



# Contribution of ethnicity and deprivation to paediatric critical care outcomes in the UK, 2008–21: a national retrospective cohort study



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## Summary

**Background** Evidence from UK paediatric intensive care units (PICUs) demonstrates increased incidence of admission among children of Asian and Black ethnicity and children residing in more deprived areas. We aimed to investigate whether mortality in PICU is associated with ethnicity and child poverty.

**Methods** This national cohort study included children aged 0–15 years who were admitted to PICUs in the UK between Jan 1, 2008, and Dec 31, 2021. Participating PICUs were affiliated with and reported outcome data to the Paediatric Intensive Care Audit Network (PICANet), from which we extracted data for this analysis. Key exposures were ethnicity, categorised as Asian, Black, Multiple, Other, and White, and area-level deprivation at the time of admission, quantified with the Children in Low-Income Families measure of an area's proportion of children living in families with income less than 60% of the median income and receiving out-of-work benefits or tax credits. The primary outcome was mortality during PICU stay. Mixed-effects logistic regression clustered by admitting PICU centre and individual patient was used to examine the association between key exposures and mortality during PICU stay for all admissions and then separately for planned and unplanned admissions.

**Findings** This analysis included 245 099 admissions for 163 163 children during the study period, during which 102 990 (63·1%) had unplanned PICU admissions. 15 017 (9·2%) admissions were for children of Asian ethnicity, 7244 (4·4%) for children of Black ethnicity, 4514 (2·8%) for children of multiple ethnicities, 3831 (2·4%) for children of other ethnicities, and 100 241 (61·4%) for children of White ethnicity. Ethnicity data were missing for 32 316 (19·8%) of admissions. Observed PICU mortality across planned and unplanned admissions was 3·7% (9056 deaths per 245 099 admissions). Crude PICU mortality was highest among Asian children (1336 [5·1%; 95% CI 4·9–5·5] deaths per 26 022 admissions) and lowest among White children (4960 [3·2%; 3·1–3·3] deaths per 154 041 admissions), indicating a higher relative odds of PICU mortality among Asian children than White children for all admission types (odds ratio [OR] 1·52 [95% CI 1·42–1·62]). Odds of PICU mortality did not differ between children of Black and White ethnicity (OR 1·04; 95% CI 0·93–1·15). Children of multiple ethnicities (OR 1·23 [95% CI 1·08–1·39]) and other ethnicities (1·20 [1·05–1·38]) showed increased odds of PICU mortality relative to White children. PICU mortality ranged from 1025 (3·1%; 95% CI 2·9–3·3) deaths per 33 331 admissions for children in the least deprived quintile to 2432 (4·2%; 4·0–4·4) deaths per 58 110 admissions among children in the most deprived quintile, demonstrating an association between PICU mortality and area-level child poverty (OR 1·13 [95% CI 1·03–1·23]).

**Interpretation** Variation in PICU mortality by ethnicity and area-level deprivation highlights the importance of further investigation into systemic drivers of disparities in PICU outcomes in the UK. Targeted strategies to mitigate drivers of inequalities are essential.

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## Introduction

There is growing recognition of the effects of socio-economic deprivation and racial and ethnic inequities on children's health-care outcomes. Children from economically disadvantaged areas or minority ethnic backgrounds experience worse health outcomes than those from economically advantaged areas and those of White ethnicity across a range of acute care conditions, with the majority of this research originating from the USA.<sup>1,2</sup>

Evidence from both the UK and the USA shows an increased incidence of admissions to paediatric intensive care units (PICUs) with rising levels of deprivation.<sup>3–5</sup> We have previously reported increased rates of PICU admission for children of Asian and Black ethnicities in the UK.<sup>3</sup> Less is known on how this increased risk of admission to PICU relates to outcomes after admission. A study conducted across 15 PICUs in the USA showed higher PICU mortality in children residing in more deprived areas than in those living in less deprived areas.<sup>6</sup>

## Research in context

### Evidence before this study

There is increasing evidence of the adverse effects of social determinants of health on children's intensive care outcomes. We searched Medline and Embase databases from inception to Nov 29, 2024; the search string was ("P?ediatric\*", "child\*", "adolescen\*" AND "Critical care", "intensive care" AND "race", "racial", "ethnic\*" OR "socio\*", "deprivation", "poverty", "insur\*", "income", "Disparit\*" OR "equity" AND "Mortality", "readmission", and "length of stay" OR "Outcome").

Key publications were supplemented with manual searches of reference lists. Evidence from the USA, although varied, shows worse PICU outcomes for children without health insurance (a proxy for socioeconomic deprivation), for children living in deprived areas, and for children from minority ethnic backgrounds. We found a scarcity of published literature on PICU outcomes from the UK, most of which present data that are more than 15 years old. For example, a 2009 study from England reported worse PICU outcomes in children of south Asian ethnicity but found no association of PICU mortality with deprivation. In 2024, we reported disparities in the incidence of paediatric intensive care unit (PICU) admissions in the UK

between 2008 and 2021, with a higher incidence of critical care admission in children of Black and Asian ethnicity than among children of White ethnicity and higher among children living in the most deprived areas than among children living in the least deprived areas.

### Added value of this study

Child poverty in the UK has increased in the past decade. During this time, the proportions of different ethnic groups have also changed. Here we present an analysis of contemporary, nationwide data for children aged 0–15 years admitted to UK PICUs between Jan 1, 2008, and Dec 31, 2021, collated by the Paediatric Intensive Care Audit Network, and we explore the effect of ethnicity and deprivation on PICU mortality, length of stay, and unplanned readmission to PICU within 60 days.

### Implications of all the available evidence

The disproportionate burden of PICU mortality, longer stays, and unplanned readmissions among children of minority ethnicities and those from deprived areas shows that targeted, community, and hospital-based interventions are urgently needed to improve PICU outcomes across the UK.

A study from the UK showed increased mortality in children of south Asian ethnicity compared to White children, however, the findings are based on data collected more than 10 years ago.<sup>7</sup> A recent study from the UK showed that Asian and Black children were more likely than White children to need cardiopulmonary resuscitation—a marker of severe illness—during their intensive care admission.<sup>8</sup>

Admission to paediatric intensive care is a relatively rare event with an annual incidence of admission of roughly 150 per 100 000 children per year in the UK and 320 per 100 000 children per year in the USA.<sup>9,10</sup> PICU admission is a specialised high cost resource; although paediatric intensive care admissions make up just 2–6% of children's acute hospital admissions, they account for 10–25% of paediatric hospital spending in a high-resource setting.<sup>10–14</sup> With the increasing prevalence of complex chronic conditions in the paediatric population, PICU utilisation is projected to increase in the coming years.<sup>15–17</sup> It is therefore crucial to understand which children, based on their social and clinical characteristics, are at heightened risk once admitted to PICU in order to effectively intervene and reduce avoidable morbidity and mortality.

