Supplemental material

BMJ Publishing Group Limited (BMJ) disclaims all liability and responsibility arising from any reliance placed on this supplemental material which has been supplied by the author(s)

Arch Dis Child

Supplementary material 1. Characteristics (baseline) of participants included at each stage of the study, excluding twins*¶.

Characteristics	Stage 1 England (n=11,372)		Stage 2 Linked (n=7,429)		Stage 3 Eligible (n=5,290)		Stage 4 Final sample (n=4,940)	
	n	(%)	n	(%)	n	(%)	n	(%)
Pregnancy and child-related								
Gestational age at birth**	39.4	(2.0)	39.4	(1.9)	39.8	(1.3)	39.8	(1.3)
Female	5,549	(48.9)	3,690	(49.1)	2,686	(49.5)	2,517	(49.9)
Age at Key Stage 4**	16.2	(0.3)	16.2	(0.3)	16.2	(0.3)	16.2	(0.3)
No older siblings	5,747	(51.4)	3,709	(51.2)	2,641	(50.8)	2,492	(51.2)
Smoked during pregnancy								
Never	4,660	(65.9)	5,129	(65.1)	3,745	(63.8)	3,515	(64.4)
Gave up	1,384	(13.3)	899	(13.3)	635	(13.2)	601	(13.4)
Kept smoking	2,313	(20.8)	1,397	(21.6)	910	(23.0)	824	(22.2)
Mod/heavy alcohol in preg.	775	(7.5)	522	(7.4)	391	(7.7)	370	(7.7)
Sociodemographic								
Maternal age (years)**	30.1	(6.0)	29.8	(5.9)	29.7	(6.1)	29.8	(6.0)
Maternal education								
Higher	2,678	(27.0)	1,926	(24.8)	1,584	(23.6)	1,551	(25.0)
Medium	929	(8.8)	652	(8.5)	486	(8.1)	471	(8.5)
Lower	5,022	(46.3)	3,366	(47.6)	2,371	(48.7)	2,238	(49.2)
Other	424	(2.5)	230	(2.5)	137	(2.3)	112	(2.0)
None	2,279	(15.4)	1,243	(16.6)	706	(17.3)	568	(15.3)
Highest parental social class								
Managerial/Professional	4,392	(44.9)	3,208	(43.4)	2,549	(42.1)	2,477	(44.2)
Intermediate	3,200	(28.1)	2,101	(28.4)	1,445	(27.9)	1,348	(28.2)
Semi-routine/routine	2,951	(22.0)	1,720	(23.0)	1,056	(24.3)	921	(22.6)
Not applicable	829	(5.0)	400	(5.2)	240	(5.7)	194	(4.9)
Mother working at age 9 m.	4,758	(47.0)	3,470	(47.1)	2,669	(47.9)	2,571	(49.4)
Maternal relationship status								
Married	6,779	(60.1)	4,639	(58.7)	3,415	(56.5)	3,220	(57.9)
Cohabitation	2,751	(25.9)	1,821	(26.9)	1,277	(27.8)	1,196	(27.9)
Single mother	1,817	(13.9)	960	(14.4)	598	(15.7)	524	(14.2)
Maternal ethnicity: White	8,543	(86.4)	5,859	(86.1)	4,363	(88.1)	4,174	(89.6)
Language spoken at home								
English only	8,984	(90.9)	6,075	(90.9)	4,525	(90.7)	4,305	(92.0)
English + other language	1,770	(9.1)	1,001	(9.1)	765	(9.3)	635	(8.0)

Supplemental material

BMJ Publishing Group Limited (BMJ) disclaims all liability and responsibility arising from any reliance
placed on this supplemental material which has been supplied by the author(s)

Arch Dis Child

Supplementary material 1 (cont.). Characteristics (baseline) of participants included at each stage of the study, excluding twins*¶.

