

Towards reducing variations in infant mortality and morbidity: a population-based approach

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Scientific summary

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Scientific summary

Background

Mortality rates in the first year of life have fallen over the past 30 years in the UK. However, there remains wide variation in infant mortality rates throughout the UK and the rates also remain relatively high compared with economically similar countries. As a result, the UK government developed a NHS target to reduce socioeconomic inequalities in infant mortality. A review of this target found large knowledge gaps with no adequate explanation of why infant mortality rates vary widely across the UK. In parallel, there has been an increase in the number of babies delivered at late preterm (34–36 weeks) and moderately preterm (32–33 weeks) gestations. Limited and largely retrospective data from outside the UK suggest that these babies experience significant early mortality and morbidity, and are at an increased risk of adverse developmental outcomes compared with babies born at term. However, their impact on the NHS is unknown. In particular, it is not known how differences in obstetric and neonatal practice and socioeconomic deprivation contribute to long-term child development and whether or not there are potentially modifiable factors for reducing mortality and morbidity in this population.

Rationale and objectives

Our overall aim was to undertake a programme of inter-related population-based studies to work towards reducing variations in infant mortality and morbidity. This work focused attention on two key areas:

1. improving understanding of the socioeconomic inequalities in infant mortality rates
2. establishing the impact of late and moderately preterm (LMPT) birth on mortality and morbidity and the extent to which these can be reduced.

The rationale and objectives for these two streams of work are as described below.

Understanding inequalities in cause-specific infant mortality

The limitations of all-cause mortality analyses meant that it is not clear how the widening deprivation gap is influenced by changes in the underlying trends for specific causes of death. The objectives of our work were to identify the main causes of neonatal mortality and stillbirth associated with socioeconomic inequalities, to explore the reasons underlying these cause-specific inequalities in mortality and to improve comparisons of mortality between health regions accounting for variations in case mix.

The Late And Moderately Preterm Birth Study

There was a paucity of prospective studies of LMPT birth that enabled investigation of the impact of early-life factors on long-term developmental outcomes. We therefore carried out a population-based prospective cohort study with the objectives of defining the impact of socioeconomic factors on LMPT birth rates, the impact of birth at 32–36 weeks' gestation on neonatal and postnatal services and the impact of a range of socioeconomic, obstetric and neonatal factors on infant health and developmental outcomes at 2 years of age.

Methods

Understanding inequalities in cause-specific infant mortality

We explored socioeconomic inequalities in cause-specific mortality in four ways.

Socioeconomic inequalities in cause-specific neonatal mortality

We undertook a cause-specific analysis of neonatal mortality using data on all neonatal deaths and live births in England between 1 January 1997 and 31 December 2008. In order to calculate socioeconomic inequalities in neonatal mortality at an area level we utilised the Index of Multiple Deprivation (IMD). Poisson regression models were used to estimate the relative deprivation gap (comparing mortality in the most deprived and least deprived deciles) in rates of neonatal mortality (overall and by specific cause) and to estimate the proportion of the deprivation gap in overall neonatal mortality explained by each cause.

Socioeconomic inequalities in cause-specific stillbirth rates

To understand whether or not national socioeconomic inequalities are similar for neonatal mortality and stillbirth, we undertook a cause-specific analysis of all stillbirths and live births in England between 1 January 2000 and 31 December 2007. Similarly, we utilised the IMD to calculate area-level socioeconomic inequalities in stillbirth rates. Poisson regression models were used to estimate the relative deprivation gap (comparing mortality in the most deprived and least deprived deciles) in rates of stillbirth (overall and by specific cause) and to estimate the proportion of the deprivation gap in overall neonatal mortality explained by each cause.

Exploring the reasons underlying cause-specific inequalities in mortality

In order to understand how socioeconomic inequalities in neonatal mortality relating to congenital anomalies arose, we undertook an analysis of data from a large UK congenital anomaly register. We analysed data on nine selected congenital anomalies with poor prognostic outcome that were audited as part of the UK fetal anomaly screening programme. All pregnancies with an end date between 1 January 1998 and 31 December 2007 were included in the analyses. We explored socioeconomic variation throughout the pathway including the overall risk of the anomalies in utero, the rate of termination of pregnancy, the rate of stillbirth, the rate of live birth with an anomaly and neonatal mortality associated with an anomaly.