Building on previous work by our group that showed disparities in the incidence of admission to paediatric intensive care according to deprivation and ethnicity across the UK, we aimed to explore whether there are any disparities in paediatric outcomes following admission. We used a large, nationally representative dataset to examine outcomes in children admitted to UK PICUs over a 14-year period, assessing whether there are any inequalities in outcomes of children

admitted to PICU according to a child's ethnicity and the degree of child poverty in the area where a child is living.

## Methods

### Study design and participants

We obtained outcome data for children aged 0–15 years admitted to UK PICUs between Jan 1, 2008, and Dec 31, 2021, from the Paediatric Intensive Care Audit Network (PICANet). Data quality is ensured through regular validation visits, ensuring all eligible PICU admissions are captured. Full details about data collection are provided on the PICANet website.

### Variables

Available demographic variables comprised child characteristics (age at admission, sex, ethnic group, and small area geography where the child lived; known as lower layer super output area in England and Wales, data zone in Scotland, and super output area in Northern Ireland) and admission characteristics (diagnostic group, planned vs unplanned admission, month of admission, year of admission, and interventions received during admission such as invasive ventilation, vasoactive medication, renal replacement therapy, and extracorporeal membrane oxygenation [ECMO]).

### Key exposure variables

The key exposure variables, ethnicity and deprivation, were used as factors of interest to identify inequities in health-care outcomes.

For more on PICANet see <https://www.picanet.org.uk/data-collection/>

In the UK, ethnicity (rather than race) is recorded in routine health-care data.<sup>18</sup> Recognising that race is a social construct without a biological basis, our study considers ethnicity as a social and structural determinant rather than a marker of genetic or biological differences.<sup>19</sup> Ethnicity of children admitted to PICU was recorded and categorised according to UK Census 2021 groupings used by the UK Office for National Statistics into six major groupings: Asian (Bangladeshi, Chinese, Indian, Pakistani, and other); Black (African, Caribbean, and other); Multiple (White and Black Caribbean, White and Black African, White and Asian, and multiple other); Other (Arab or other), Unknown (missing or declined), and White (British, Irish, and other).<sup>20</sup> Ethnicity was recorded in PICA Net in a similar way to all national routine audit datasets, by local staff based on discussion with families, inspection of medical records, and documented by medical or administrative staff, but the data do not allow us to distinguish which method was used in each case.

Deprivation at the time of admission was quantified with the Children in Low-Income Families (CiLIF)

measure<sup>21</sup> of the proportion of children living in families in receipt of out-of-work benefits or tax credits, and where their reported income is less than 60% of the median income.

Fifths of deprivation were generated for each individual year between 2008 and 2021 based on ranking the resident population (<16 years) of areas in the UK to ensure equal sized groups, with 1 being least deprived and 5 being most deprived. If an area was missing information for the CiLIF measure, we replaced it with data for the nearest available year.

### Statistical analysis

The primary outcome for the analysis was mortality during PICU stay. Secondary outcomes were length of PICU stay and unplanned readmission within 60 days (defined as any subsequent unplanned admission in the month of or the following month from the index admission).

Cohort characteristics are summarised with descriptive statistics. Length of stay and duration of invasive ventilation were summarised by each of the key exposure variables with medians and IQRs. The

|                                         | Asian<br>(n=15 017; 9.2%) | Black<br>(n=7244; 4.4%) | Multiple<br>(n=4514; 2.8%) | Other<br>(n=3831; 2.4%) | White<br>(n=100 241; 61.4%) | Missing<br>(n=32 316; 19.8%) | Total<br>(n=163 163; 100.0%) |
|-----------------------------------------|---------------------------|-------------------------|----------------------------|-------------------------|-----------------------------|------------------------------|------------------------------|
| <b>Sex</b>                              |                           |                         |                            |                         |                             |                              |                              |
| Male                                    | 8565 (57.0%)              | 4111 (56.8%)            | 2583 (57.2%)               | 2200 (57.4%)            | 56 646 (56.5%)              | 18 269 (56.5%)               | 92 374 (56.6%)               |
| Female                                  | 6450 (43.0%)              | 3131 (43.2%)            | 1931 (42.8%)               | 1629 (42.5%)            | 43 579 (43.5%)              | 14 041 (43.4%)               | 70 761 (43.4%)               |
| <b>Age group</b>                        |                           |                         |                            |                         |                             |                              |                              |
| <1 month                                | 2836 (18.9%)              | 977 (13.5%)             | 874 (19.4%)                | 596 (15.6%)             | 19 288 (19.2%)              | 5754 (17.8%)                 | 30 325 (18.6%)               |
| 1 month to <1 year                      | 4465 (29.7%)              | 1980 (27.3%)            | 1478 (32.7%)               | 1158 (30.2%)            | 29 882 (29.8%)              | 9556 (29.6%)                 | 48 519 (29.7%)               |
| 1 year to <5 years                      | 3629 (24.1%)              | 1970 (27.2%)            | 1154 (25.6%)               | 1031 (26.9%)            | 22 386 (22.3%)              | 8001 (24.8%)                 | 38 171 (23.4%)               |
| 5 years to <11 years                    | 2259 (15.0%)              | 1258 (17.4%)            | 532 (11.8%)                | 584 (15.2%)             | 13 374 (13.3%)              | 4158 (12.9%)                 | 22 165 (13.6%)               |
| 11 years to <16 years                   | 1828 (12.2%)              | 1059 (14.6%)            | 476 (10.5%)                | 462 (12.1%)             | 15 311 (15.3%)              | 4847 (15.0%)                 | 23 983 (14.7%)               |
| <b>Area level deprivation quintile*</b> |                           |                         |                            |                         |                             |                              |                              |
| 1 (least deprived)                      | 901 (6.0%)                | 341 (4.7%)              | 533 (11.8%)                | 348 (9.1%)              | 15 442 (15.4%)              | 4995 (15.5%)                 | 22 560 (13.8%)               |
| 2                                       | 1152 (7.7%)               | 531 (7.3%)              | 585 (13.0%)                | 363 (9.5%)              | 16 618 (16.6%)              | 5263 (16.3%)                 | 24 512 (15.0%)               |
| 3                                       | 2074 (13.8%)              | 949 (13.1%)             | 781 (17.3%)                | 460 (12.0%)             | 17 632 (17.6%)              | 5971 (18.5%)                 | 27 867 (17.1%)               |
| 4                                       | 3268 (21.8%)              | 1792 (24.7%)            | 971 (21.5%)                | 595 (15.5%)             | 18 760 (18.7%)              | 6696 (20.7%)                 | 32 082 (19.7%)               |
| 5 (most deprived)                       | 6524 (43.4%)              | 3038 (41.9%)            | 1268 (28.1%)               | 1165 (30.4%)            | 19 206 (19.2%)              | 6325 (19.6%)                 | 37 526 (23.0%)               |
| Missing                                 | 1098 (7.3%)               | 593 (8.2%)              | 376 (8.3%)                 | 900 (23.5%)             | 12 583 (12.6%)              | 3066 (9.5%)                  | 18 616 (11.4%)               |
| <b>Primary diagnosis group</b>          |                           |                         |                            |                         |                             |                              |                              |
| Cardiovascular                          | 4552 (30.3%)              | 1780 (24.6%)            | 1338 (29.6%)               | 1208 (31.5%)            | 27 718 (27.6%)              | 7202 (22.3%)                 | 43 798 (26.8%)               |
| Gastrointestinal                        | 974 (6.5%)                | 417 (5.8%)              | 314 (7.0%)                 | 227 (5.9%)              | 6280 (6.3%)                 | 2282 (7.1%)                  | 10 494 (6.4%)                |
| Infection                               | 773 (5.1%)                | 341 (4.7%)              | 230 (5.1%)                 | 189 (4.9%)              | 5853 (5.8%)                 | 1961 (6.1%)                  | 9347 (5.7%)                  |
| Neurological                            | 1675 (11.1%)              | 825 (11.4%)             | 464 (10.3%)                | 458 (12.0%)             | 11 412 (11.4%)              | 4026 (12.5%)                 | 18 860 (11.6%)               |
| Other†                                  | 3062 (20.4%)              | 1691 (23.3%)            | 890 (19.7%)                | 810 (21.1%)             | 23 483 (23.4%)              | 7843 (24.3%)                 | 37 779 (23.2%)               |
| Respiratory                             | 3981 (26.5%)              | 2190 (30.2%)            | 1278 (28.3%)               | 939 (24.5%)             | 25 495 (25.4%)              | 9002 (27.9%)                 | 42 885 (26.3%)               |
| <b>Admission type</b>                   |                           |                         |                            |                         |                             |                              |                              |
| Planned                                 | 5092 (33.9%)              | 2186 (30.2%)            | 1562 (34.6%)               | 1553 (40.5%)            | 38 715 (38.6%)              | 10 909 (33.8%)               | 60 017 (36.8%)               |
| Unplanned                               | 9909 (66.0%)              | 5049 (69.7%)            | 2951 (65.4%)               | 2277 (59.4%)            | 61 450 (61.3%)              | 21 354 (66.1%)               | 102 990 (63.1%)              |

