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Trends in inequalities in looked after children in England 2004-2019: a local area ecological analysis

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ABSTRACT

Objective: To assess trends in inequalities in children becoming looked after (CLA) in England between 2004 and 2019, after controlling for unemployment, a marker of the recession and risk factor for child maltreatment.

Design: longitudinal local area ecological analysis

Setting: 150 English upper-tier local authorities.

Participants: Children under the age of 18.

Primary outcome measure: The annual age-standardised rate of children becoming looked after (CLA rate) across English local authorities, grouped into quintiles based on their level of income deprivation. Slope indices of inequality (SII) were estimated using longitudinal segmented mixed effects models, controlling for unemployment.

Results: Since 2008, there has been a precipitous rise in CLA rates, and a marked widening of inequalities. Unemployment was associated with rising CLA rates: for each percentage point increase in the unemployment rate, an estimated additional 9 children per 100,000 (95% CI 6-11) per year became looked after the following year. However, inequalities increased independently of the effect of unemployment. Between 2007 and 2019, after controlling for unemployment, the gap between most and least deprived areas increased by 15 children per 100,000 per year (95% CI 4-26) relative to the 2004-2006 trend.

Conclusions: The dramatic increase in the number of CLA has been greater in poorer areas, and in areas more deeply affected by the recession. But trends in unemployment do not explain the decade-long rise in inequalities, suggesting that other socioeconomic factors, including rising child poverty and reduced spending on Children's Services, may be fuelling inequalities. Policies to safely reduce the rate of children becoming looked after should urgently address the social determinants of child health and wellbeing.

STRENGTHS AND LIMITATIONS OF THE STUDY

- This study is the first to quantify inequalities in child welfare outcomes in England longitudinally, using segmented mixed effects models to show that the gap in rates of children entering care between most and least deprived areas is on the rise after controlling for unemployment.
- The study uses routinely available data for the whole of England, and explores several child welfare outcomes in order to describe trends throughout the child welfare system.
- An important limitation is that, using an ecological area-level analysis, we cannot conclude that children entering care were directly affected by the exposures of interest.

INTRODUCTION

Improving the health outcomes and life chances of children looked after (CLA) is a matter of public health concern (1). In England, over the last decade, the prevalence of CLA increased dramatically, from 53 to 64 per 10,000 children, a rise of 20 percent. At last count, in March 2019, their number exceeded 78,000 (2). The health outcomes and life chances of these children, many of whom have experienced abuse, neglect and other forms of acute adversity, may differ markedly from those of their peers. On average, individuals who have been looked after face worse outcomes across a range of measures, throughout the life-course – physical and mental health, education, offending, employment, income – relative to those who have not come in contact with child welfare services. (3)

Reducing the economic burden associated with the consequences of CLA is of particular concern to policymakers: supporting CLA represents a major expenditure at local authority (LA) level. Across England, between 2011 and 2018, CLA spend increased by £1.9bn in real terms, to £4.6bn. Children's services have been described as approaching breaking point (4). Internationally, there have been increasing calls for a preventative approach to CLA that addresses upstream risk factors for child abuse and neglect (5).

A number of factors may have contributed to rising CLA rates in England over the last decade. High profile serious case reviews (6), shifting understanding of the impact of different forms of childhood adversity (7), and legal judgements clarifying LA statutory responsibilities (8), may all affect thresholds for child welfare intervention. Wider economic changes may also underlie trends in CLA rates. Growing up in adverse socioeconomic circumstances (SECs) is an important risk factor for child abuse and neglect and for children being taken into care (9), with poverty, unemployment and parental financial stress recognised as contributory causal factors (10,11). Several experimental and quasi-experimental studies from the US have shown that raising family income and reducing poverty leads to a reduction in rates of child abuse and neglect (10,12).

In 2008, the onset of the financial recession led to rising unemployment in England, and to fiscal policy with far-reaching social consequences. In 2010 the UK government began introducing a series of austerity measures with the stated intention of eliminating the budget deficit and reducing the national debt (13). The welfare system has been a principal focus of cuts and reforms (14). These have adversely affected, in particular, families with children and those at greatest risk of poverty, fuelling a rise in child poverty (15). At the same time,

regressive cuts to LA budgets have led to reduced spending on early childhood education and care, and other prevention services (16). Whilst increases in unemployment during the recession were dispersed across all parts of the country, changes in welfare provision and cuts to prevention have disproportionately affected deprived areas (17). If these changes are leading to increased incidence of child abuse and neglect, we would expect CLA rates to rise more rapidly in more deprived areas.

There are stark differences in rates of CLA across LAs in England (1). Less clear is how these are changing over time. Our aim in this study is to determine whether the rate of children becoming looked after increased more in deprived areas of the country, after controlling for unemployment – so parcelling out the effects of the recession itself from the effects of other possible drivers of changing inequalities. We further quantify trends in inequalities in children experiencing other forms of child welfare intervention, in order to assess whether findings for CLA are consistent across child welfare outcomes.

METHODS

Data sources and measures

We undertook a longitudinal, local area ecological analysis of CLA rates in England. We used routinely available data from 150 upper-tier LAs between 2004 and 2019, based on 2010 boundaries (see appendix 1). Two LAs, the City of London and the Isles of Scilly, were excluded due to their small population size.

Our primary outcome of interest was the annual age-standardised rate of children becoming looked after by LAs in England (hereafter referred to as 'CLA rate'). Panel data for the number of CLA, by age group, were drawn from the 'children looked after data return', submitted by LAs to the Department for Education on 31st March annually (2). We refer to the financial year by the latter year throughout. Direct age standardisation was performed using the national population distribution of children.

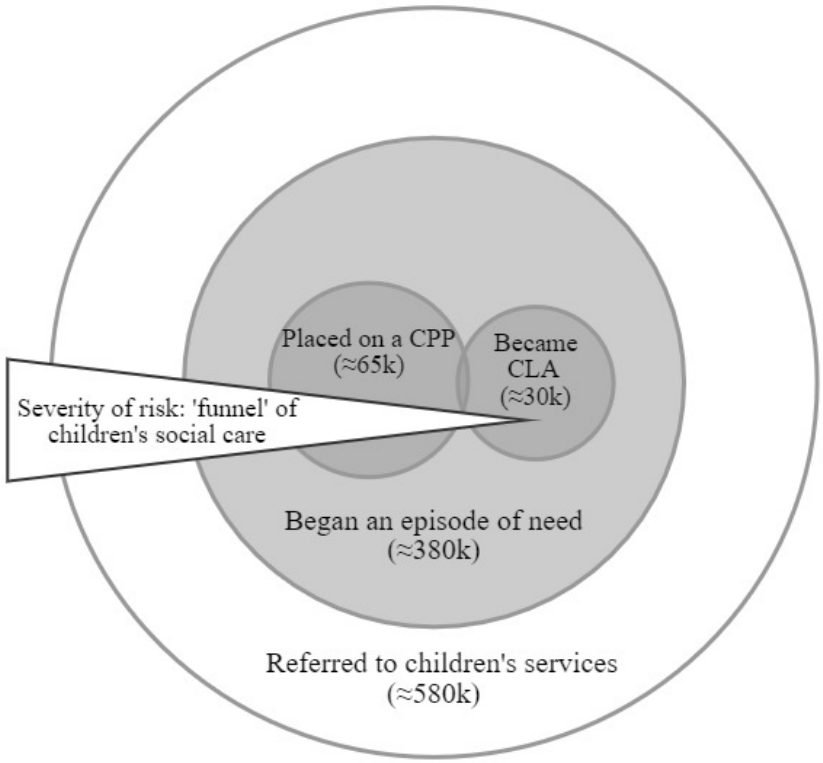
Secondary outcomes captured the wider population of children known to children's social care. Figure 1 outlines the different child welfare outcomes. The system has been likened to a 'funnel', with a progressively smaller number of children experiencing increasingly acute interventions. We used the annual age standardised rate of children becoming the subject of a Child Protection Plan ('CPP rate'), and children beginning an 'episode of need' ('CIN rate'). Data for these outcomes between 2010 and 2019 were sourced

Figure 1 - Description of the Children's Social Care System in England

The children's social care system has been described as series of 'filters and funnels'[∞]. Using this analogy, through the funnel, successive phases of risk assessment and service response determine a child's incident status:

1. **Referrals**. At the wide end of the funnel are all referrals.
2. **Children in Need**. A child is 'in need' (CIN), if deemed to require additional support in order to achieve a reasonable standard of health and development. An episode of need relates to an open case following a LA's acceptance of a referral to children's social care.
3. **Child Protection Plan**. A Child Protection Plan (CPP) may be drawn up where, following an investigation, concerns persist as to whether a child is suffering, or likely to suffer, significant harm.
4. **Children Looked After** (CLA) are at the narrow end of the funnel, enduring adversity sufficiently severe for the State to intervene in their upbringing[£].

This figure represents the 'funnel' of children's social care, and shows the overlap between incident child welfare status. Size and overlaps are not to scale. Child population estimates are taken from most recent data returns, for the period 2018-19. In rare cases, due to residual safeguarding concerns, a child in care may also be subject to a CPP.



∞ Gibbons J, Bell C, Conroy S. Operating the child protection system: a study of child protection practices in English local authorities. London: HMSO; 1995.
£ Emmott EH, Jay MA, Woodman J. Cohort profile: Children in Need Census (CIN) records of children referred for social care support in England. BMJ Open. 2019;9(2):e023771.

from the Children in Need (CIN) Census records of children referred for social care support in England (18). For children on a CPP, a breakdown of numbers by category of abuse were available. Disaggregation by age group was requested via a Freedom of Information request, and obtained for years 2012 to 2019.

