Ethnic Differences in Birth Outcomes in England

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1. Introduction

There is a growing literature on the sources of ethnic inequalities in a variety of outcomes including health, education, earnings and retirement in the UK. Most of this work, however, focuses on adult outcomes[1]. This is in no small part due to data availability. In this paper we use the new Millennium Cohort Study (MCS) to look at ethnic differences in outcomes of children at birth. This paper is the first part of a wider research agenda that will document sources of ethnic inequalities in early childhood outcomes using the MCS[2].

There is also an increasing body of research that shows that increased birthweight and length of gestation is positively associated with cognitive and health outcomes later in life, independent of other socio-economic factors[3]. This begs the question – are there factors that explain differences in duration of gestation and birthweight and do these vary by ethnicity? There is epidemiological evidence that length of gestation and birthweight vary by ethnicity. This appears to hold even after differences in socio-economic factors have been controlled for and a recent paper presents evidence that this may be in part due to earlier maturation of Black and Asian foetuses[4]. Despite this

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[1] See for instance see the work of James Nazroo, for example Nazroo, J. (2003), "The structuring of ethnic inequalities in health: economic position, racial discrimination and racism", *American Journal of Public Health*, 93, 2, 277-284.

[2] In earlier work, we also looked at sources of ethnic inequality in child outcomes at 9 months. It turns out that two of the most important determinants of all parent assessed outcomes at 9 months are gestational age at delivery and birthweight. Because of this, we thought that in our first piece, it was important to document in detail ethnic differences in these two outcomes as a starting block for our future research in this area. Understanding what drives these differences potentially has important policy implications.

[3] See for example Richards, M., Hardy, R., Kuh, D. and Wadsworth, M.E.J. (2002), "Birthweight, postnatal growth and cognitive function in a national UK birth cohort", *International Journal of Epidemiology*, 31, 342-348 and Record, R.G., McKeown, T., Edwards, J.H. (1969), "The relation of measured intelligence to birth weight and duration of gestation" *Ann Hum Genet*, 33, pp. 71-79.

[4] Patel RR, Steer, P., Doyle, P. Little M. and Elliott, P. (2004), "Does gestation vary be ethnic group? A London based study of over 122 000 pregnancies with spontaneous onset of labour", *International Journal of Epidemiology*, 33, 107-113.

evidence, a recent survey article by Savitz (2004) argues that these studies come far short of showing that these differences are purely genetic and argues that the "possibility of a modifiable social or behavioural explanation for these patterns remains highly plausible, but largely untested"[5]. In this paper we hope to look at this issue in regard to gestational age at birth and birthweight to see what may be driving ethnic differences in birth outcomes.

In particular we focus on length of gestation in days and birthweight and look at whether these birth outcomes vary by ethnicity in the MCS sample, and how much of this is due to: differences in maternal behaviour before and during birth; differences in socio-economic background; differences in family composition and fertility decisions; or other observed factors such as parental height. Clearly an important determinant of birthweight will be length of gestation and another interesting question is to determine whether there are factors that impact on both gestation and birthweight (controlling for gestation), or only on gestation, or only on birthweight and the importance of this for different ethnic groups.

This paper provides a first look at these relationships as a starting point for future research that will look at the impact of background factors including birthweight and duration of gestation on cognitive and health outcomes at 9 months and 3 years. The paper is largely descriptive and describes raw differences in these birth outcomes and then differences after background characteristics have been controlled for. It shows what background characteristics are important in explaining birth outcomes and how these characteristics vary by ethnic group. The paper concentrates of the following characteristics:

- maternal behaviour before the birth such as smoking behaviour, drinking behaviour, pre-pregnancy body mass index (BMI)[6] and weight, use of ante-natal care and attending ante-natal classes

- family composition/status variables such as number of previous children, single parent status and age of having child

- longer term socio-economic background factors measured by parent's education and income[7]

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[5] Savitz, D. (2004), "Commentary: Ethnic differences in gestational age exist: but are they 'normal'", *International Journal of Epidemiology*, 33, pp114-115.

[6] The Body Mass Index is measured as weight in kilograms divided by height in metres squared. It is used in this paper to classify people as underweight (BMI less than 18.5), normal (BMI in the range of 18.5 to 24.9), overweight (BMI in the range of 25 to 29.9) and obsese (BMI 30 and above).

[7] We would have liked to have controlled for parental employment history but there is currently a problem with these variables in the MCS that mean that it is not possible to use them in this paper. Pre-existing maternal health indicators also are available in the MCS data and we plan to utilize this data in future research when we look at child outcomes including health outcomes. Our income data relates to family income when the child is 9 months old – not during pregnancy. We look at the

- other characteristics of parents such as parental height or whether they have twins or triplets.

The first set of characteristics that we have described as 'maternal behaviour' are factors that potentially could be influenced by better information and resources before and during pregnancy. The second set of characteristics that we have termed as 'family characteristics' cannot be altered by policy, but again parents' fertility decisions may be influenced by understanding what effect the size of family, timing of pregnancy and family circumstances may have on their child's early outcomes. The third set of characteristics we have labelled 'longer term socio-economic background factors' and in this paper we proxy this using parental education and income. Whilst socio-economic status can be influenced by policy in the longer term, it is much more difficult to change short term. The last set of characteristics are a group of factors that will be important determinants of birth outcomes but over which policy makers can have little influence[8].

What is important to understand is that all of these potential explanatory factors tend to vary by ethnicity and it is important to see how much differences in ethnic outcomes are reduced or increased once these factors are controlled. This is what the paper attempts to do. Understanding these relationships may help inform policy makers about the best forms of interventions for different ethnic groups in improving birth outcomes that are known to have a crucial role in determining later health and cognitive outcomes. In Section 2 we describe the data we use in the analysis and look at how our background characteristics vary by ethnicity. In section 3 we present our results that look at sources of ethnic inequality in outcomes at birth. In section 4 we offer concluding remarks and outline the topics that need to be considered in future research.