Data are n (%). PICU=paediatric intensive care unit. LSOA=lower layer super output area. SOA=super output area. \*At LSOA, data zone, or SOA level. †Other includes blood or lymphatic, body wall and cavities, endocrine or metabolic, multisystem, musculoskeletal, oncology, other, and trauma.

**Table 1: Characteristics of individual children admitted to PICU, by ethnicity**

Paediatric Index of Mortality (PIM2) score was used to characterise severity of illness.<sup>22</sup> The PIM score is a predictive tool used to estimate the risk of mortality at the time of admission based on a set of physiological and clinical variables. The PIM3 score was only introduced in 2015, so the PIM2 score was chosen since this was applicable for the entire study period. As the PIM2 score is likely to be skewed due to outliers with a high severity of illness on admission, median PIM2 scores with IQRs were calculated for each of the main exposure variables.

Associations between the key exposure variables (ethnicity and area-level deprivation) were explored with one another and then with interventions received in PICU (ECMO, vasoactive medication, renal replacement therapy, and invasive mechanical ventilation), duration of ventilation, and with the primary and secondary outcomes.

In model building we used a causal inference approach and directed acyclic graphs (DAGs) to identify the minimal sufficient adjustment set of confounders for each exposure for the primary outcome of mortality in PICU, and secondary outcomes of length of PICU stay and unplanned readmission (appendix pp 1–4). Variables included in the DAG were age (already grouped by PICANet as <1 month, 1–11 months, 1–4 years, 5–10 years, and 11–15 years), sex (male and female), primary diagnosis group (cardiovascular, gastrointestinal, infection, neurological, respiratory, and other), severity of illness, time of year of admission, and year of admission.

The models for the primary and secondary outcomes were adjusted by the same variables since both length of PICU stay and readmission were considered adverse health-care outcomes with a similar explanatory framework as PICU mortality. For deprivation as the main exposure, we adjusted for ethnicity, but for ethnicity we did not adjust for any additional variables.

For the primary outcome of PICU mortality, mixed-effects logistic regression models to estimate odds ratios (ORs) with admitting PICU and individual patient as random effects were constructed for all admissions and then separately for planned and unplanned admissions.

For the secondary outcome of length of PICU stay, we used mixed-effects negative binomial regression models to estimate incidence rate ratios (IRRs), with admitting PICU and individual child as random effects. For the secondary outcome of unplanned PICU readmission within 60 days, we built mixed-effects logistic regression models clustered by child, excluding children who died during their index admission. The models for the secondary outcomes considered all admissions.

Interaction tests looking for any evidence of modification of the effect of racial or ethnic group by area-level child poverty were performed, and if evidence of interaction was found then subsequent results were presented in a stratified breakdown.

Due to the high level of missing data on ethnicity, we conducted two additional sensitivity analyses to ensure

the robustness of our findings: one imputing all missing ethnicities as Asian and the other imputing all missing ethnicities as White to compare the most extreme possible outcomes. A further sensitivity analysis for length of stay was conducted, removing any patients who had died in PICU.

All statistical analyses were performed with Stata 18, while figures were generated in R with the ggplot2 package. The Stata code for all models is provided in the appendix (p 4).

