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Does the Month of Birth Affect Educational and Health Outcomes? A Population-Based Analysis Using the Northern Ireland Longitudinal Study

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Abstract: Studies in the US, the UK and Europe found children born close to the cut-off date for the start of school year face disadvantage in terms of educational attainment. This is attributed to the fact that pupils born shortly before the cut-off date are almost a year younger than many of their classmates. They are in an earlier stage of their intellectual, emotional and physical development and are thus *relatively* disadvantaged. Differences in growth and health outcomes by birth month have been found in other studies. This paper tests whether long-term educational and health disadvantages of individuals born just before the start of school year cut-off date of July 1st exist in Northern Ireland. The analysis is based on a c.28 per cent representative population sub-sample of young people aged 12-18 in 2001 in the Northern Ireland Longitudinal Study (NILS) with linked 2001 and 2011 Census records. Findings indicate no educational or health disadvantages over a decade for individuals born in May and June.

I INTRODUCTION

Birth month has been identified as influencing many outcomes in later life ranging from sporting prowess, through health, to educational outcomes (see below). In education, especially in the British context, the problems of lower attainment for the 'summer-born' with July and August birthdays have often been

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highlighted (DFE, 2010), with poor educational outcomes in school across a variety of social indicators. In this case, the date in England that divides the school year is September 1st. Birth month has also been associated with particular types of illness and poorer health outcomes in later life in the United States although this has been observed for people born in the winter months (Buckles and Hungerman, 2013). The existence of these differentials, usually observed in the United Kingdom in studies based on large administrative datasets such as those produced by school reporting systems or social surveys, raises questions about whether health and educational differentials can be observed across entire populations, and the relative size of these effects in comparison with other social determinants of health and educational outcomes.

This paper attempts to investigate this theme using the Northern Ireland Longitudinal Study (NILS). This is interesting for two reasons. Firstly, the NILS is a c.28 per cent sample of the Northern Ireland population and is therefore of sufficient size to permit generalisations for the entire population. It is also longitudinal – this means that it is possible to follow the fortunes of groups of people through time (here between 2001 and 2011). Unlike longitudinal cohort surveys it has low attrition rates because it is based on linking data from the successive censuses of the population rather than survey follow up at subsequent waves. Secondly, Northern Ireland is different to other parts of the United Kingdom, more particularly England and Wales. Because the Northern Ireland school year divides on July 1st rather than September 1st, the study of birth-month effects on later educational success is to some extent a natural experiment.

The school starting age is four years in Northern Ireland. Every child who reaches the age of four by the 1st July of every year should begin compulsory education at the beginning of September of the same year (Department of Education, 1989, sec. F73; Department of Education, 2016). Children who turn four after 1st July are enrolled in the following year. The text of the legislation and the parental guidance information supplied by the Department for Education do not state exceptions to this rule.[1] Starting school at a later age than four is very uncommon in Northern Ireland. Everything being equal it might be expected that birth-month disadvantage might be concentrated for those with May and June births unlike July and August births (in England). Northern Ireland therefore stands as an

[1] The text of the Education and Libraries (Northern Ireland) Order 1986 is the legal basis for the school year cut-off date in Northern Ireland. It states under section F73: " Where a person attains the age of four years – (a) on any date occurring in the period beginning on (and including) 1st September in any year and ending on (and including) 1st July in the following year, he shall be deemed not to have attained the lower limit of compulsory school age until 1st August in that following year; (b) on any date occurring in the period beginning on (and including) 2nd July in any year and ending on (and including) 31st August in the same year, he shall be deemed not to have attained the lower limit of compulsory school age until 1st August in the following year." (Department of Education 1989, sec F73).

interesting case study because of this difference. The paper begins by discussing the literature on birth-month effects on health and education outcomes in the next section. It then describes and discusses the NILS dataset and the variables that are included in the analysis. After this, the results are presented and discussed, before drawing conclusions.

II LITERATURE REVIEW

There is a substantial international literature on whether (and how, and how much) the month of birth influences later life outcomes in education, health, morbidity, mortality, employment and general wellbeing. There is evidence that the month of birth shapes later life chances across a variety of domains, although the evidence is not unanimous and there remain questions as to how birth month is important; whether it is the age of starting school, age at testing, relative age of children in the year cohort, exposure to environmental factors, or socio-economic differentials in the timing of planned births through the year that matter. Outside the direct focus of this paper, but worthwhile noting nevertheless, is the pervasive influence of birth month on sporting success (Bell and Daniels, 1990; Ponzo and Scoppa, 2014; Wattie *et al*., 2007; Helsen *et al*., 2005) across a variety of countries and a diverse range of sports.

