Reductions in hospital care among clinically vulnerable children aged 0–4 years during the COVID-19 pandemic

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ABSTRACT

Objective To quantify reductions in hospital care for clinically vulnerable children during the COVID-19 pandemic.

Design Birth cohort.

Setting National Health Service hospitals in England.

Study population All children aged <5 years with a birth recorded in hospital administrative data (January 2010–March 2021).

Main exposure Clinical vulnerability defined by a chronic health condition, preterm birth (<37 weeks’ gestation) or low birth weight (<2500 g).

Main outcomes Reductions in care defined by predicted hospital contact rates for 2020, estimated from 2015 to 2019, minus observed rates per 1000 child years during the first year of the pandemic (March 2020–2021).

Results Of 3 813 465 children, 17.7% (one in six) were clinically vulnerable (9.5% born preterm or low birth weight, 10.3% had a chronic condition). Reductions in hospital care during the pandemic were much higher for clinically vulnerable children than peers: respectively, outpatient attendances (314 vs 73 per 1000 child years), planned admissions (34 vs 10) and unplanned admissions (105 vs 79). Clinically vulnerable children accounted for 50.1% of the reduction in outpatient attendances, 55.0% in planned admissions and 32.8% in unplanned hospital admissions. During the pandemic, weekly rates of planned care returned to prepandemic levels for clinically vulnerable children and non-vulnerable children. Reductions in care differed by ethnic group and level of deprivation. Virtual outpatient attendances increased from 3.2% to 24.8% during the pandemic.

Conclusion One in six clinically vulnerable children accounted for one-third to one-half of the reduction in hospital care during the pandemic.

INTRODUCTION

Rates of hospital contact (outpatient attendances, planned and unplanned hospital admissions) among 0–4-year-olds are highest for infants and have increased steadily in England over the past decade.1–4 Hospital utilisation patterns differ markedly by age and clinical vulnerability: children born preterm, with low birth weight or a congenital anomaly, have substantially more admissions than other children.1–4,5

Hospital contacts reduced substantially during the COVID-19 lockdown,6–9 which likely most impacted high intensity users of planned hospital care, such as children born too early or too small or with underlying health conditions.1,10 Postponed or cancelled planned hospital care may result in delayed diagnoses or treatments, which could be detrimental to health or development.11 Fewer unplanned hospital admissions might reflect fewer infections, injuries or other health problems due to reduced exposure during pandemic restrictions but could also reflect unmet need.

This study aimed to quantify reductions in planned and unplanned hospital care for clinically vulnerable children and non-vulnerable peers.
during the COVID-19 pandemic using national, longitudinal administrative hospital data for England. We measured planned hospital contacts (admissions and outpatient attendances) and unplanned admissions among children with chronic health conditions or born preterm or low birth weight and children with no recorded clinical vulnerability as well as by ethnicity and area-based deprivation. Reductions were quantified as the difference between predicted and observed rates of hospital contacts during the first year of the pandemic. We also examined whether rates of contact returned to prepandemic levels and described changes in the type of outpatient contact (eg, face to face or virtual).

METHODS
Study population and data source
Children were included in the cohort if aged 0–4 years and their birth was recorded in hospital administrative data in the English NHS (Hospital Episode Statistics (HES)) between 1 January 2010 and 31 March 2021. HES records 97% of all births in England.12 Children were followed until the earliest of fifth birthday or 31 March 2021 (online supplemental figure 1). All contacts with NHS hospitals in England (including admitted patient care and outpatient attendances) were linked using the encrypted HES Identifier (ID). Accident and emergency (A&E) attendances could not be included as patient-level linkage is via Token ID.13 We combined consecutive consultant episodes and hospital transfers to form admissions.14