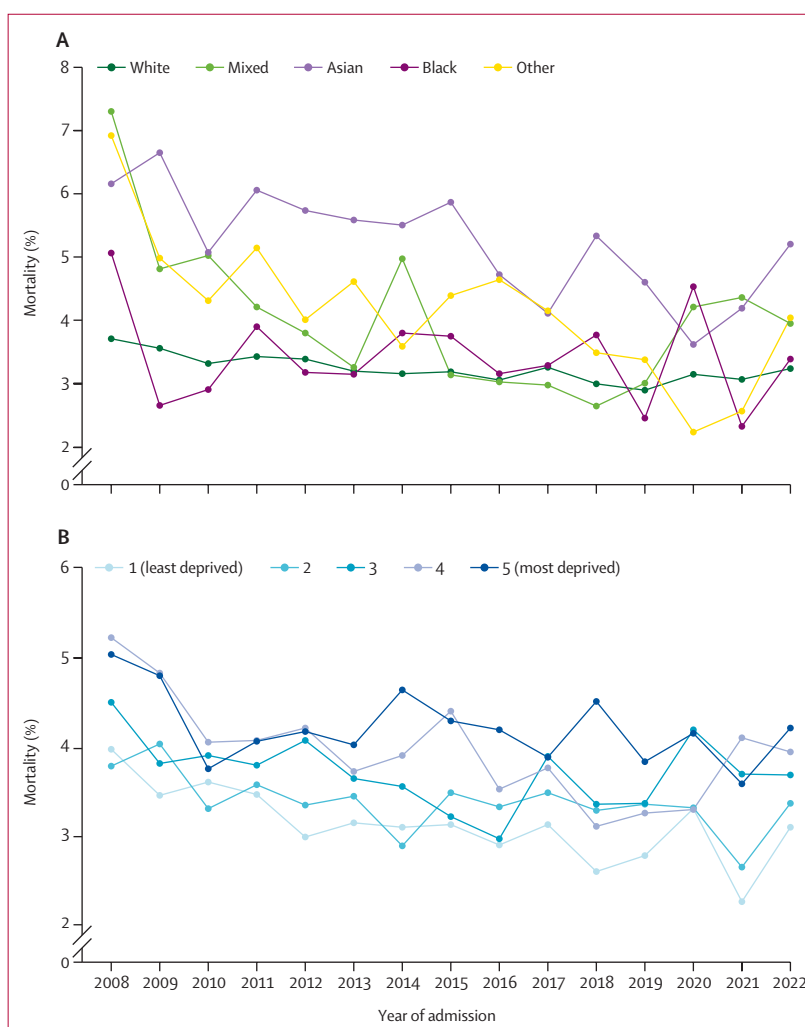
### Role of the funding source

There was no funding source for this study.

### Results

245 099 admissions from 163 163 children were reported to PICANet for the period Jan 1, 2008, to Dec 31, 2021; cohort characteristics are listed in table 1 and the

[See Online for appendix](#)



**Figure: Mortality in UK paediatric intensive care units between Jan 1, 2008, and Dec 31, 2021, by ethnicity (A) and deprivation quintile (B)**

Deprivation was quantified with the Children Living in Low-Income Families measure.

appendix (p 5). More than half of first admissions were unplanned, and most children admitted to PICU were of White ethnicity. Ethnicity information was missing in 32 316 (19.8%) children; however, data completeness improved over the study period (data not shown). Children from more deprived areas were over-represented in the PICU population. The majority of children from Asian and Black ethnicities were in the highest deprivation quintile, whereas children of White ethnicity were more evenly distributed among the quintiles.

Mortality across all admissions was 3.7% (9056 deaths per 245 099 admissions), and this decreased over time (figure). The median length of stay was 53 h (IQR 23–130). Among children who survived to PICU discharge, 15 789 (6.7%) of 245 099 admissions were followed by an unplanned readmission within 60 days.

Severity of illness on admission, mortality, readmission rate, and receipt of any ECMO, vasoactives, or renal replacement therapy are compared across ethnicities and deprivation quintiles in table 2. Median severity of illness (predicted risk of mortality) on admission was highest in children of Asian ethnicity. Median severity of illness on admission was comparable for Black and White children. Among all ethnic groups, children of Asian ethnicity were most likely to have received ECMO, vasoactive medications, or renal replacement therapy during their PICU stay.

PICU mortality was highest among admissions for Asian children throughout the study period (figure). Crude PICU mortality was highest among children of Asian ethnicity and lowest among children of White ethnicity (table 2). Children of Asian Pakistani ethnicity had the highest crude PICU mortality (5.8% [95% CI 5.4–6.3]; appendix p 6). A comparison of relative odds of PICU mortality, by ethnicity, showed that children of Asian ethnicity had increased odds of PICU mortality compared to White children (OR 1.52 [95% CI 1.42–1.62]; table 3). The increased mortality among admissions of Asian children was apparent across both planned and unplanned admissions, but the relative odds of PICU mortality relative to White children was most pronounced in planned admissions (OR 1.72 [95% CI 1.42–2.08]).

We found no difference in odds of PICU mortality between children of Black and White ethnicity (table 3), and for all admission types, the odds of PICU mortality were increased in children of multiple ethnicities (OR 1.23 [95% CI 1.08–1.39]) and other ethnicities (OR 1.20 [95% CI 1.05–1.38]) compared to White children (table 3).

The longest median length of stay was seen in children of Asian ethnicity (66 h [IQR 25–157]; table 2). A longer length of PICU stay was seen in children of non-White ethnicity than in those of White ethnicity (Asian, IRR 1.15 [95% CI 1.13–1.16]; Black, 1.11 [1.09–1.13]; multiple, 1.07 [1.05–1.10]; and other, 1.12 [1.09–1.14]; table 4).

