larger fall in attendances (down by 52% vs 39% for high acuity patients).

Appendix D provides results for the three most common reasons to attend A&E and for cardiovascular diagnoses vs other medical diagnoses.

Figure 5 (in Appendix D) presents monthly effects by reasons to attend A&E for the three most frequent reasons (trauma/ musculoskeletal, gastrointestinal, circulation/chest conditions) compared to all others combined. Out of the three groups, attendances for trauma/ musculoskeletal had the biggest fall of over 68% in attendances, in April 2020 compared to April 2019 levels, while attendances for both circulation/chest attendance and gastrointestinal complaints fell by approximately 57%. A&E attendances for all other complaints (i.e excluding trauma/musculoskeletal, chest/circulation and gastrointestinal) fell by 54% in April 2020 and had a smaller decrease during the winter of 2020/21 (38%).

Figure 6 (in Appendix D) presents monthly effects for attendances with a cardiovascular diagnosis versus any other medical diagnoses. Attendances from patients with cardiovascular medical diagnoses fell by 58% in April 2020 before rising back to just below pre-pandemic levels, falling 39% (from April 2019 levels) in January 2021, then recovering to near pre-COVID levels in the summer of 2021. Attendances with a non-cardiovascular medical diagnosis followed very similar patterns.

4. Discussion

Our results document the very large disruption in emergency care in England associated with the pandemic. All types of emergency attendance groups we analyse show two very large dips in attendances associated with the first wave (Spring 2020) and second ('alpha') wave (winter 2020/21) of COVID-19. Over the longer run we see a return to 'normal' levels of attendances from mid 2021 with a small dip associated with the winter 2021/22 'Omicron' wave.

We test hypotheses related to how COVID-19 risk and lockdowns affected different patient groups. Overall our results demonstrate a surprising similarity in the patterns of changes in attendances between very different patient groups. Despite the negative impact of COVID-19 lockdowns on mental health, we only see a slightly smaller impact of the onset of the pandemic on mental health attendances (47% fall) than for physical health (59% fall). Mental health attendances did recover to normal levels more quickly (by May 2020) and were only significantly lower than pre-pandemic in two of the months of the second wave (Jan and Feb 2021) as opposed to six months for physical health attendances. Both older people (>65) and children (<18) had a similar pattern of attendances through the pandemic. The subgroup with the lower COVID-19 risk, children, suffered a *larger* fall in attendances associated with the COVID-19 waves. One potential explanation for attendances of older patients not having a larger response to the pandemic would be the higher acuity of older patients. However, we find both high and low