2. The MCS data, ethnicity and child outcomes

2.1 The Millennium Cohort Study (MCS)

In this paper we use the first survey of the Millennium Cohort Study, which covers a survey of the parents of almost 19,000 children born in the UK in 2000/01. The survey was carried out when the babies were around 9 months old and collected retrospective information on the pregnancy, birth and first 9 months of the child's life.

One of the huge advantages of the MCS compared to the earlier birth cohort studies is that it has a large sample on non-white babies, particularly in England where just over 26 per cent of the babies *in the sample* are non-white. There has, however, been

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sensitivity of our result have carried out some analysis including income variables but this does little to change our results. We will look at this question in future analysis.

[8] Of course, this is not quite true in the case of multiple births that are a consequence of fertility treatment. For instance policy makers have placed restrictions on the number of foetuses that can be implanted when having IVF treatment.

deliberate over-sampling of ethnic minority and other disadvantaged groups and this group represents just over 14 per cent of non-white babies born in England at this time[9].

2.2 Ethnic Groups

In this paper, we define four different ethnic groups[10]. Whilst a more detailed ethnic breakdown is available from the survey, the methodology we employ requires us to have quite large sample sizes. In future work we will consider the sensitivity of our results to our aggregation strategy. The groups we define are:

1. White

2. Black

3. Asian

4. Other - including mixed ethnic origin.

2.3 Length of gestation and birthweight

In this paper we consider 2 child outcomes at birth – length of gestation in days and birthweight. The MCS provides data on birthweight in kilograms and a derived measure of gestation (in days). There is quite a large literature looking at the determinants of birthweight and the impact of factors such as smoking during pregnancy[11]. There is less of a literature on the determinants of gestation and given the clear link between gestation and birthweight, we feel it is important from a policy perspective to try and disentangle the impact of background factors on both these factors, and indeed birthweight controlling for gestation. We discuss the methodological issues in doing this in the next section.

2.4 How do background characteristics vary by ethnicity?

We finish this section by showing summary statistics by ethnicity for the background characteristics we will control for in our analysis. These are shown in Table 2.2.

There are a number of background characteristics that vary markedly by ethnicity. The first is smoking behaviour. Around 34 per cent of mothers of white children smoked before becoming pregnant and 27 per cent also smoked during pregnancy. These figures are similar to mothers of mixed and other racial origins where the comparable figures are 35 per cent before and 26 per cent during pregnancy although these women

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[9] In all work presented below we re-weight the data to take account of this over-sampling.

[10] The MCS defines 8 main ethnic groups: White, Mixed, Indian, Pakistani, Bangladeshi, Black Caribbean, Black African and Other.

[11] See for example, Goldstein, H. (1977), "Smoking in pregnancy: some notes on the statistical controversy", *British Journal of Preventive and Social Medicine*, 31, 13-17.

on average smoked fewer cigarettes per day before and during the pregnancy. Among mothers of Asian children only 5 per cent smoked before pregnancy and 3 per cent during pregnancy. For the mother's of black children the figures were 21 per cent before becoming pregnant and 17 per cent during pregnancy.

Another big ethnic difference in mothers' behaviour regards drinking during pregnancy. 37 per cent of mothers of white children drank alcohol during their pregnancy, compared with only 2 per cent of mothers of Asian children, 17 per cent of mothers of Black children and 30 per cent of mothers of children from other ethnic origins.

The physical characteristics of the parents of children from different ethnic backgrounds also differ. In our paper we control for parental height, weight and a categorical measure of the mother's pre-pregnancy body mass index (BMI) where the base group is those with normal BMI[12]. We see from Table 2 that mothers of Asian children are on average round 5 cm shorter than mothers from other ethnic groups. On the other hand, fathers of white children are on average around 5 cm taller than fathers of children of other racial origin. In terms of weight, mothers of Black children have a higher average weight and much more dispersion around this mean than other ethnic groups. The mothers of Asian children have the lowest average weight before pregnancy and the lowest dispersion. We also see that 10 per cent of the mothers of Asian children and 9 per cent of mothers of children of mixed or other racial origin are underweight for their height compared to 5 percent of mothers of White and Black children. On the other side, over 40 per cent of mothers of Black children are either overweight or obese compared to around 26 to 28 per cent of mothers of children from other ethnic backgrounds.

There is very little difference in when women of children from different racial origins make their first ante-natal visit. There is, however, a big difference across ethnicities in the attendance at ante-natal classes with 40 per cent of mothers of White children attending, compared to 22 per cent of mother of Asian children, 29 per cent of mothers of Black children and 33 per cent of mothers of children of mixed or other ethnic origins. These differences are quite large and could point to an important factor that might impact on birth outcomes. The variable, however, is highly endogenous in our examples as by definition, the mothers of children born prematurely are much less likely to be able to attend ante-natal classes. We therefore reluctantly exclude this variable in most of our analysis but consider its impact on the sample of children who were not premature (born before 37 weeks) to look at the potential influence of this variable.

The age of mothers also varies across ethnic groups ranging from an average of 27.4 years for mothers of Asian children to 30.4 years for mothers of Black children. The average size of the family also varies across ethnic groups with the mothers of Asian

[12] A normal BMI is taken as those women whose pre-pregnancy BMI fell in the range 18.5 to 24.9, see footnote 6.

children having an average of 1.19 older children compared to 1.07 for mothers of Black children, 0.83 for mothers of White children and 0.81 for mothers of children from mixed or other ethnic backgrounds. The proportion of lone parents also varies markedly for different ethnic groups with 47 per cent of the mothers of Black children being lone parents, 26 per cent of the mothers of children from Mixed or Other ethnic origins, 13 per cent of mothers of White children and 5 per cent of mothers of Asian children.