In England, drawing on the National Pupil Database and longitudinal surveys Crawford *et al*. (2013) observe that there are differentials associated with the summer-born in July and August having lower scores in tests as they proceed through school and, at the end of schooling, when transiting to further and to higher education. Important findings highlighted in this study are that birth-month effects are largest at younger ages, but that they decrease in size with age with little evidence of detrimental effects persisting into adulthood. In considering why these differentials are observed, Crawford *et al*. (2013; 2014) make a very good case for 'age-at-test' as being the dominant driver for the poorer performance of the summer-born. It was also noted that this disadvantage for the youngest in the class is more wide ranging than just educational performance but could also influence the perceptions that pupils held of themselves (and how they were viewed by teachers) and could lead to a greater probability of being diagnosed with special educational needs. Similar patterns were also observed internationally where children born at the end of the academic year performed more poorly than those born at other times. In Sweden, for instance, where the academic year ends on December 31st, children born in November and December did not fare as well as those born in the Spring. Another study found that in Iceland, where school starts in the autumn, pupils born in the first quarter of the year showed lower test performance (Ólafsdóttir and Ásgeirsdóttir, 2014). Interestingly, Attention Deficit

Hyperactivity Disorder (ADHD) was noted in another study (Boland *et al*., 2015) to be diagnosed for children born at the end of the academic year with higher rates for November and December births in Sweden and also New York State (which also has an academic year that ends on the last day of December).

There is less consensus about the long-term influence of birth month and, in particular, relative within-year age effects. Wright (2015) found that birth month had little influence on entrance to higher education and the type of university entered and, as was seen above, birth-month effects appeared to diminish with increasing age. Crawford *et al*. (2013; 2014) also note little evidence of significant effects on labour market outcomes; these authors did question, however, whether they would find statistically significant differentials if they had data for the whole population or a substantial portion of it, although they argue that the diminution of birth-month effects with increasing age is not implausible. On the other hand, Bell and Daniel (2010) note that a persistent disadvantage is associated with the month of birth; and there have been other findings that children born at the end of the school year tend to earn less (Kawaguchi, 2011) and are less likely to occupy high-level occupations such as Chief Executive Officers (CEOs) (Du *et al*., 2012).

It has been observed (Montez and Friedman, 2015) that the relationship between educational attainment and health and longevity is one of the most robust seen in the social sciences. Individuals with poorer educational outcomes tend to have poorer health and live shorter lives. This statement would be enough, in itself, to focus attention on birth month and later health outcomes given the strong possibility that the educational performance of those born later in the academic year is worse than for individuals born earlier. Everything else being equal it might be expected that the summer-born in the UK context could have poorer *general* health outcomes as might those born in May and June in Northern Ireland.

The international literature thus far is inconclusive. This is at least partly caused by the fact that the school starting age varies between five and seven years across countries, and also the school year cut-offs vary. Mortensen *et al*. (1999) found in Denmark, where the school years starts in August, that February and March births had higher rates of schizophrenia than those born in other months, whilst Doblhammer and Vaupel (2001) found that birth month influences mortality. In the United States, where the school year cut-off varies by state, Buckles and Hungerman (2013) found multiple health disadvantages for the winter-born in comparison with those who plan births for the spring and the summer, which they attribute in part to the socio-economic status, age, and partnership status of mothers. Boland *et al*. (2015) again in the US, point to the increased chance of ADHD for the winter-born, but also suggest that other months are associated with other types of illness, with March births, for example, having a statistically higher incidence of cardiac illness.

This literature review generates a number of research questions. Firstly, does the month of birth influence later life educational outcomes in Northern Ireland?

There is a substantial body of evidence that the summer-born in England and Wales experience educational disadvantage, and there is some support from other countries with different academic year dates that late born experience similar differentials. Secondly, are the summer-born in Northern Ireland more likely to experience poorer health outcomes than individuals born at other times of year? Given the link between educational outcomes and health noted above, there is a plausible mechanism which might indicate that the summer-born could also have poorer health. In the Northern Ireland context, where the academic year runs July 1st-June 30th, it is expected that the main disadvantage will be felt by those born in May and June – unlike in England and Wales where the birth-month disadvantage is considered to be for those born in July and August. An important caveat to these first two questions, however, concerns the likelihood that birth-month educational differentials diminish with increasing age, falling from primary school to less than one percentage point (Crawford *et al*., 2013) at entry to higher education. A third question, therefore, seeks to examine whether educational and health differentials are apparent for the adult population at ages where the respondents could have completed A-Levels and university-level education. The analysis presented below sets out to explore these questions using cohorts of NILS members aged 12-18 in 2001 and 22-28 in 2011, although analysis was also undertaken for those aged 24-28 in 2011 as a robustness check.

III DATA

The analysis is based on a subset of data drawn from the Northern Ireland Longitudinal Study (NILS). The NILS is a representative sample of c.28 per cent of the population of Northern Ireland and was drawn from records from the Northern Ireland Health Card Registration system (NIHCR), based on 104 random birthdates out of the 365 possible which are then linked to census and other administrative data sources. These birth dates are confidential and so NILS members are anonymous. The NILS members in our study were subsequently linked to the 2001 and 2011 Census returns in a secure environment by a trusted third party(Johnston *et al*., 2010).[2] Data on the birth months of all NILS members, as captured by birth registration data, were made available together with their self-reported educational qualifications and health status from the census. We concentrate the analysis on a subset of the NILS which included all members (N=36,087), who were born between 1983 and 1989. The respondents were thus 12 to 18 years old at the time of the 2001 Census and subsequently 22 to 28 years

[2] The 2001 Census was held on 29 April 2001, and the 2011 Census was held on 27 March 2011.

old in 2011. The 2011 NILS-Census linkage provided self-reported data on educational qualification and health, whereas data from the 2001 Census-link provided contextual information on their household circumstances ten years earlier. Access to these microdata was provided in the 'safe-setting' of a secure data laboratory located within the Northern Ireland Statistics and Research Agency (NISRA), subject to stringent confidentiality undertakings and under close supervision.

