Child mortality in England during the first year of the COVID-19 pandemic

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ABSTRACT

Objectives To quantify the relative risk (RR) of childhood deaths across the whole of England during the first year of the COVID-19 pandemic, compared with a similar period of 2019.

Design This work is based on data collected by the National Child Mortality Database (NCMD). Deaths from 1 April 2020 until 31 March 2021 (2020–2021) were compared with those from the same period of 2019–2020. RR and excess mortality were derived for deaths in 2020–2021 vs 2019–2020.

Setting All deaths reported to NCMD in England of children under 18 years of age, between April 2019 and March 2021.

Participants 6490 deaths of children, under the age of 18 years, reported to the NCMD over the study period.

Results Children had similar demographics in the 2 years. There were 356 (198–514) fewer deaths in 2020–2021 than in 2019–2020 (RR 0.90 (0.85 to 0.94), p<0.001). Deaths from infection (RR 0.49 (0.38 to 0.64)) and from other underlying medical conditions (RR 0.75 (0.68 to 0.82)) were lower in 2020–2021 than 2019–2020, and weak evidence (RR 0.50 (0.23 to 1.07), p=0.074) that this was also true of deaths from substance abuse.

Conclusions Childhood mortality in England during the first year of the SARS-CoV-2 pandemic was lower than expected, with over 300 fewer deaths than the preceding 12 months. The greatest reduction was in children less than 10 years old. It is important that we learn from this effect that potentially offers alternative ways to improve the outcome for the most vulnerable children in our society.

BACKGROUND

In England, the Office for National Statistics (ONS) published data suggesting an increase in the total population mortality of 14% for 2020 compared with previous years.[1] While the direct impact of COVID-19 is significant, the widespread changes in healthcare and society over the year are also likely to have had broad impacts on access to healthcare and the risks of infections. The COVID-19 pandemic also comes at a time with England reporting its lowest levels of infant mortality on record[2]; and as the pandemic progressed, children appeared to be one of the age groups least affected by the virus,[3] but potentially most effected by the social changes put in place: with the closure of schools, specific concerns over their mental health[4–6] and the delivery of antenatal care.[7 8] Consequently, the overall impact of COVID-19 on childhood mortality is unclear.[9] While some children have died

> **What is already known on this topic?**
>
> ► In England, overall mortality during 2020 was 14% higher than the previous year.
> ► The direct impact of COVID-19 in children is relatively small, but widespread changes in healthcare are likely to have had broad impacts on child health.

> **What this study adds?**
>
> ► There was an unexpected fall in overall child mortality in England, most marked in younger children and those with underlying health conditions.
> ► It is important that we learn from this effect that potentially offers alternative ways to improve the outcome for the most vulnerable children in our society.

as a direct consequence of COVID-19, concerns remain that others may have suffered due to social restrictions,[10–12] with specific concerns over those already at higher risk due to medical problems or in difficult socioeconomic environments.[13] The overall excess mortality for children is unknown, and while initial estimates have suggested an overall reduction in child mortality across England,[14] identifying which children were most affected, whether this affects all demographic groups and how this relates to the lockdown measures, needs clarifying.

In England, all children have their deaths reviewed by a specialist service, the Child Death Overview Panels (CDOPs); and from 1 April 2019, the National Child Mortality Database (NCMD) was formed to collate data on all children who die in England before their 18th birthday, with death notifications required by statute within 48 hours.[15] The aim of this analysis was to quantify the relative risk (RR) of childhood deaths, across the whole of England during the first year of the COVID-19 pandemic, compared with the previous year.

METHODS

The NCMD commenced data collection on 1 April 2019 and collects data from all 58 CDOPs across England.[16] All deaths of children in England will ultimately be reviewed in depth by the CDOPs, but this process often takes many months. In this work, similar to our previous work,[14] to obtain a provisional category of death, all child deaths reported to the NCMD were coded contemporaneously by the

Table 1 Characteristics and comparisons of all childhood deaths, between April 2019 and March 2020 comparing by year of death (April–March)