The education qualifications and income of parents also vary markedly across ethnic groups and the relative social disadvantage of ethnic minorities has already been well documented. White parents on average are better educated and have higher income and the parents of Asian children the least well off and educated in our data.

Finally we also control for incidences of multiple births and these are slightly more common for Black children and least common for Asian children in our sample.

Table 2.1 Summary Statistics

Background characteristics	*Child's Ethnicity* *White*		*Asian*		*Black*		*Other*	
Male child	0.51	(0.50)	0.49	(0.50)	0.54	(0.50)	0.48	(0.50)
Smoked before pregnancy	0.34	(0.47)	0.05	(0.21)	0.21	(0.41)	0.35	(0.48)
No. cigs before pregnancy	4.27	(7.44)	0.39	(2.47)	1.61	(4.16)	3.81	(7.09)
Smoked during pregnancy	0.27	(0.44)	0.03	(0.18)	0.17	(0.37)	0.26	(0.44)
No. cigs during pregnancy	2.02	(4.85)	0.14	(1.08)	0.77	(2.72)	1.87	(5.08)
Drank Alcohol during preg	0.37	(0.48)	0.02	(0.15)	0.20	(0.40)	0.30	(0.46)
Weekly units alcohol	0.57	(1.96)	0.02	(0.19)	0.17	(0.93)	0.41	(1.56)
Weight before pregnancy	64.4	(12.6)	58.4	(11.1)	67.9	(14.2)	62.4	(12.8)
BMI - underweight	0.05	(0.21)	0.10	(0.30)	0.05	(0.21)	0.09	(0.29)
BMI - overweight	0.19	(0.39)	0.19	(0.39)	0.26	(0.44)	0.21	(0.40)
BMI - obese	0.09	(0.29)	0.07	(0.25)	0.15	(0.36)	0.07	(0.25)
Week of first antenatal visit	11.08	(3.26)	11.04	(3.67)	12.01	(4.18)	11.67	(3.71)
Attended antenatal classes	0.40	(0.49)	0.22	(0.41)	0.29	(0.45)	0.33	(0.47)
Age at birth	29.3	(5.7)	27.4	(5.3)	30.4	(6.0)	29.3	(5.9)
Number of older children	0.83	(0.95)	1.19	(1.24)	1.07	(1.07)	0.81	(0.98)
Lone parent	0.13	(0.33)	0.05	(0.23)	0.47	(0.50)	0.26	(0.44)
Mother's highest qual:								
Level 1	0.08	(0.27)	0.06	(0.23)	0.03	(0.18)	0.03	(0.17)
Level 2	0.29	(0.46)	0.16	(0.37)	0.16	(0.37)	0.21	(0.41)
Level 3	0.13	(0.34)	0.12	(0.32)	0.09	(0.29)	0.11	(0.32)
Level 4 or 5	0.41	(0.49)	0.37	(0.48)	0.56	(0.50)	0.49	(0.50)
Father's highest qual:								
Level 1	0.05	(0.22)	0.04	(0.19)	0.02	(0.15)	0.03	(0.17)
Level 2	0.21	(0.40)	0.10	(0.30)	0.07	(0.25)	0.11	(0.31)
Level 3	0.12	(0.33)	0.06	(0.25)	0.02	(0.15)	0.08	(0.28)
Level 4 or 5	0.37	(0.48)	0.38	(0.49)	0.29	(0.45)	0.40	(0.49)
Family Income:								
> £7,800 & ≤ £15,600	0.17	(0.37)	0.32	(0.47)	0.19	(0.40)	0.22	(0.42)
> £15,600 & ≤ £20,800	0.22	(0.42)	0.28	(0.45)	0.24	(0.43)	0.16	(0.37)
> £20,800 & ≤ £26,000	0.13	(0.34)	0.05	(0.23)	0.06	(0.25)	0.09	(0.29)
> £26,000	0.36	(0.48)	0.16	(0.37)	0.18	(0.39)	0.33	(0.47)
Twins	0.03	(0.17)	0.02	(0.13)	0.04	(0.20)	0.03	(0.18)
Triplets	0.00	(0.02)	0.00	(0.04)	0.00	(0.00)	0.00	(0.00)
Mother's height (cm)	164.5	(6.8)	159.7	(6.3)	164.4	(7.3)	163.8	(7.3)
Father's height (cm)	179.0	(7.1)	174.1	(7.6)	175.6	(7.3)	176.0	(7.3)
No. of obs	7660		1177		442		622	
(sum of weights)	(7733)		(477)		(216)		(424)	

Note: All data is weighted to take account of sampling procedures in England. Standard errors are shown in parentheses. All height variables show means for non-missing data.

3. Preliminary Findings

3.1 Introduction and methodological approach

We now move on to present the preliminary findings of our research. In our final analysis we will attempt to control more adequately for the prior employment history of the child's parents and maternal health[13].

As we outlined in the introduction, we consider two outcomes: length of gestation in days and birthweight measured in kilograms. In our analysis, we begin by showing the distribution of outcomes across ethnic groups. We then use simple regression models to show the raw differences in ethnic outcomes (specification *i*), the differences once we control for height and multiple pregnancies (specification *ii*), the differences once we also control for socio-economic background factors (specification *iii*) and finally the differences when we control for maternal behaviour before and during the pregnancy (specification *iv*).

When looking at the determinants of birthweight, we firstly consider a model where we ignore length of gestation. We then move on to consider if there are factors that explain differences in birthweight given gestation. We think that both questions are of policy interest.