Characteristics	Stage 1 England (n=11,372)		Stage 2 Linked (n=7,429)		Stage 3 Eligible (n=5,290)		Stage 4 Final sample (n=4,940)	
	n	(%)	n	(%)	n	(%)	n	(%)
Sociodemographic (cont.)								
Index of Multiple Deprivation								
Poorest quintile	4,041	(23.3)	2,325	(24.4)	1,430	(24.4)	1,248	(22.8)
Second quintile	2,469	(19.3)	1,617	(19.8)	1,168	(20.6)	1,089	(20.3)
Middle quintile	1,947	(20.5)	1,369	(20.9)	1,035	(21.3)	989	(21.8)
Fourth quintile	1,533	(18.9)	1,080	(17.8)	849	(17.7)	823	(18.4)
Richest quintile	1,381	(18.0)	1,038	(17.2)	808	(16.0)	791	(16.8)
Maternal cognitive score**	-	-	-	-	-	-	0.0	(0.99)
Schooling outcomes								
Key Stage 3 (age 16)								
English GCSE								
<Expected (Level <2)	-	-	2,416	(34.3)	1,575	(33.4)	1,394	(31.3)
Expected (Level ≥2 & <3)	-	-	3,813	(50.4)	2,769	(51.0)	2,632	(52.5)
>Expected (Level ≥3)	-	-	1,195	(15.3)	944	(15.5)	914	(16.2)
Math GCSE								
<Expected (Level <2)	-	-	2,354	(33.3)	1,517	(32.3)	1,329	(29.9)
Expected (Level ≥2 & <3)	-	-	3,638	(48.5)	2,658	(49.5)	2,529	(51.0)
>Expected (Level ≥3)	-	-	1,432	(18.2)	1,113	(18.2)	1,082	(19.1)
General outcomes								
Five GCSEs	-	-	4,186	(54.6)	3,152	(55.1)	3,030	(57.4)
Attainment 8	-	-	45.4	(19.7)	45.7	(20.0)	47.1	(18.9)

* Numbers do not exactly match those of the flowchart, as all these descriptive statistics have been produced excluding twins.

¶ All percentages consider the complex survey sampling of MCS and percentages from Stages 2-4 additionally consider longitudinal attrition.

** Mean (standard deviation)

Stage 1 - England: Initial MCS participants from England, considering baseline weights.

Stage 2 - Linkage: MCS participants from England with productive educational data linkage. Weights consider longitudinal attrition at age 7 (when educational data linkage was carried out).

Stage 3 - Eligible: Participants that, additionally, meet the eligibility criteria (excluding pre-term births, no data on gestational age, birth weight exclusions, not speaking English, and not being present at the follow-up visit at age 14). Weights consider longitudinal attrition at age 14.

Stage 4 - Final sample: Final sample of participants included in the analysis, after excluding those that were examined in a different academic year, had missing data for the educational outcomes, had an Attainment 8 score of zero, or had missing data for the confounders, including maternal cognitive ability. Weights consider longitudinal attrition at age 14.

Supplemental material

BMJ Publishing Group Limited (BMJ) disclaims all liability and responsibility arising from any reliance placed on this supplemental material which has been supplied by the author(s)

Arch Dis Child

Supplementary material 2. Univariate association between participants' characteristics and KS4 results at age 16 in English (n=5,026) and Mathematics (n=5,012)*, Millennium Cohort Study.