|                                        | Median PIM2 risk of mortality on admission (IQR) | Median length of stay, h (IQR) | Received invasive ventilation (95% CI) | Median duration of ventilation, days (IQR) | Mortality, n/N (%; 95% CI)   | Proportion of admissions with an unplanned readmission in 60 days (95% CI) | Received ECMO (95% CI) | Received any vasoactives (95% CI) | Received renal replacement therapy (95% CI) |
|----------------------------------------|--------------------------------------------------|--------------------------------|----------------------------------------|--------------------------------------------|------------------------------|----------------------------------------------------------------------------|------------------------|-----------------------------------|---------------------------------------------|
| <b>Ethnicity</b>                       |                                                  |                                |                                        |                                            |                              |                                                                            |                        |                                   |                                             |
| Asian                                  | 2.26 (0.90–5.60)                                 | 66 (25–157)                    | 68.6% (68.0–69.1)                      | 3 (2–7)                                    | 1336/26 022 (5.1%; 4.9–5.5)  | 9.0% (8.6–9.3)                                                             | 1.4% (1.2–1.5)         | 35.5% (35.0–36.1)                 | 4.0% (3.8–4.3)                              |
| Black                                  | 1.87 (0.78–4.91)                                 | 63 (25–146)                    | 65.6% (64.8–66.4)                      | 3 (2–7)                                    | 424/12 564 (3.4%; 3.1–3.7)   | 8.8% (8.3–9.3)                                                             | 1.2% (1.0–1.3)         | 30.0% (29.2–30.8)                 | 2.5% (2.2–2.8)                              |
| Multiple                               | 1.94 (0.80–4.91)                                 | 62 (25–142)                    | 67.9% (66.8–69.0)                      | 3 (2–6)                                    | 284/7224 (3.9%; 3.5–4.4)     | 7.8% (7.2–8.4)                                                             | 1.1% (0.9–1.4)         | 35.0% (33.9–36.1)                 | 2.9% (2.5–3.3)                              |
| Other                                  | 2.01 (0.89–4.78)                                 | 64 (25–149)                    | 72.0% (70.8–73.0)                      | 3 (2–6)                                    | 243/6001 (4.1%; 3.6–4.5)     | 7.8% (7.1–8.5)                                                             | 1.0% (0.8–1.3)         | 34.1% (32.8–35.2)                 | 3.4% (3.0–3.9)                              |
| White                                  | 1.73 (0.75–4.52)                                 | 52 (23–127)                    | 67.9% (67.7–68.1)                      | 3 (2–6)                                    | 4960/154 041 (3.2%; 3.1–3.3) | 6.8% (6.6–6.9)                                                             | 1.2% (1.2–1.3)         | 32.6% (32.3–32.8)                 | 3.1% (3.0–3.1)                              |
| <b>Area level deprivation quintile</b> |                                                  |                                |                                        |                                            |                              |                                                                            |                        |                                   |                                             |
| 1 (least deprived)                     | 1.53 (0.70–4.11)                                 | 50 (23–120)                    | 64.4% (63.9–64.9)                      | 3 (2–5)                                    | 1025/33 331 (3.1%; 2.9–3.3)  | 6.2% (5.9–6.5)                                                             | 1.0% (0.9–1.1)         | 31.0% (30.6–31.5)                 | 3.1% (2.9–3.3)                              |
| 2                                      | 1.69 (0.75–4.47)                                 | 52 (23–125)                    | 66.4% (65.9–66.9)                      | 3 (2–6)                                    | 1225/36 681 (3.3%; 3.2–3.5)  | 6.4% (6.1–6.6)                                                             | 1.1% (1.0–1.3)         | 33.0% (32.6–33.5)                 | 3.1% (2.9–3.2)                              |
| 3                                      | 1.82 (0.76–4.66)                                 | 55 (24–131)                    | 69.1% (68.6–69.5)                      | 3 (2–6)                                    | 1534/41 877 (3.7%; 3.5–3.8)  | 6.4% (6.2–6.7)                                                             | 1.2% (1.1–1.4)         | 33.7% (33.2–34.1)                 | 3.2% (3.0–3.4)                              |
| 4                                      | 1.89 (0.79–4.85)                                 | 58 (24–135)                    | 69.2% (68.8–69.6)                      | 3 (2–6)                                    | 1906/48 560 (3.9%; 3.8–4.1)  | 6.9% (6.6–7.1)                                                             | 1.2% (1.1–1.3)         | 33.5% (33.0–33.9)                 | 3.1% (2.9–3.2)                              |
| 5 (most deprived)                      | 1.92 (0.79–4.95)                                 | 56 (23–135)                    | 67.2% (66.8–67.6)                      | 3 (2–6)                                    | 2432/58 110 (4.2%; 4.0–4.4)  | 7.6% (7.4–7.8)                                                             | 1.2% (1.1–1.3)         | 31.9% (31.6–32.3)                 | 3.0% (2.9–3.2)                              |

ECMO=extracorporeal membrane oxygenation. PIM2=Paediatric Index of Mortality 2.

**Table 2: Severity of illness on admission, mortality, readmission rate, and receipt of any ECMO, vasoactives, or renal replacement therapy, by ethnicity and deprivation**

The highest crude rates of unplanned readmission within 60 days were seen in Asian and Black children (table 2). Children of Asian, Black, and multiple ethnicity showed increased odds of unplanned readmission within 60 days compared to White children (table 4).

Severity of illness on admission and PICU mortality increased with degree of deprivation (table 2). Odds of PICU mortality increased with increasing levels of child poverty (table 3). Children living in the most deprived quintile had higher odds of PICU mortality than children living in the least deprived quintile (OR 1.13 [95% CI 1.03–1.23]).

Length of PICU stay was longer for children living in the most deprived quintile than children living in the least deprived quintile (IRR 1.05 [95% CI 1.03–1.06]; table 2; table 4). The odds of unplanned readmission within 60 days were higher for children living in the most deprived quintile than for children living in the least deprived quintile (IRR 1.11 [95% CI 1.04–1.18]; table 4).

We found no evidence of effect modification between ethnicity and deprivation (*p* value for interaction test 0.35) and therefore do not present stratified results. The results of sensitivity analyses were consistent with those of the primary analysis (appendix pp 6–7).

## Discussion

Using 14 years of national data, our study highlights significant inequalities in paediatric intensive care outcomes in the UK. Children of Asian ethnicity had higher mortality following admission to PICU than White children. Mortality was also higher in children living in areas with higher levels of child poverty. Both children of Asian ethnicity and children from more deprived areas were more severely unwell at admission (as measured by the PIM2 score) than children of White ethnicity and those from less deprived areas. Children of non-White ethnicity had longer stays in PICU and increased odds of unplanned readmission to PICU within 60 days compared with those of White ethnicity.

These are, to the best of our knowledge, the first published data from the UK to report worse intensive care outcomes in children from more deprived areas. We used a measure of deprivation based on the proportion of children in an area living in families receiving unemployment benefits or with low income. Although this measure captures a key dimension of disadvantage, it does not represent the full complexity of deprivation, which includes housing, education, health-care access, and maternal health and social support. These structural disadvantages shape the complex pathway from home and community settings to critical care, influencing both the risk of acute illness and access to health care. Evidence from the UK has shown increased use of unscheduled and emergency care in children residing in more deprived areas.<sup>23</sup> Our previous research has shown that the association

|                                         | All admissions   | Unplanned admissions | Planned admissions |
|-----------------------------------------|------------------|----------------------|--------------------|
| <b>Ethnicity*</b>                       |                  |                      |                    |
| Number of admissions                    | 205 672          | 123 744              | 81 928             |
| White                                   | Ref              | Ref                  | Ref                |
| Asian                                   | 1.52 (1.42–1.62) | 1.41 (1.31–1.52)     | 1.72 (1.42–2.08)   |
| Black                                   | 1.04 (0.93–1.15) | 0.92 (0.82–1.04)     | 1.20 (0.89–1.62)   |
| Multiple                                | 1.23 (1.08–1.39) | 1.18 (1.03–1.35)     | 1.05 (0.72–1.54)   |
| Other                                   | 1.20 (1.05–1.38) | 1.15 (0.98–1.33)     | 1.57 (1.11–2.23)   |
| <b>Area level deprivation quintile†</b> |                  |                      |                    |
| Number of admissions                    | 182 852          | 110 605              | 72 247             |
| 1 (least deprived)                      | Ref              | Ref                  | Ref                |
| 2                                       | 1.05 (0.95–1.15) | 1.04 (0.94–1.16)     | 1.06 (0.82–1.36)   |
| 3                                       | 1.12 (1.02–1.23) | 1.12 (1.01–1.24)     | 1.12 (0.88–1.42)   |
| 4                                       | 1.13 (1.04–1.24) | 1.10 (0.99–1.21)     | 1.17 (0.92–1.48)   |
| 5 (most deprived)                       | 1.13 (1.03–1.23) | 1.07 (0.97–1.18)     | 1.18 (0.94–1.50)   |