As a measure of SEC, we used the income deprivation score of the 2010 Indices of Multiple Deprivation (19). This is a non-overlapping count of individuals who, as a result of low earnings, qualify for means-tested benefits, as a proportion of the total population (20). We used 2010 scores based on 2008 data, collected prior to the implementation of austerity policies, to avoid conflating the time-invariant measure of deprivation with unmeasured time-varying exposures that may be changing in response to austerity policies, and so contributing to changing inequalities. In descriptive analyses, we categorised the income deprivation score, assigning LAs to quintiles such that 20% of the 2008 child population was apportioned to each quintile. In regression models, we used a continuous measure of the income deprivation score, converted to a weighted rank by assigning a value from 0 to 1 based on the midpoint of the LA's range in the cumulative distribution. When using this value as a continuous exposure variable in the regression model, the estimated coefficient expresses the change in the Slope Index of Inequality (SII), a commonly used indicator of the association between health outcomes and socioeconomic deprivation (21). The same value can be used to derive the change in the Relative Index of Inequality (RII) when the outcome variable in the regression model is log-transformed and the estimated coefficient exponentiated. In our statistical analyses, the SII represents the absolute difference, and the RII the relative difference, in child welfare outcomes between the LA of lowest and highest level of income deprivation, taking into account the distribution of the child population across LAs (22).

Our analyses also included LA unemployment rates as a covariate in order to separate out the impact of the recession on child welfare outcomes, and so determine whether changes in inequalities were independent of the effects of unemployment. We used data on the number of people claiming Jobseeker's Allowance, plus those claiming Universal Credit who are out of work, as a proportion of residents aged 16-64, in the financial year(23). Although the measure does not capture all unemployment, it is precise and stable at local-area level, is highly correlated with survey-based measures of unemployment (24), and spans the time period of interest. Since the effects of unemployment on child welfare outcomes are unlikely to be immediate, we lagged the variable by one year.

Statistical analysis

First, we assessed descriptive trends for our outcome CLA rate, across LAs grouped into quintiles of income deprivation, between 2004 and 2019. Second, we estimated a segmented linear regression model, with: age-standardised CLA rate as the outcome; year, unemployment rate and income deprivation weighted rank as continuous independent variables; and random intercept and slope terms to account for the correlation between measurements within LAs. Based on our initial descriptive analysis, we included a linear spline for the effect of calendar year, with one knot indicating the timing of the change in trend. We used an iterative search procedure to confirm the knot position resulting in the model with the smallest Bayesian Information Criterion value (25,26). We included an interaction between the spline terms for the effect of year and deprivation to allow for potential differences in trend by SEC. Full details are provided in appendices 2-3.

We used this model to assess whether there was a significant change in the trend in CLA over this period, whether this differed by level of LA income deprivation, and the potential contribution of unemployment to trends in our outcome. We estimated all model parameters by maximum likelihood, using generalized likelihood ratio statistics to compare nested models, and Wald statistics to test hypotheses about model parameters. Similar models were fitted for each of our secondary outcomes, CPP and CIN rates, across years for which data were available, 2012-2019 – based on our descriptive analysis no linear splines were included in these models. Models were estimated using the lme4 package (27), in R version 3.5.1. We carried out supplementary analyses, assessing descriptive trends for all outcomes stratified by age, and, for CPP, by category of abuse (appendices 4-5), and making predictions based on the model (appendix 6). Finally, we fit a model with log-transformed values of the age standardised CLA rate as the outcome in order to derive the RII, and assess trends in relative, as well as absolute inequalities (appendix 7).

Patient and Public Involvement

The research question was informed by early conversations with policymakers and practitioners in the Merseyside area, and reflects the evidence needs identified by senior leaders within Children's Social Care in a priority-mapping exercise facilitated by the What Works Centre for Children's Social Care (28). Early plots were shared with local contacts, and the ensuing discussions informed our hypotheses about drivers of recent trends, in particular age-stratified trends. These hypotheses have informed our research agenda.

RESULTS

Trends in child welfare outcomes

Figure 2 shows CLA rate, by LA income deprivation quintile. Between 2004 and 2008, overall CLA rates dipped slightly: a small increase in the most affluent quintile was offset by decreases in more deprived areas. In 2008, the absolute difference in CLA rate between most and least deprived quintiles was 144 per 100,000 (95% CI 104-184). From around 2008, there was a change in trend and CLA rates rose. A social gradient in CLA is apparent throughout, with the absolute difference between most and least deprived quintiles rising to 174 per 100,000 (95% CI 127-221) in 2019, an increase of 21% from 2008.

Figure 2 - CLA rates by LA income deprivation quintile, 2004-2019, with 95% CIs

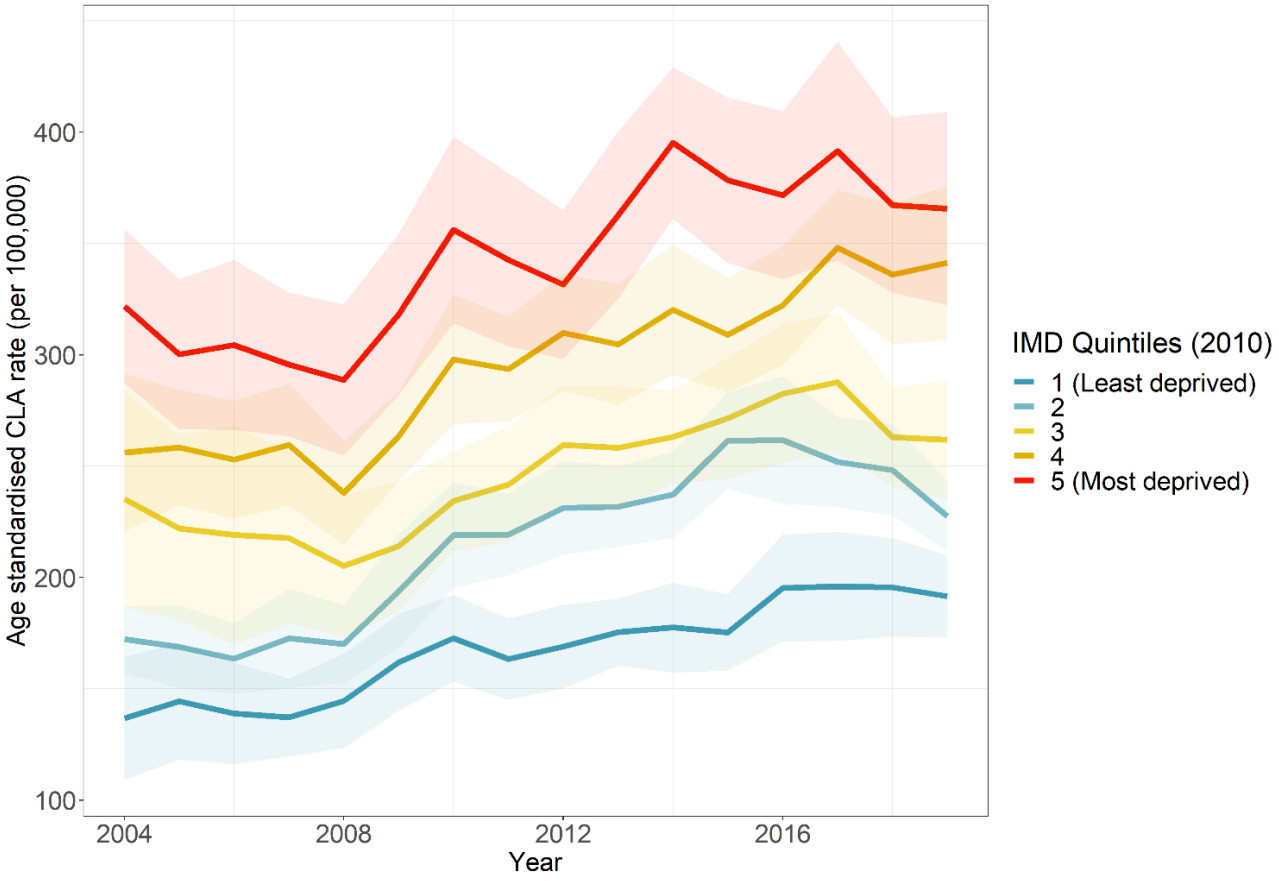
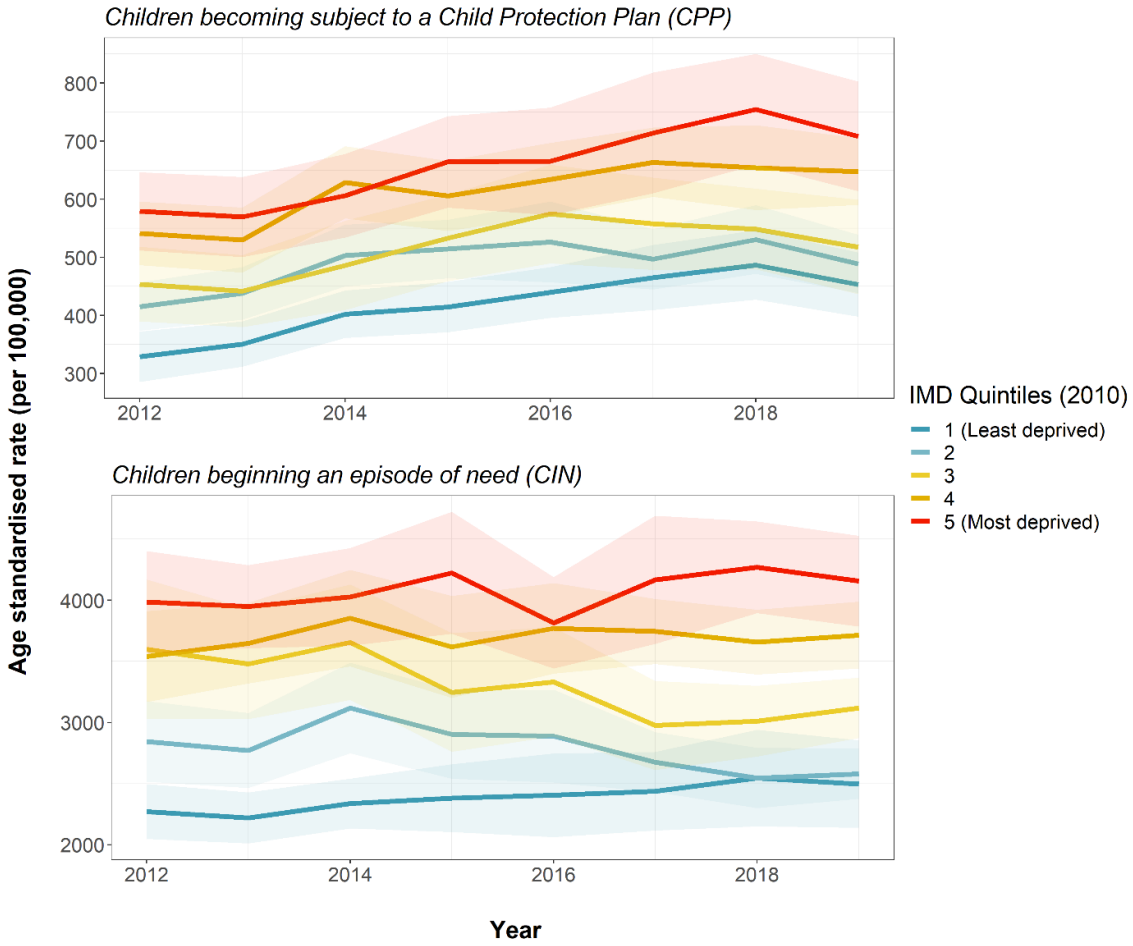