The analysis only uses the variables that are available from the census. In practice, this means that there are relevant data available on individual characteristics such as age, gender, educational qualifications, economic activity, occupation, and health conditions. There are also household-level data available including housing tenure and measures of household employment, health, and educational deprivation calculated by NISRA and we use these as summaries of household conditions as of 2001, and thus appropriate measures of the social and economic conditions of the young people in the sample for whom many census variables (e.g. education and economic activity) were not collected because of their age.

It is also possible to allow for the level of socio-economic and housing-deprivation of individuals' areas of residence because the Northern Ireland Index of Multiple Deprivation can be attached to the Super Output Area (SOA) of residence. SOAs in Northern Ireland typically have average populations of 2,000 and are aggregations of smaller Output Areas (OAs), which themselves are aggregations of postcode units that are combined in such a way as to maximise spatial compactness and social homogeneity (Martin, 2002). Crucially, for the analysis of the cohorts of young people, it is possible to know from the 2001 Census characteristics of other household members including marital status, economic activity and health.

The strength of the NILS as a census data linkage study is that there is very little attrition – unlike a conventional longitudinal survey. Subtracting those who have died, emigrated, and therefore exited the NILS, and those who newly joined the NILS between 2001 and 2011 through births and immigration to Northern Ireland, matching rates for those eligible to be matched exceed 97 per cent. However, this census base of the NILS is also one of its weaknesses. It does not provide, for instance, information on subject type of the qualification nor grade, and it does not deal at all with attitudes, beliefs and perceptions. Educational outcomes are self-reported and the census gives information only on levels of educational attainment. In 2011, there were 13 different response categories which covered current and historic qualifications such as NVQs, CSEs, GCSEs, A-Levels, vocational qualifications and degrees. For the sake of clarity and simplicity the analysis therefore focussed on whether someone had gained a degree/higher degree by 2011, at least A-Levels, and no qualifications. These were clear binary divisions that were unlikely to be confused or misremembered given the range of categories and the self-reported nature of the question.

To measure health status, the response to the question on general health was used and again this was self-reported. Respondents had a choice of five categories (very good, good, fair, bad and very bad which were coded respectively from one to five) and are combined together for some of the analysis presented (see below).

An obvious weakness is that the census is based on self-reported responses and not on data captured via an administrative system nor elicited as part of an interview process where responses can be probed or verified by the interviewer. In defence of the data, however, the information reported in the census is the only information available across a whole population and the responses do appear to have some objective reality. For example, answers to the self-rated general health questions (Mackenbach *et al*., 2002; Mossey and Shapiro, 1982), are closely related to later mortality with those stating they were in poor health having greater odds of dying subsequent to the census. Furthermore, in concentrating on younger people who have only recently gained qualifications there should be a far smaller chance of recall bias compared with, say a 65-year-old, who gained a qualification 40 years ago. Another strength of the analysis is that it makes use of population-level data. As such, there is information on a large number of people, and it looks at outcomes over a decade rather than the shorter periods and smaller samples which are commonly considered in the literature.

IV METHODS

Bivariate analyses of associations between the month of birth, educational success later in life (having obtained a university degree by the time of the 2011 Census), and reported health were carried out. 'Less than Good Health' was computed by combining the fair, bad and very bad health categories. These categories are later used in Table 3. These associations were further explored using binary logistic multilevel regression models (Snijders and Bosker, 2011). Models were run with the following dependent variables: 1) whether the respondent indicated having obtained a university degree by 2011; and 2) whether the respondents reported less than good health in 2011 (in response to question "How is your health in general?", 1= fair to very bad health, 0= good/very good health, recoded from a five-point scale). As the response variables were coded binary (degree/not a degree; fair to very bad health), logistic regression was used. In addition, in order to check our results for robustness, we also ran models examining whether respondents born in May/June were less likely than those born in other months to have obtained at least A-Levels (or higher) and whether they were more likely to report having no educational qualification in 2011. The results for having obtained at least A-Levels and having no educational qualifications are supplied as an appendix.

The models control for sex and age in years in addition to birth month. In order to assess whether age effects occur based on the school year, we included birth year cohort dummies, which are aligned with the Northern Ireland school year cut-off date, leaving the youngest birth year out as the reference category. The birth year dummies run from 1st July until 30th June. Because the vast majority of respondents lived in the parental household in 2001, the design permitted controls for parental background using data from the 2001 Census. These include parental divorce, household tenure, and three measures of household deprivation (education, employment and health).[3] The models also control for the socio-economic deprivation of the area in which the sample members lived in 2001, using a multiple deprivation score provided by the Northern Ireland Statistics Agency (NISRA 2010). Area deprivation is known to influence educational and other social outcomes later in life. Area of residence is defined using Super Output Areas (SOAs) which are used by census agencies for data dissemination, and are designed to be generally socially homogeneous, comparable in terms of population size and over time (Martin, 2002). Tables 1 and 2 contain the summary statistics for the independent variables included in the analysis. These are discussed in the following results section.