Outcome and exposure
Our primary outcome was the reduction in hospital care, defined as the difference between observed and predicted rates (per 1000 child-years (cy)) of hospital contacts (stratified into outpatient attendances, planned or unplanned admissions) during the pandemic (23 March 2020–22 March 2021). Inpatient admissions were classified as planned or unplanned using the ‘admission method’ variable (admissions have a predictable clinical need where the decision to admit may be separated in time from the actual admission).15 We also described trends in weekly rates of hospital contacts by age (from 1 January 2020 to 31 March 2021 and averaged for 2015–2019), and uptake (attended, missed, cancelled and postponed) and mode (in person, virtually) of outpatient contacts. Clinical vulnerability was defined by a chronic condition recorded up to age 4 years, or preterm birth (<37 weeks of gestation) or low birth weight (<2500g) recorded in birth or delivery records. A child had a chronic condition at a given age if at least one relevant International Classification of Diseases 10th revision (ICD-10) code (identified using code lists developed by Feudtner and Hardelid16–18) was recorded in any of their records up to that age including their birth admission. Completeness of demographic variables declined for children born during the pandemic (missingness increase by; 9% Index of Multiple Deprivation (IMD); 3% birth weight; 2% gestational age) but was unchanged for admission characteristics including inpatient admission type (planned, unplanned, birth or maternity) or outpatient attendance type (in-person and virtual), similar to outpatient data metrics published by NHS digital.19

Children with a chronic condition but missing gestation and birth weight were categorised as clinically vulnerable (chronic condition only).

We analysed risk factors associated with health service use: age (0–11 months, 1–4 years),2 quintile/fifth of deprivation derived from the national distribution of the IMD 2004 (an area measure for ~650 households20 21 and recorded ethnic group (grouped as white, black, Asian or other, including mixed and Chinese).

Statistical analyses
We calculated observed rates of hospital contacts per 1000 cy in the prepandemic period (2015–2019), stratifying by risk factors.

We calculated child-years at risk by averaging the eligible population of births recorded in HES at the beginning and end of a year, assuming no emigration and ignoring deaths. We used Poisson regression (including a linear effect of time and log of the midyear population as an offset) to model rates stratified by risk factors from 1 January 2015 to 31 December 2019. Data from 1 January to 22 March 2020 were excluded from the prepandemic period because reductions in hospital contact rates preceded the first lockdown. To calculate the reduction in hospital contacts, we predicted rates for the pandemic period, assuming that the pandemic had not occurred and previous trends would have continued. The reduction was estimated as the difference between predicted and observed rates. We also calculated reductions within the first national lockdown (23 March–23 June 2020), easing of restrictions (24 June–4 November 2020), second national lockdown (5 November–31 December 2020) and third national lockdown (1 January–22 March 2021).22

We calculated weekly rates between 1 January 2015 and 31 March 2021, using dynamic denominator study populations to accommodate temporal changes in hospital activity. Analyses stratified children with and without chronic conditions (recorded between birth and the relevant week) because we expected the differences to be largest between these comparators. Weekly rates of hospital contact were calculated by dividing the total number of weekly admissions or attendances by the weekly dynamic denominator population of children within each stratification level (ie, a child born in week 1 of 2015 would move into the 1-year-old group in week 1 of 2016 and age out of the cohort in week 1 of 2019). Weekly rates in 2020 and 2021 were plotted against average weekly rates for 2015–2019. We also modelled weekly rates between 1 January 2015 and 31 December 2019, using a Poisson model that included a linear effect of time, calendar month to account for seasonality, log of the weekly denominator population as an offset and second-order lagged residuals. A similar approach was used to estimate weekly reductions during the pandemic. Analyses were performed in Stata V.16.23

RESULTS
Population characteristics
Of the 3811465 children aged 0–4 years, 394384 (10.3%) had a record indicating a chronic condition (including congenital anomalies); 363950 (9.5%) were born preterm or low birth weight; and 83283 (2.2%) had both vulnerabilities. Overall, 675051 (17.7%) had one or more of these clinical vulnerabilities (table 1).

