



The Influence of Rising Infant Mortality on falling/stalling Life Expectancy (brief report)

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Abstract

In the post-2010 period in England, largely attributable to austerity measures, two unexpected demographic trends emerged. Infant mortality rates rose and life expectancy at best stalled, and at worse fell. Various analyses of life expectancy trends have unpicked the age-specific mortality rates but without a focus on deaths to infants aged less than one year of age. Since this age-group is the first age in life expectancy calculations, it is possible that changes in infant mortality rates form part of changes in life expectancies. This brief report investigates time trends in infant mortality and life expectancy (LE) at birth between the years 2000 and 2019 by Index of Multiple Deprivation 2015 (income) quintile. Using 2014 as the ‘jump off’ year as this was when infant mortality began to rise, alternative scenarios for the first year of life in LE calculations are used to reveal whether any differences in LE at birth occur, including if the downward trends in infant mortality observed prior to 2014 had continued to 2019. Even though the trend-based model estimates an excess of nearly 1,400 infant deaths occurred, the results show no significant impact on the life expectancy at birth calculations between the observed and scenario-based infant mortalities. This is important for researchers to know since anyone seeking to understand pre-pandemic falling / stalling life expectancies can concentrate on other aspects to determine key reasons. Further work on infant mortality is required since, post-pandemic, rates have risen again.

Keywords Infant mortality · Life expectancy at birth · Inequalities · Time trends · Null findings

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Introduction

Infant mortality rates and life expectancy at birth are both commonly used indicators of population health (Preston et al., 2001; Holdsworth et al., 2013). Infant mortality rates are calculated as deaths to infants aged less than one year per 1,000 live births. ‘Life expectancy at birth’ calculations incorporate age-specific mortality rates across all age-groups in a population in a ‘life table’ and is interpreted as the average number of years a newborn would be expected to live given the death rates in the particular period. Within the UK, infant mortality rates steadily improved during the 20th Century largely due to better living conditions, diet and sanitation, birth control, advances in medical science and the availability of healthcare (Norman et al., 2008). Concurrently, life expectancy was also improving (Aburto et al., 2021).

In the post-2010 period in England, two unexpected demographic trends were identified. Infant mortality rates (IMR) in England rose and life expectancy (LE) at best stalled, and at worse fell. For infant mortality, although rates overall were falling in the 1980s and 1990s, absolute inequalities in IMR increased between the most deprived local authorities and the rest of England. During the period of the English health inequalities initiative, 1999–2010, absolute inequalities in IMR decreased before increasing again during 2011–2017 (Robinson et al., 2019). Of concern is that infant mortality rose in England between 2014 and 2017 particularly in the most deprived areas (Taylor-Robinson et al., 2019a, b).

Although many countries have seen increases in life expectancy since 2010 (Minton et al., 2023), trends within the UK are among the worst (Leon et al., 2019). The period to 2017 experienced one of the greatest slowdowns in the rate of improvement since the 1890s (Hiam et al., 2018). Since 2010, the slowdown in LE in England represents a “new trend rather than a blip” including LE falling by around six months between 2016 and 2017 (Pike, 2019 p.1). Within the UK, the balance of evidence indicates that increasing infant mortality rates (Robinson et al., 2019; Taylor-Robinson et al., 2019a, b) and stalling/declining life expectancy (Darlington-Pollock & Norman, 2019; Hiam et al., 2018; Darlington-Pollock et al., 2022; Alexiou et al., 2021; McCartney et al., 2022; Walsh et al., 2022; McCartney & Walsh, 2023; McKee et al., 2023) are both largely attributable to austerity measures.

Higher infant mortality and declining life expectancy will result in excess mortality compared with levels which would otherwise have been expected to occur. For infant mortality in England, Taylor-Robinson et al. (2019a, b) estimate there were around 570 excess deaths to infants aged less than one year old during 2014 to 2017 compared with the number expected based on previous trends. Overlapping this period, between 2010 and 2018, Darlington-Pollock et al. (2022) estimate there were over 231,000 more deaths than expected across all ages. Both investigations were for England’s local authority geography.