Figure 3 shows the CPP and CIN rates. As with CLA rates, CPP rates have risen since 2012, and show a clear social gradient. However, the increase occurred relatively evenly across all groups of LAs, in all age groups. CIN rates also exhibit a social gradient, but trends appear to be relatively stable over time.

Figure 3 - CPP and CIN rates by LA income deprivation quintile, 2012-19, with 95% CIs



Supplementary analyses (appendix 4, appendix figures 1-3) show that the gap in CLA rates between most and least deprived quintiles differed by age. The gap is wide, but relatively stable over time in the youngest age group, children under 1. The gap is widening in the oldest age group, those aged 16-17. Finally, stratifying CPP rates by category of abuse complicates the overall picture of an even rise in rates across all LA income quintiles: we uncovered a widening gap between most and least deprived areas in rates of children becoming subject to a CPP due to concerns about emotional abuse (appendix 5, appendix figure 4).

Segmented linear regression models

Tables 1-2 summarise the results of the segmented regression analyses. For full model output and residual diagnostics, see appendices 7-8 (appendix figures 5-16). For CLA, a knot in 2007, ahead of the 2008 change in trend identified in our descriptive analysis, resulted in the best model fit, indicating a change in trend at this point (appendix 3, appendix figure 17). In our model, rising unemployment in the wake of the financial recession was independently

associated with rising CLA rates: for each percentage point increase in the unemployment rate, an estimated additional 9 children per 100,000 (95% CI 6-11) per year entered care the following year. There were no associations between CPP and CIN rates and unemployment rates.

Table 1: Association between outcomes and unemployment rate

Outcome and time period	Annual change (in children per 100,000) for a 1% increase in the unemployment rate the previous year [95% CI]
CLA rate, 2004-19	9.0 [6.5, 11.4]
CPP rate, 2012-19	-10.4 [-22.2, 1.4]
CIN rate, 2012-19	68.5 [-3.1, 140.1]

But unemployment rates do not account for differences in trends between more and less deprived LAs. In 2004, after controlling for LA unemployment, the SII was 193. This captures the absolute inequalities gap across the distribution of LAs on the basis of area deprivation, indicating that there were 193 more CLA per 100,000 in the most deprived LA, compared to the least deprived (95% CI 140-246). Between 2004 and 2007, this gap declined by 11 children per 100,000 per year (95% CI 0-22) (table 2). From 2007 there was a significant change in the trend in inequalities: the gap increased by 15 children per 100,000 per year (95% CI 4-26) relative to the previous trend. Relative inequalities follow the same trend (appendix 7). Altogether, based on our model, we estimate that an additional 18,567 (95% CI 3,553 - 33,394) children were taken into care between 2007 and 2019, than would have been expected had the rise from 2007 occurred in more deprived LAs as it did in the median LA (appendix 6, appendix figure 18).

Table 2: Trends in the Slope Index of Inequality across child welfare outcomes

Outcome and time period	Annual change (in children per 100,000) in the Slope Index of Inequality [95% CI]
CLA	
2004-07	-11.4 [-22.3, -0.5]
2007-19, relative to previous trend	14.9 [3.6, 26.2]
CPP	
2012-19	4.4 [-11.2, 20.0]
CIN	
2012-19	47.1 [-62.7, 156.9]

DISCUSSION

Main findings

The dramatic rise in CLA in England since 2008 has been greater in poorer areas of the country, increasing inequalities. Overall an additional 18,567 (95% CI 3,553 - 33,394) children were taken into LA care between 2007 and 2019 than would be expected if the rise from 2007 had occurred more evenly across LAs. These findings cannot be explained by local economic trends, and are consistent with our hypothesis that austerity measures may have contributed to rising rates of child welfare outcomes. Our analysis also shows that the rise in CLA was associated with rising unemployment at LA level, a marker of the recession.

Trends in inequalities in CLA are not simply mirroring broader trends throughout the 'funnel' of children's social care. Whilst CPP rates are also rising, and show a clear social gradient, we did not find a greater increase in more deprived compared to less deprived areas for children becoming the subject of a CPP and beginning an episode of need.

Several studies have described trends in child welfare outcomes or child maltreatment in the UK. These support our finding of a change in trend and rising rates from around 2007-08 (29) and add context, demonstrating that the turn has followed a thirty-year decline in overall rates – though the rise in CPPs due to neglect and emotional abuse have been rising since the 1990s (30). However, to our knowledge no studies have yet documented trends in inequalities. Paul Bywaters and colleagues at the Child Welfare Inequalities Project began producing evidence of persistent and systematic inequalities in child welfare outcomes in the UK beginning in 2015 (3). This longitudinal analysis of inequalities is indebted to their work.

Strengths and limitations

This study is the first to quantify inequalities in child welfare outcomes longitudinally. A strength is that it uses routinely available data for the whole of England, and explores several child welfare outcomes in order to describe trends throughout the child welfare system.

There are several important study limitations. Due to the lack of individual level data, we used an ecological area-level analysis, and cannot identify whether children entering care were directly affected by income deprivation and unemployment. Conceptually, our portrayal of children's social care as a funnel reflects a theoretical model of how a well-functioning system might operate (figure 1), and may not reflect the trajectory of many individual

children and families experiencing child welfare intervention. The association between income deprivation and unemployment rates and child welfare outcomes in our analysis may be due to trends in unobserved time-varying confounding factors that varied between LAs.

Trends in the data reflect the interaction between underlying need and children's services response and we interpret our findings in this light, with caution. Previous analyses by Bywater and colleagues demonstrated the existence of an "inverse intervention law" in child welfare outcomes: a greater risk of intervention in affluent compared to deprived LAs for the same level of neighbourhood deprivation (31), despite lower overall intervention rates. Our models at the level of LAs do not account for the inverse intervention law or rising thresholds reported in more deprived areas. However, this must add weight to our findings: insofar as they reflect changing underlying need, our estimates of the SII are likely to be highly conservative.

Potential explanations of our findings

Changing thresholds

Several changes during this time period may have influenced thresholds for intervention. Firstly, the death by violence of baby Peter Connelly occurred in 2007, when we see a change in the trend of CLA in our data (32). Media and political narratives that emerged in the aftermath of his death centred on the failure of children's services to intervene (33), and ensuing reports by The Children and Family Court Advisory and Support Service note a 'Baby P effect', a marked, short-term rise in applications for care orders in a risk-averse environment (6). This likely accounts for some of the change in trend and initial rise in CLA rates from 2007. Others have argued that a greater policy focus on early intervention and adoption in order to improve outcomes for children experiencing adversity has led to a more interventionist, less family-oriented approach (34). Secondly, in 2009 the Southwark Judgement clarified and reinforced LAs' statutory duties in relation to 16-17 year olds presenting to the LA as homeless (8). This, together with a general shift in practice towards regarding adolescents as vulnerable children rather than nascent adults (35), and greater awareness of extra-familial forms of abuse and principles of contextual safeguarding (36), may be contributing to the rising rates of 16-17 year olds across all outcomes. However, these events are unlikely to fully explain the long-term rise in CLA rates disproportionately affecting more deprived areas.

Economic trends

We found evidence of a positive association between unemployment and CLA rates. Though evidence from the UK is scarce, this aligns with Gillham et al.'s finding of a correlation between male unemployment and child physical abuse in Scotland in the early 1990s (37) and more recent and extensive evidence from the US demonstrating an association between the recession and increased risk of abuse (38–40). The family stress model posits that heightened stress due to adverse SECs may erode mental health and strain domestic relationships, leading to negative parenting behaviours and increased risk of child abuse and neglect. Barr et al.'s study of the mental health impact of the recession lends credence to this theorised mechanism, demonstrating an association between unemployment and mental health problems in the UK over the same period(17). Yet unemployment did not fully explain changes in CLA rates in our analysis, and unemployment rates have fallen rapidly since 2012: unemployment cannot explain the continued increase in CLA after 2012, nor does it explain rising inequalities. Austerity policies subsequent to the initial recession "shock" may have compounded poor outcomes, affecting inequalities in CLA in several ways.