Measure	Number with data	2019 (n=3423)	2020 (n=3067)	P value
Age				
Median (IQR) (years)	6490	0.2 (0.0–5.3)	0.1 (0.0–6.2)	0.215
Sex	6354			0.939
Female		1466 (43.5%)	1304 (43.7%)	
Male		1901 (56.5%)	1683 (56.3%)	
Ethnic group	5597			0.155
Asian or Asian British		557 (18.9%)	462 (17.4%)	
Black or black British		252 (8.6%)	247 (9.3%)	
Mixed		188 (6.4%)	156 (5.9%)	
Other		94 (3.2%)	65 (2.5%)	
White		1855 (63.0%)	1721 (64.9%)	
Deprivation measure (1–10)[19]	6339	4 (2–7)	4 (2–7)	0.904
Region	6490			0.885
East Midlands		283 (8.3%)	251 (8.2%)	
East of England		339 (9.9%)	278 (9.1%)	
London		609 (17.8%)	563 (18.4%)	
North East		154 (4.5%)	138 (4.5%)	
North West		500 (14.6%)	431 (14.1%)	
South East		468 (13.7%)	403 (13.1%)	
South West		252 (7.4%)	235 (7.7%)	
West Midlands		451 (13.2%)	436 (14.2%)	
Yorkshire and Humber		367 (10.7%)	332 (10.8%)	
Place of death	6362			<0.001
Abroad		10 (0.3%)	25 (0.8%)	
Home		428 (12.7%)	531 (17.7%)	
Hospice		145 (4.3%)	117 (3.9%)	
Hospital		2615 (77.8%)	2193 (73.1%)	
Other		165 (4.9%)	133 (4.4%)	

Numbers are n (%) or median (IQR) as appropriate.
Comparisons were made using Fisher's exact test or Mann-Whitney U test as appropriate.

same three independent coders (all paediatricians (DO, PF, KL)) to identify the most likely category of the cause of death.[17] All coders recorded a provisional category of death (see below) or that there was insufficient information provided. For each death, if two or more coders agreed on a category, this was taken as the most likely category; and where no two coders agreed, the category highest in the following hierarchy was used (based on categorisation used by CDOPs).[18]

1. Suicide.
2. Substance abuse.
3. Trauma (subcategorised to those deaths due to road traffic accidents, drownings and 'other').
4. Malignancy.
5. Underlying medical condition.
6. Intrapartum event.
7. Preterm birth.
8. Infection.
9. Sudden unexpected deaths in infancy or childhood (SUDIC).

In addition, the CDOPs also report baseline characteristics of the child, from which the following data were derived from the notification form:
▶ Sex of individual (female, male, other (including not known)).
▶ Ethnic group (Asian or Asian British, black or black British, mixed, other, unknown, white).
▶ Age at death.
▶ The region where the death was reported from.
▶ From the child's home postcode, the Index of Multiple Deprivation (IMD), a measure of local deprivation[19] (on a score of 1–10) with a lower value suggesting greater deprivation.

From 1 March 2020, linkage with virology PCR results was performed with Public Health England; and from April 2020, the Joint Agency Response to unexpected child deaths during the COVID-19 pandemic protocol was amended to include postmortem viral swabs from all children dying with no immediately identifiable cause.[20]

Statistical analysis

Deaths of children occurring from 1 April 2020 until 31 March 2021 (2020–2021) were compared with those from the same period of 2019–2020. Initially, we compared the characteristics of those children who died in 2020–2021 vs 2019–2020. Comparisons were made using Fisher's exact test for categorical data, and Mann-Whitney U test for age and the IMD category. Next, using the total number of deaths over the 2 years, the number of excess deaths in 2020–2021 was calculated using the 2019–2020 data. In addition, the RR of deaths between the 2 years was compared using a Negative Binomial Regression model,[6] chosen to remain consistent with other work within the cohort. The population of interest was for all deaths of children, including neonatal deaths, before their 18th birthday. Overall population size was assumed to be 12 023 568 (the ONS 2019 midyear population estimate).[21] This model was then repeated with the deaths stratified by month of death, and then by demographics of the population: age of death, ethnic group, sex, region of the country and deprivation score (the ONS IMD[19]). Models were repeated with the risk calculated for each category, and overall p values derived to test if the risk of death and year were modified by the characteristic being tested. Population profile was obtained from the 2019 ONS population estimates[21] for all measures except ethnicity, which was based on the 2011 census data.[22] Absolute numbers of deaths and excess mortality for 2020–2021 vs 2019–2020 (with CIs) were also calculated from the frequencies seen. Finally, we repeated the main model restricting it to each provisional category of death.