Characteristics	English						p	Math						p¶
	Failed		Low pass		High pass (A-A*)			Failed		Low pass		High pass (A-A*)		
	n	(%)	n	(%)	n	(%)		n	(%)	n	(%)	n	(%)	
Pregnancy and child-related														
Gestational age at birth**	39.7	(1.2)	39.8	(1.3)	39.9	(1.3)	0.062	39.7	(1.2)	39.8	(1.3)	39.9	(1.4)	0.069
Sex														
Female	558	(24.9)	1,399	(54.5)	586	(20.6)	<0.001	679	(30.2)	1,326	(51.4)	534	(18.4)	0.259
Male	914	(40.1)	1,240	(48.6)	329	(11.3)		722	(32.1)	1,203	(48.8)	548	(19.1)	
Age at Key Stage 4**	16.2	(0.3)	16.2	(0.3)	16.2	(0.3)	0.207	16.2	(0.3)	16.2	(0.3)	16.2	(0.3)	0.513
Older siblings														
No	724	(32.2)	1,328	(51.5)	481	(16.3)	0.715	668	(29.9)	1,286	(50.7)	569	(19.4)	0.198
Yes	748	(33.0)	1,311	(51.5)	434	(15.5)		733	(32.5)	1,243	(49.4)	513	(18.1)	
Smoked during pregnancy														
Never	909	(27.3)	1,913	(53.6)	738	(19.1)	<0.001	872	(26.5)	1,790	(50.6)	88	(22.9)	<0.001
Gave up	170	(29.9)	334	(55.1)	103	(15.0)		166	(29.3)	331	(53.5)	110	(17.2)	
Kept smoking	393	(49.0)	392	(43.6)	74	(7.4)		363	(45.3)	408	(46.5)	84	(8.2)	
Mod/heavy alcohol in preg.														
No	1,337	(32.0)	2,448	(51.8)	850	(16.2)	0.043	1,288	(30.9)	2,333	(50.0)	1,014	(19.1)	0.126
Yes	129	(39.0)	184	(47.6)	64	(13.4)		113	(33.9)	196	(51.4)	68	(14.7)	
Sociodemographic, age 9 m.														
Maternal age (years)**	28.5	(5.9)	30.0	(5.9)	31.6	(5.7)	<0.001	28.7	(6.0)	29.9	(5.9)	31.5	(5.5)	<0.001
Maternal education														
Higher (NVQ 4 and 5)	341	(22.3)	773	(49.5)	448	(28.2)	<0.001	315	(20.2)	704	(45.5)	539	(34.3)	<0.001
Medium (NVQ 3)	106	(22.0)	261	(55.3)	109	(22.7)		92	(20.1)	266	(55.3)	117	(24.6)	
Lower (NVQ 1 and 2)	711	(33.7)	1,288	(55.2)	274	(11.1)		682	(32.2)	1,245	(54.0)	340	(13.8)	
Other/None§	314	(48.7)	317	(42.2)	84	(9.1)	<0.001	312	(48.5)	314	(43.2)	86	(8.3)	<0.001
Highest parental social class														
Managerial/Professional	555	(22.7)	1,330	(54.3)	612	(23.0)	<0.001	504	(20.5)	1,242	(50.6)	745	(28.9)	<0.001
Intermediate	424	(33.6)	758	(53.3)	192	(13.1)		398	(31.4)	761	(55.3)	211	(13.3)	
Semi-routine/routine	397	(45.8)	470	(46.7)	85	(7.5)		409	(46.2)	437	(45.1)	103	(8.7)	
Not applicable	96	(51.9)	81	(39.1)	26	(9.0)		90	(52.4)	89	(39.4)	23	(8.2)	
Mother working														
No	854	(39.5)	1,168	(46.7)	400	(13.8)	<0.001	808	(37.6)	1,153	(46.8)	455	(15.6)	<0.001
Yes	618	(25.4)	1,471	(56.5)	515	(18.1)		593	(24.4)	1,376	(53.5)	627	(22.1)	

Supplemental material

BMJ Publishing Group Limited (BMJ) disclaims all liability and responsibility arising from any reliance placed on this supplemental material which has been supplied by the author(s)

Arch Dis Child

Supplementary material 2 (cont.). Univariate association between participants' characteristics and KS4 results at age 16 in English (n=5,026) and Mathematics (n=5,012) GCSEs*, Millennium Cohort Study.