Changes to welfare provision and prevention

Regressive cuts to English LA budgets, with deeper cuts in more deprived areas, have precipitated a shift in expenditure away from prevention towards acute services(16). Between 2011 and 2018, spending on CLA increased by 68% in real terms, whereas spending on early years preventative services (including Sure Start) and non-statutory young people's services fell about 21%. Reports of rising thresholds for early help in more resource constrained settings, have raised concerns that we are 'storing up trouble' for the future(41). A surge in children entering care who might have benefited from early support could explain the greater rise in more deprived LAs. Adolescents may be particularly susceptible to the consequences of austerity, exposed as they are on multiple fronts, not just in the household and schools, but increasingly in the wider community. Combined cuts to welfare benefits, youth services(42), children's mental health services (43), and community policing(44), might disproportionately affect adolescents in more deprived areas, contributing to widening inequalities in this age group.

Changes to welfare benefits have led to rising child poverty, a contributory causal factor in child abuse and neglect (10,15). Averages losses in earning were particularly high in the more deprived West Midlands and the North West (15). The most vulnerable children on the edge of care, living in families already struggling to cope, may be particularly sensitive to

changes in welfare benefit provision. In particular, the phased introduction of Universal Credit from 2013, with its monthly payments in arrears, enhanced conditionality and punitive sanctions, may have compounded financial stress (15) and parental mental health (45). This would increasingly lead to more children entering care in deprived areas, contributing to trends in inequalities uncovered in our study. Further research is needed to investigate the impact of changing LA prevention spend and child poverty on child welfare outcomes.

Policy and practice implications

We demonstrate that the increase in CLA rates from 2007 has been greater in more deprived LAs. Although it is not possible to say what constitutes an appropriate CLA rate (46), a differential rise by LA deprivation that cannot be explained by the recession is consistent with an increase in underlying need fuelled by welfare changes and cuts to prevention services. While anti-poverty social work practice has a crucial role to play in safely reducing CLA rates and inequalities (47), this must be supported by wider policies to address the social conditions of children's lives. At the national level, this must begin with a renewed commitment to ending child poverty. Tightened social security for families with children, and increased funding for LA Children's Services, are safeguarding priorities. At the local level, holding the line on prevention services, amidst statutory pressures, may yield long-term social and economic benefits. Investment in children is key.

SUPPLEMENTARY MATERIALS

Appendix 1: Harmonising data

Where changes to LA boundaries in 2009 led to the formation of two upper tier unitary authorities from a single county, CLA numbers for preceding years were split between these LAs based on their 2009 child population ratio. In the publicly available data, for reasons of confidentiality, numbers from one to five inclusive were supressed. For each missing value we therefore imputed a random integer in this range. There were only three cases of missing data, across two years, early in the implementation of the CIN census: age stratified data were not available for Havering and Newham in 2012, or Norfolk in 2013. Given the low degree of missingness, we performed complete case analyses.

Appendix 2: Model formulae

Segmented linear regression model for age standardised CLA rate, including linear spline:

$$y_{ij} = \beta_0 + \beta_1 x_{1ij} + \beta_2 x_{2i} + \beta_3 x_{3j} + \beta_4 x_{4j} + \beta_5 x_{3j} x_{2i} + \beta_5 x_{4j} x_{2i} + U_i + V_i x_{3j} + \varepsilon_{ij}$$

Let:

- y_{ij} denote the rate of children taken into care in LA i in year j
- x_{1ij} denote covariate lagged unemployment rate, coded as a continuous variable and dependent on LA i and on year j
- x_{2i} denote the weighted rank of deprivation dependent on LA i, a continuous variable ranging from 0 to 1
- x_{3j} denote the first spline term, which is year j coded as continuous variable and centered at 2004
- x_{4j} denote the second spline term, a continuous variable that takes the value of 0 for year j≤2007, and j−2007 for year j>2007. This defines a segmented regression with knot in 2007.
- $(U_i, V_i) \sim BVN(0, S_0)$ denote random intercept and slope for LA i
- $\varepsilon_{ij} \sim N(0, S_1)$ denote the random error for LA i in year j

Linear regression model for age standardised CPP and CIN rates:

$$y_{ij} = \beta_0 + \beta_1 x_{1ij} + \beta_2 x_{2i} + \beta_3 x_{3j} + \beta_4 x_{3j} x_{2i} + U_i + V_i x_{3j} + \varepsilon_{ij}$$

Let:

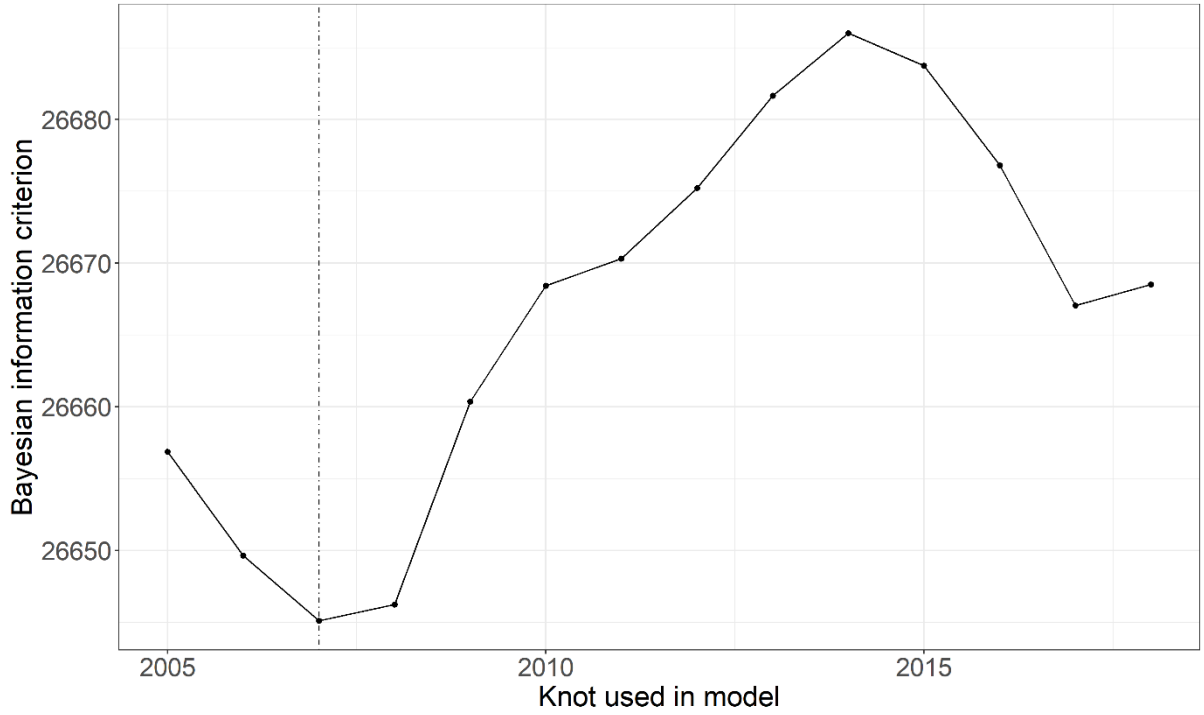
- y_{ij} denote the rate of children taken into care in LA i in year j
- x_{1ij} denote covariate lagged unemployment rate, coded as a continuous variable and dependent on LA i and on year j

- x_{2i} denote the weighted rank of deprivation dependent on LA i, a continuous variable ranging from 0 to 1
- x_{3j} denote year j, coded as continuous variable and centered at 2004
- $(U_{i,}\ V_i) \sim BVN(0, S_0)$ denote random intercept and slope for LA i
- $\varepsilon_{ij} \sim N\ (0, S_1)$ denote the random error for LA i in year j

Appendix 3: Breakpoint analysis

In our model for age standardised CLA rates, we used an iterative search procedure in order to identify which breakpoint offered the best fit. Appendix figure 17 shows the BIC value for each successive breakpoint used in the model. This led us to fit a knot in 2007.

Appendix figure 17 - CLA model - breakpoint analysis



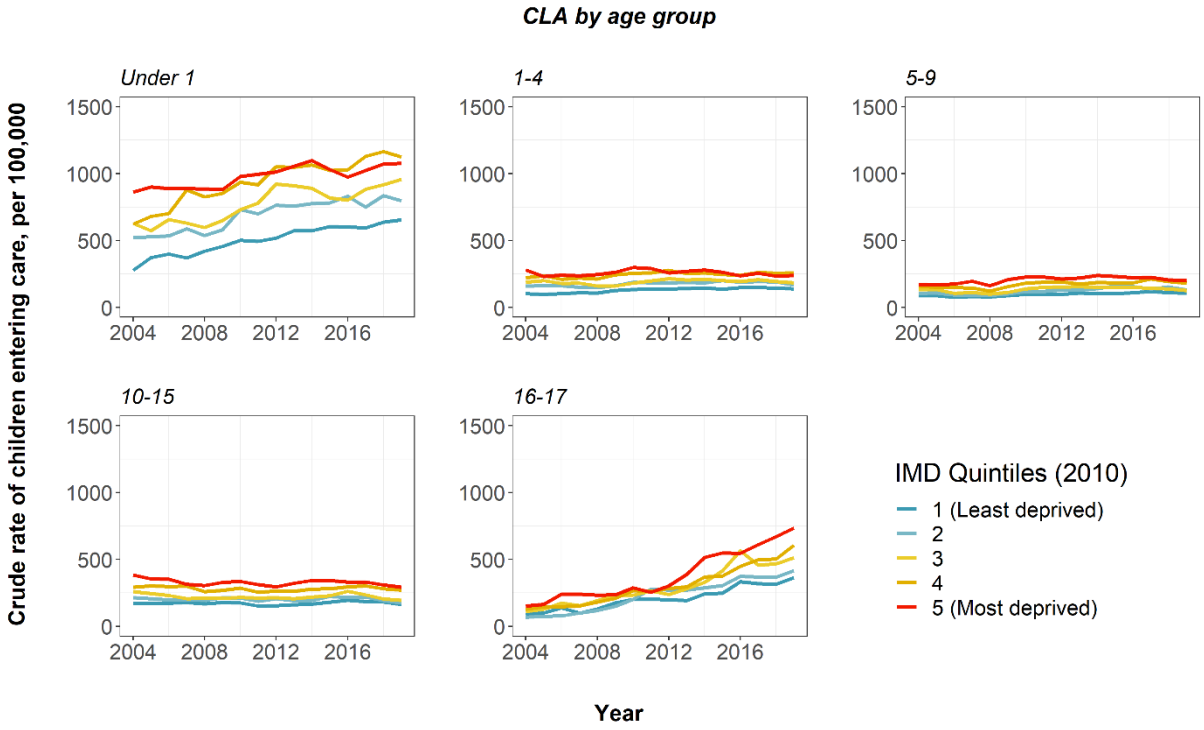
Appendix 4: Age stratified analyses of crude CLA, CPP and CIN rates by LA deprivation quintile