Data are presented as median (IQR), number (%), absolute difference (95% CI) or RR ratio (95% CI). Where frequency counts were below 5, or could be derived, absolute numbers are not presented. Analysis was performed using Stata V.16. Existing parent and public involvement representation supported the project throughout (see the Acknowledgements section).

RESULTS

Data were downloaded from the NCMD system on 7 June 2021. Between April 2019 and March 2020 (inclusive), there were 3423 deaths of children, under the age of 18 years, reported to the NCMD. For the corresponding period from April 2020, this had dropped to 3067. Children who died between April 2020 and March 2021 had similar median ages (p=0.215), sex distribution (p=0.939), median deprivation scores (p=0.904)

Table 2 Relative risk (RR) of death by calendar month, age, sex, deprivation, region and ethnicity; with estimates of RR between years and the number of excess deaths calculated

Measure	Comparison of deaths between 2019 and 2020 (April–March)					
	2019	2020	Excess deaths	RR	P value	p_{interaction}
All deaths	3423	3067	−356 (−514 to −198)	0.90 (0.85 to 0.94)	<0.001	
Stratified by month of death						0.181
April	**262**	**268**	**6 (−39 to 51)**	**1.02 (0.86 to 1.21)**	**0.794**	
May	**270**	**269**	**−1 (−47 to 45)**	**1.00 (0.84 to 1.18)**	**0.966**	
June	238	234	−4 (−47 to 39)	0.98 (0.82 to 1.18)	0.854	
July	261	263	2 (−43 to 47)	1.01 (0.85 to 1.20)	0.930	
August	308	263	−45 (−92 to 2)	0.85 (0.72 to 1.01)	0.060	
September	275	245	−30 (−75 to 15)	0.89 (0.75 to 1.06)	0.189	
October	294	221	−73 (−117 to −29)	0.75 (0.63 to 0.90)	0.001	
November	**318**	**245**	**−73 (−120 to −26)**	**0.77 (0.65 to 0.91)**	**0.002**	
December	333	267	−66 (−114 to −18)	0.80 (0.68 to 0.94)	0.007	
January	**315**	**283**	**−32 (−80 to 16)**	**0.90 (0.77 to 1.05)**	**0.191**	
February	**256**	**237**	**−19 (−63 to 25)**	**0.93 (0.78 to 1.10)**	**0.392**	
March	293	272	−21 (−68 to 26)	0.93 (0.79 to 1.09)	0.377	
Stratified by age						<0.001
Less than 1 year	2155	1993	−162 (−288 to −36)	0.92 (0.87 to 0.98)	0.012	
1–4 years	394	264	−130 (−180 to −80)	0.67 (0.57 to 0.78)	<0.001	
5–9 years	243	197	−46 (−87 to −5)	0.81 (0.67 to 0.98)	0.029	
10–14 years	289	274	−15 (−62 to 32)	0.95 (0.80 to 1.12)	0.527	
15–17 years	342	339	−3 (−54 to 48)	0.99 (0.85 to 1.15)	0.908	
Stratified by sex						0.926
Male	1901	1683	−218 (−335 to −101)	0.89 (0.83 to 0.95)	<0.001	
Female	1466	1304	−162 (−265 to −59)	0.89 (0.83 to 0.96)	0.002	
Stratified by deprivation measure*						0.912
1/2	1134	1012	−122 (−213 to −31)	0.89 (0.82 to 0.97)	0.008	
3/4	764	692	−72 (−147 to 3)	0.91 (0.82 to 1.00)	0.059	
5/6	616	529	−87 (−153 to −21)	0.86 (0.76 to 0.96)	0.010	
7/8	476	413	−63 (−121 to −5)	0.87 (0.76 to 0.99)	0.035	
9/10	364	339	−25 (−77 to 27)	0.93 (0.80 to 1.08)	0.346	
Stratified by region						0.885
East Midlands	283	251	−32 (−77 to 13)	0.89 (0.75 to 1.05)	0.166	
East of England	339	278	−61 (−110 to −12)	0.82 (0.70 to 0.96)	0.014	
London	609	563	−46 (−113 to 21)	0.92 (0.82 to 1.04)	0.179	
North East	154	138	−16 (−49 to 17)	0.90 (0.71 to 1.13)	0.349	
North West	500	431	−69 (−129 to −9)	0.86 (0.76 to 0.98)	0.024	
South East	468	403	−65 (−123 to −7)	0.86 (0.75 to 0.98)	0.028	
South West	252	235	−17 (−60 to 26)	0.93 (0.78 to 1.11)	0.441	
West Midlands	451	436	−15 (−73 to 43)	0.97 (0.85 to 1.10)	0.615	
Yorkshire and Humber	367	332	−35 (−87 to 17)	0.90 (0.78 to 1.05)	0.186	
Stratified by ethnic group						0.153
Asian or Asian British	557	462	−95 (−158 to −32)	0.83 (0.73 to 0.94)	0.003	
Black or black British	252	247	−5 (−49 to 39)	0.98 (0.82 to 1.17)	0.823	
Mixed	188	156	−32 (−68 to 4)	0.83 (0.67 to 1.03)	0.085	
Other	94	65	−29 (−54 to −4)	0.69 (0.50 to 0.95)	0.022	
White	1855	1721	−134 (−251 to −17)	0.93 (0.87 to 0.99)	0.025	