Characteristics	English						p	Math						p¶
	Failed		Low pass		High pass (A-A*)			Failed		Low pass		High pass (A-A*)		
	n	(%)	n	(%)	n	(%)		n	(%)	n	(%)	n	(%)	
Sociodemographic (cont.)														
Maternal relationship status														
Married	834	(27.1)	1,730	(52.9)	696	(20.0)	<0.001	796	(25.4)	1,636	(50.8)	824	(23.8)	<0.001
Cohabitation	398	(36.7)	654	(51.2)	169	(12.1)		370	(35.0)	642	(51.1)	201	(13.9)	
Single mother	240	(46.1)	255	(46.7)	50	(7.2)		235	(46.4)	251	(45.1)	57	(8.5)	
Maternal ethnicity														
White	1,259	(33.3)	2,215	(51.0)	773	(15.7)	0.047	1,169	(30.3)	2,148	(49.9)	917	(18.9)	0.734
Other ethnicity	213	(26.5)	424	(55.5)	142	(18.0)		232	(31.3)	381	(51.7)	165	(17.9)	
Language spoken at home														
English only	1,302	(33.3)	2,294	(51.2)	784	(15.5)	0.001	1,218	(31.5)	2,233	(50.1)	915	(18.4)	0.011
English + other language	170	(24.4)	345	(55.4)	131	(20.2)		183	(27.0)	296	(49.3)	167	(23.7)	
Index of Multiple Deprivation														
Poorest quintile	491	(44.6)	624	(46.0)	168	(9.4)	<0.001	474	(43.4)	617	(45.0)	190	(11.6)	<0.001
Second quintile	355	(35.6)	579	(50.7)	182	(13.7)		331	(34.1)	574	(50.8)	206	(15.1)	
Middle quintile	259	(30.8)	556	(53.3)	182	(15.9)		265	(30.4)	529	(53.1)	203	(16.5)	
Fourth quintile	199	(25.1)	455	(55.2)	179	(19.7)		180	(23.2)	419	(52.0)	228	(24.8)	
Richest quintile	168	(22.9)	425	(53.7)	204	(23.4)		151	(20.3)	390	(20.1)	255	(29.6)	
Maternal cognitive score**	-0.26	(0.91)	0.02	(0.96)	0.47	(1.11)	<0.001	-0.29	(0.91)	0.00	(0.95)	0.48	(1.08)	<0.001

*Parameters were estimated considering the complex design of the MCS sample. The counts reflect the absolute number of participants included.

**Mean (S.D.)

¶Chi-square or mean difference, as appropriate.

§No education and Other/overseas educational qualifications were displayed together as a safeguarding procedure, as some counts were <10.

Supplemental material

BMJ Publishing Group Limited (BMJ) disclaims all liability and responsibility arising from any reliance
placed on this supplemental material which has been supplied by the author(s)

Arch Dis Child

Supplementary material 3. Univariate association between participants' characteristics and KS4 results at age 16: Passing five GCSEs with marks ≥5, including English and Mathematics (n=5,012) and Attainment 8 score (n=4,940)*, Millennium Cohort Study.