For the age stratified analyses, we calculated rates for each of our outcomes using child population data, broken down by the same age bands available in the routine and FoI data, sourced from the Office for National Statistics (ONS) mid-year population estimates, accessed via Stat-Xplore[1]. These formed our denominator. We plotted rates for all age-stratified outcomes, across years for which data were available, enabling a comparison, by

[1] Office for National Statistics. Population Estimates for UK, England and Wales, Scotland and Northern Ireland: Stat-Xplore; 2019 [Available from: https://stat-xplore.dwp.gov.uk].

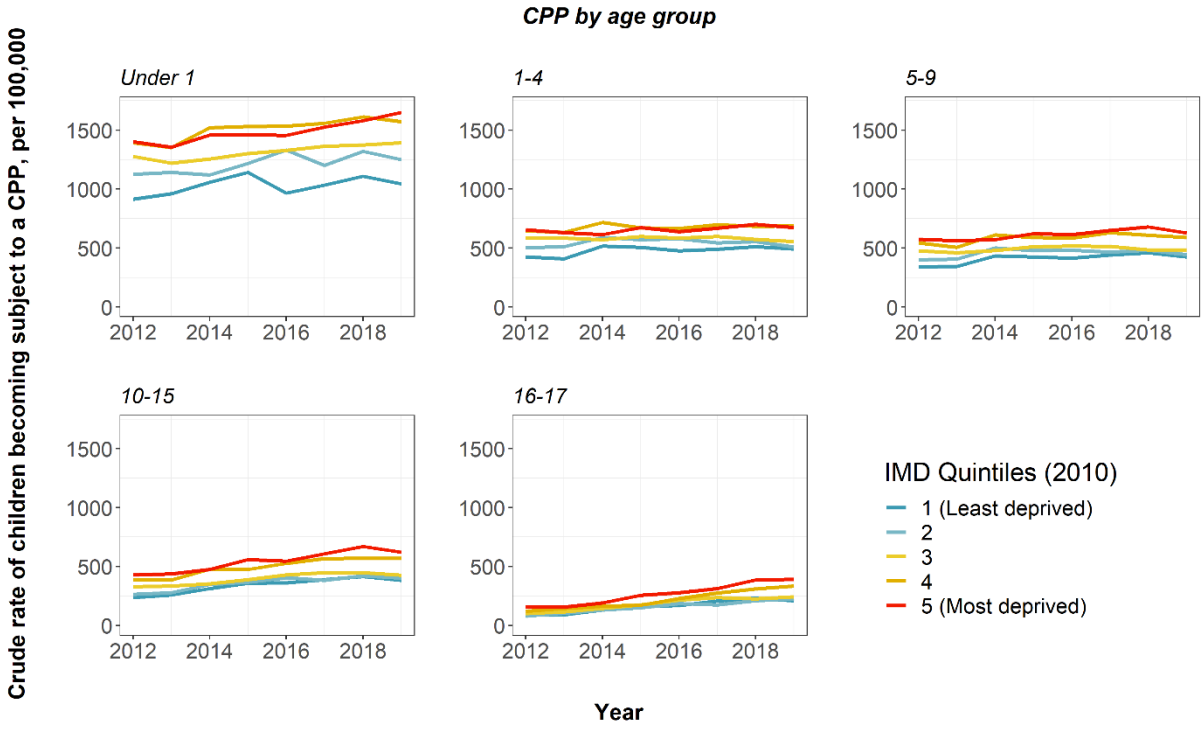
age group, across outcomes. Appendix figure 1 shows that the rise in CLA rates was mainly due to children under the age of 1 and children aged 16-17 entering care. Though wide, the gap in rates between most and least deprived LAs for the youngest age group does not appear to be widening. In the oldest age group however, there is a pronounced increase in the gap from 2010.

Appendix figure 1 - CLA rates by LA income deprivation quintile, stratified by age

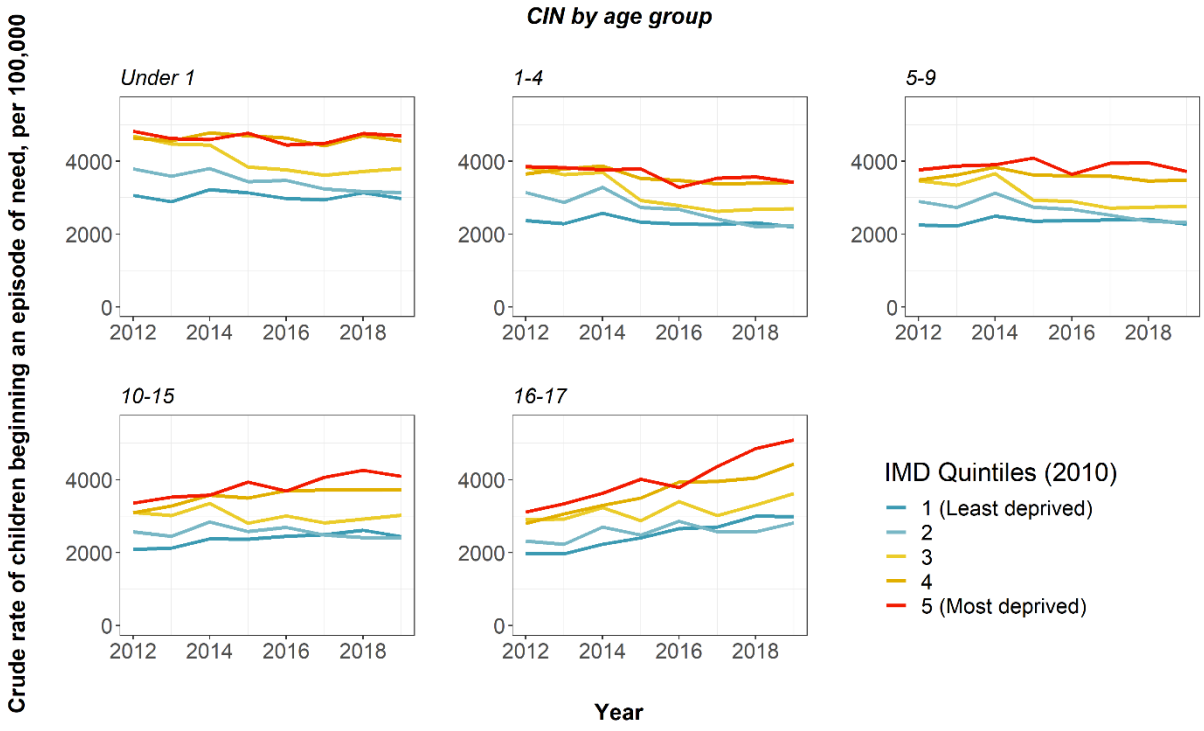


We sought to determine whether trends in CLA were reflected through the funnel of children's social care (appendix figures 2-3). The funnel remains widest in children under the age of 1. However, the gap between most and least deprived areas is relatively stable over time regardless of the stage. In children aged 16-17, the funnel narrows considerably from CIN to CPP, then widens once more at the level of CLA. The discontinuity is unique to this age group and may relate to the CPP's focus on risks within the family home. Acute risks to older children are often in the community, from peer groups and criminal networks. This may lead children to be placed directly on a CLA when need becomes acute. The gap in rates between most and least deprived areas appears to be widening in both CIN and CLA for this older age group: trends in CLA may well be reflecting, and concentrating, trends in CIN.