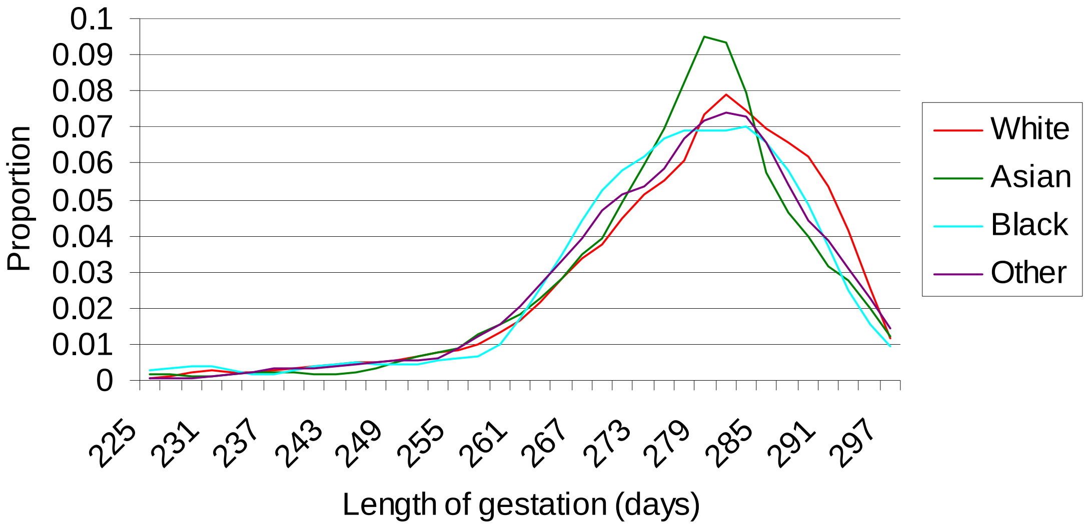
Of course, one problem with all our models is that there are likely to be unobservable characteristics of the mother that determine both our outcome variables and also some of our controls – that is a number of our explanatory variables are potentially endogenous. This endogeneity could bias our estimates of the impact of these factors. For example, in our final model. it highly likely that there are unobserved determinants of both gestation and birthweight that will potentially bias our estimates of the impact of gestation. In the final part of the paper we make an attempt to control for this endogeneity to see how robust our preliminary findings are.

3.2 Ethnicity and the determinants of length of gestation

In Figure 3.1 we show the distribution of length of gestation in days by ethnicity. It is clear from the Figure that the distribution of length of gestation differs across ethnic groups. White children have a gestational distribution which is clearly to the right of the other ethnic groups. For Black and Other children, the distribution of length of gestation is much more spread than for White and Asian children, but clearly to the left of the distribution for White children.

[13] For instance, we have information on whether the mother has diabetes or develops gestational diabetes during pregnancy. It is well known that incidence of gestational diabetes varies markedly by ethnicity and it will be crucial to account for this in our final analysis.

Figure 3.1 Distribution of length of gestation by ethnicity



If we turn to Table 3.1 we see that on average Asian children's gestation is 1.3 day less than White children, Black children's gestation 2.4 days less and Other children's gestation 1.8 days less. All these differences are statistically significant at conventional levels. We also see from specification *i* that male babies on average are born 0.6 days earlier than girl babies and again this difference is significant.

These raw ethnic differences are reduced once we control for parental height and multiple birth status. Mother's height has a significant impact on length of gestation with each additional centimetre increasing gestation by 0.14 days. The difference in the average height of the mothers of White and Asian children (around 5 centimetres) completely explains the observed difference in gestation between White and Asian babies (0.7 days).

When we control for socio-economic factors and maternal behaviour the differences are further reduced for all but Black children[14]. So what are the important determinants of gestation? As we have already highlighted – mother's but not father's height is an important determinant of gestation. Mother's and Father's education is also important but *not* income[15].

Interestingly smoking behaviour before and during pregnancy does *not* impact of length of gestation. This suggests that the well documented detrimental affect of smoking on birthweight operates independently of gestation. We will look at this issue in more detail in the next section.

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[14] Although the difference is still significantly below the raw difference.

[15] It must be remembered that our income measure is family income when the child was 9 months old. The results to not change significantly if we exclude income from our analysis.

Table 3.1 – Sources of ethnic differences in length of gestation (days)

Background characteristics	*Specification* *i.*		*ii*		*iii*		*iv*	
Constant	277.1	(0.21)	258.9	(4.8)	259.1	(4.9)	255.2	(56.0)
Sex of child	-0.59	(0.29)	-0.70	(0.27)	-0.71	(0.27)	-0.70	(0.27)
Ethnicity:								
Asian	-1.26	(0.64)	-0.90	(0.62)	-0.74	(0.63)	-0.74	(0.66)
Black	-2.40	(0.94)	-2.03	(0.90)	-2.24	(0.90)	-2.12	(0.91)
Other	-1.78	(0.68)	-1.58	(0.65)	-1.68	(0.65)	-1.55	(0.65)
Twins			-25.8	(0.9)	-25.8	(0.8)	-25.6	(0.8)
Triplets			-57.1	(5.8)	-56.6	(5.8)	-55.5	(5.8)
Mother's height (cm)			0.14	(0.02)	0.13	(0.02)	0.12	(0.03)
Father's height (cm)			-0.02	(0.02)	-0.03	(0.02)	-0.03	(0.02)
Mother's highest qual:								
Level 1					0.99	(0.67)	0.78	(0.67)
Level 2					0.60	(0.52)	0.31	(0.53)
Level 3					1.58	(0.60)	1.18	(0.61)
Level 4 or 5					1.65	(0.53)	1.37	(0.55)
Father's highest qual:								
Level 1					1.59	(0.81)	1.49	(0.81)
Level 2					2.28	(0.62)	2.22	(0.62)
Level 3					1.75	(0.67)	1.67	(0.68)
Level 4 or 5					2.26	(0.60)	2.12	(0.60)
Family Income:								
> £7,800 & ≤ £15,600					0.69	(0.53)	0.70	(0.58)
> £15,600 & ≤ £20,800					0.43	(0.52)	0.40	(0.60)
> £20,800 & ≤ £26,000					-0.07	(0.60)	-0.07	(0.68)
> £26,000					-0.07	(0.54)	-0.05	(0.63)
No. cigs before pregnancy							-0.04	(0.03)
No. cigs during pregnancy							-0.04	(0.05)
Drank alcohol during preg							0.89	(0.32)
Weekly units alcohol							0.02	(0.08)
Weight before pregnancy							0.01	(0.03)
BMI – underweight							-1.92	(0.71)
BMI – overweight							-0.26	(0.50)
BMI – obese							0.01	(0.97)
Week first ante-natal visit							0.67	(0.17)
(Week first ante-natal visit)^2							-0.02	(0.01)
Age at birth							0.16	(0.21)
Age at birth squared/100							-0.45	(0.35)
Number of older children							0.12	(0.16)
Lone parent							0.13	(0.65)
Number of observations	9901		9901		9901		9901	
R^2	0.002		0.104		0.107		0.112	