Hospital contacts prepandemic
Hospital contacts were much higher among infants than children aged 1–4 years: 60.1% (95% CI 60.0 to 60.3) of infants and 8.2% (8.1–8.2) of 1–4-year-olds had ≥1 outpatient attendance each year, reflecting 1538 outpatient attendances per 1000 cy for infants and 302 for 1–4-year-olds (online supplemental figure 2, online supplemental table 1). Overall, 31.2% (31.1–31.3) of clinically vulnerable children had ≥1 outpatient attendance compared with 14.1% (14.1–14.2) of those with no known
vulnerability reflecting 1483 attendances per 1000 cy for children with any vulnerability and 295/1000 cy for those without. Patterns were similar for planned and unplanned hospital admissions. Children with chronic conditions had the highest rates of admissions across all strata (online supplemental figures 3 and 4). Children born preterm or low birth weight but with no chronic condition had similar admission rates to their peers born at term or weighing ≥2500 g (online supplemental figure 2).

### Hospital contacts during the pandemic

There were stark reductions in rates of all hospital contact types during the pandemic (table 2, online supplemental tables 2-4). Reductions were much larger for children with a chronic condition (outpatient: −492 (−505 to −480) contacts per 1000 cy; planned: −91/1000 cy (−95 to −86); unplanned: −230/1000 cy (−236 to −224)) than those without and particularly high for children with a chronic condition, with less perceptible changes among those without a chronic condition. Outpatient attendances rapidly returned to prepandemic rates for infants but remained below 2015–19 averages for older children. Planned admissions returned to prepandemic rates only for infants (figure 2).

#### Trends in hospital contacts

Outpatient attendances reduced sharply before and during the first national lockdown, among children of all ages with a chronic condition, with less perceptible changes among those without a chronic condition. Outpatient attendances rapidly returned to prepandemic rates for infants but remained below 2015–19 averages for older children. Planned admissions followed a similar pattern, with a return to prepandemic rates only for infants (figure 2).

A similar pattern was observed for reductions in rates of unplanned admissions, and these remained below prepandemic levels for both groups at all ages (figure 2). In 2020, the

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**Table 1** Demographic characteristics of children born between 1 January 2015 and 31 March 2021 by vulnerability status