Numbers are frequency counts or RR plus 95% CI as appropriate.
RR derived from Negative Binomial Model (all alpha values approximating to 0).
Bolded rows represent periods of national lockdown.
Some demographic data missing, so denominators may vary between analyses.
*Level one is most deprived area, 10 is least deprived.

and ethnic groups (p=0.155) to those who died in 2019–2020 (table 1). However, the place of death did appear to be different (p<0.001), with more children dying at home (531 (17.7%) vs 428 (12.7%)) in 2020–2021 than 2019–2020. A total of 70

children died following a positive SARS-CoV-2 test at any time, with 3 in March 2020 and 67 in the subsequent 12 months.

Overall, there were 356 (198–514) fewer deaths in 2020–2021 than in 2019–2020 (RR 0.90 (0.85 to 0.94), p<0.001)
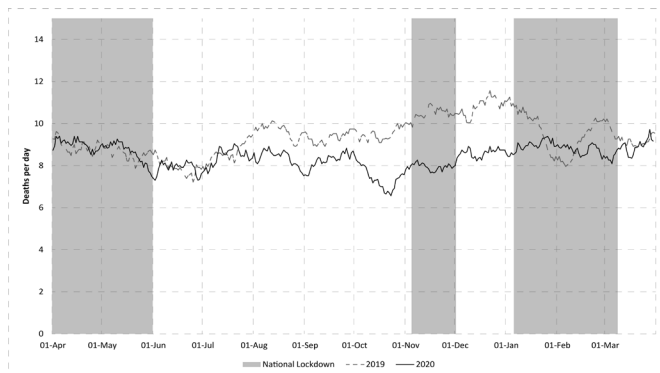
Figure 1 Mean number of deaths per day (21-day smoothed (arithmetic) average) by time period. Periods of national lockdown shaded.

(table 2). There was evidence that the reduction in deaths was different by age (p<0.001), but no evidence that this reduction was significantly modified by month of death (p=0.181), sex (p=0.926), deprivation score (p=0.912), region (p=0.885) or ethnicity (p=0.153). When stratifying by month, fewer deaths appeared to occur in 2020–2021 than 2019–2020, in October (RR 0.75 (0.63 to 0.90)), November (RR 0.77 (0.65 to 0.91)) and December (RR 0.80 (0.68 to 0.94)) (figure 1). When stratifying by age of death, fewer deaths of children below 10 years occurred in 2020–2021 than 2019–2020 (infants under 1 year, RR 0.92 (0.87 to 0.98); 1–4 years, RR 0.67 (0.57 to 0.78); and 5–9 years, RR 0.81 (0.67 to 0.98)), but for older children there was no significant reduction in number of deaths (10–14 years, RR 0.95 (0.80 to 1.12); 15–17 years, RR 0.99 (0.85 to 1.15)). When stratifying by deprivation, deaths were lower in 2020–2021 for all categories except the least deprived (RR 0.93 (0.80 to 1.08)) although there was limited evidence for interaction overall. Similarly, when stratifying deaths by ethnicity, there was some evidence of a reduction in mortality for all groups except black or black British children (RR 0.98 (0.82 to 1.17)), but only limited evidence (p=0.1534) for an overall interaction. There was little change in the RRs between males and females.