Note: All data is weighted to take account of sampling procedures. Standard Errors are shown in parentheses. Missing dummy variables for mother's and father's height and qualifications are also included in regressions where these variables appear.

Interestingly, women who drink during pregnancy have on average almost a day longer length of gestation. As we saw in section 2 the largest group doing this are mothers of White and Other children. Pre-pregnancy weight, on the other hand, has no affect on gestation, but being underweight for your height reduces gestation by almost

2 days. As we saw from Table 2.1, around 10 per cent of mothers of Asian and Other children were underweight before getting pregnant. The timing of a women's first ante-natal visit also impacted on gestation with first visits between 12 and 22 weeks providing the best gestational outcomes[16]. Finally twins and triplets had significantly shorter length of gestation with twins being born on average 26 days earlier and triplets 56 days earlier. Age, family size and lone parent status had no impact on gestational outcomes.

We also know whether the mother attended ante-natal classes and we also looked at the impact of this on babies who made it to 37 weeks gestation and therefore would not have precluded their mother from attending such classes which tend to start between 28 and 34 weeks gestation. We found that attending an ante-natal class increased gestation for this group of full-term babies by 1.15 days and this effect was highly significant[17]. From Table 2.1 we saw that there was big differences across ethnic groups in attendance at ante-natal classes and this may be a potential policy focus to increase length of gestation for ethnic minority groups.

3.2 Ethnicity and the determinants of birthweight

We begin this sub-section by showing the distribution of birthweights by ethnicity of the child. We see that the distribution of birthweights for White babies is to the right of all other ethnic groups and the distribution for Asian babies is to the left of all other ethnic groups. The distribution for Black and Other Children are virtually on top of each other, but there is much wider dispersion in the Black birthweight distribution – similar to what we saw for length of gestation.

Turning to Table 3.2 we see from specification *i*, that compared to White babies, Asian babies are on average around 290 grams lighter, Black babies around 160 grams lighter and Other babies around 140 grams lighter. Male babies are around 120 grams heavier than female babies. When we control for parental height and multiple births (specification *ii*) and socio-economic factors (specification *iii*) these differences are reduced by between 30 and 80 grams. However, once we control for maternal behaviour before and during pregnancy, the gap widens again for all groups except children in the 'Other' ethnic category.

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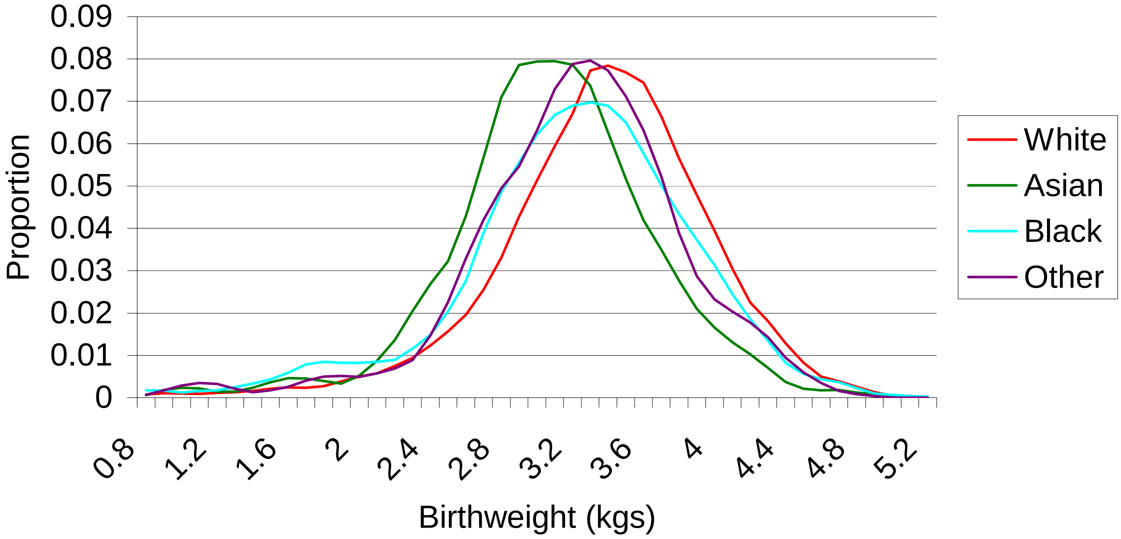
[16] We have excluded women who had their first ante-natal visit after 24 weeks because babies in our sample started being born from 23 weeks onwards. This meant losing around 1.5 per cent of our sample.

[17] The standard error of this estimate was 0.22. The sample size for his equation was 9072.

Figure 3.2 Distribution of birthweight by ethnicity



So what are the important determinants of birthweight ignoring length of gestation? We see from Table 3.2 that mother's and father's height are important determinants of birthweight whereas only mother's height was important for length of gestation. Parent's education is important but now income also plays an important role that wasn't observed with length of gestation.