| Birth year | None (n=2 773 420; 72.7%) | LBW/preterm only (n=280 667; 7.4%) | CC only (n=311 101; 8.2%) | Both (n=83 283; 2.2%) | Missing (n=364 994; 9.6%) | Total (n=3 813 465) |
|------------|---------------------------|----------------------------------|---------------------------|-------------------------|--------------------------|---------------------|
|            | n                         | %                               | n                         | %                       | n                        | %                   |
| **Sex**    |                           |                                  |                           |                         |                          |                     |
| Male       | 1 406 322                  | 50.7                             | 134 871                    | 48.1                    | 183 964                   | 59.1                |
| Female     | 1 366 276                  | 49.3                             | 145 481                    | 51.8                    | 127 006                   | 40.8                |
| Missing    | 822                       | 0.0                              | 315                       | 0.1                     | 131                      | 0.04                |
| **Age**    |                           |                                  |                           |                         |                          |                     |
| Infants    | 400 330                    | 14.4                             | 36 445                     | 13.0                    | 276 411                   | 8.9                 |
| 1–4 years old | 2 373 090                     | 85.6                             | 244 222                    | 87.0                    | 283 460                   | 91.1                |
| **Ethnicity** |                        |                                  |                           |                         |                          |                     |
| White      | 1 958 159                  | 70.6                             | 184 525                    | 65.8                    | 228 023                   | 73.3                |
| Black/Black British | 126 067                      | 4.5                             | 15 477                     | 5.5                     | 14 150                    | 4.6                 |
| Asian/Asian British | 295 850                      | 10.7                            | 41 516                     | 14.8                    | 33 610                    | 10.8                |
| Any other ethnic groups | 239 079                      | 8.6                             | 24 085                     | 8.6                     | 25 135                    | 8.1                 |
| Missing    | 154 265                    | 5.6                             | 15 064                     | 5.4                     | 10 183                    | 3.3                 |
| **IMD**    |                           |                                  |                           |                         |                          |                     |
| Q1 (most deprived) | 668 113                      | 24.1                            | 83 204                     | 29.7                    | 89 425                    | 28.7                |
| Q2         | 550 124                    | 19.8                             | 60 337                     | 21.5                    | 67 853                    | 21.8                |
| Q3         | 468 995                    | 16.9                             | 45 794                     | 16.3                    | 55 924                    | 18.0                |
| Q4         | 413 514                    | 14.9                             | 37 446                     | 13.3                    | 47 670                    | 15.3                |
| Q5 (least deprived) | 400 528                      | 14.4                            | 34 530                     | 12.3                    | 43 052                    | 13.8                |
| Missing    | 272 146                    | 9.8                             | 19 356                     | 6.9                     | 7 177                     | 2.3                 |
| **Birth year** |                         |                                  |                           |                         |                          |                     |
| 2015       | 45 046                     | 16.5                             | 46 590                     | 16.6                    | 68 814                    | 22.1                |
| 2016       | 431 324                    | 17.0                             | 49 020                     | 17.5                    | 63 505                    | 19.9                |
| 2017       | 465 975                    | 16.8                             | 49 358                     | 17.6                    | 55 396                    | 17.8                |
| 2018       | 443 438                    | 16.0                             | 47 406                     | 16.9                    | 47 628                    | 15.3                |
| 2019       | 431 854                    | 15.6                             | 41 713                     | 14.9                    | 40 107                    | 12.9                |
| 2020       | 409 956                    | 14.8                             | 38 128                     | 13.6                    | 30 598                    | 9.8                 |
| 2021       | 93 327                     | 3.4                             | 8 445                      | 3.0                     | 5 053                     | 1.6                 |

**Notes:** 
CC, chronic conditions; IMD, Index of Multiple Deprivation; LBW, low birth weight.
autumn–winter peak in unplanned admissions was diminished relative to previous years; however, following the reopening of primary schools at the end of the third lockdown on 8 March 2021, there was an increase in unplanned admission rates for all children, particularly those with a chronic condition (figure 2, online supplemental figure 7). Trends did not consistently differ across deprivation levels (online supplemental figures 8 and 9) or by ethnic group (online supplemental figures 10–12).

For all age groups, a spike in cancellations and postponement of outpatient appointments preceded the first lockdown by