IV RESULTS

Table 1 contains the frequency distributions of respondents born in each month of the year. The table shows that the sample is evenly distributed by the month of birth and confirms that statistical comparisons are appropriate and that there is no systematic bias in this respect. The highest proportion of births were in June at 9.2 per cent, the lowest at 7.4 per cent in December. Table 2 shows summary statistics for the 2011 response variables and covariates (including the 2011 household variables). About 34 per cent (N=12,220) of the study sample had a degree by 2011, 21 per cent (N=7,578) have achieved A-Levels, but not a degree, and only 9 per cent (N= 3,172) had no educational qualification in 2011. Only 8 per cent (N=2,871) of the respondents were in less than good health. In 2011 the sample mean age was 24.9, and by implication was 14.9 in 2001. In 2001, 17 per cent of the sample (N= 6,171) were in households with parents divorced or separated, 23 per cent (N= 8,228) were in educationally deprived households, and just over 24 per cent (N=8,805) were in households where neither parent was in work.

[3] Household deprivation are 2001 Census-based NILS variables measured for two domains: education and employment. An educationally deprived household is defined as household in which no person aged 19 to pensionable age has A-Level education or higher and no person aged 16 to 18 is in full-time education. Employment deprivation is defined by households in which no household member aged 16 to 74 is full-time employed.

Table 1: Frequency Distribution of the Analytical Sample Across Month Of Birth

Month of Birth	*N*	*Percent*
January	3,117	8.6
February	2,754	7.6
March	3,249	9.0
April	2,810	7.8
May	3,221	8.9
June	3,306	9.2
July	2,875	7.9
August	3,250	9.0
September	3,170	8.8
October	2,999	8.3
November	2,679	7.4
December	2,657	7.4
Total	36,087	100

Table 2: Summary Statistics for Response Variables and Covariates Used in the Analysis

Variable	*Obs.*	*Count*		*Percent*	
Respondent has a degree in 2011	36,087	12,220		33.9	
Respondent has A-Levels (or higher)	36,087	19,802		54.9	
Respondent has no qualifications	36,087	3,172		8.8	
Respondent has less than good self-reported health in 2011	36,087	2,871		7.9	
Sex: female	36,087	18,430		51.1	
Parents divorced or separated 2001	36,087	6,171		17.1	
Parents House-owner 2001	36,087	27,595		76.5	
Parental educational deprivation 2001	36,087	8,228		22.8	
Parental employment deprivation 2001	36,087	8,805		24.4	
Variable	*Obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*
Age in 2011	36,087	24.90	1.969	22	28
Multiple Area deprivation (log-transformed)	36,087	2.878	0.739	0.788	4.419

Table 3: Percentages of Respondents With a Degree and With Bad Health in 2011 By the Month of Birth

Month of Birth	*Respondent has a degree in 2011*		*Less than good health in 2011*	
	Percent	*N*	*Percent*	*N*
January	32.15	1,002	7.80	243
February	33.08	911	7.70	214
March	33.06	1,074	7.48	243
April	35.02	984	8.08	227
May	36.11	1,163	8.26	266
June	35.69	1,180	7.92	262
July	32.97	948	8.14	234
August	33.48	1,088	7.69	250
September	33.82	1,072	8.90	282
October	33.74	1,012	7.80	234
November	32.85	880	7.80	209
December	34.10	906	7.79	207
Total (all months combined)	33.86	12,220	7.96	2,871
Chi-Squared test (11d.f.)	22.21		6.26	
Cramer's V	0.025		0.013	
p-value	0.023		0.856	

Table 3 shows the percentages of respondents by birth month who by the time of the 2011 Census had obtained a university degree, and also the proportions reporting bad or very bad general health. As the two months before and after the cut-off (July) can effectively be seen as being treatment and control groups, we would expect especially those born in June to be strongly significantly more disadvantaged than those born in July, who are one year older.

Table 3 clearly demonstrates that those individuals born closer to the cut-off date for the start of the Northern Ireland school year are no more disadvantaged with respect to the likelihood of obtaining a university degree, nor are they any more likely to report being in less than good health, compared to those born in other months. That is individuals in the 1983-1989 birth cohort who were born in May and June were no less likely to obtain a degree than those born in August, October or any other month of the year. If anything, those born in April, May and June are marginally more likely than those born in other months to obtain a degree, but the difference is very small and only 2.25 percent more than the overall rate for all individuals irrespective of month. A Chi-squared test of difference detects a significant ($p<0.05$) difference in row proportions across the 12 months (Table 3). However, it should be noted that the large sample size will show even substantially very small differences as statistically significant when assessed by the chi-squared test. Moreover, a Cramer's V statistic confirms that the effect size is very weak (Table 3). With regard to self-reported bad health in 2011 for those aged 22 to 28, there are no substantially or statistically significant differences by the month of birth (as confirmed by Chi-squared and Cramer's V statistics).