Smoking during *and before* pregnancy also has a significant and negative effect on the child's birthweight[18]. In our sample 79 per cent of women who smoked before becoming pregnant also smoked during pregnancy. The average number of cigarettes smoked by those women who smoked before pregnancy was 12.6 whereas the average for those who smoked during pregnancy was 7.5. This means that for a women who had these smoking patterns before and during pregnancy their baby would on average be around 140 grams lighter and the impact on birthweight of the before pregnancy smoking similar to the smoking during pregnancy. As we saw from Table 2.1 mothers of White and Other babies are much more likely to smoke. In Figure 3.3 we show the distribution of birthweight outcomes for mothers of White babies distinguishing between those who smoked during pregnancy and those who did not.

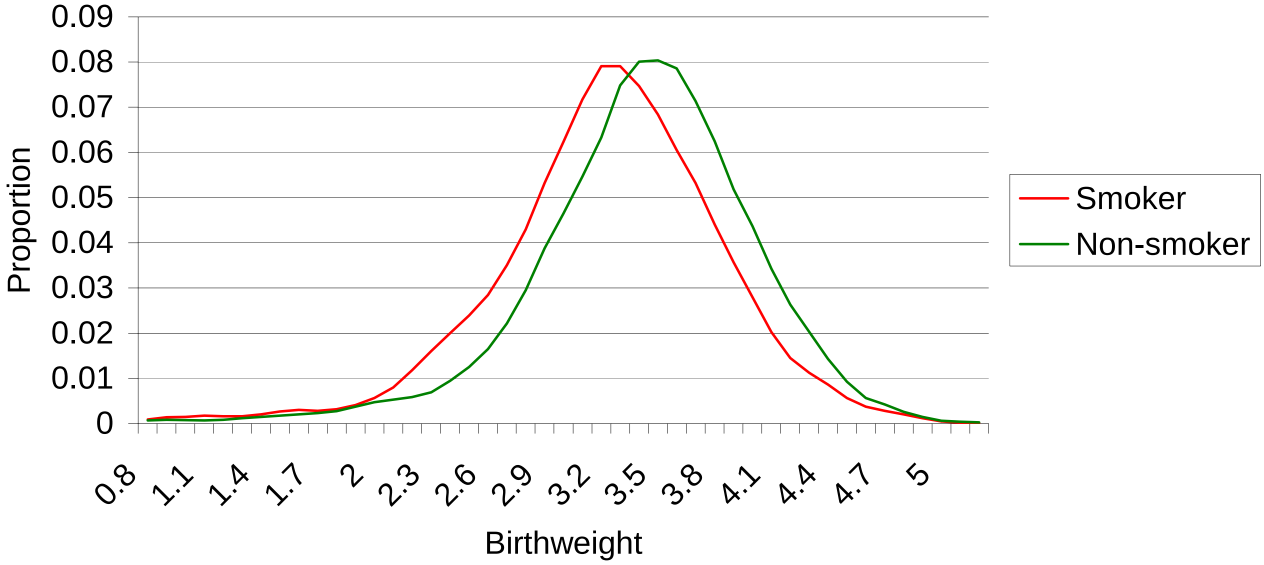
[18] In our original specification we controlled for incidence of smoking before and during pregnancy and number of cigarettes. The incidence measures were always insignificant both measures were included and for this reason we only include number of cigarettes rather than incidence.

Table 3.2 – Sources of ethnic differences in birthweight

Background characteristics	*Specification* *i.*		*ii*		*iii*		*iv*	
Constant	3.31	(0.01)	0.08	(0.19)	0.11	(0.20)	0.50	(0.23)
Sex of child	0.12	(0.01)	0.12	(0.01)	0.12	(0.01)	0.12	(0.01)
Ethnicity:								
Asian	-0.29	(0.03)	-0.21	(0.03)	-0.20	(0.03)	-0.25	(0.03)
Black	-0.16	(0.04)	-0.10	(0.04)	-0.11	(0.04)	-0.19	(0.04)
Other	-0.14	(0.03)	-0.11	(0.03)	-0.11	(0.03)	-0.10	(0.03)
Twins			-0.99	(0.03)	-0.99	(0.03)	-1.00	(0.03)
Triplets			-1.90	(0.23)	-1.90	(0.23)	-1.69	(0.23)
Mother's height (cm)			0.015	(0.001)	0.014	(0.001)	0.011	(0.001)
Father's height (cm)			0.005	(0.001)	0.004	(0.001)	0.004	(0.001)
Mother's highest qual:								
Level 1					0.04	(0.03)	0.03	(0.03)
Level 2					0.04	(0.02)	0.03	(0.02)
Level 3					0.05	(0.02)	0.04	(0.02)
Level 4 or 5					0.07	(0.02)	0.07	(0.02)
Father's highest qual:								
Level 1					-0.01	(0.03)	0.00	(0.03)
Level 2					0.03	(0.02)	0.03	(0.02)
Level 3					0.03	(0.03)	0.03	(0.03)
Level 4 or 5					0.05	(0.02)	0.06	(0.02)
Family Income:								
> £7,800 & ≤ £15,600					0.06	(0.02)	0.02	(0.02)
> £15,600 & ≤ £20,800					0.11	(0.02)	0.06	(0.02)
> £20,800 & ≤ £26,000					0.07	(0.02)	0.01	(0.03)
> £26,000					0.08	(0.02)	0.04	(0.02)
No. cigs before pregnancy							-0.006	(0.001)
No. cigs during pregnancy							-0.009	(0.002)
Drank alcohol during preg							0.015	(0.013)
Weekly units alcohol							-0.003	(0.003)
Weight before pregnancy							0.006	(0.001)
BMI - underweight							-0.105	(0.028)
BMI - overweight							0.009	(0.020)
BMI - obese							-0.037	(0.038)
Age at birth							-0.014	(0.008)
Age at birth squared/100							0.015	(0.014)
Number of older children							0.076	(0.006)
Lone parent							0.018	(0.026)
Number of observations	9901		9901		9901		9901	
R^2	0.026		0.146		0.152		0.196	

Note: All data is weighted to take account of sampling procedures. Standard Errors are shown in parentheses. Missing dummy variables for mother's and father's height and qualifications are also included in regressions where these variables appear.

