**Temporal changes in gestational age at birth in live-births in Scotland (2005 – 2020): A descriptive epidemiological study protocol**

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# Background

Gestational age at birth is one of the principal determinants of health as it is closely linked to neonatal and infant morbidity and mortality, as well as the risk of long-term health sequelae in adult life. Global estimates suggest that approximately 15 million babies were born preterm i.e. before 37 weeks’ gestation in 2014.1 Preterm birth rates vary substantially between different regions; from a pooled estimate of 8.7% in Europe up to 13.4% in North Africa.1 There is an increasing body of evidence reporting rising levels of preterm birth rates in many, but not all, countries.2,3 Whilst advances in neonatal care have reduced mortality and morbidity among preterm infants, there has been little progress in the prevention of preterm birth.

Existing epidemiological evidence suggests that the factors contributing to the observed increase in preterm births varies between countries and regions. In the U.S.,4 Latin America,5 and Iceland,6 the rise in preterm birth rates appears to have been driven by an increase in provider-initiated preterm deliveries. An increase in provider-initiated preterm births might be attributed to an increasing proportion of women with obstetric complications or medical comorbidities that necessitate preterm delivery and/or enhanced identification of women requiring preterm delivery and/or a rise in avoidable medical provider-initiated preterm births.

In other settings, including in Europe3 and Australia,7 there is evidence that increasing numbers of spontaneous preterm births, with or without preterm rupture of membranes, may also be playing a role. The cause for this increase has not been established; the aetiology of spontaneous preterm birth is poorly understood, and many spontaneous preterm births have no distinct addressable clinical risk factor.9,10 A multitude of socio-demographic, environmental, clinical and behavioural factors have been linked to an increased risk of spontaneous preterm births and could play a role in changing trends over time.8, 9 However, differences in rates of preterm births between high-income countries, as well as heterogeneous time trends are suggestive of modifiable population factors that affect preterm birth risk.10

At later gestations, rates of induction of labour and caesarean birth at and beyond term have risen in many countries, as a consequence of mounting evidence of increased perinatal mortality and maternal morbidity associated with prolonged gestations. In Sweden, a multi-centre, randomised controlled trial demonstrated reduced perinatal mortality in pregnancies induced at 41 weeks compared with 42 weeks.11 In 2020, Alkmark *et al* published a systematic review and individual participant data meta-analysis of randomised trials evaluating the impact of expectant management until 42 weeks versus induction of labour at 41 weeks on perinatal outcome. They found that induction of labour at 41 weeks improved perinatal outcomes compared with expectant management, without increasing caesarean delivery rate in nulliparous women.12

Norman *et al* conducted a comprehensive analysis of population-based data from Scotland between 1980 and 2004, reporting an overall singleton preterm birth rate of 5.8%.13 They documented an increasing trend in preterm birth rates over time after adjusting for maternal age at delivery, and attributed this to a rise in both provider-initiated (prelabour caesarean section or induction of labour) as well as spontaneous premature births. The increase in preterm birth rates over time was associated with a decline in stillbirth, and neonatal and perinatal mortality, leading the authors to conclude that the rise in medically-indicated preterm births was likely to be appropriate. In this update, we hypothesise that, since the publication of data covering 1980-2004, preterm deliveries have continued to increase with spontaneous and provider-initiated causes equally contributing to this phenomenon in Scotland. Both the prevalence of induction of labour and caesarean sections at term are likely to have risen over this period reducing the proportion of post-term deliveries. We also expect that, in line with expanding health inequalities, the relative proportion of preterm deliveries have continued to increase in women at extremes of maternal age, and those who belong to the lowest Scottish Index of Multiple Deprivation (SIMD) quintiles. Identifying population-wide exposures and designing health policies to mitigate them could be facilitated by a broader focus on gestational age distribution.

# Aim and objectives

The overall aim of this study is to describe temporal changes in gestational age at birth among all live deliveries (singleton and multiple pregnancies to be considered separately) in Scotland between 2005 and 2020.

The specific objectives are:

1. To calculate the percentage of deliveries that are preterm, term and post-term, overall and stratified by key socio-demographic characteristics of maternal age and area-level socioeconomic status between 2005 and 2020, and maternal ethnicity between 2015 and 2020.

2. To assess if there have been changes over time (2005-2020) in the percentage of deliveries that are preterm, term and post-term.

3. To explore if temporal trends in the percentage of deliveries that are preterm, term and post-term vary by maternal age and/or area-level socioeconomic status.