Table 4 contains four binary logistic multilevel regression models that were carried out to facilitate comparison with other studies in the literature. The left hand side of the table shows binary logistic regression multilevel models for reporting having a university degree in 2011. Model 1 includes birth month as the sole predictor and July as the reference category, whilst Model 2 includes the full set of covariates. The right hand side of Table 2 shows multilevel models for less than good (fair to bad) self-reported health using the same approach with Models 3 and 4 respectively including just birth month, and finally the full set of covariates. For each of the two outcomes, the second 'full' models (Models 2 and 4) control for: respondents' sex (male is the reference category), age (in years), parental divorce/separation, and for households: 2001 tenure, as well as educational, employment and health deprivation. The coefficients for the binary logistic multilevel models are presented as odds ratios with their 95 per cent confidence intervals in parentheses.

Model 1 shows that there are some monthly variations. Contrary to expectation, sample members born in April, May and June (the youngest in the Northern Ireland academic year) are a few percentage points *more* – not less – likely than those born in other months to have a degree in 2011. For example, the odds of having gained a degree by 2011 of those born in May are 16 per cent higher than for those born in July, and the odds of those born in June are 15 per cent higher. However, these monthly variations are barely statistically significant. The statistical significant, but weak effect sizes for birth months April to June may well be an artefact of the exceptionally large sample size of the NILS. When looking at age effects in years, we find that the middle year cohorts tend to have a higher likelihood than the youngest and older cohorts to have a degree. However, older respondents are not more likely than the youngest ones to have obtained a degree by 2011. Once the covariates are added in Model 2, the situation with regard to birth month does not change. However, the signs and statistical significance of the control variables are very much as might be expected from other literature (see, for example, Breen and Jonsson, 2005). In particular, educational and employment deprivation of the parental household decrease the odds of having a degree, whereas home ownership of the household (relative to social and private renting households) and female sex of the respondent increase the odds of getting a degree.

There is a very similar picture with regard to general health in Models 3 and 4 (Table 3). Those born in May and June are no more likely to report less than good health in 2011, at age 22 to 28 years, than individuals born in other months. There

Table 4: Binary Logistic Multilevel Models – The Effect of the Month of Birth on Educational Success and Self-reported Health in Early Adulthood

	DV: Respondent has a Degree				*DV: Less than Good Health*			
	M1 Odds Ratio [95% CI]		*M2 Odds Ratio [95% CI]*		*M3 Odds Ratio [95% CI]*		*M4 Odds Ratio (CIs)*	
January	0.985		0.984		0.957		0.952	
	[0.785	1.166]	[0.862	1.122]	[0.785	1.166]	[0.762	1.190]
February	1.024		1.020		0.931		0.931	
	[0.912	1.149]	[0.892	1.166]	[0.759	1.142]	[0.741	1.169]
March	1.016		1.014		0.921		0.924	
	[0.909	1.135]	[0.888	1.158]	[0.756	1.122]	[0.735	1.160]
April	1.106*		1.166		1.114		1.096	
	[0.987	1.239]	[0.987	1.378]	[0.911	1.364]	[0.829	1.450]
May	1.165*		1.182*		1.081		1.070	
	[1.044	1.301]	[1.039	1.346]	[0.891	1.313]	[0.859	1.332]
June	1.153*		1.176*		0.973		0.963	
	[1.033	1.286]	[1.033	1.338]	[0.801	1.182]	[0.774	1.199]
July	refcat		refcat		refcat		Refcat	
August	1.048		1.048		0.942		0.946	
	[0.938	1.170]	[0.934	1.175]	[0.774	1.146]	[0.777	1.151]
September	1.055		1.058		1.128		1.130	
	[0.944	1.179]	[0.943	1.188]	[0.931	1.366]	[0.932	1.370]
October	1.058		1.072		0.944		0.944	
	[0.945	1.184]	[0.954	1.205]	[0.773	1.152]	[0.773	1.153]
November	0.998		0.996		0.966		0.969	
	[0.888	1.121]	[0.883	1.124]	[0.786	1.186]	[0.789	1.190]
December	1.088		1.056		0.933		0.934	
	[0.968	1.221]	[0.936	1.191]	[0.759	1.147]	[0.760	1.148]

Table 4: Binary Logistic Multilevel Models – The Effect of the Month of Birth on Educational Success and Self-reported Health in Early Adulthood (contd.)