Appendix figure 2 - CPP rates by LA income deprivation quintile, stratified by age



Appendix figure 3 - CIN rates by LA income deprivation quintile, stratified by age

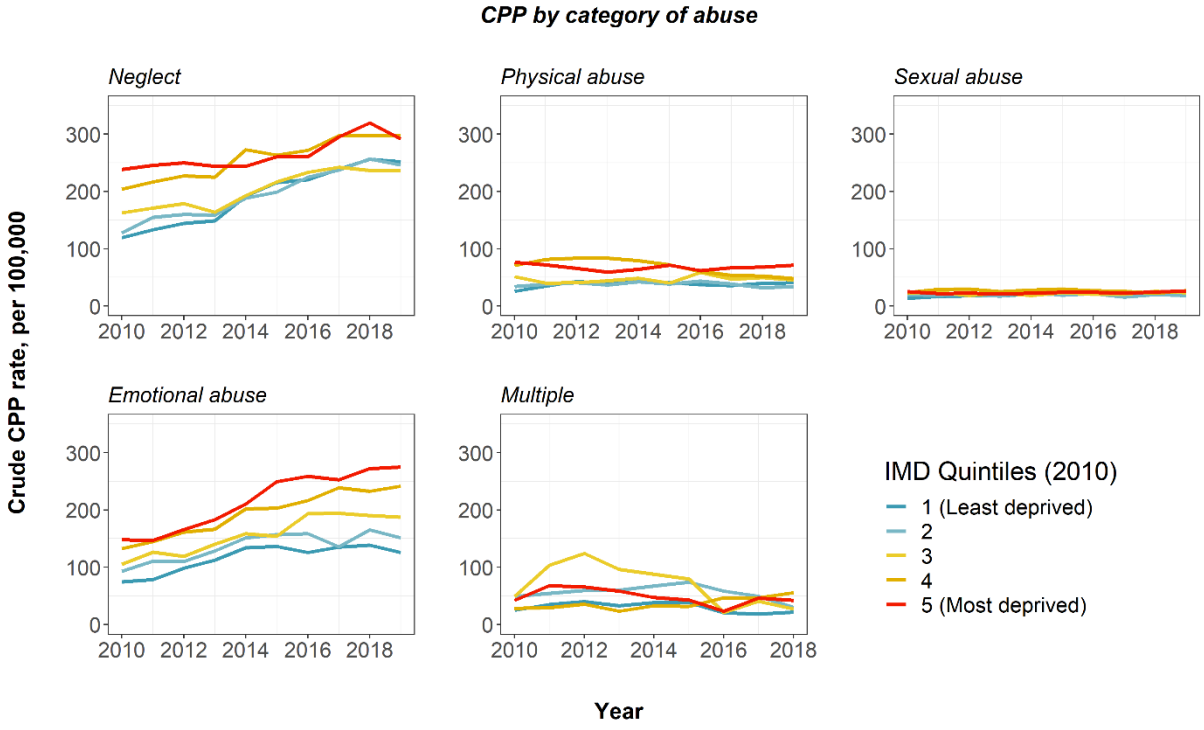


Appendix 5: Crude CPP rates by deprivation quintile, stratified by category of abuse

We plotted CPP rates for all categories of abuse, enabling a comparison across categories (appendix figure 4). Neglect, then emotional abuse, are the most commonly recorded primary categories of abuse. Rates for these categories are rising. Where neglect is recorded, the gap

in rates between most and least deprived areas appears to have declined slightly from 2014. In contrast, where emotional abuse is recorded, the gap increased dramatically from 2014. Further research is needed to understand how recording practices, child welfare systems, social care practices, and underlying need, may differ by area level income deprivation.

Appendix figure 4 - CPP rates by LA income deprivation quintile, stratified by category of abuse



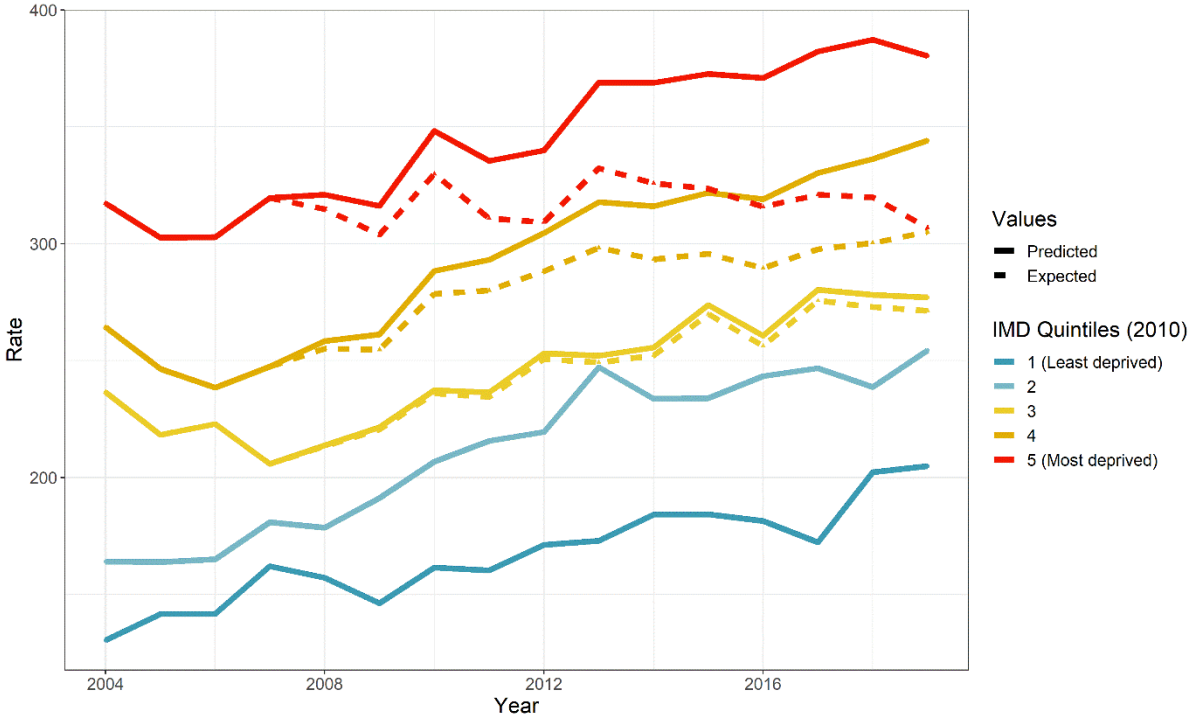
Appendix 6: predictions based on the model

We predict expected CLA rates if the rise in rates from 2007 had occurred in more deprived LAs as it did in the median LA (such that 50% of the 2008 child population live in more deprived areas):

$$y_{ij} = \beta_0 + \beta_1 x_{1ij} + \beta_2 x_{2i} + \beta_3 x_{3j} + \beta_4 x_{4j} + \beta_5 x_{3j} x_{2i} + \beta_5 x_{4j} \boldsymbol{x_5} + U_i + V_i x_{3j} + \varepsilon_{ij}$$

Where $\boldsymbol{x_5}$ denotes the weighted rank of deprivation in the median LA in the cumulative distribution. This scenario preserves the change in trend from 2007 and unemployment rates, but posits that, after controlling for unemployment rates, the change in trend should not disproportionately affect areas based on their levels of income deprivation. Appendix figure 18, showing LAs grouped by quintiles, illustrates predicted rates according to this scenario.

Appendix figure 18 - CLA model - predictions based on the model



Appendix 7: Full model output[2]

The following tables summarise the full output for each of the models in turn:

- Age standardised CLA rates
- Age standardised CLA rates, log-transformed (results exponentiated)
- Age standardised CPP rates
- Age standardised CIN rates

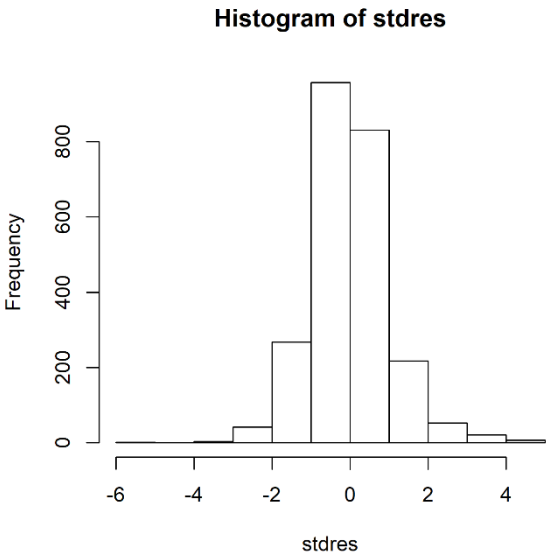
[2] Hlavac M. stargazer: Well-Formatted Regression and Summary Statistics Tables. R package version 5.2.2.; 2018.

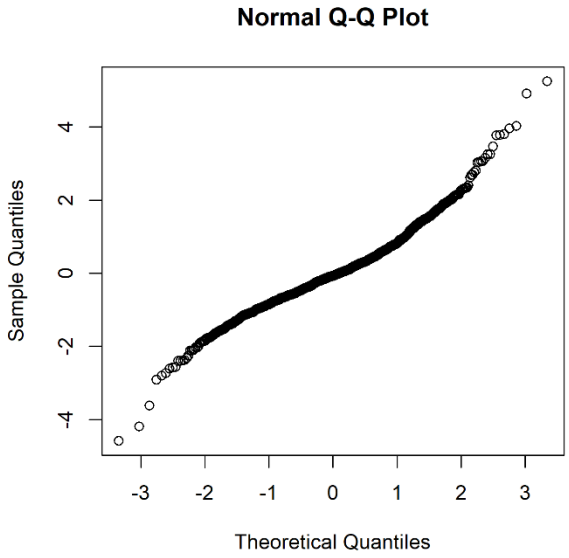
Model	**CLA, 2004-2019**	**CLA, 2004-2019**	**CPP, 2012-2019**	**CIN, 2012-2019**
Dependent variable	CLA rate (per 100,000)	Log-transformed CLA rate (per 100,000)	CPP rate (per 100,000)	CIN rate (per 100,000)
Intercept	104.31** (71.56, 137.05)	114.41 ** (101.41, 129.07)	365.74** (306.30, 425.19)	2,190.79** (1,798.70, 2,582.88)
Unemployment rate (lagged)	8.95** (6.48, 11.43)	1.04** (1.03, 1.05)	-10.41 (-22.17, 1.36)	68.52 (-3.06, 140.10)
Spline 1	3.43 (-3.41, 10.27)	1.03** (1.01, 1.06)	12.69** (3.09, 22.29)	-6.76 (-74.71, 61.19)
Deprivation	192.93** (140.01, 245.86)	2.51** (2.07, 3.05)	304.12** (198.42, 409.81)	1,637.02** (949.98, 2,324.07)
Spline 2	1.89 (-5.21, 8.99)	1.00 (0.98, 1.03)	4.38 (-11.20, 19.95)	47.08 (-62.71, 156.88)
Spline 1: deprivation	-11.38* (-22.27, -0.49)	-0.94** (-0.90, -0.98)	-	-
Spline 2: deprivation	14.86* (3.55, 26.16)	1.06** (1.01, 1.10)	-	-
Observations	2,400	2,400	1,197	1,195
Log Likelihood	-13,279.74	211.43	-7,599.82	-9,727.10
Akaike Inf. Crit.	26,581.49	-400.87	15,217.63	19,472.20
Bayesian Inf. Crit.	26,645.10	-337.25	15,263.42	19,517.98
Note:	* p < 0.05, ** p < 0.01	* p < 0.05, ** p < 0.01	* p < 0.05, ** p < 0.01	* p < 0.05, ** p < 0.01
		All coefficients are exponentiated		