Various analyses of life expectancy trends have unpicked the age-specific mortality rates (e.g. Hiam et al., 2018; Leon et al., 2019; Darlington-Pollock et al., 2022; McCartney & Walsh, 2023) but without a focus on deaths to infants aged less than one year of age. Since this age-group is the first age in life table calculations it is possible that changes in infant mortality rates form part of changes in life expectancies at birth. Life tables use the probability of surviving from a younger age-group

to the next older age. If this probability is lower (e.g. infant mortality is higher) then fewer survive (e.g. to age 1–4) and this will have a knock-on effect in successively older age-groups and the number of years of life expectancy which are reported will be suppressed.

To determine whether rising infant mortality contributes to stalling life expectancies, this brief report will:

- Show time trends in infant mortality and life expectancy at birth between 2000 and 2019 by Index of Multiple Deprivation (IMD) 2015 (income) quintile.

Using 2014 as the ‘jump off’ year as this was when infant mortality began to rise, alternative scenarios for the first year of life in LE calculations will then reveal whether any differences in life expectancy at birth occur:

- If instead of the mid-year estimates (MYEs), live births are the denominators for age < 1 mortality rates, as used in infant mortality calculations.
 - If the infant mortality observed in 2014 had continued unchanged to 2019.
 - If the downward trends in infant mortality rates observed prior to 2014 had continued to 2019.
- This is expected to be the most telling scenario, especially for more deprived areas. Prior to 2014, it would have been reasonable to expect infant mortality to continue to fall.

Data and Methods

Annual vital statistics data from 2000 to 2019 on live births and deaths by age-group for the Lower Super Output Area (LSOA) geography have been accessed from the Office for National Statistics (ONS). Denominators have similarly been obtained from the ONS LSOA mid-year estimates (MYEs). Consistent with Taylor-Robinson et al. (2019a, b), the LSOAs were grouped into five categories (quintiles) of the income deprivation score of the 2015 Index of Multiple Deprivation.

Life expectancies have been calculated using an abridged life table (with age-groups 0, 1–4, 5–9 ... 80–84, 85+). See ONS (2019, 2023) for an explanation of life table calculations and life expectancy assumptions. Based on advice by Toson and Baker (2003), the specific life table version used here is an ONS (2016) Excel template. The life table inputs are age-specific mortality counts and mid-year populations across all age-groups by deprivation quintile. The outputs of interest are life expectancies at birth (and 95% confidence intervals) for each deprivation quintile.

Initial calculations in the life tables use deaths to infants aged less than one year divided by the mid-year estimate for age < 1. The life table uses this mortality rate to calculate the probability of survival to the next age-group; in an abridged life table this is the age-group 1–4. The variants, as noted above, relate to the first year of life, age < 1, of the life table. All the other age-specific mortality rates in the life table are the same in each scenario. Thus, in Table 1, we are varying the ‘Population’ and

Table 1 Extract from life table template (ONS, 2016)

Age	n	a_x	Population	Deaths	M_x	e_x	Lower 95% CI	Upper 95% CI
<1	1	0.1	2,533	20	0.0079	71.99	71.42	72.56
1–4	4	0.5	11,130	1	0.0001	71.55	71.04	72.07

Notes: n Width of the age intervals used in the abridged life table, a_x Fraction of the age interval lived by those in the cohort population who die in the interval. a_x is equal to 0.5 for all age-groups except <1s where 0.1 is used. *Population* Population in age interval, *Deaths* Number of deaths in the age interval, M_x Age-specific death rate, e_x Life expectancy at the beginning of the age interval

N.B. The Population and Death counts and other reported data in Table 1 are from the original ONS Template and are not part of the calculations / results in this paper.

‘Deaths’ inputs for age < 1 which are used to calculate the mortality rate M_x and are interested in any ensuing variations in e_x and associated confidence intervals (CIs) for that first age-group.

The first alternative scenario uses deaths to infants divided by the number of live births, the infant mortality calculation, rather than the counts of those aged < 1 from the mid-year estimates (MYEs). As denominators, these will differ because, although the MYEs include counts of birth registrations, there are adjustments to the populations for deaths and for subnational and international migration into and out of each area. The MYEs for aged 0 become progressively higher than births during 2015 to 2019 (particularly in less deprived areas) and this suppresses rates in comparison with using births. Since it is usual in UK applied demography to use mid-year (30th June) estimates as denominators in rates, the variants below use the MYEs.

The second scenario includes the infant mortality for each quintile in 2014 and then holds the 2014 mortality constant for each subsequent year to 2019. This is to provide a simple comparison as if nothing changed from 2014 onwards.