Figure 3.3 Distribution of birthweight by smoking status – mothers of white babies



This shows that the two distributions are fairly similar and the effect of smoking is to shift the mean birthweight downwards. What is interesting about our findings in Table 3.2, is the importance of smoking before pregnancy. This finding clearly needs further investigation.

Mother's weight before pregnancy is also an important determinant of their child's birthweight whereas it was not a determinant of length of gestation. Children of women of a certain weight, who are either underweight or obese are smaller than otherwise similar children from mothers who are not underweight or obese.

Finally women who have had previous children, have on average higher birthweight children with birthweight increasing on average by 76 grams for every additional child. Children who are twins or triplets also have significantly lower birthweights. Age is also an important determinant of birthweight with birthweight increasing with age at an increasing rate (though by relatively modest amounts of between 4 and 13 grams for each additional year of age).

We have seen that factors such as mother's height, being underweight for height, multiple births and education of parents impacts on both gestation and birthweight, not controlling for gestation. It is interesting to see whether these variables impact on both gestation and birthweight or whether their effect is purely through impacting on gestation that in turn has an impact on birthweight. The results of doing this are shown in Table 3.3. Obviously gestation will not impact on birthweight linearly and we include a cubic in gestation in our preferred specification although we also show the results of specifying a linear model. We only present specifications *i* and *iv* in Table 3.3.

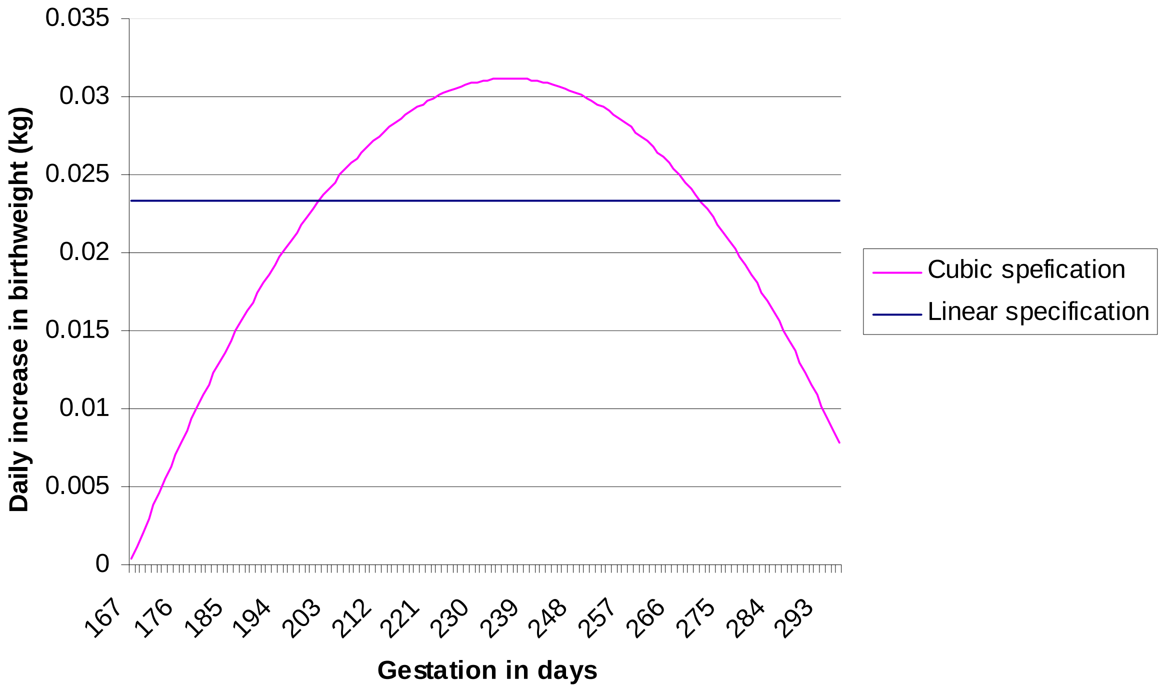
Table 3.3 – Sources of ethnic differences in birthweight controlling for gestation

