Socio-economic gradients in low birthweight in three countries

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Comparative cohort analyses can help shed light on the processes underlying child health and development trajectories, and explore the role of national policies in improving outcomes and in reducing inequalities (Waldfogel, 2013). Such policies, and the national contexts within which they are couched, can have differential impacts at different lifestages. A growing literature has used this comparative approach to demonstrate sizable average gaps in child outcomes between richest and poorest households across several countries, and that the amplitude of these gaps varies across countries, with less generous welfare systems such as the US showing greater disparities (Bradbury, Corak, Waldfogel, & Washbrook, 2017). This literature having focused on cognitive and behavioural outcomes, we know less about child health from this comparative angle, and in particular about health at birth, with some notable exceptions.

Health at birth is an interesting outcome as it a first marker of both cognitive and health subsequent trajectories (Currie and Moretti, 2007). Work by Martinson and Reichman (2016) has shown that strong gradients low birth weight by household income exist in the United States, United Kingdom, Canada, and Australia. The relationship between socioeconomic status and low birthweight was strongest in the United States, but was present in all countries. This confirms therefore similar trends found for older ages and for non-health outcomes by researchers such as Bradbury, Corak, Waldfogel, & Washbrook (2017). As with the afore-mentioned literature, this study is based on rich, representative and relatively comparable data from Anglo-Saxon countries. Recent expansion to this type of data sources to other European countries allows to expand to comparison to other settings that are similar enough for comparison purposes, but also sufficiently different to allow a richer understanding on the role of context in the development of inequalities.

However, comparing country-specific studies is complex. Aside from differences in variable harmonization and modelling choices, much of the US literature on socio-economic inequalities in postnatal health has focused on differences across household income, while European studies tend to focus on maternal education as the key measure of socio-economic status. These differential approaches to measuring socio-economic status are problematic as it can give rise to observing different associations with health outcomes. For example, Panico and colleagues (2015) have shown strong gradients in low birth weight by maternal education in France, while the relationship between income and birthweight was only significant within the low educated group. While different socioeconomic indicators such as income and education show strong mutual associations, they are not interchangeable measures of an underlying entity, "socioeconomic status" (Bartley, 2016). Therefore, international studies are often difficult to compare, making it challenging to consider the body of literature as a whole and to be able to comment meaningfully on the importance of the national contexts in creating these health inequalities.

In this paper, we compare gradients in birthweight by maternal education, a key determinant of child well-being which has been less explored in the infant health inequalities literature, particularly in the US, using high quality data from three countries: France (the *Etude Français depuis l'Enfance*, Elfe), UK (Millennium Cohort Study, MCS), and the USA (Early Childhood Longitudinal Study, ECLS-B). These relatively comparable child cohort studies provide data on birth outcomes, alongside rich contextual information on family circumstances and health behaviours. After examining whether different patterns in the relationship between maternal education and low birthweight exist across these different national contexts, we analyse the role of key micro-level mechanisms, such as income (which we conceptualize here as a mechanism underlying inequalities, rather than a stratifying

variable in itself), maternal smoking during the pregnancy, the use of antenatal care, and maternal pre-pregnancy health; and whether the relative importance of these mechanisms vary across different national contexts.

Data

This paper analyses inequalities in infant health across three countries, relying on three large, nationally representative studies with comparable, rich data on family characteristics, birth outcomes, and pathway variables. The studies key characteristics are described below.

Table 1: Description of the three studies

	ECLS-B	**MCS**	**Elfe**
Country	USA	UK	France
Year of birth of cohort members	2001	2000-2002	2011
Initial sample size	10,700	19,244	18,322
Age of CM at first wave	9 months	About 9 months	Birth and about 2 months

Sample inclusion

To compare across the three studies, we restrict to births at 33 weeks gestation and above, as this was an exclusion criteria for Elfe. This excludes 11.5% of the sample for the ECLS and 2.8% of the MCS sample. In both studies, births before 33 weeks gestation had a slight pattern by maternal education (excluded births are slightly more likely to be to less educated mothers). Differences were only marginally significant for ECLS ($p=0.067$), and slightly more so for MCS ($p=0.0012$). This implies that results presented here for ECLS and MCS might slightly under-estimate the real educational gradients in low birthweight. We therefore run sensitivity analyses for MCS and ECLS including births at 33 weeks gestation and lower.

Elfe only includes mothers aged 18 and over for consent issues. We chose not to apply this same restriction to the ELCS and MCS samples because in France births under 18 are extremely rare, therefore the exclusion does not change the representativeness of the study, while it would be a problematic exclusion criteria for the American and British samples. Using data from the national civil registry, we find that in 2011 only 0.5% of births in continental France were to mothers aged under 18 at birth (Insee, 2017).