The final scenario includes counts of deaths for 2015–2019 based on the pre-2014 downward trends in infant mortality rates. These rates are estimated by fitting a logistic curve to the IMRs for each deprivation quintile 2000 to 2014 (prior to the IMR upturn). Figure 2 in the results illustrates the observed IMRs 2000–2019 and modelled IMRs 2015 to 2019 based on the 2000–2014 trends. Death counts are obtained from the estimated trend rates by multiplying by live births and dividing by 1,000. These counts for each quintile are then used as the numerator in the mortality rates for aged < 1 in the life tables. The impact of increased infant mortality is then the difference between what actually happened (observed) and what might reasonably have been expected (predicted by the trend model).

Results

For England, Infant Mortality Rates fell between 2000 and 2014 from 4.87 to 3.35 apart from a rise between 2007 and 2008 (Fig. 1). Infant mortality increased after 2014 and remained higher until 2019. Life Expectancy at Birth increased steadily from 2000 to 2011 and has stalled/fallen thereafter. At 81.04 years in 2019, LE at birth is lower than the 81.29 years in 2011.

Table 2 reports the Life Expectancies at Birth by deprivation quintile in 2019 by the original approach and by the three scenario variants. In the original LEs, there is a gradient between the most and least deprived areas which are respectively 76.89

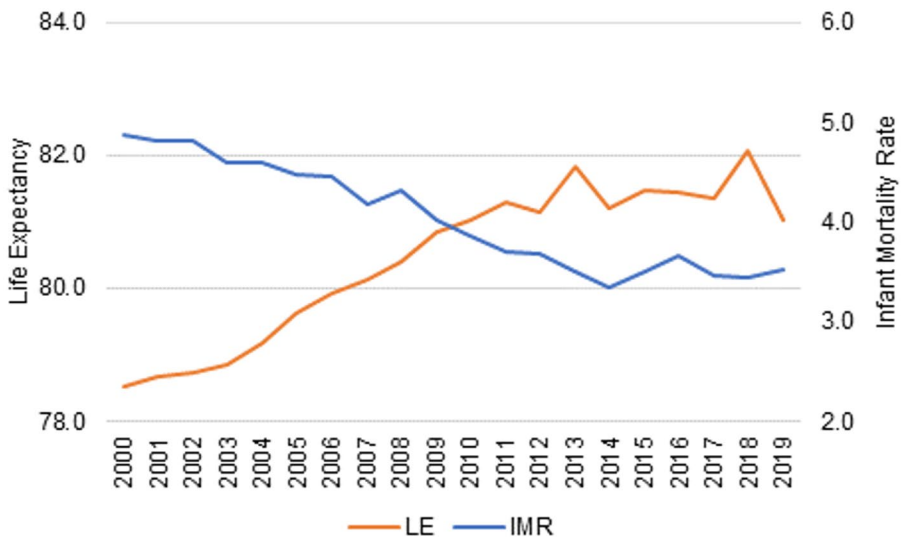


Fig. 1 Infant Mortality Rates and Life Expectancy at Birth: England 2000–2019

Table 2 Life expectancy at birth (and 95% confidence intervals) in 2019 under various scenarios

	Scenarios			
	Original	1: Live Births	2: Constant	3: Trend
Q1 (Most Deprived)	76.89 (76.81–76.97)	76.89 (76.81–76.96)	76.91 (76.83–76.98)	76.97 (76.89–77.05)
Q2	79.47 (79.40–79.55)	79.47 (79.40–79.54)	79.48 (79.41–79.55)	79.52 (79.45–79.60)
Q3	81.37 (81.30–81.44)	81.37 (81.30–81.43)	81.38 (81.31–81.44)	81.41 (81.34–81.48)
Q4	82.80 (82.73–82.86)	82.79 (82.72–82.86)	82.79 (82.72–82.85)	82.81 (82.75–82.88)
Q5 (Least Deprived)	84.24 (84.18–84.31)	84.23 (84.16–84.30)	84.27 (84.20–84.33)	84.29 (84.22–84.35)

to 84.24 years. In the first scenario which uses live births as the denominator for the age < 1 age-specific mortality, there is effectively no difference in the LE at birth. In the second scenario, which holds the infant mortality constant at the 2014 rates, there is a very marginal increase in life expectancies in 2019.