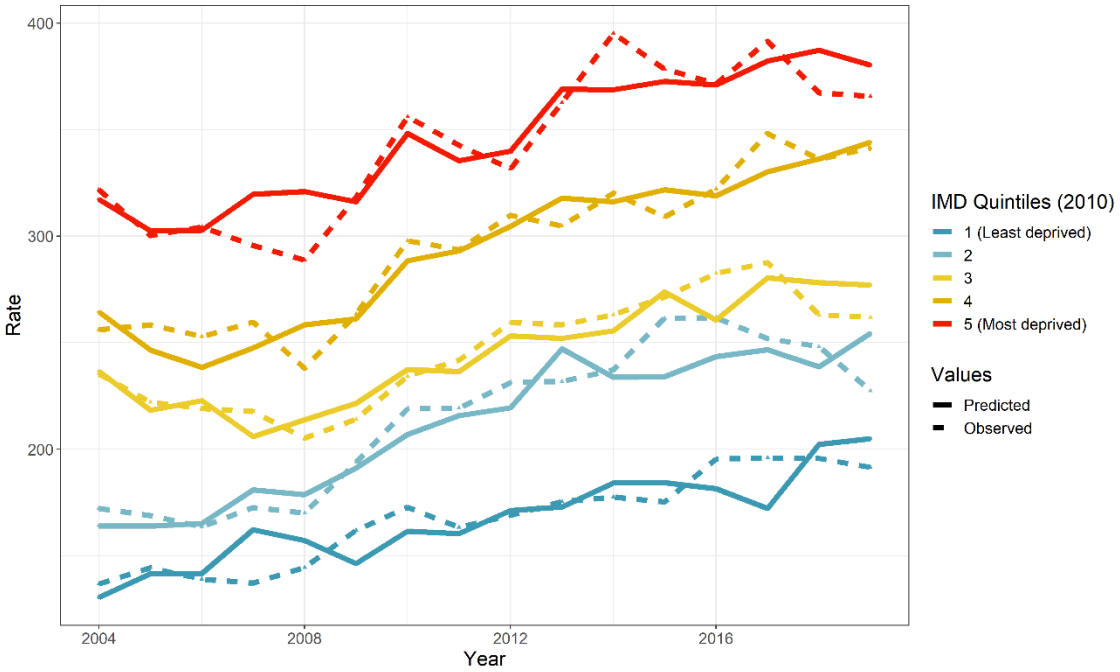
Appendix 8: residual diagnostics

The residuals from our model are normally distributed. Plotting standard normal quantiles against the data results in a relatively linear pattern. When grouped by quintile, predicted and observed values of CLA rates appear relatively consistent:

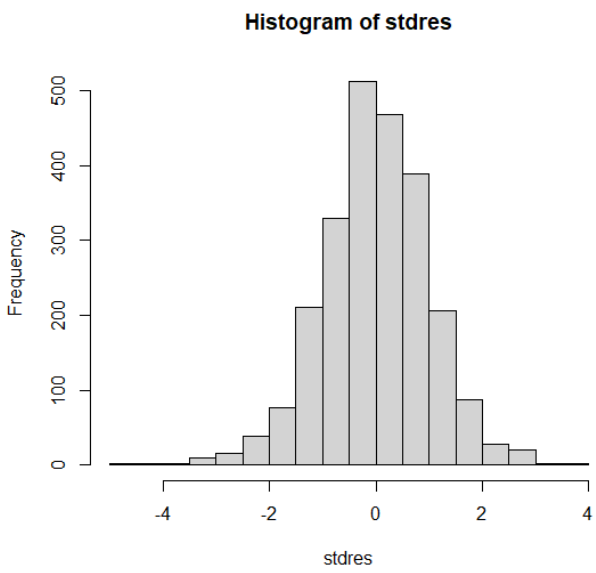
a. CLA model (absolute inequalities): see appendix figures 5-7

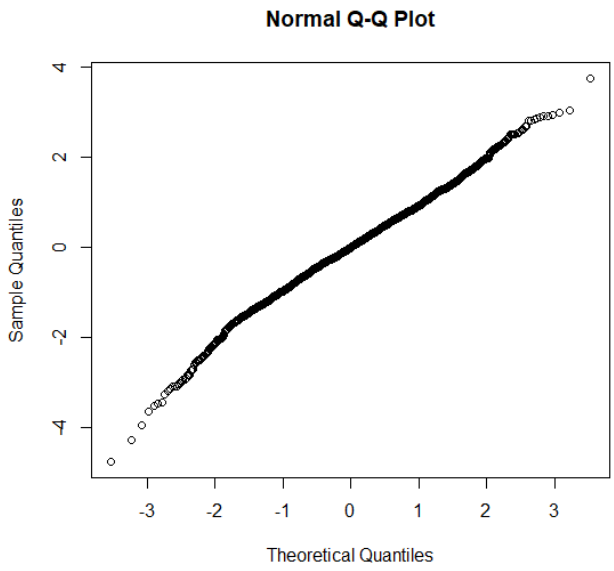


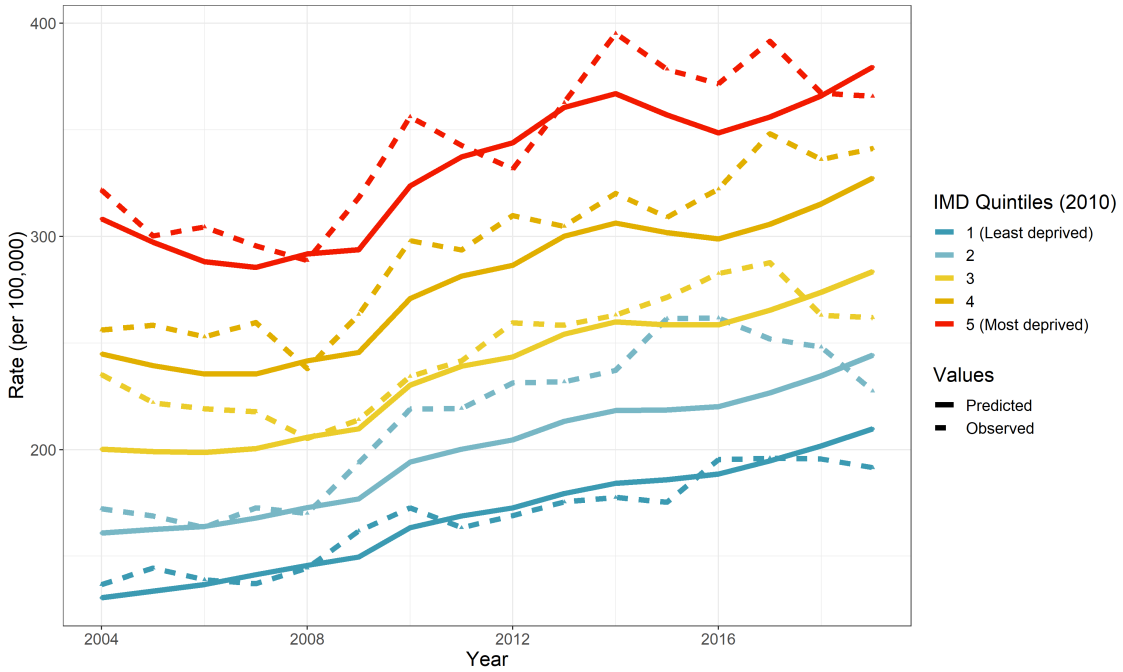




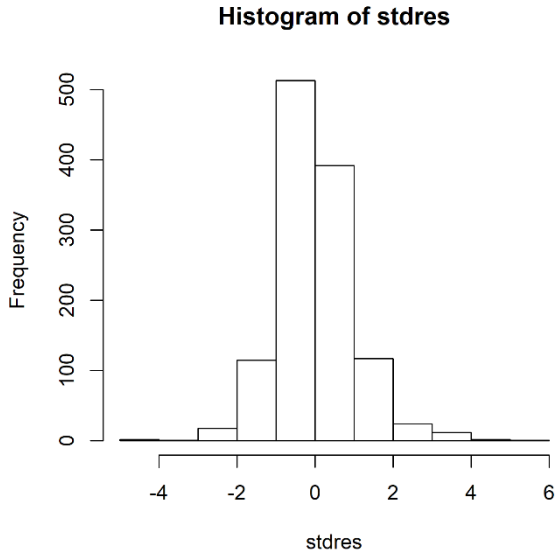
b. CLA model (relative inequalities): see appendix figures 8-10