We currently carry out complete case analyses, producing unweighted analytical sample of 12,286 for Elfe, 15,857 for MCS and 10,300 for ECLS. In future sensitivity analyses, we will check if our baseline models change substantially when using non-complete and complete case samples.

Model variables

Our key outcome variable is low birthweight, modelled as a binary variable, indicating whether the cohort child weighted 2500 grams or less at birth. In sensitivity analyses, we will exclude births over 4500 grams from the reference category. This exclusion, already tested for Elfe, did not change the substantive findings reported here.

Our main independent variable is the highest maternal educational qualification. We prefer this variable to a composite measure of the highest educational qualification in the household as the literature suggests that maternal characteristics are more important for pregnancy outcomes. Based on other comparative work (Bradbury, Corak, Waldfogel, & Washbrook, 2017), in our main analyses we distinguish three broad maternal education groups: high, equivalent to a US bachelor's degree or more; medium, equivalent to some college in the US or vocational qualifications; and low, equivalent to a US high school diploma or less. In the UK, we classify A-levels in the medium category. While A-level study normally takes places between ages 16 and 18, when high

school diplomas are usually prepared, authors comparing the British and US system (Bradbury et al., 2017) have argued that A-levels have more in common with the first year of a US college degree than high school. This is because students can only access A-level study if they have attained adequate grades at GCSE (typically 5 or more GCSEs at grade C or above, achieved by only about half the population). Furthermore, A-level study is specialized around 3 to 4 academic subjects, and therefore covers relatively advanced material.

We test a number of potential micro-level mechanisms to explain health gradients: Household income, modelled as quintiles of equivalised household income; Health behaviours, including smoke during the third trimester of the pregnancy, the number of cigarettes smoked per day during pregnancy and any alcohol consumption during the pregnancy; Maternal pre-pregnancy BMI, as a marker of maternal health before the pregnancy, categorised using WHO cut-offs (WHO, 2000) of underweight, normal, overweight and obese; Any pregnancy complications during pregnancy from: gestational diabetes, hypertension, eclampsia and pre-eclampsia, placenta previa; and whether antenatal care started from the first trimester, as a marker of prompt access to healthcare.

All models include for a number of covariates: child sex; parity (whether the child is first born versus later parities); multiple pregnancy indicator; mother's height (in cm); whether the mother worked during pregnancy; marital status of parents at birth; maternal age and age squared; maternal nativity (whether she is born in the study country or not). In alternative models, we run models that do not include maternal work, marital status, maternal age and maternal nativity as covariates, given their strong associations with maternal education.

Methods

We carry out linear regression models of maternal education on low birthweight, built as follow: Model 1only includes the covariates; Model 2 includes covariates and household income; Model 3 includes covariates and maternal BMI; Model 4 includes covariates and pregnancy health complications; Model 5 includes covariates and access to antenatal care; Model 7 includes covariates and all mechanisms. In future work, to compare estimates in each country, an Individual Participant Data (IPD) meta-analysis 2 stage approach will be carried out as follow (Riley et al., 2010).

Survey weights are used in all analyses to correct for both non-random sampling design, and for non-response to the survey. For all surveys, these weights are derived by the survey teams, for detail of their construction see (Juillard et al, 2015; Plewis et al, 2007; Bethel et al, 2005).

Results

Preliminary results suggest relatively similar gaps in the three samples studied, although with some notable differences (see Table 2). The gaps appeared to be slightly larger in the UK than France and the US (Model 1). Compared to the middle education group, children born to low educated mothers appeared to be most disadvantaged in the UK and France, and less so in the US. On the other hand, children born to the most educated mothers appeared to be most advantaged in the US and UK, and less so in France.

Including income in the models (Model 2) explained about half of the US high educated mother advantage, and was less important elsewhere. Notably, all income quintiles reported a lower risk of low birthweight than the bottom income quintile in the US; in the UK, an advantage could only be seen for the top three income quintiles, and in France, only for the top income quintile.

For France, health behaviours (in particular maternal smoking during the pregnancy) appeared to explain about half of the low education disadvantage (Model 3). These variables also decreased slightly the coefficients for the low educated group in the UK and USA, but not as markedly.

Including pre-pregnancy BMI (Model 4) or whether antenatal care started from the first trimester (Model 6 – variable to be delivered imminently for the French dataset) did not change any of the coefficients in any country. Including pregnancy complications appeared to explain a small amount of both the low educated disadvantage

and the high educated advantage in the US, and about a quarter of the low educated disadvantage in France, but did not appear to matter in the UK (Model 5).