In the third scenario, which is based on rates as if the pre-2014 trends had continued (Fig. 2), the differences to the original life expectancies are slightly more than the constant rate scenario but are still only marginal differences. In the trend scenario, translating the longer life expectancies from years into days represents an extra 28 days of life in the most deprived areas and 15 days in the least deprived. The

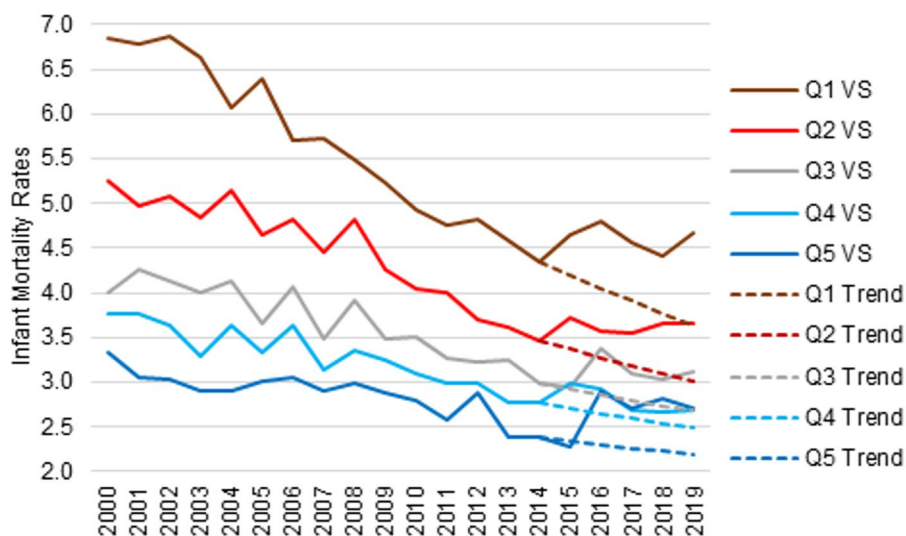


Fig. 2 Vital Statistics (VS) based and Modelled Trends in Infant Mortality Rates, England 2000–2019. Note: Q1 = Most Deprived; Q5 = Least Deprived

trend scenario also allows the estimation of the likely level of excess mortality which occurred by subtracting the trend-based mortality counts from the observed vital statistics counts. During 2014 to 2019, it is estimated in this way that 1,392 excess infant mortality deaths occurred, over 40% of which would be in the most deprived areas.

As Table 2 shows, all the life expectancies in the three scenarios lie within the confidence intervals of the original LEs.

Summary

The results show that there is no significant impact on the life expectancy at birth calculations between the observed and scenario-based infant mortalities even though the trend-based model estimates an excess of almost 1,400 infant deaths occurred. This is important for researchers to know since anyone seeking to understand pre-pandemic falling/stalling life expectancies can concentrate on other aspects to determine key reasons. Specific aspects worthy of attention can include mortality in mid-life (Darlington-Pollock & Norman, 2019; Polizzi & Dowd, 2024; Zazueta-Borboa et al., 2025) and by cause of death (Polizzi et al., 2024), that early childhood health promotion has positive life course health consequences (Guyer et al., 2009) with area deprivation (dis-) advantages accumulating through the life course (Jivraj et al., 2021). Further work on infant mortality is also required since, post-pandemic, rates have risen again (Akanni et al., 2024) with differences in rates by ethnic group and deprivation emerging (Esan et al., 2024; Taylor-Robinson & Esan, 2025).

Strategic targeting (demographically and geographically) can fit with the UK Government's shift from 'sickness to prevention' (UK Government, 2025) including the 'Child Health Action Plan' to create the healthiest and happiest generation of children

in Britain. However, financial challenges remain with the NHS in crisis following a decade of austerity (Alderwick & Dunn, 2025). Focussing on spatial clusters of the most deprived communities can be resource efficient in alleviating poverty (Clarke et al., 2025). Tellingly, research shows that public investment improves health outcomes, but disinvestment has the opposite effect (Taylor-Robinson et al., 2019a, b). Cuts to disability benefits potentially undermine government plans to tackle child poverty (Child Poverty Action Group, 2025) and there is concern that disability cuts will widen England's north-south divide (Bambra et al., 2025).

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Data Availability All data and calculations are available as supplementary information in spreadsheets with the input data, each scenario and the trend modelling.

Declarations

Competing Interests The authors declare no competing interests.

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