4. To explore if there are temporal trends in the percentage of preterm deliveries by gestational age (extremely preterm/very preterm/moderate to late preterm) or by mode of delivery onset (provider initiated/spontaneous).

**Methods**

## Data source

This descriptive epidemiological study will utilise the Scottish Morbidity Records 2 (SMR02) database. The SMR02 database includes all day case and in-patient admissions to maternity specialities in Scotland.14 It will be used for identification of live births managed in maternity units (≥98% of births in Scotland) and home births (≤2% of births in Scotland).15

## Data preparation

This study will be restricted to live deliveries from 22 weeks’ gestation between 2005 and 2020, and all data will be prepared and analysed separately for singleton and multiple deliveries.

Our main outcome of interest is gestational age at birth, with deliveries categorised as follows:

* <36 weeks (preterm birth)
* 37+0 weeks – 41+6 weeks (term birth)
* >42 weeks (post-term birth)

Our main exposure of interest is calendar time, with this available as both a continuous exposure (increments of one year) and as a categorical exposure for three calendar year periods (2005-09; 2010-2014; 2015-2020).

Other exposures of interest include: (1) maternal age (<20 years, 20-24 years, 25-29 years, 30-34 years, 35-39 years and >40 years); (2) Scottish Index of Multiple Deprivation (SIMD) quintiles (areas ranked from least deprived [rank 1] to most deprived [rank 5]) and (3) maternal ethnic group. Ethnic groups will be classified into the following categories: White (Scottish, Other British, Irish, Gypsy/Traveller, Polish, Other White ethnic group), South Asian (Pakistani/Pakistani Scottish/Pakistani British, Indian/ Indian Scottish/ Bangladeshi British), Black/Caribbean/African (Black/Black Scottish/Black British, Caribbean/Caribbean Scottish/ Caribbean British, Other Caribbean/ Black, African/African Scottish/African British, Other African), Mixed or other ethnic group (Any mixed/multiple ethnic groups, Arab/Arab Scottish/Arab British, Other Asian/Asian Scottish/Asian British, Other ethnic group) and Unknown/missing (Refused/ not provided by patient, Not known, missing). Ethnicity data recording only became mandatory for this dataset in 2021, and so completeness for ethnicity is variable across the study period; therefore, we will restrict analyses with the ethnicity variable to 2015-2020 only.

For preterm deliveries, there will be a further breakdown of the numbers of deliveries by gestational age. The number of deliveries will be categorised as extremely preterm birth (22+0-27+6weeks), very preterm birth (28+0-31+6 weeks) and moderate to late preterm birth (32+0-36+6 weeks), and will be used to describe any temporal trends within these sub-categories.

Preterm births will also be categorised as provider initiated [caesarean sections (elective or emergency) or Induction of Labour (IOL)] and spontaneous onset of labour [with preterm prelabour rupture of membranes (PPROM) or without PPROM] to explore whether there have been temporal changes in the percentages of provider initiated or spontaneous preterm deliveries.

## Statistical Analysis

Initial checks of the data will include: (1) examining the extent of missing data for key variables that are included in the analysis (e.g. numbers of deliveries with unknown on whether they were singleton/multiple, or on mother’s SIMD, mode of delivery, maternal age etc); (2) calculating the percentage of deliveries at 22 and 23 weeks gestation to assess whether inclusion of these data are appropriate or whether there are clear changes over time which might indicate changes in recording practices; and (3) looking at the median gestational week at delivery (with interquartile ranges), stratified by singleton or multiple deliveries and by year of delivery.

We will calculate and plot the distribution of gestational age groups (i.e., the percentage of deliveries that are preterm, term and post-term), overall and by year of birth and by year groups (2005-09; 2010-2014; 2015-2020) for singleton and multiple deliveries separately. We will then calculate and plot the percentage of all deliveries in each gestational age group overall and by year group by: [1] maternal age group and [2] SIMD. Due to data availability, we will only look at the distribution of deliveries by gestational age by ethnicity group for the most recent period (2015-2020), and not stratify further by trends over time.

We then assess whether there is any evidence of a change in the percentage of deliveries by gestational age category over time (pre-term, term, and post-term) and if this varied by maternal age or socioeconomic status, using aggregate logistic regression weighted by the number of deliveries.

Subsequently, we will focus only on the preterm deliveries, looking at if there is evidence of changes over time in gestational age at delivery (extremely preterm/very preterm/moderate to late preterm) or evidence of changes by mode of delivery onset type using aggregate logistic regression, weighted by the number of deliveries per category.

All analyses will be stratified by singleton or multiple deliveries. We will use R version 3.6.1 to conduct all statistical analyses.

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