| n       | N      | %     | Predicted | Observed | Difference | % change | Predicted | Observed | Difference (95% CI) | % change |
|---------|--------|-------|-----------|----------|------------|----------|-----------|----------|-------------------|----------|
| Outpatient attendances |         |       |           |          |            |          |           |          |                   |          |
| Total   | 370623 | 2765941 | 3.4      | 1500674  | 1173091    | −327583  | −21.8     | 543      | 424               | −118     |
| No known vulnerability | 232976 | 2243088 | 10.4     | 635226   | 471743     | −163483  | −25.7     | 283      | 210               | −73      |
| Any vulnerability   | 137647 | 522853  | 26.3     | 865448   | 701348     | −164100  | −19.0     | 1655     | 1341              | −114     |
| LBW/preterm only    | 29622  | 226439  | 13.1     | 946600   | 76039      | −18621   | −19.7     | 418      | 336               | −82      |
| CC only             | 86825  | 231671  | 37.5     | 586026   | 475226     | −110800  | −18.9     | 2530     | 2051              | −4781    |
| Both                | 21200  | 64743   | 32.7     | 184762   | 150083     | −34679   | −18.8     | 2854     | 2318              | −5361    |
| Any CC              | 107762 | 296414  | 36.4     | 771219   | 625309     | −145910  | −18.9     | 2602     | 2110              | −4921    |
| Planned admissions |         |       |           |          |            |          |           |          |                   |          |
| Total   | 52280  | 2765941 | 1.9      | 144980   | 92618      | −52362   | −36.1     | 52       | 33                | −19      |
| No known vulnerability | 15287 | 2243088 | 0.7      | 40568    | 17022      | −23546   | −58.0     | 18       | 8                 | −10      |
| Any vulnerability   | 36993  | 522853  | 7.1      | 104412   | 75596      | −28816   | −27.6     | 200      | 145               | −551     |
| LBW/preterm only    | 1389   | 226439  | 0.6      | 3675     | 1522       | −2153    | −58.6     | 16       | 7                 | −10      |
| CC only             | 31038  | 231671  | 13.4     | 85367    | 65506      | −19861   | −23.3     | 368      | 283               | −867     |
| Both                | 4566   | 64743   | 7.1      | 15370    | 8568       | −6802    | −44.3     | 237      | 132               | −1051    |
| Any CC              | 35603  | 296414  | 12.0     | 100929   | 74074      | −26855   | −26.6     | 341      | 250               | −911     |
| Unplanned admissions |       |       |           |          |            |          |           |          |                   |          |
| Total   | 131134 | 2765941 | 4.7      | 442174   | 179366     | −262808  | −59.4     | 160      | 65                | −95      |
| No known vulnerability | 66830 | 2243088 | 3.0      | 254263   | 77713      | −176550  | −69.4     | 113      | 35                | −79      |
| Any vulnerability   | 64304  | 522853  | 12.3     | 187911   | 101653     | −86258   | −45.9     | 359      | 194               | −1651    |
| LBW/preterm only    | 6046   | 226439  | 2.7      | 25520    | 7228       | −18292   | −71.7     | 113      | 32                | −81      |
| CC only             | 52285  | 231671  | 22.6     | 134055   | 84126      | −49929   | −37.2     | 579      | 363               | −2161    |
| Both                | 5973   | 64743   | 9.2      | 28336    | 10299      | −18307   | −63.7     | 438      | 159               | −2791    |
| Any CC              | 58248  | 296414  | 19.7     | 162648   | 94425      | −68223   | −41.9     | 549      | 319               | −2301    |

*268256 (8.8%) children missing gestational age and birth weight data.
†Significantly different from children with no known vulnerability (5% level of significance).
‡Any CC combines CC only and both.
CC, chronic conditions; LBW, low birth weight.
3 weeks (online supplemental figure 13). There was an increase in tele/virtual outpatient attendances during the pandemic and face-to-face visits did not return to prepandemic levels in any age group (online supplemental table 8 and figure 14).

**DISCUSSION**

This population-based cohort study of all children aged <5 years in England found large and disproportionate reductions in planned and unplanned hospital contacts during the COVID-19 pandemic for clinically vulnerable groups. The one in six clinically vulnerable children accounted for over half the reduction in outpatient attendances and planned admissions, and one-third of the reduction in unplanned admissions. While absolute reductions were larger for vulnerable children, they were smaller in relative terms compared with children with no recorded vulnerability suggesting that hospitals prioritised these children. We saw some evidence of recovery in planned care during the pandemic among infants, but not among older children.

This study’s main strength is the use of a birth cohort of all children born in an NHS hospital in England (97% of all births). This large sample size gave us enough data to calculate weekly rates of hospital contacts. The longitudinal nature of the data allowed us to identify chronic conditions from diagnostic codes recorded in all admissions since birth, using a clinically developed coding system.16

Limitations include underascertainment of chronic conditions for children who could not be admitted to hospital due to the pandemic. These children may have been managed in primary care, or as outpatients, where chronic conditions coding is mostly missing. Furthermore, older children would have had more time for chronic conditions to be diagnosed. This likely explains the decline in prevalence of chronic conditions in more recent years. Analyses were restricted by variables available in HES (eg, use of IMD 2004). Vulnerability may be underestimated for the 10% of children who were excluded from the study due to missing gestational age and birth weight data. Multiple imputation of missing data was not feasible given the study size. We could not quantify the reduction in A&E attendances, as this dataset is not yet linkable to admission records. However, recent studies investigating A&E attendances in children reported similar reduced service use during the pandemic.24 25 Our rates did not account for deaths in the denominator (0.5%), non-NHS healthcare or emigration, but these events are rare. Our modelling approach required several assumptions, and our estimates of impacts are likely conservative.