Data are *n* or odds ratio (95% CI). PICU mortality is shown across all admissions and then subdivided into planned admissions and unplanned admissions. Discrepancies in total numbers of admissions are due to missing data on ethnicity and deprivation quintiles. The number of unplanned admissions is higher than in table 1 (*n*=102 990) as table 1 presents data by individual child (first admission only), whereas the models include all unplanned admissions, including multiple admissions for the same child. PICU=paediatric intensive care unit. \*Admitting PICU and child included as random effect. †Adjusted for ethnicity, admitting PICU, and child included as random effect.

**Table 3: Relative odds of PICU mortality, by ethnicity and deprivation**

between deprivation and health-care use extends into critical care with an increased incidence of PICU admission in children living in areas with higher levels of child poverty.<sup>3</sup> Children from more deprived areas arrive in PICU more critically unwell, and deprivation is associated with an increased risk of childhood acute illness that might need unplanned intensive care admission, such as asthma and traumatic injury.<sup>24,25</sup>

In the UK, child poverty has increased over the past decade and progress towards improving infant mortality has stalled.<sup>26,27</sup> More than one in five child deaths nationally could potentially be avoided if children in the most deprived areas had the same risk of mortality as those in the least deprived areas.<sup>27</sup> Policies to reduce the root causes of child poverty and potentially preventable critical illness are urgently needed.

The reasons behind the worse outcomes in children of Asian, other, and multiple ethnicities are not clearly understood. Ethnicity is a complex construct that includes dimensions such as language, cultural heritage, nationality, and migration history.<sup>19,28</sup> Systemic health-care challenges, including institutional biases, language barriers, mistrust, and cultural factors, might disproportionately affect families from minority ethnic backgrounds. Experiences of racism, xenophobia, and discrimination—both within and beyond health-care settings—might also influence outcomes. A recent child death review found that modifiable factors in health service provision, such as access to health care, access to interpreting services, and communication between services, were implicated in around 10% of child deaths nationally.<sup>27</sup> Although our study took place in a context with universal access to health care that is free

|                                                                                                                                                                                                                                                                                   | Incidence rate ratio (95% CI) |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| <b>Length of stay</b>                                                                                                                                                                                                                                                             |                               |
| Ethnicity (n=205 849)*                                                                                                                                                                                                                                                            |                               |
| White                                                                                                                                                                                                                                                                             | Ref                           |
| Asian                                                                                                                                                                                                                                                                             | 1.15 (1.13–1.16)              |
| Black                                                                                                                                                                                                                                                                             | 1.11 (1.09–1.13)              |
| Multiple                                                                                                                                                                                                                                                                          | 1.07 (1.05–1.10)              |
| Other                                                                                                                                                                                                                                                                             | 1.12 (1.09–1.14)              |
| Area level deprivation quintile† (n=183 020)                                                                                                                                                                                                                                      |                               |
| 1 (least deprived)                                                                                                                                                                                                                                                                | Ref                           |
| 2                                                                                                                                                                                                                                                                                 | 1.04 (1.02–1.05)              |
| 3                                                                                                                                                                                                                                                                                 | 1.06 (1.04–1.07)              |
| 4                                                                                                                                                                                                                                                                                 | 1.07 (1.06–1.09)              |
| 5 (most deprived)                                                                                                                                                                                                                                                                 | 1.05 (1.03–1.06)              |
| <b>Readmission within 60 days</b>                                                                                                                                                                                                                                                 |                               |
| Ethnicity (n=201 478)*                                                                                                                                                                                                                                                            |                               |
| White                                                                                                                                                                                                                                                                             | Ref                           |
| Asian                                                                                                                                                                                                                                                                             | 1.32 (1.25–1.39)              |
| Black                                                                                                                                                                                                                                                                             | 1.25 (1.16–1.34)              |
| Multiple                                                                                                                                                                                                                                                                          | 1.16 (1.05–1.28)              |
| Other                                                                                                                                                                                                                                                                             | 1.11 (0.99–1.23)              |
| Area level deprivation quintile† (n=179 117)                                                                                                                                                                                                                                      |                               |
| 1 (least deprived)                                                                                                                                                                                                                                                                | Ref                           |
| 2                                                                                                                                                                                                                                                                                 | 1.02 (0.95–1.09)              |
| 3                                                                                                                                                                                                                                                                                 | 0.99 (0.93–1.06)              |
| 4                                                                                                                                                                                                                                                                                 | 1.05 (0.98–1.12)              |
| 5 (most deprived)                                                                                                                                                                                                                                                                 | 1.11 (1.04–1.18)              |
| Discrepancies in total numbers of admissions are due to missing data on ethnicity and deprivation quintiles. * Admitting paediatric intensive care unit (PICU) and child included as random effect. † Adjusted for ethnicity, admitting PICU and child included as random effect. |                               |
| <b>Table 4: Length of stay and unplanned readmission within 60 days, by ethnicity and deprivation (all admissions)</b>                                                                                                                                                            |                               |

at the point of use, practical barriers to access persist for many families.<sup>29</sup> Addressing these structural barriers is crucial for reducing disparities and ensuring equitable health-care access for all children.

Previous research has shown an overlap between complex health conditions, ethnicity, and deprivation, with children with existing medical complexity being more likely to be of minority ethnicity or from more deprived areas.<sup>17,30</sup> Children with a medical complexity are overrepresented in the PICU population, with more admissions, longer stays, and higher in-hospital mortality.<sup>17,31,32</sup> Other factors such as parental consanguinity have been associated with an increased risk of certain genetic conditions. Although this area was not examined in our study, it may be relevant to child health outcomes and highlights the importance of accessible, culturally sensitive information and support for families. Children at the intersection of medical complexity, socioeconomic deprivation, and minority ethnicity constitute a group likely to be at the highest

risk of poor outcomes. These children face compounded systemic barriers that require a coordinated and nuanced approach to health-care delivery.