Background characteristics	*Specification* *i.*		*i*		*iv*		*iv*	
Constant	-3.706	(0.089)	31.774	(4.444)	-5.537	(0.204)	20.660	(4.219)
Sex of child	0.133	(0.009)	0.135	(0.009)	0.134	(0.009)	0.136	(0.009)
Length of gestation (days)	0.025	(0.000)	-0.439	(0.054)	0.023	(0.000)	-0.328	(0.051)
Length of gestation squared			0.002	(0.000)			0.002	(0.000)
Length of gestatn cubed/1000			-0.003	(0.000)			-0.002	(0.000)
Ethnicity:								
Asian	-0.257	(0.021)	-0.265	(0.020)	-0.228	(0.021)	-0.231	(0.021)
Black	-0.098	(0.030)	-0.104	(0.030)	-0.137	(0.029)	-0.142	(0.029)
Other	-0.099	(0.022)	-0.101	(0.022)	-0.069	(0.021)	-0.071	(0.020)
Twins					-0.402	(0.027)	-0.365	(0.027)
Triplets					-0.379	(0.184)	-0.195	(0.183)
Mother's height (cm)					0.008	(0.001)	0.008	(0.001)
Father's height (cm)					0.005	(0.001)	0.005	(0.001)
Mother's highest qual:								
Level 1					0.016	(0.021)	0.014	(0.021)
Level 2					0.018	(0.017)	0.019	(0.017)
Level 3					0.016	(0.019)	0.016	(0.019)
Level 4 or 5					0.038	(0.017)	0.041	(0.017)
Father's highest qual:								
Level 1					-0.034	(0.026)	-0.035	(0.025)
Level 2					-0.018	(0.020)	-0.022	(0.019)
Level 3					-0.012	(0.021)	-0.015	(0.021)
Level 4 or 5					0.009	(0.019)	0.005	(0.019)
Family Income:								
> £7,800 & ≤ £15,600					0.004	(0.018)	0.010	(0.018)
> £15,600 & ≤ £20,800					0.048	(0.019)	0.051	(0.019)
> £20,800 & ≤ £26,000					0.016	(0.022)	0.022	(0.021)
> £26,000					0.037	(0.020)	0.037	(0.020)
No. cigs before pregnancy					-0.005	(0.001)	-0.005	(0.001)
No. cigs during pregnancy					-0.008	(0.001)	-0.009	(0.001)
Drank alcohol during preg					-0.007	(0.010)	-0.008	(0.010)
Weekly units alcohol					-0.004	(0.003)	-0.003	(0.003)
Weight before pregnancy					0.006	(0.001)	0.006	(0.001)
BMI - underweight					-0.060	(0.023)	-0.061	(0.022)
BMI - overweight					0.014	(0.016)	0.011	(0.016)
BMI - obese					-0.037	(0.031)	-0.040	(0.030)
Age at birth					-0.018	(0.007)	-0.017	(0.007)
Age at birth squared/100					0.026	(0.011)	0.025	(0.011)
Number of older children					0.073	(0.005)	0.068	(0.005)
Lone parent					0.016	(0.021)	0.022	(0.021)
Number of observations	9901		9901		9901		9901	
R^2	0.401		0.4129		0.441		0.489	

Note: All data is weighted to take account of sampling procedures. Standard Errors are shown in parentheses. Missing dummy variables for mother's and father's height and qualifications are also included in regressions where these variables appear.

We can see from Table 3.3 that length of gestation has a significant impact on the child's birthweight. For every extra day of gestation, birthweight increases on average by around 23 grams. Of course this relationship is not linear and this is illustrated in Figure 3.4 below for our preferred model.

Figure 3.4 – Impact of gestation on increases in birthweight



Of course, it is highly likely that there are unobservable characteristics of mothers that are correlated with both gestation and birthweight and this could bias our estimates of the gestation effect. In an attempt to correct for this possible bias we use instrumental variable techniques. This requires us to find at least one variable or instrument that determines gestation but not birthweight, controlling for gestation. We can only do this in our linear model and we present this as an illustration of the possible biases caused by unobservable factors that determine both gestation and birthweight. We use the week the mother first had her first ante-natal visit as an instrument for gestation as this was a strong predictor of gestation and in tests seemed to satisfy instrument validity tests[19]. This reduces our estimate of the effect of an increase of one day in gestation from 23 grams to 15 grams and these estimates are significantly different from each other suggesting that endogeneity may be an issue. Indeed it is highly likely that other control variables are also endogenous (such as income and education) and that we might also over-estimate the impact of these variables on birth outcomes. We will look at this issue in future research.

[19] We used week of first visit and week of first visit squared. The Sargan test of the validity of the one over-indentifying instrument was easily passed (p-value 0.19).

Going back to Table 3.3 we see that even when we control for length of gestation, there still remains significant ethnic differences in birthweights. The other interesting point to emerge from Table 3.3 is that once we control for gestation, the impact of parental education becomes insignificant except for women with level 4/5 qualifications. This suggests that parents' education has a much more significant effect in extending length of gestation and through this birthweight rather than directly impacting on birthweight. Smoking on the other hand has no impact on length of gestation yet has a significant negative impact on birthweight. Factors such as mother's height impacts on gestation and birthweight controlling for gestation.

4. Conclusions and areas for future research

There is clear evidence that increased birthweight and length of gestation is positively associated with cognitive and health outcomes later in life, independent of other socio-economic factors. There is also clear evidence that these two outcomes vary by ethnicity. Are there factors that explain differences in duration of gestation and birthweight and do these vary by ethnicity?

In this paper we saw that the following factors had a positive impact on length of gestation :

- Mother's height
- Consuming alcohol during pregnancy
- Mother not being underweight for her height
- Not being a twin or triplet
- Mother and father's education
- The timing of the mother's first ante-natal visit
- Attending ante-natal classes

A lot of these factors vary by ethnicity and policies that attempt to increase attendance at ante-natal classes, educating women about the dangers of being underweight when commencing a pregnancy could help reduce some of these ethnic inequalities in gestational outcomes.

The following factors had a positive impact on child's birthweight

- Mother and father's height
- Not smoking before and during pregnancy
- Weight

- Not being underweight or obese
- Not having multiple births
- Income
- Education of father and mother
- Age of mother

Some but not all of these factors had also been determinants of gestation and in the case of parental education, most of its positive effect on birthweight operates through its effect on gestation. Factors like mother's height impact on gestation and birthweight controlling for gestation. Other factors such as income, father's height and smoking - only impact on birthweight.

Again this has important policy implications. Firstly it appears that smoking before getting pregnant as well as during pregnancy can impact on a child's birthweight. This actually reduces the birthweight gap between mothers of white babies and those of Asian and Black babies who smoke significantly less. Secondly the importance of not being underweight or obese when starting a pregnancy could also be addressed through education initiatives. Mothers of Asian and Other children are much more likely to be underweight and mothers of black children much more likely to be overweight and so policies that educate women about the risks of being underweight or obese may help reduce ethnic differences in birthweights. But one of the most important things to ensure a good birthweight is increasing the length of gestation.