	DV: Respondent has a Degree		*DV: Less than Good Health*	
	M1 Odds Ratio [95% CI]	*M2 Odds Ratio [95% CI]*	*M3 Odds Ratio [95% CI]*	*M4 Odds Ratio (CIs)*
Cohort: born before July ’83		0.899		1.032
		[0.795 1.017]		[0.507 2.100]
Cohort: July ’83 – June ’84		1.034		0.966
		[0.932 1.147]		[0.525 1.777]
Cohort: July ’84 – June ’85		1.209*		0.956
		[1.045 1.397]		[0.568 1.610]
Cohort: July ’85 – June ’86		1.425*		0.964
		[1.170 1.736]		[0.627 1.484]
Cohort: July ’86 – June ’87		1.440*		0.951
		[1.120 1.851]		[0.670 1.350]
Cohort: July ’87 – June ’88		1.267		1.096
		[0.933 1.719]		[0.831 1.444]
Cohort: July ’88 – June ’89		refcat		Refcat
Sex: female		1.879*		1.302*
		[1.792 1.970]		[1.200 1.413]
Parents divorced		0.664*		1.399*
		[0.617 0.715]		[1.263 1.550]
Accommodation owner-occupied, 2001		2.072*		0.563*
		[1.927 2.227]		[0.510 0.620]
Parental household, 2001: educational deprivation		0.515*		1.281*
		[0.481 0.550]		[1.163 1.411]

Table 4: Binary Logistic Multilevel Models – The Effect of the Month of Birth on Educational Success and Self-reported Health in Early Adulthood (contd.)

	DV: Respondent has a Degree		*DV: Less than Good Health*	
	M1 Odds Ratio [95% CI]	*M2 Odds Ratio [95% CI]*	*M3 Odds Ratio [95% CI]*	*M4 Odds Ratio (CIs)*
Parental household, 2001:				
employment deprivation		0.696*		1.111*
		[0.655 0.739]		[1.017 1.214]
Log multiple area deprivation score (2001)		0.722*		1.121*
		[0.693 0.753]		[1.050 1.196]
Constant		0.010*	0.001	0.001*
		[0.002 0.056]	[0.000 0.010]	[0.000 0.010]
Level-2 Variance	0.256	0.068	0.196	0.199
Likelihood-ratio test against single-level model	900.22*	67.56*	4.72*	63.13*
Likelihood-ratio test M2 against M1		3275.91*	2046.52*	2046.52*
N (individuals)	36,087	36,087	36,087	36,087
N (SOA's)	890	890	890	890

Note: * P<0.05; In parentheses: 95 per cent confidence intervals. Health less than good includes health categories from fair to very bad.

are no substantially or statistically significant month of birth effects in either the uncontrolled model (M3) or the controlled model (M4). Also, age in school year cohorts has no effect on the respondents' self-reported health in later life. The effects of the control variables are, as expected, statistically significantly related to poor self-reported health later in life: being female, having been exposed to educational, employment and health deprivation in the parental household earlier in life, and area-deprivation, are all positively related to self-reported less than good health ten years later as an adult.

We undertook the same models for having obtained at least A-Levels and for having no qualifications at all in 2011. These models showed no systematic birth-month effects in the expected direction and corroborated the findings for degree-level qualifications and self-reported health in general. The model with having at least A-Levels as the dependent variable mirrors the results for having a degree, and for having no qualification, only the January-born are slightly less likely to have no qualification than the other birth months. We do not present these findings here for reasons of space. These models are supplied in Table 5 in the Appendix to this paper.

V DISCUSSION AND CONCLUSION

This paper sought to test whether relative age, an individual's month of birth within school year cohorts, influenced later educational success and health. There is evidence in the literature that relative age within school year has an influence on later educational outcomes (Crawford *et al*., 2013) albeit with a diminishing effect with increasing age. There is also evidence for a birth-month effect that goes beyond this with specific medical conditions being related to certain months of birth and sporting prowess and income amongst other themes all being related to seasonal birth factors (see, for example, Buckles and Hungerman, 2013). It should be noted that education is also known to have an influence on health with poorer health being associated with poorer education. This suggests that there are potentially at least two separate processes in play with relative age within school year having an impact on educational outcomes, but other factors associated with birth month and season influencing other aspects such as health.

This analysis of a cohort of young people in Northern Ireland between 2001 and 2011 was unable to detect a considerable birth-month effect on later life educational success by 2011. The birth-month effects that we found were small and, in particular, they did not show the expected disadvantage of the summer-born. Large socio-economic effects of the direction predicted by the literature (Breen and Jonsson, 2005; Sullivan, 2001) were, however, observed. Living in a household with employment and education deprivation, and with divorced/separated parents decreased the chances of having a degree by 2011, for instance. However, no expected birth-month effect was detected despite the large numbers in the study increasing the likelihood of finding even a small effect. Similarly, Wright (2015), finds no significant relationship between term of birth (i.e. season) and probability of attending university in a multilevel analysis of Universities and Colleges Admissions Service (UCAS) data. Other factors, such as parental divorce and socio-economic deprivation were far more influential. Similarly, no birth-month effects were observed for general health in 2011 although socio-economic effects of the expected sign were seen. Some studies from other contexts (Buckles and Hungerman, 2013) found a tendency among parents of higher socio-economic status to plan when to give birth. This would allow parents to thereby avoid the summer months. Theoretically, this could bias study results. However, the fact that the distributions of birth months in the NILS data is very balanced and unrelated to parental educational advantage, as Table 1 and Table 6 (Appendix) demonstrate, gives us confidence that this is not a noticeable phenomenon in Northern Ireland and has not biased our results.