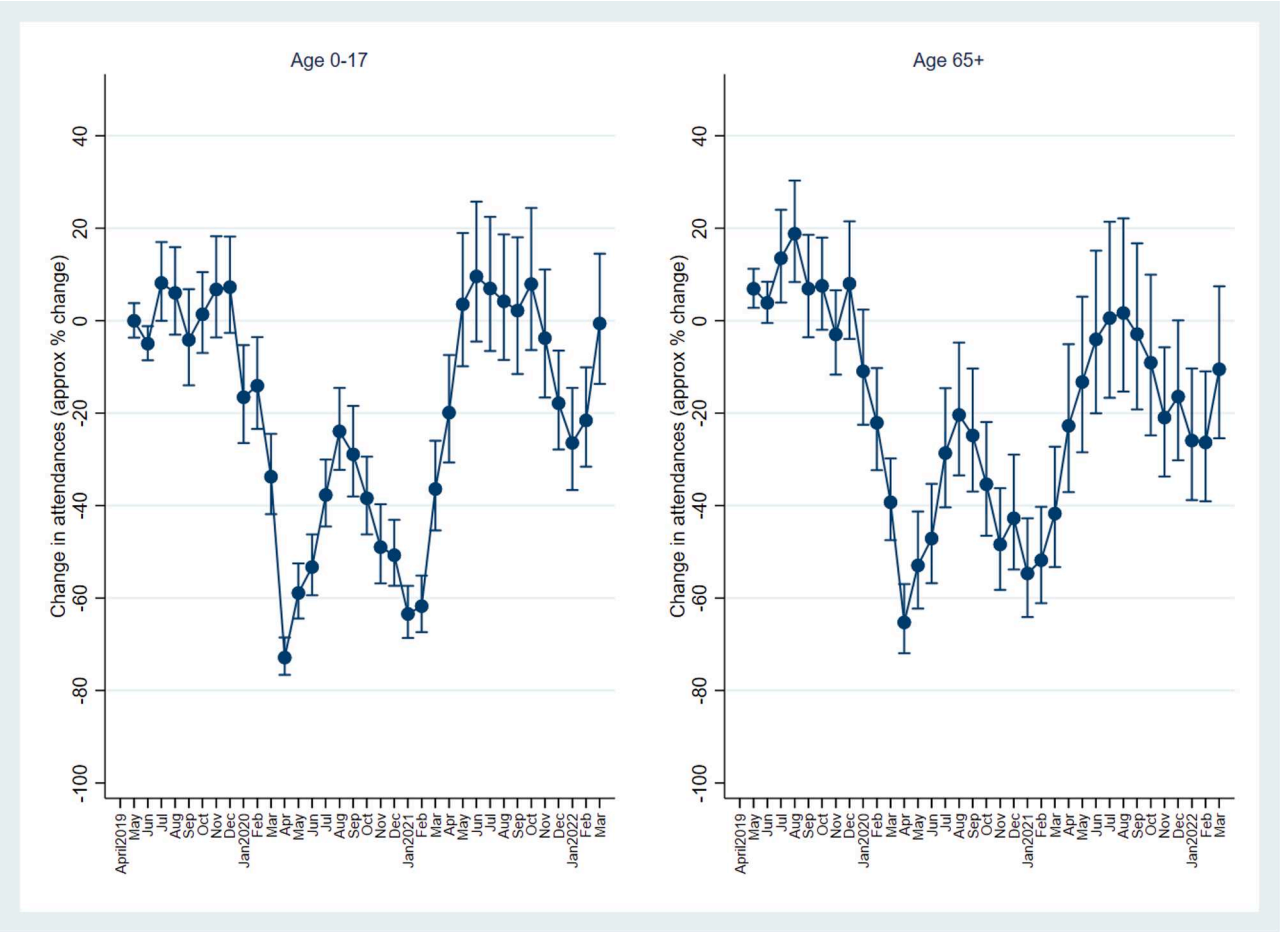

Fig. 3. Estimated approximate % changes for months from May 2019 to March 2022 (compared to April 2019) for children and older people's attendances for a subsample of trusts in England.

acuity patients suffered similar large falls in attendances, with only a slightly larger fall for low acuity patients in both waves of COVID-19.

When looking across clinical areas, we again observe a strikingly similar pattern of fluctuations in attendances through the pandemic. This seems to contradict the hypothesis that different groups of patients would be affected very differently by the risk of COVID-19 or the lockdown restrictions. The only notable difference is the larger fall in attendances in patients with Trauma/Musculoskeletal issues. This may be directly related to the lockdown restrictions, since people had limitations on travelling and were less engaged in outdoor activities during lockdown periods. As with our results for high/low acuity patients, there is little evidence of differences between potentially more or less 'urgent' clinical conditions in terms of changes in attendances. We show that attendances associated with cardiovascular complaints had approximately the same pattern as for other types of attendances, with large reductions associated with the first and second COVID-19 waves. This is particularly surprising as heart disease is the leading cause of death after dementia and Alzheimer's disease [27], and so cardiovascular-related attendances might be expected not to be as 'discretionary' as others.

Overall there is not good evidence of a "backlog effect" with demand that was displaced during the pandemic reappearing afterwards in A&E. Only a few of the subgroups (gastrointestinal and circulatory conditions) show some statistically significant increase in attendances from April 2019 in the late-COVID period, and these are not the subgroups with the largest falls in attendances in the earlier periods. The falls in emergency attendances across many different subgroups of patients in 2020 and early 2021 may therefore be evidence of unmet need [13,28]. There is no evidence of a rise in attendances by any particular subgroup of patients which could be associated with the decline in A&E performance which developed in 2022 [19].

4.1. Limitations

One limitation of the analysis is that we use a subset of the trusts in England for which we have reliable data. However, we show that our sample is broadly representative of the total population of emergency department attendances according to observable characteristics in the data.

A further limitation is that we consider only emergency department attendances and are unable to account for possible substitution between emergency care, general practitioner appointments, or other forms of primary care. We also cannot account for local time-varying differences in the COVID-19 pandemic in England, although most restrictions were implemented at the national level [21]. Finally, in common with much research around the COVID-19 pandemic, we are uncertain as to the exact causes of the patterns of activity we see during the pandemic. While emergency department attendances are usually demand-led, we are unable to separate demand and supply influences on the patterns we find in the data.