Finally, our full model (Model 7) shows that the variables we consider appear to capture well the education gradient in low birthweight for the US, and, to a smaller extent, for France, they appear to not explain any of the UK gradient, which is the sample with the largest gaps.

Conclusions

It is perhaps surprising that the size of the gaps in low birthweight by maternal education in the UK, France and the US were not more different, particularly given the literature comparing gradients in child outcomes in the UK and US, and given what is known about the generous French welfare system and its support for families. However, pregnancy is a lifestage during which extra welfare and healthcare options are often accessible, in the three countries. For example, while France and the UK have relatively good healthcare coverage for all age groups, in stark contrast to the US, during pregnancy all three countries provide extra coverage so that out-of-pocket expenses for pregnant women are relatively low and comparable across the three countries. These preliminary results therefore suggest that such policies, particularly in the US, may be helping in reducing expected socio-economic inequalities in early child outcomes, rendering them comparable to other developed countries.

Our analyses did however shed light on some interesting differences. First, the advantage conferred by higher educational qualifications appeared to be more important in our two Anglo-Saxon settings than France, suggesting a that these highly educated groups might be setting off on different trajectories, as suggested by the "diverging destinies" framework (McLanahan, 2004). Second, income was a more important mechanisms in the US than the two other countries, suggesting that for this setting, financial access to services or goods is an important process in understanding health inequalities in the US, but less so for its European counterparts, particularly France. This can probably be reconducted to differential redistribution policies, particularly for families with children, between the three countries. Differences across the three studies in the role of health behaviours, pre-pregnancy health, antenatal care, and pre-pregnancy complications were relatively small, except for a larger importance of pregnancy smoking in France in explaining the low educated advantage.

This is ongoing work, and a number of steps still need to be undertaken to check the robustness of these preliminary conclusions. Notably, a number of specification checks and sample inclusions sensitivity analyses have to be carried out, in particular to insure that, in harmonizing as much as possible samples and variables across the three studies, we are not substantially biasing our results. We are confident that these analyses will be completed by April 2019.

Table 2: Coefficients of linear regression models of low birthweight. All models include controls (1)

	Model 1 Basic	**Model 2** Basic + hh Income	**Model 3** Basic + Health behaviours	**Model 4** Basic + BMI	**Model 5** Basic + Preg complications	**Model 6** Basic +Antenatal care	**Model 7** Full
USA – ECLS							
Low education	0.011**	0.008*	0.009*	0.013***	0.010**	0.011**	0,007
High education	-0.013***	-0,007	-0.012***	-0.014***	-0.011**	-0.013***	-0,007
Income quintile		-0,015*					-0,013
Income quintile 3		-0,022***					-0,019**
Income quintile 4		-0,033***					-0,028***
Income quintile 5		-0,032***					-0,027***
Cigarettes per day			0.002***				0.002***
Any alcohol			-0,001				0
Overweight				-0.012***			-0.015***
Obese				-0.011**			-0.019***
Underweight				0,014			0,014
Pregnancy complications					0.045***		0.050***
Early antenatal care						0.013*	0,012
UK - MCS							
Low education	0,020***	0,016***	0,015***	0,021***	0,020***	0,020***	0,012***
High education	-0,015***	-0,015***	-0,014***	-0,016***	-0,015***	-0,015***	-0,014***
Income quintile		-0,006					-0,006
Income quintile 3		-0.011*					-0,007
Income quintile 4		-0.018***					-0.012*
Income quintile 5		-0.027***					-0.020***
Any smoke during pre			0,046***				0,043***
Any alcohol			0,008***				0,010***
Overweight				-0,014**			-0,016**
Obese				-0,010**			-0,011***
Pregnancy complications					0.045***		0.050***
Early antenatal care						0,005	0,004
France - Elfe							
Low education	0,021***	0,018***	0.013***	0.022***	0.016***		0.009**
High education	-0.007**	-0.004	-0.005*	-0.009***	-0.007**		-0.005*
Income quintile		0.002					0.003
Income quintile 3		-0.006					-0.004
Income quintile 4		-0.008					-0.0002
Income quintile 5		-0.013**					-0.006
Any smoke during preg			-0.005***				-0.006***
Any alcohol			-0.003				-0.002
Overweight				-0.011**			-0.016**
Obese				-0.012***			-0.019***
Underweight				0.037***			0.016***
Pregnancy complications					0.055**		0.060***
Early antenatal care							
Controls (1)	yes	yes	yes	yes	yes	yes	yes

*** p<0.01, ** p<0.05, * p<0.1

(1) Child sex; parity; multiple birth; mother's height; mother employment status during preg; marital status; maternal age, age squared; maternal nativity.

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