Improving comparisons of mortality between health regions

The aim of this work was to improve comparisons of mortality between health regions by understanding variations in the classification of births at < 24 weeks' gestation as either a live birth or a fetal loss. At the primary care trust (PCT) level, we combined national data on live and stillbirths by gestational age between 1 January 2005 and 31 December 2008 with information on late fetal losses of 22⁺⁰–23⁺⁶ weeks. These data allowed a comparison of the proportion of births at < 24 weeks' gestation registered as live born between PCTs and the impact on PCT-level infant mortality rates of excluding these extremely preterm infants.

Late And Moderately Preterm Birth Study

We explored the impact of LMPT birth through a prospective population-based study of infants born at 32–36 weeks' gestation.

Recruitment of the cohort

Between September 2009 and December 2010, all mothers who were resident in a geographically defined area of Leicestershire and Nottinghamshire and delivered singletons at 32–36 weeks' gestation were eligible to participate in the study with their babies. A group of babies born at term (≥ 37 weeks' gestation) during the same time period and in the same geographical region was also recruited as a control group. All multiple births at or beyond 32 weeks' gestation were eligible to participate. This resulted in a cohort of 1146 babies born late or moderately preterm and 1258 babies born at term. Data collection for mothers included information relating to general medical and obstetric history, antenatal care, labour and delivery.

Impact of socioeconomic factors on preterm birth

Mothers were interviewed using a semistructured questionnaire to obtain sociodemographic details and information about lifestyle, living and working conditions and antenatal health. These data were used to clarify the contribution of socioeconomic deprivation in LMPT birth and assess whether or not area-level deprivation effects are explained by individual socioeconomic factors.

Neonatal outcomes

Data were collected about the infants' clinical course until hospital discharge, including length of stay, types of care, interventions and investigations, including the need for resuscitation at delivery, neonatal unit (NNU) admission and respiratory support. Information was obtained about common and important neonatal morbidities such as jaundice, hypoglycaemia, hypothermia and feeding difficulties.

Health and developmental outcomes at 2 years of age

Data were collected at 2 years of age via a parent-completed questionnaire. This comprised items to assess general health, respiratory function, neurosensory (vision, motor and hearing) function and standardised measures to assess cognitive development (Parent Report of Children's Abilities – Revised), behaviour problems and socioemotional competence (Brief Infant and Toddler Socioemotional Assessment). The prevalence of adverse health, respiratory, cognitive and behavioural outcomes in LMPT children compared with term-born control infants was assessed using risk ratios both before and after adjustment for important confounders. Socioeconomic and neonatal predictors of adverse neurodevelopmental outcomes among children born LMPT were also explored.

Economic costs of late and moderately preterm birth

Neonatal and maternal data collection forms captured a comprehensive profile of resources used by each infant until final hospital discharge or death. Data relating to infants' utilisation of resources use over the first 2 years of life were collected via parent-completed questionnaires administered when the infants were 6 months, 1 year and 2 years of age. Resource inputs were valued using a combination of primary research, based on established accounting methods, and data collated from secondary national tariff sets. Cost comparisons were carried out using Student's *t*-test for LMPT infants compared with term-born controls. Regression modelling was used to estimate the relationship between gestational age at birth and total costs over the first 2 years.

Key findings

Understanding inequalities in cause-specific infant mortality

- Although there was an absolute decrease in neonatal mortality over the period 1997–2007, the relative deprivation gap (ratio of mortality in the most deprived decile to that in the least deprived decile) increased, with the percentage of excess deaths associated with deprivation increasing from 32% in 1997–9 to 51% in 2003–5.
- Almost 80% of the relative deprivation gap in all-cause mortality was explained by premature birth and congenital anomalies.
- Rates of stillbirth were twice as high in the most deprived decile as in the least deprived, and this wide gap did not diminish over time. Unexplained antepartum stillbirths accounted for 50% of this deprivation gap.
- Although rates of severe anomalies and method of detection were similar for all deprivation groups, the rate of termination after antenatal diagnosis of a congenital anomaly was lower in the most deprived areas than in the least deprived areas (63% vs. 79%).
- Because of the socioeconomic variation in rates of termination for congenital anomaly the rate of neonatal deaths associated with a congenital anomaly was 98% higher in the most deprived areas, explaining the patterns seen in the national mortality study.