The results with regard to attainment in higher education are perhaps not so surprising, given findings by other authors (Campbell *et al*., 2013) that the effect of relative age within year decreases as individuals progress to higher education. It might be that by the time higher education is ended, as in this analysis, and individuals are in their twenties, the earlier patterns of disadvantage have been washed out or swamped by broader social and economic drivers of educational attainment. Many studies that have detected birth-month effects in education are based on survey or administrative data collected as part of schooling. They use test scores and panel data with shorter intervals between time-points, measured during secondary schooling. The waves are aligned with the national regime of student testing and more frequent monitoring in contrast to the ten-year age band used by the NILS. These studies have been designed to detect different shorter-term effects on educational attainment within school contexts. These differences might well exist within Northern Ireland schools too, but cannot be picked up with the NILS data and are a limitation of this analysis.

Another limitation is, as mentioned in the introduction, the differing policy context between Northern Ireland and other places: the school starting age differs between Northern Ireland (of 4 years), Great Britain (5 years), and other countries and so does the cut-off month of the school year. Thus, our findings are not generalisable across different (national) policy contexts. To summarise, the fact that the current analysis does not see a statistically significant negative birth-month effect on the educational success of adults suggests several hypotheses. One is that socio-economic effects in the Northern Ireland school system are so large that they outweigh the effects of birth month. Alternatively, it is possible that as relative age effects diminish with increasing absolute age other chances to gain educational qualification by other routes, for example through the further education sector and distance learning (including the Open University), mean that by the time adulthood is reached small earlier differences in attainment have been equalised.

The null result with regard to health is noted but is harder to explain given some of the effects noted in large epidemiological studies such as those undertaken in the US (eg Buckles and Hungerman, 2013), but might be attributed to some of the limitations of our analysis. Nevertheless, the NILS is an exceptionally large dataset, allowing for the analysis of a cohort representative of the population of Northern Ireland aged 12 to 18 in 2001 and subsequently 22 to 28 in 2011. Given its large sample size, even very small differences by the month of birth of individuals should have been picked up by our data. The conclusion must be either that these differences do not exist at an observable level for young people, or that the census general health question is a relatively blunt instrument. It cannot, for instance, provide detailed information on the specific health conditions discussed in the Danish and United States studies reviewed earlier. Despite this, the general health question is able to provide reliable information, since it was found to be strongly related to objective health conditions and mortality outcomes (Mackenbach *et al*., 2002; Mossey and Shapiro, 1982). Furthermore, in line with other studies (Woods *et al*., 2005; Doebler and Glasgow, 2016), we found socio-economic and area-level deprivation indicators to be strongly related to less than good reported health. The findings therefore cannot be discounted and the observation that there is no long-term health disadvantage for the summer-born, or indeed those born at other times of the year, is therefore interesting and noteworthy.

The analysis does not rule out earlier educational effects during schooling but the NILS cannot address these issues. Instead, administrative data from primary, secondary and grammar schools on educational attainment, birth month and the other economic and social covariates of performance are required using other microdata linkage approaches to consider fully the potential importance of birth month in Northern Ireland. Further analysis might also detect similar patterns with regard to health in Northern Ireland to those noted in other jurisdictions but this again will require further linkage of other data from health administrative data systems from which more finely grained information may be available in the future.

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APPENDIX:

Table 5: Binary Logistic Multilevel Models – The Effect of the Month of Birth on Educational Success and Self-Reported Health in Early Adulthood

	DV: Respondent has at least A-Levels				*DV: Respondent: No educational qualifications*			
	M1 Odds Ratio (CIs)		*M2 Odds Ratio (CIs)*		*M1 Odds Ratio (CIs)*		*M2 Odds Ratio (CIs)*	
January	0.985		1.068		0.761*		0.763*	
	[0.785	1.166]	[0.944	1.209]	[0.750	0.980]	[0.761	0.964]
February	1.024		1.094		0.940		0.930	
	[0.912	1.149]	[0.964	1.242]	[0.741	1.168]	[0.741	1.168]
March	1.016		1.037		0.924		0.923	
	[0.909	1.135]	[0.914	1.176]	[0.735	1.159]	[0.735	1.159]
April	1.106*		1.18*		1.096		1.096	
	[0.987	1.239]	[1.014	1.388]	[0.828	1.450]	[0.828	1.450]
May	1.165*		1.116*		1.106		1.069	
	[1.044	1.301]	[0.987	1.262]	[0.867	1.336]	[0.859	1.331]
June	1.153*		1.195*		0.966		0.963	
	[1.033	1.286]	[1.057	1.351]	[0.773	1.199]	[0.773	1.199]
July	refcat	refcat	refcat	refcat	refcat	refcat	refcat	refcat
August	1.048		1.065		0.926		0.926	
	[0.938	1.170]	[0.956	1.187]	[0.760	1.112]	[0.769	1.114]
September	1.055		1.039		0.921		0.920	
	[0.944	1.179]	[0.931	1.159]	[0.763	1.109]	[0.763	1.109]
October	1.058		1.051		0.931		0.920	
	[0.945	1.184]	[0.941	1.174]	[0.762	1.111]	[0.762	1.111]
November	0.998		1.031		0.903		0.924	
	[0.888	1.121]	[0.920	1.155]	[0.767	1.123]	[0.760	1.123]

Table 5: Binary Logistic Multilevel Models – The Effect of the Month of Birth on Educational Success and Self-Reported Health in Early Adulthood (contd.)