Finally, repeating the analysis by category of death showed that deaths categorised as infection (RR 0.49 (0.38 to 0.64)) and from other underlying medical conditions (RR 0.75 (0.68 to 0.82)) were lower in 2020–2021 than 2019–2020, and there was weak evidence (p=0.074) that this was also true of deaths from substance abuse (table 3). Mortality from malignancy (p=0.861), preterm birth (p=0.619), intrapartum events (p=0.186), trauma (p=0.102), suicide (p=0.467) and SUDIC (p=0.583) was similar between the 2 years. Overall, there was strong evidence that the profile of deaths differed between the 2 years (p<0.001).

DISCUSSION

Childhood mortality In England during the profound healthcare and social changes implemented during the first year of the SARS-CoV-2 pandemic was lower than the preceding year, with over 300 fewer deaths than expected. The reduction in overall mortality was most marked in children less than 10 years of age and appeared due to fewer deaths from infections (other than SARS-CoV-2), and fewer deaths of children from underlying conditions. In addition, the reduction in mortality appeared to occur during the winter months, where the seasonal increase, often caused by pathogens other than COVID-19, was not apparent. This period coincided with the prolonged lockdown in England from January to April 2021; suggesting that public health measures may be able to modify a significant number of childhood deaths every year.

The main limitation of this work is precision of the estimates. Death in childhood is fortunately a rare event, with absolute mortality across the 2 years of around 27 per 100 000 children per year. While we had adequate precision to identify an overall reduction in deaths, and the likely causal conditions (eg, infection) in which this occurred, we had less power to identify small, but still potentially important differences that might indicate which children were most affected by the broad social changes, and for which children the effects were less clear. Finally, like all work using routine data, case ascertainment may not be 100%, although reporting to NCMD is a statutory requirement and cohort completeness has previously been reported as good,[6] though we had missing data for some measures (eg, ethnicity).

Table 3 Number of deaths by year (starting April) stratified by provisional category of death with estimates of relative risk (RR) between years and proportion of excess deaths

Measure	Comparison of deaths between 2019 and 2020 (April–March)				
	2019	2020	Excess deaths	RR	P value
All deaths	3423	3067	−356 (−514 to −198)	0.90 (0.85 to 0.94)	<0.001
Malignancy	258	262	4 (−41 to 49)	1.02 (0.86 to 1.21)	0.861
Preterm	902	881	−21 (−104 to 62)	0.98 (0.89 to 1.07)	0.619
Intrapartum events	166	191	25 (−12 to 62)	1.15 (0.93 to 1.42)	0.186
Infection	164	81	−83 (−114 to −52)	0.49 (0.38 to 0.64)	<0.001
Trauma	164	195	31 (−6 to 68)	1.19 (0.97 to 1.46)	0.102
Road traffic accident	54	62	8 (−13 to 29)	1.15 (0.80–1.65)	0.458
Drowning	19	25	6 (−7 to 19)	1.32 (0.72–2.39)	0.367
Substance misuse	20	10	−10 (−21 to 1)	0.50 (0.23 to 1.07)	0.074
Suicide	109	120	11 (−19 to 41)	1.10 (0.85 to 1.43)	0.467
SUDIC	432	416	−16 (−73 to 41)	0.96 (0.84 to 1.10)	0.583
Underlying medical condition	1085	810	−275 (−360 to −190)	0.75 (0.68 to 0.82)	<0.001

Numbers are frequency counts or RR plus 95% CI as appropriate.
Some deaths had insufficient information to assign a likely category of death.
RR derived from Negative Binomial Model (all alpha values approximating to 0).
SUDIC, sudden unexpected deaths in infancy or childhood.