5. Conclusions

We have evidence from several countries and disease areas that patients avoided or delayed seeking necessary healthcare during the pandemic [3,29–31], although it is often unclear what role was played by patients' attitudes or policy changes such as lockdowns [12]. The

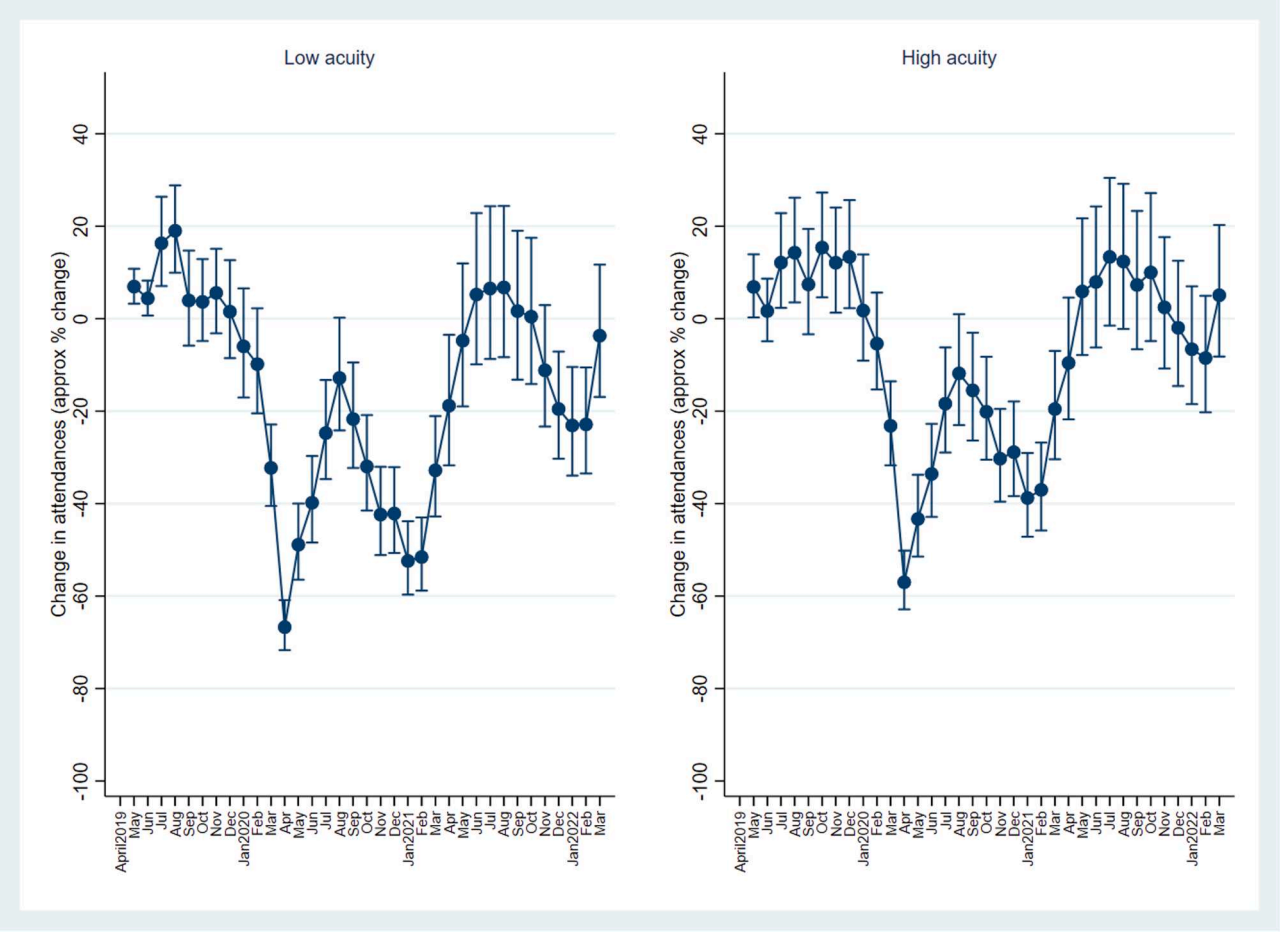

Fig. 4. Estimated approximate % changes for months from May 2019 to March 2022 (compared to April 2019) for high and low acuity attendances for a subsample of trusts in England.

policy implications of this study mainly relates to the lockdown policies [21,22], messaging [24] and changes in health care delivery [23] that occurred in the UK during the pandemic. We show that these policies are associated with reduced emergency care utilisation substantially for all groups of emergency care patients, irrespective of COVID-19 risk or acuity including those with urgent care needs.

Some literature in communications science has considered ways in which COVID-19 messaging could be improved [32], including by highlighting individual risks or improving trust in public health authorities [33]. However little research seems to consider the trade off between communicating the importance of COVID-19 mitigation and risks from delaying or avoiding health care.

Therefore policymakers should take care when messaging to patients to "Protect the NHS" [24], recognise the potential harmful effects of lockdowns, and beware the unmet need that may result from changes in health care provision on all patients during health emergencies.

CRediT authorship contribution statement

Nikita Jacob: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Rita Santos:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Peter Sivey:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare no competing interests.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at 10.1016/j.healthpol.2024.105168

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