Reductions in hospital care for children during the pandemic have been reported in Europe,7 26–33 Asia,34 North35–38 and South America.39 Most studies investigated A&E attendances or unplanned admissions.25–39 Other studies report a reduction in asthma-related paediatric emergency department attendances39 and reduced likelihood of admission, assessment and surgery for children with epilepsy.40 Furthermore, significant reductions in infection-related hospitalisations have been observed,30 34 36 41 particularly for children under 5 years.41 Two studies conducted national level analyses.30 32 We believe our study reports the first population-level reductions in planned care (admissions and outpatient) for children with health risk-factors for a full year of the pandemic. Previous research in adult populations has reported on the disproportionate burden of COVID-19 infection, hospitalisation and death in minority ethnic groups.42 43

**Table 3** Difference in predicted and observed rates of hospital contact per 1000 child-years among children aged 0–4 years during the pandemic (March 2020–2021) by period and clinical vulnerability

|                       | First lockdown 23 March–23 June 2020 | Easing of restrictions 24 June–4 November 2020 | second lockdown Nov five to Dec 31, 2020 | third lockdown Jan one to March 22, 2021 |
|-----------------------|--------------------------------------|-----------------------------------------------|-----------------------------------------|----------------------------------------|
| **Outpatient attendances** |                                      |                                               |                                         |                                        |
| Total                 | 232 (231 to 233)                     | 213 (212 to 214)                               | 217 (216 to 218)                        | 214 (213 to 216)                       |
| No known vulnerability | 218 (217 to 219)                     | 206 (205 to 206)                               | 209 (208 to 210)                        | 207 (206 to 208)                       |
| Any vulnerability      | 240 (239 to 241)                     | 220 (219 to 221)                               | 223 (222 to 224)                        | 221 (220 to 222)                       |
| LBW/preterm only       | 265 (264 to 266)                     | 245 (244 to 246)                               | 248 (247 to 249)                        | 246 (245 to 247)                       |
| CC only                | 252 (251 to 253)                     | 232 (231 to 233)                               | 235 (234 to 236)                        | 233 (232 to 234)                       |
| Both                   | 263 (262 to 264)                     | 243 (242 to 243)                               | 246 (245 to 246)                        | 244 (243 to 245)                       |
| Any CC                 | 252 (251 to 253)                     | 232 (231 to 233)                               | 235 (234 to 236)                        | 233 (232 to 234)                       |
| **Planned admissions** |                                      |                                               |                                         |                                        |
| Total                 | 63 (62 to 64)                        | 55 (54 to 56)                                  | 57 (56 to 58)                           | 59 (58 to 60)                          |
| No known vulnerability | 59 (59 to 60)                        | 50 (49 to 51)                                  | 52 (51 to 53)                           | 54 (53 to 55)                          |
| Any vulnerability      | 88 (87 to 89)                        | 79 (78 to 79)                                  | 81 (80 to 82)                           | 83 (82 to 84)                          |
| LBW/preterm only       | 113 (112 to 114)                     | 100 (99 to 101)                                | 103 (102 to 104)                        | 105 (104 to 105)                       |
| CC only                | 99 (99 to 100)                       | 89 (88 to 90)                                  | 92 (91 to 93)                           | 94 (93 to 95)                          |
| Both                   | 109 (108 to 109)                     | 99 (98 to 99)                                  | 102 (101 to 103)                        | 104 (103 to 105)                       |
| Any CC                 | 99 (99 to 100)                       | 89 (88 to 89)                                  | 92 (91 to 93)                           | 94 (93 to 95)                          |
| **Unplanned admissions** |                                      |                                               |                                         |                                        |
| Total                 | 56 (55 to 57)                        | 46 (45 to 46)                                  | 48 (47 to 48)                           | 50 (49 to 51)                          |
| No known vulnerability | 52 (52 to 53)                        | 40 (39 to 41)                                  | 42 (41 to 43)                           | 44 (43 to 45)                          |
| Any vulnerability      | 72 (71 to 73)                        | 61 (60 to 61)                                  | 63 (62 to 63)                           | 65 (64 to 66)                          |
| LBW/preterm only       | 97 (96 to 98)                        | 81 (80 to 81)                                  | 84 (83 to 84)                           | 86 (85 to 86)                          |
| CC only                | 91 (91 to 92)                        | 80 (79 to 80)                                  | 83 (82 to 83)                           | 85 (84 to 86)                          |
| Both                   | 100 (99 to 100)                      | 89 (88 to 89)                                  | 92 (91 to 93)                           | 94 (93 to 95)                          |
| Any CC                 | 89 (89 to 90)                        | 79 (79 to 80)                                  | 82 (81 to 82)                           | 84 (83 to 84)                          |