	DV: Respondent has at least A-Levels		*DV: Respondent: No educational qualifications*	
	M1 Odds Ratio (CIs)	*M2 Odds Ratio (CIs)*	*M1 Odds Ratio (CIs)*	*M2 Odds Ratio (CIs)*
December	1.088	1.092	0.877	0.876
	[0.968 1.221]	[0.975 1.224]	[0.719 1.068]	[0.719 1.068]
Cohort: born before July '83		refcat		refcat
Cohort: July '83 – June '84		0.922		1.295
		[0.654 1.301]		[0.726 2.310]
Cohort: July '84 – June '85		0.874		1.394
		[0.652 1.172]		[0.850 2.284]
Cohort: July '85 – June '86		0.9711		1.306
		[0.762 1.236]		[0.870 1.962]
Cohort: July '86 – June '87		1.167		1.107
		[0.962 1.417]		[0.799 1.534]
Cohort: July '87 – June '88		1.138		1.042
		[0.978 1.324]		[0.807 1.346]
Cohort: July '88 – June '89		1.178*		0.988
		[1.044 1.328]		[0.804 1.214]
Sex: Female		1.804		0.586*
		[1.725 1.888]		[0.541 0.634]
Parents divorced		0.753		1.283*
		[0.707 0.803]		[1.168 1.409]
Accommodation owner-occupied, 2001		2.093		0.377*
		[1.969 2.224]		[0.344 0.413]

Table 5: Binary Logistic Multilevel Models – The Effect of the Month of Birth on Educational Success and Self-Reported Health in Early Adulthood (contd.)

	DV: Respondent has at least A-Levels		*DV: Respondent: No educational qualifications*	
	M1 Odds Ratio (CIs)	*M2 Odds Ratio (CIs)*	*M1 Odds Ratio (CIs)*	*M2 Odds Ratio (CIs)*
Parental household, 2001: educational deprivation		0.516		2.183*
		[0.480 0.547]		[2.000 2.380]
Parental household, 2001: employment deprivation		0.735		1.253*
		[0.696 0.776]		[1.151 1.364]
Log multiple area deprivation score (2001)		0.726		1.604*
		[0.697 0.755]		[1.494 1.722]
Constant		0.239		0.047*
		[0.069 0.823]		[0.006 0.382]
SOA				
Level-2 Variance	0.085	0.004	0.099	0.090
Likelihood-ratio test against single-level model	900.22	86.48	4.72	76.33
Likelihood-ratio test M2 against M1	698.78		18,706.6	
N (individuals)	36,087	36,087	36,087	36,087
N (SOAs)	890	890	890	890

Note: * P<0.05; In parentheses: 95 per cent confidence intervals. Health less than good includes health categories from fair to very bad.

Table 6: Respondents' Months of Birth by Educational Advantage of the Parental Household in 2001, Frequencies and Percentages

		Household-Level Educational Deprivation (2001)		*Whether Head of Household Has a Degree (2001)*		
Birth Month		*Household Not Educationally Deprived (2001)*	*Household Educationally Deprived (2001)*	*Has a Degree (2001)*	*Has No Degree*	*Total*
January	N	1,873	1,244	447	2,670	3,117
	%	8.6	8.8	8.9	8.6	8.6
February	N	1,661	1,093	375	2,379	2,754
	%	7.6	7.7	7.5	7.6	7.6
March	N	1,990	1,259	440	2,809	3,249
	%	9.1	8.9	8.8	9.0	9.0
April	N	1,749	1,061	422	2,388	2,810
	%	7.9	7.5	8.4	7.7	7.8
May	N	1,963	1,258	471	2,750	3,221
	%	8.9	8.9	9.4	8.8	8.9
June	N	2,012	1,294	456	2,850	3,306
	%	9.2	9.1	9.1	9.2	9.2
July	N	1,741	1,134	386	2,489	2,875
	%	7.9	7.9	7.7	8.0	7.9
August	N	1,953	1,297	455	2,795	3,250
	%	8.9	9.1	9.1	8.9	9.0
September	N	2,002	1,168	434	2,736	3,170
	%	9.2	8.2	8.7	8.8	8.8
October	N	1,778	1,221	406	2,593	2,999
	%	8.1	8.6	8.1	8.3	8.3
November	N	1,597	1,082	347	2,332	2,679
	%	7.3	7.6	6.9	7.5	7.4
December	N	1,572	1,085	362	2,295	2,657
	%	7.2	7.6	7.2	7.4	7.4
Total	N	21,891	14,196	5,001	31,086	36,087
	%	100	100	100	100	100