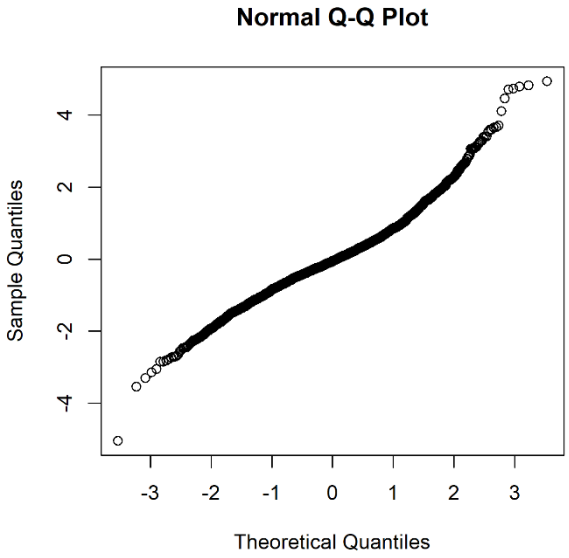


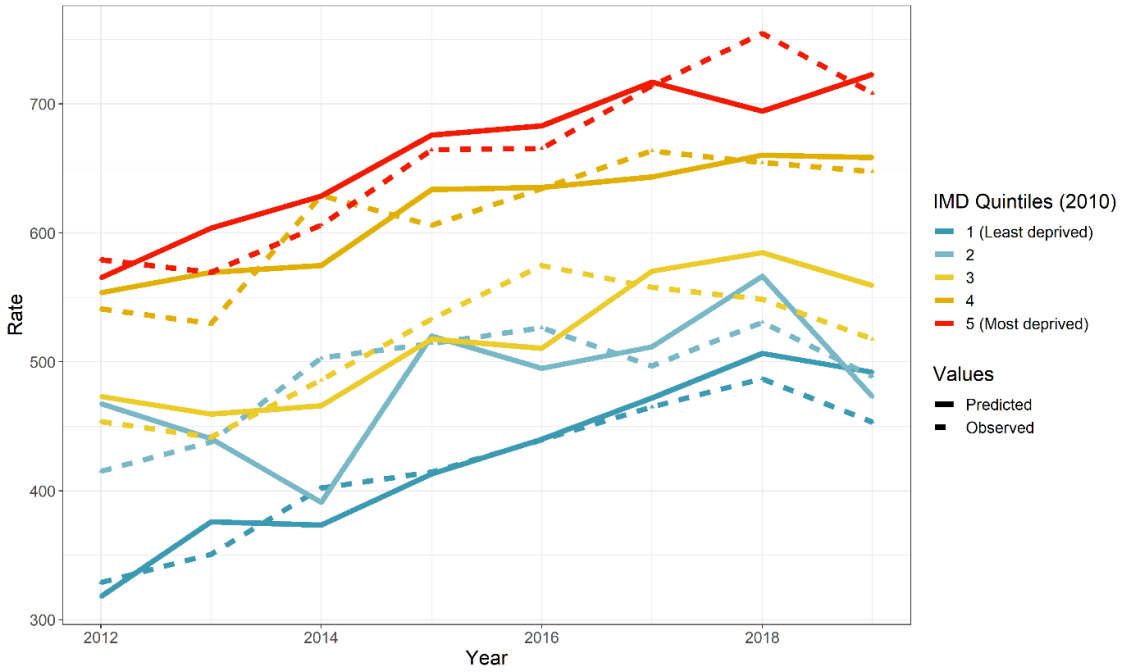




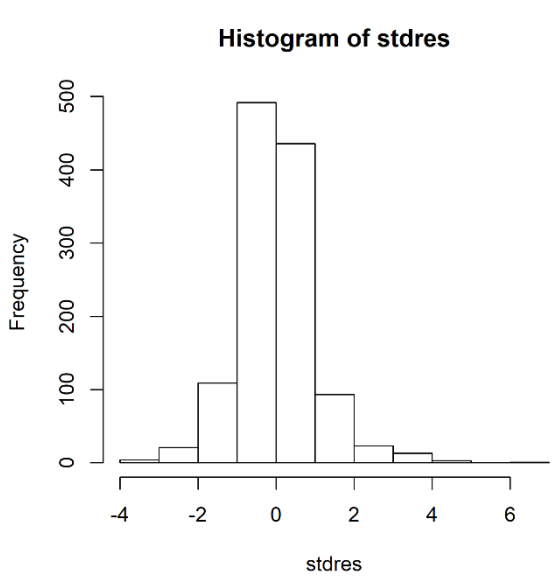
c. CPP model: see appendix figures 11-13

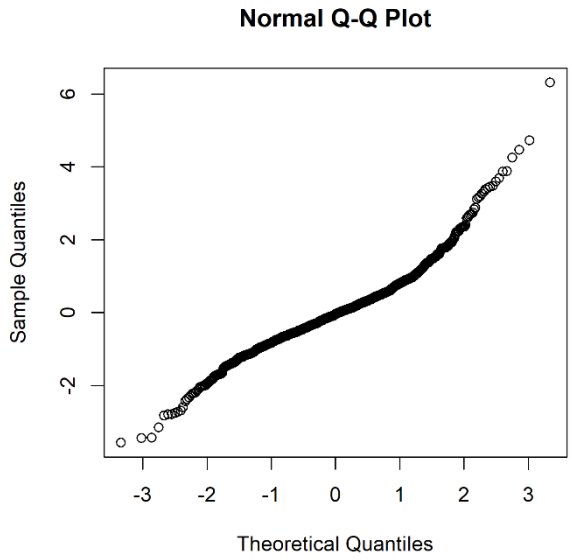






d. CIN model: see appendix figures 14-16





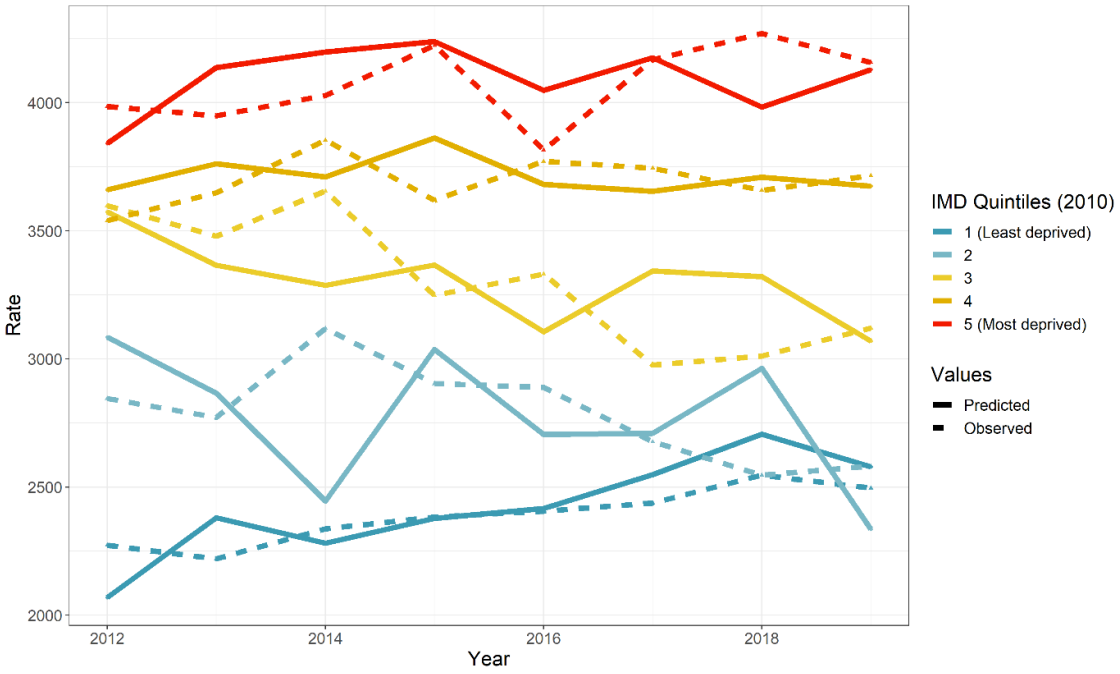


Figure legends

Manuscript figures

Figure 1: Description of the Children's Social Care System in England

Figure 2: CLA rates by LA income deprivation quintile, 2004-2019, with 95% CIs

Figure 3: CPP and CIN rates by LA income deprivation quintile, 2012-19, with 95% CIs

Appendix figures

Appendix figure 1: CLA rates by LA income deprivation quintile, stratified by age

Appendix figure 2: CPP rates by LA income deprivation quintile, stratified by age

Appendix figure 3: CIN rates by LA income deprivation quintile, stratified by age

Appendix figure 4: CPP rates by LA income deprivation quintile, stratified by category of abuse

Appendix figure 5: CLA model - absolute inequalities - histogram of standardised residuals

Appendix figure 6: CLA model - absolute inequalities - quantile quantile plot

Appendix figure 7: CLA model - absolute inequalities - comparing observed and predicted rates

Appendix figure 8: CLA model - relative inequalities - histogram of standardised residuals

Appendix figure 9: CLA model - relative inequalities - quantile quantile plot

Appendix figure 10: CLA model - relative inequalities - comparing observed and predicted rates

Appendix figure 11: CPP model - histogram of standardised residuals

Appendix figure 12: CPP model - quantile quantile plot

Appendix figure 13: CPP model - comparing observed and predicted rates

Appendix figure 14: CIN model - histogram of standardised residuals

Appendix figure 15: CIN model - quantile quantile plot

Appendix figure 16: CIN model - comparing observed and predicted rates

Appendix figure 17: CLA model - breakpoint analysis

Appendix figure 18: CLA model - predictions based on the model

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Data sharing and ethics

The publicly available, aggregate data can be accessed from the Place-based Longitudinal Data Resource (PLDR) (48), and the code is available upon reasonable request. Research Ethics committee approval was not required for secondary data analysis.

Contributorship statement

DB is lead author and guarantor. DT-R and BB are joint senior author. DB and DT-R planned the study. DB, BB and DT-R analysed the data, supported by KM, DS, SW, ET and AA. DB, DT-R and BB led the drafting and revision of the manuscript. All authors contributed to the interpretation of the data and revision of the manuscript; all authors approved the submitted version of the manuscript. We confirm that authors have no conflicts of interest to disclose.

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