- Wide between-PCT variation existed in the classification of extremely preterm births (< 24 weeks) and, consequently, the percentage of infant deaths arising from these births ranged from 20% to 80%.
- Excluding births at < 24 weeks led to significant changes in infant mortality rankings of PCTs indicating that infant death rates in PCTs in England are significantly influenced by variation in the registration of births when viability is uncertain.

The Late And Moderately Preterm Birth Study

- Women from the most deprived areas were 49% more likely to have a LMPT baby. After adjusting for individual-level socioeconomic factors, there was no significant association between area deprivation and LMPT birth.
- Infants born at 32–36 weeks' gestation were significantly more likely to require resuscitation at delivery, admission to a NNU and respiratory support than those born at ≥ 37 weeks' gestation.
- Neonatal morbidities, including jaundice, hypothermia, hypoglycaemia and feeding difficulties, were more common in LMPT infants than in term-born infants and LMPT infants were less likely to receive breast milk.
- Neurosensory impairments were significantly more common in children born LMPT than in control infants (1.6% vs. 0.3%). However, cognitive impairment conferred the greatest long-term burden of deficit and was present in 16% of LMPT children, compared with 10% of control children [adjusted relative risk 1.42, 95% confidence interval (CI) 1.08 to 1.86].
- Children born LMPT were at increased risk of delayed socioemotional development, mild respiratory problems and poorer general health compared with term-born peers after adjustment for confounders.
- Socioeconomic deprivation, male sex, maternal hypertensive disease, antenatal recreational drug use and not receiving breast milk by neonatal hospital discharge were independent predictors of neurodevelopmental disability following LMPT birth.
- Late and moderately preterm birth was associated with significant additional costs during the period of the initial hospitalisation and over the first 2 years of life: the mean cost difference was £3507 (95% CI £3009 to £4160) to discharge, which increased to £3562 (95% CI £2897 to £4287) for resource utilisation up to 2 years.

Conclusions

This programme of research studies has led to key findings relevant to reducing inequalities in infant mortality that have important implications for policy and practice, as well as future research recommendations.

Implications for policy and practice

1. Commissioners and others responsible for clinical governance should exercise greater caution when reviewing unadjusted early-life mortality rates, particularly when these relate to individual trusts.
2. When more sophisticated analysis is not possible, it is prudent at least to exclude babies born at < 24 weeks' gestation from analyses. Variation in mortality rates between areas relating to terminations for congenital anomaly should be recognised.
3. Neonatal services should review the care they offer to babies born late or moderately preterm to ensure that it is appropriate for their needs and the identified risks faced by this group.
4. Women considering delivery of their baby at 32–36 weeks' gestation should be counselled that there is a small increased risk of developmental problems. The risk is higher among those with greater socioeconomic risk and when hypertension is the indication for early delivery.
5. The nature of the developmental problems affecting these babies appears to be primarily cognitive, social and emotional, and this is most prevalent in children from a relatively deprived background.
6. Provision of paediatric services for the assessment, follow-up and support for infants born LMPT should be tailored to their gestation-specific needs and reflect the difference in developmental problems seen between these children and those born very preterm.

Recommendations for future research

As a result of this programme of work, a range of new research questions emerged, and funding to pursue some of these has already been sought or is already in place:

1. Understanding the choices of different groups of women when dealing with a pregnancy in which a major congenital anomaly has been identified to ensure that the reported socioeconomic variations in rates of termination do not arise from systematic differences in the delivery of services.
2. Understanding decision-making regarding the interpretation of signs of life at the limit of viability in order to standardise the implementation of guidelines and reduce the impact of the variation.
3. Longer-term follow-up of the LMPT cohort to determine how early cognitive problems evolve over time and whether there is developmental plasticity in this group. This will also enable assessment of whether or not delays in early socioemotional development manifest as behaviour problems or peer relationship difficulties later in childhood.
4. Evaluation of the efficacy of early parenting interventions for improving cognitive and socioemotional development in the LMPT population.
5. Development, implementation and evaluation of potential follow-up schemes for children born late or moderately preterm and their families.

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