Previous work in a PICU population has examined the role of sex as a social determinant of health, showing although male children are more likely to be admitted to PICU, female children have higher mortality after admission.<sup>33,34</sup> Therefore, we did not focus on this association in our work.

Our study's strengths include its use of a large, high quality national dataset spanning 14 years. All UK nations contribute to the PICANet database, ensuring our findings are broadly representative of the population. We used the CiLIF measure to describe deprivation, enabling comparisons across the UK regions: England, Wales, Northern Ireland, and Scotland. This measure directly reflects children's experiences.

We had data on several important variables, including disease severity, primary diagnosis, and whether an admission was elective. This information allowed us to disentangle the separate effects of ethnicity and deprivation, allowing us to distinguish between health-care differences and highlight inequities.<sup>28</sup>

Our study is limited by missing data on ethnicity and deprivation. Accurate recording of ethnicity in health-care data is essential for designing services that meet the health needs of all segments of society.<sup>35</sup> Improved data collection, especially accurate recording of ethnicity, is essential to ensure health equity in critical care services for children. Ethnicity is recorded in PICANet in a variety of ways, either from discussion with families or extraction of medical records. Although self-report is the gold standard, ethnicity can be assigned by health-care staff on the basis of race or appearance, which carries a risk of misclassification; it is not clear in what proportion of patients this misclassification occurs.

Our study only captures deaths that occur in intensive care, meaning that deaths in the community, emergency department, or after PICU discharge (eg, in a hospice) are not captured. Although we were able to adjust for relevant confounders, there is likely to be residual confounding, especially since we do not have information on children's comorbidities.<sup>36</sup> Fully understanding the level of comorbidities in populations is essential to understand whether the health-care use of populations is proportionate to their health-care needs. Deprivation was considered at the area level with potential for misclassification as it might not accurately capture a child's individual level of deprivation. The relationship between deprivation and poor outcomes might be bidirectional, with complex child health needs potentially contributing to financial hardship and deepening disadvantage. Additionally, family size is associated with both deprivation and ethnicity, with larger families being more common in areas of higher deprivation. Since our deprivation

measure is based on population-ranked quintiles of children rather than families, we were unable to account for differences in household size. This limitation might introduce unmeasured confounding, as family size could influence health-care exposure, illness transmission, and healthcare-seeking behaviour.

In conclusion, our study highlights a clear effect of ethnicity and deprivation on outcomes of children admitted to PICU. These findings underscore the need for research into the underlying mechanisms, including access barriers tied to deprivation, marginalisation, immigration, and language, to clearly understand these mechanisms to enable targeted intervention. Additionally, coordinated action to address the upstream social determinants of child health is urgently needed. Interventions aimed at reducing poverty, improving access to health care, and addressing structural barriers in marginalised communities are likely to be crucial in reducing disparities in critical care outcomes. Given that the most deaths both in PICU and nationally occur in children aged younger than 1 year, investment into high-quality, accessible early-years care is particularly important. This study is UK-based, but the findings have international relevance, highlighting the need for health systems globally to engage with the social context in which critically ill children live and present for care.

#### Contributors

HM, SS, and PR devised and designed the study, planned the analysis, and critically revised the Article. RF and SS gave guidance on statistical methods. HM drafted the Article. HB, CL, KM, GJ, PD, and RF critically revised the Article. HM and SS have accessed and verified the data. HM, SS, and PR were responsible for the decision to submit the manuscript for publication.

#### Declaration of interests

We declare no competing interests.

#### Data sharing

The data used in this study were obtained from the Paediatric Intensive Care Audit Network (PICANet) and are not publicly available. Individual participant data and associated data dictionaries will not be made available by the authors due to data sharing restrictions. Access to data can be requested directly from PICANet subject to data access policies. Additional documents such as the study protocol and statistical analysis plan are available upon request from the corresponding author.