Characteristics	Five GCSEs ≥5 marks				p	Attainment 8		p¶
	No		Yes					
	n	(%)	n	(%)		Mean	S.D.	
Pregnancy and child-related								
Gestational age at birth**	39.7	(1.2)	39.8	(1.3)	0.019	0.03		0.017
Sex								
Female	865	(38.2)	1,674	(61.8)	<0.001	49.4	(18.7)	<0.001
Male	1,117	(48.9)	1,356	(51.1)		44.9	(18.7)	
Age at Key Stage 4**	16.2	(0.3)	16.2	(0.3)	0.120	0.02		0.117
Older siblings								
No	970	(42.9)	1,553	(57.1)	0.347	47.5	(18.7)	0.197
Yes	1,012	(44.4)	1,477	(55.6)		46.7	(19.0)	
Smoked during pregnancy								
Never	1,230	(36.9)	2,320	(63.1)	<0.001	50.1	(19.6)	<0.001
Gave up	245	(43.5)	362	(56.5)		46.5	(17.3)	
Kept smoking	507	(62.7)	348	(37.3)		38.8	(15.0)	
Mod/heavy alcohol in preg.								
No	1,818	(43.2)	2,817	(56.8)	0.088	47.3	(18.8)	0.009
Yes	164	(48.4)	213	(51.6)		44.4	(19.5)	
Sociodemographic, age 9 m.								
Maternal age (years)**	28.6	(5.9)	30.7	(5.8)	<0.001	0.18		<0.001
Maternal education								
Higher (NVQ 4 and 5)	438	(28.4)	1,120	(71.6)	<0.001	55.4	(21.4)	<0.001
Medium (NVQ 3)	151	(32.3)	324	(67.7)		51.8	(19.7)	
Lower (NVQ 1 and 2)	990	(46.4)	1,277	(53.6)		44.8	(16.3)	
Other/None §	403	(62.2)	309	(37.8)		39.3	(16.5)	
Highest parental social class								
Managerial/Professional	737	(30.5)	1,754	(69.5)	<0.001	53.1	(19.7)	<0.001
Intermediate	586	(45.8)	784	(54.2)		45.2	(16.9)	
Semi-routine/routine	535	(60.4)	414	(39.6)		40.0	(15.5)	
Not applicable	124	(67.7)	78	(32.3)		37.4	(18.1)	
Mother working								
No	1,116	(51.4)	1,300	(48.6)	<0.001	44.2	(18.9)	<0.001
Yes	866	(35.6)	1,730	(64.4)		50.1	(18.3)	

Supplemental material

BMJ Publishing Group Limited (BMJ) disclaims all liability and responsibility arising from any reliance placed on this supplemental material which has been supplied by the author(s)

Arch Dis Child

Supplementary material 3 (cont.). Univariate association between participants' characteristics and KS4 results at age 16: Passing five GCSEs with marks ≥5, including. English and Mathematics (n=5,012) and Attainment 8 score (n=4,940)*, Millennium Cohort Study.

Characteristics	Five GCSEs ≥5 marks				p	Attainment 8		p
	Yes		No					
	n	(%)	n	(%)		Mean	S.D.	
Sociodemographic (cont.)								
Maternal relationship status								
Married	1,128	(36.1)	2,128	(63.9)	<0.001	50.6	(19.8)	<0.001
Cohabitation	531	(49.2)	682	(50.8)		43.9	(16.9)	
Single mother	323	(62.4)	220	(37.6)		39.2	(14.9)	
Maternal ethnicity								
White	1,669	(44.1)	2,565	(55.9)	0.145	46.9	(18.4)	0.030
Other ethnicity	313	(39.7)	465	(60.3)		48.8	(22.0)	
Language spoken at home								
English only	1,737	(44.3)	2,629	(55.7)	0.001	46.8	(18.3)	<0.001
English + other language	245	(35.4)	401	(64.6)		50.8	(23.7)	
Index of Multiple Deprivation								
Poorest quintile	658	(58.8)	623	(41.2)	<0.001	41.0	(19.1)	<0.001
Second quintile	478	(47.8)	633	(52.2)		45.5	(18.9)	
Middle quintile	368	(42.3)	629	(57.7)		47.0	(17.4)	
Fourth quintile	268	(34.9)	559	(65.1)		51.4	(17.4)	
Richest quintile	210	(28.8)	586	(71.2)		52.7	(18.8)	
Maternal cognitive score**	-0.28	(0.92)	0.21	(1.01)	<0.001	0.28		<0.001

*Parameters were estimated considering the complex design of the MCS sample. The counts reflect the absolute number of participants included.

**Mean (S.D.). Correlation coefficient between continuous variables and Attainment 8 score.

¶Chi-square, mean difference or correlation, as appropriate.

§No education and Other/overseas educational qualifications were displayed together as a safeguarding procedure, as some counts were <10.