*Significantly different from children with no known vulnerability (5% level of significance).

CC, chronic conditions; LBW, low birth weight.
Our study did not examine COVID-19 related contacts because hospitalisation is rare as children typically experience mild asymptomatic disease.\textsuperscript{44 45} However, we identified small differences in reductions of hospital care for children in the Asian ethnic group and for children in the most deprived quintile. This suggests that inequalities exacerbated by COVID-19 in adult populations might also extend to children from more deprived, minority ethnic backgrounds.

Potential mechanisms underpinning reductions in planned care likely represent restrictions to access, supported by a rise in postponed outpatient care. Our findings show these restrictions were mitigated in infants, who have a high frequency of hospital care and for whom interventions are likely to be more time critical than in older children.\textsuperscript{3} A move to virtual appointments may have exacerbated existing inequalities for families without access to the internet at home.

Reductions in unplanned care may be driven by opposing factors. Previous studies reported decreases in unplanned infection-related hospitalisations due to reduced social exposure and increased hygiene, with little change in admissions for non-infectious causes like appendicitis.\textsuperscript{27 30 31 34 41} Others have reported reductions in injury.\textsuperscript{46} The spike in unplanned admissions after schools reopened in autumn 2020 and in March 2021 when the third lockdown ended likely reflects increased socialisation. Other positive effects could include reduced exposure to triggers for respiratory disease (eg, air pollution)\textsuperscript{40} and improved medication adherence through increased parental supervision. Negative implications could include reduced extrinsic interventions through education, health and social care professionals,\textsuperscript{7 48} or delaying or avoiding medical care due to fears of hospital-acquired COVID-19 infection.\textsuperscript{38 49–51} Additionally, these reductions could represent missed opportunities for earlier and more effective intervention.\textsuperscript{11 52}

This analysis was the first step in quantifying deferred or foregone hospital care during the pandemic. Studies using routine administrative data report only acute hospital presentations,\textsuperscript{37 38} which may reflect late or missed diagnoses.\textsuperscript{11 52} Our findings confirm and quantify the reduction in hospital contacts for preschool children in England during the first year of the COVID-19 pandemic. Research is needed to understand reductions in planned care, the types of care, procedures or treatments affected and the short-term and long-term implications for children with specific conditions. More research will be needed to ascertain whether contact rates have returned to previous levels since the end of restrictions. Further research will also be needed to identify vulnerable groups likely to experience adverse outcomes from unmet healthcare in order to target ‘catch-up’ funding and resources to prevent or mitigate these adverse outcomes.\textsuperscript{53}

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Data availability statement Data may be obtained from a third party and are not publicly available. The data used in this analysis are expected to be available to accredited researchers in 2022 (as part of the ECHID Database) by applying to the data providers (DfE and NHS Digital).

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