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#### References

- Mitchell HK, Reddy A, Perry MA, Gathers C-A, Fowler JC, Yehya N. Racial, ethnic, and socioeconomic disparities in paediatric critical care in the USA. *Lancet Child Adolesc Health* 2021; 5: 739–50.
- Andrist E, Clarke RG, Phelps KB, et al. Understanding disparities in the pediatric ICU: a scoping review. *Pediatrics* 2024; 153: e2023063415.
- Mitchell HK, Seaton SE, Leahy C, et al. Contribution of ethnicity, area level deprivation and air pollution to paediatric intensive care unit admissions in the United Kingdom 2008–2021. *EClinicalMedicine* 2024; 75: 102776.
- Andrist E, Riley CL, Brokamp C, Taylor S, Beck AF. Neighborhood poverty and pediatric intensive care use. *Pediatrics* 2019; 144: e20190748.
- Myers CN, Chandran A, Psoter KJ, Bergmann JP, Galiatsatos P. Indicators of neighborhood-level socioeconomic position and pediatric critical illness. *Chest* 2023; 164: 1434–43.
- McCrory MC, Akande M, Slain KN, et al, and the Pediatric Acute Lung Injury and Sepsis Investigators (PALISI) Network Social Determinants of Health Subgroup. Child opportunity index and pediatric intensive care outcomes: a multicenter retrospective study in the United States. *Pediatr Crit Care Med* 2024; 25: 323–34.
- Parslow RC, Tasker RC, Draper ES, et al, and the Paediatric Intensive Care Audit Network. Epidemiology of critically ill children in England and Wales: incidence, mortality, deprivation and ethnicity. *Arch Dis Child* 2009; 94: 210–15.
- Mustafa K, Buckley H, Feltbower R, Kumar R, Scholefield BR. Epidemiology of cardiopulmonary resuscitation in critically ill children admitted to pediatric intensive care units across England: a multicenter retrospective cohort study. *J Am Heart Assoc* 2021; 10: e018177.
- PICANet. Paediatric Intensive Care Audit Network Annual Report 2021. Data collection period January 2018–December 2020. Published January 2022. [https://www.picanet.org.uk/wp-content/uploads/sites/25/2022/04/PICANet-2021-Annual-Report\\_v1.1-22Apr2022.pdf](https://www.picanet.org.uk/wp-content/uploads/sites/25/2022/04/PICANet-2021-Annual-Report_v1.1-22Apr2022.pdf) (accessed June 12, 2025).
- Killien EY, Keller MR, Watson RS, Hartman ME. Epidemiology of intensive care admissions for children in the US from 2001 to 2019. *JAMA Pediatr* 2023; 177: 506–15.
- Morris K, Fortune P-M. Paediatric Critical Care: GIRFT Programme National Specialty Report. January 2022. <https://gettingitrightfirsttime.co.uk/medical-specialties/paediatric-critical-care/> (accessed July 9, 2024).
- Keeble E, Kossarova L. Focus on: Emergency hospital care for children and young people. April 24, 2017. <https://www.nuffieldtrust.org.uk/research/focus-on-emergency-hospital-care-for-children-and-young-people> (accessed June 12, 2025).
- Kelly E, Lee T, Sibiet L, Waters T. Public spending on children in England: 2000 to 2020. June 12, 2018. Institute for Fiscal Studies. <https://ifs.org.uk/publications/public-spending-children-england-2000-2020> (accessed June 6, 2025).
- Weiss AJ, Liang L, Martin K. Overview of hospital stays among children and adolescents, 2019. Statistical brief #299. November 2022. US Agency for Healthcare Research and Quality. <https://hcup-us.ahrq.gov/reports/statbriefs/sb299-Hospital-Stay-Children-2019.jsp> (accessed Sept 23, 2024).
- Shapiro MC, Boss RD, Donohue PK, Weiss EM, Madrigal V, Henderson CM, and the Pediatric Chronic Critical Illness Collaborative\*. A snapshot of chronic critical illness in pediatric intensive care units. *J Pediatr Intensive Care* 2021; 13: 55–62.
- Kanthimathinathan HK, Plunkett A, Scholefield BR, Pearson GA, Morris KP. Trends in long-stay admissions to a UK paediatric intensive care unit. *Arch Dis Child* 2020; 105: 558–62.
- Fraser LK, Parslow R. Children with life-limiting conditions in paediatric intensive care units: a national cohort, data linkage study. *Arch Dis Child* 2018; 103: 540–47.
- UK Government. Writing about ethnicity. October, 2024. <https://www.ethnicity-facts-figures.service.gov.uk/style-guide/writing-about-ethnicity/> (accessed June 21, 2024).
- Howe CJ, Bailey ZD, Raifman JR, Jackson JW. Recommendations for using causal diagrams to study racial health disparities. *Am J Epidemiol* 2022; 191: 1981–89.
- Office for National Statistics. Ethnic group, England and Wales: Census 2021. Nov 29, 2022. <https://www.ons.gov.uk/people-populationandcommunity/culturalidentity/ethnicity/bulletins/ethnicgroupenglandandwales/census2021> (accessed Sept 21, 2024).
- UK Department for Work and Pensions. Children in low income families: local area statistics. March 26, 2020. <https://www.gov.uk/government/collections/children-in-low-income-families-local-area-statistics> (accessed Jan 8, 2024).
- Slater A, Shann F, Pearson G, and the Paediatric Index of Mortality (PIM) Study Group. PIM2: a revised version of the Paediatric Index of Mortality. *Intensive Care Med* 2003; 29: 278–85.

- 23 Coughlan CH, Ruzangi J, Neale FK, et al. Social and ethnic group differences in healthcare use by children aged 0–14 years: a population-based cohort study in England from 2007 to 2017. *Arch Dis Child* 2022; **107**: 32–39.
- 24 Lo D, Lawson C, Gillies C, et al. Association between socioeconomic deprivation, ethnicity and health outcomes in preschool children with recurrent wheeze in England: a retrospective cohort study. *Thorax* 2024; **79**: 1050–59.
- 25 Lee AR, Kingdon CC, Davie M, Hawcutt D, Sinha IP. Child poverty and health inequalities in the UK: a guide for paediatricians. *Arch Dis Child* 2023; **108**: 94–101.
- 26 Marmot M, Allen J, Boyce T, Goldblatt P, Morrison J. Health equity in England: the Marmot review 10 years on. Institute of Health Equity. February, 2020. <https://www.instituteofhealthequity.org/the-marmot-review-10-years-on> (accessed June 12, 2025).
- 27 National Child Mortality Database. Child Mortality and Social Deprivation. National Child Mortality Database Programme Thematic Report. Data from April 2019 to March 2020. Published May 2021. [https://ncmd.info/wp-content/uploads/2021/05/NCMD-Child-Mortality-and-Social-Deprivation-report\\_20210513.pdf](https://ncmd.info/wp-content/uploads/2021/05/NCMD-Child-Mortality-and-Social-Deprivation-report_20210513.pdf) (accessed March 23, 2025).
- 28 Zhang CX, Quigley MA, Bankhead C, Bentley T, Otasowie C, Carson C. Ethnic differences and inequities in paediatric healthcare utilisation in the UK: a scoping review. *Arch Dis Child* 2023; **108**: 518–24.
- 29 Robertson R, Williams E, Buck D, Breckwoldt J. Ethnic health inequalities and the NHS driving progress in a changing system. June, 2021. <https://www.nhs.uk/wp-content/uploads/2023/05/Ethnic-Health-Inequalities-Kings-Fund-Report.pdf> (accessed June 12, 2025).
- 30 Fraser LK, Gibson-Smith D, Jarvis S, Norman P, Parslow RC. Estimating the current and future prevalence of life-limiting conditions in children in England. *Palliat Med* 2021; **35**: 1641–51.
- 31 Daham S, Larsson E, Eksborg S, Hamrin TH. Mortality following admission to the paediatric intensive care unit: a Swedish longitudinal cohort study. *Acta Paediatr* 2024; **113**: 2423–29.
- 32 O'Brien S, Nadel S, Almossawi O, Inwald DP. The impact of chronic health conditions on length of stay and mortality in a general PICU. *Pediatr Crit Care Med* 2017; **18**: 1–7.
- 33 Almossawi O, Friend A, Palla L, et al. Is there a sex difference in mortality rates in paediatric intensive care units? A systematic review. *Front Pediatr* 2023; **11**: 1225684.
- 34 Almossawi O, O'Brien S, Parslow R, Nadel S, Palla L. A study of sex difference in infant mortality in UK pediatric intensive care admissions over an 11-year period. *Sci Rep* 2021; **11**: 21838.
- 35 Aspinall PJ. Measuring the health patterns of the 'mixed/multiple' ethnic group in Britain: data quality problems, reporting issues, and implications for policy. *Int J Soc Res Methodol* 2018; **21**: 359–71.
- 36 Essink-Bot ML, Lamkaddem M, Jellema P, Nielsen SS, Stronks K. Interpreting ethnic inequalities in healthcare consumption: a conceptual framework for research. *Eur J Public Health* 2013; **23**: 922–26.