However, in contrast to emerging data on the mortality seen in adults,[23] the restrictions and adaptations across England in 2020 to combat COVID-19 resulted in a dramatic reduction of childhood deaths, particularly in the younger children. The social restrictions during this time were broad, and included school and nursery closures,[24] with secondary impacts including reductions in air pollution and road traffic.[25] In low/middle-income countries, a substantial indirect excess mortality is predicted[26] and across the world, measures of child mortality appear heterogeneous[9] with the benefits of the social restrictions and the direct impact of COVID-19 likely to balance differently across different countries and pre-existing patterns of disease. However, in England, 2020 is likely to be the safest year on record for child deaths.[2] While the NCMD has collated data since April 2019, crude mortality over time is well recorded through other statutory instruments, with ONS data showing little change in overall childhood mortality over the last 5 years.[2] The coincidence of maximum lockdown regulations and the maximum reduction in mortality for younger children suggests that the lockdown regulations, including social distancing and reduction of social mixing, appeared most beneficial to younger children and perhaps to certain ethnic groups. While we know that children from some ethnic minority groups appear to be more likely to test positive[14] and subsequently die[27] of COVID-19, this pragmatic investigation of both the pandemic, and the responses to it, was unable to confirm a change in the profile of children dying in 2020–2021 from the preceding year. However, the reduction in all-cause mortality appeared greater for some ethnic minority groups and in areas of higher deprivation, groups recognised as having higher risk of death than others.[13 28] The measures put in place during the first year of the pandemic may have mitigated this patterning, although it should be noted that for most subgroups, mortality was reduced, and we had small absolute numbers making it difficult to show evidence of a real difference between any subgroups investigated here.

COVID-19 did contribute to overall childhood mortality; 70 children in this work died with a positive COVID-19 test and COVID-19 is likely to be the cause of death in around half of these.[27] However, there was clear evidence that the reduction in mortality was seen in two key areas: those children with underlying diseases and those who died of infections, despite COVID-19. The category of 'underlying diseases' was used to capture those children with an underlying condition able to explain their deaths, although the precipitant/contributory factor in many of these cases may also have been an infectious agent (eg, accelerating existing poor health in a child with complex needs). Consequently, it seems likely that reductions in infection underpin much of the effect seen; but whether this was through simple measures, like hand washing, or through substantial social changes, like the closure of nurseries and schools, is unclear.

Finally, we did not see clear increases in any single category of death. However, impacts may take time to show due to increasing numbers and precision, or through pathways which may take time to impact on mortality (eg, delayed diagnosis of malignancies or lack of mental health inpatient capacity). Possible increases in some categories of death were seen and we cannot exclude a small rise in suicide,[29 30] intrapartum[31] or trauma deaths,[32] although numbers remained small.

These data demonstrate that child deaths caused by (seasonal) infections are potentially substantially modifiable at population level. Impressive reductions in respiratory syncytial virus (RSV) and other respiratory virus infections in the winter months were reported in the first pandemic year.[33] Indeed, while some pathogens appeared to rebound to normal seasonal levels after opening of schools and nurseries, and lifting of social distancing,[34] RSV appeared to remain suppressed through the simple measures of mask wearing and enhanced hand washing.[35] However, with the end of social distancing regulations in England, alongside the large cohort of immune-naïve children at risk, protected by the lockdown measures in 2020, the ongoing burden of RSV in young children is predicted to he high throughout the winter of 2021/2022.[36]

CONCLUSION

What these data show is that, during 2020–2021, when multiple measures were introduced with the aim of reducing morbidity and mortality from COVID-19 in the adult population, there was an unexpected fall in overall child mortality in England, most marked in younger children and those with underlying health conditions and infectious disease other than COVID-19. The magnitude of this fall (around 10%), including those children living in the most deprived conditions, a group for whom previous attempts to reduce excess mortality have generally been less successful, makes clear that we need to investigate what aspect of societal reorganisation and the restrictions faced by the whole population have had this effect. It is important that we learn from this effect, and identify which changes implemented over the last year would remain acceptable to protect the most vulnerable children in our society.

surveillance of child mortality during the COVID-19 pandemic is delivered by the NCMD programme, with the purpose to investigate an outbreak/incident to help in disease control and prevention. This work is classified as Usual Practice in Public Health and Health Protection (http://www.hra-decisiontools.org.uk/research/docs/definingresearchtable_oct2017-1.pdf) under the UK Policy Framework for Health and Social Care Research, and was reviewed by the Chair of the Central Bristol NHS Research Ethics Committee with confirmation that NHS ethical approval was not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. Aggregate data may be available on request to the corresponding author, and subject to approval by HQIP.

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