

Supplementary Online Content

Guggenheim JA, Williams C; UK Biobank Eye and Vision Consortium. Role of educational exposure in the association between myopia and birth order. *JAMA Ophthalmol*. Published online October 8, 2015. doi:10.1001/jamaophthalmol.2015.3556.

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This supplementary material has been provided by the authors to give readers additional information about their work.

eAppendix. Method Used to Assess the Association Between Birth Order and Level of Refractive Error

To assess the relationship between birth order and the *level* of refractive error, linear regression analyses were conducted for the same sets of independent variables used in Model 1 and Model 2, with refractive error as the dependent variable.

The regression models were:

Model 1.

$$y = \beta_1 \times \text{birth order} + \beta_2 \times \text{age} + \beta_3 \times \text{sex}$$

Model 2.

$$y = \beta_1 \times \text{birth order} + \beta_2 \times \text{age} + \beta_3 \times \text{sex} + \beta_4 \times \text{highest qualification}$$

To display the latter results graphically (eFigure 1), linear regressions were carried out while excluding a term for birth order, and then the residuals were plotted against birth order.

Model 1.

$$\text{plot } y' \text{ vs. birth order, where: } y' = \beta_2 \times \text{age} + \beta_3 \times \text{sex}$$

Model 2.

$$\text{plot } y'' \text{ vs. birth order, where: } y'' = \beta_2 \times \text{age} + \beta_3 \times \text{sex} + \beta_4 \times \text{highest qualification}$$

eTable 1. Participants Included in the Model 1 and Model 2 Analysis Samples (N=89,120)

Sample characteristics/Exclusion criteria	Number of participants excluded (row percentage)	Number of participants remaining (row percentage)
All participants	-	502,682 (100%)
Underwent ophthalmic assessment	387,806 (77.1%)	114,876 (22.9%)
Self-reported ocular history of cataract, etc.	9,394 (8.2%)	105,482 (91.8%)
Autorefracton reading error	82 (0.1%)	105,400 (99.9%)
Age <40 or >69 years-old	491 (0.5%)	104,909 (99.5%)
Non-White ethnicity	11,341 (10.8%)	93,568 (89.2%)
Unknown birth order	950 (1.0%)	92,618 (99.0%)
Non-singleton birth (e.g. twin)	2,810 (3.0%)	89,808 (97.0%)
Unknown highest educational qualification	688 (0.8%)	89,120 (99.2%)

Row percentages are expressed as a percentage of the starting sample from the row above.

eTable 2. Participants Included in the Model 3 Analysis Sample (N=25,278)

Sample characteristics/Exclusion criteria	Number of participants excluded (row percentage)	Number of participants remaining (row percentage)
All participants	-	502,682 (100%)
Underwent ophthalmic assessment	387,806 (77.1%)	114,876 (22.9%)
Self-reported ocular history of cataract, etc.	9,394 (8.2%)	105,482 (91.8%)
Autorefracton reading error	82 (0.1%)	105,400 (99.9%)
Age <40 or >69 years-old	491 (0.5%)	104,909 (99.5%)
Non-White ethnicity	11,341 (10.8%)	93,568 (89.2%)
Unknown birth order	950 (1.0%)	92,618 (99.0%)
Non-singleton birth (e.g. twin)	2,810 (3.0%)	89,808 (97.0%)
Unknown highest educational qualification	688 (0.8%)	89,120 (99.2%)
Unknown maternal age	53,602 (60.1%)	35,518 (39.9%)
Unknown Townsend Deprivation Index	50 (0.1%)	35,468 (99.9%)
Unknown current time outdoors in summer	1,682 (4.7%)	33,786 (95.3%)
Unknown birth weight	8,508 (25.2%)	25,278 (74.8%)

Row percentages are expressed as a percentage of the starting sample from the row above.

eTable 3. Participants Included in the Model 4 Analysis Sample (N=57,447)

Sample characteristics/Exclusion criteria	Number of participants excluded (row percentage)	Number of participants remaining (row percentage)
All participants	-	502,682 (100%)
Underwent ophthalmic assessment	387,806 (77.1%)	114,876 (22.9%)
Self-reported ocular history of cataract, etc.	9,394 (8.2%)	105,482 (91.8%)
Autorefractometry reading error	82 (0.1%)	105,400 (99.9%)
Age <40 or >69 years-old	491 (0.5%)	104,909 (99.5%)
Non-White ethnicity	11,341 (10.8%)	93,568 (89.2%)
Unknown birth order	950 (1.0%)	92,618 (99.0%)
Non-singleton birth (e.g. twin)	2,810 (3.0%)	89,808 (97.0%)
Unknown age completed full time education	33,361 (36.0%)	57,447 (64.0%)

Row percentages are expressed as a percentage of the starting sample from the row above.

eTable 4. OR for Myopia and High Myopia by Birth Order, After Excluding Only Children

	Model 1 ^a		
	OR	95%CI	P
MYOPIA (N=77,696)			
First vs. second born	1.11	(1.07 to 1.15)	7.70E-09
First vs. third born	1.16	(1.11 to 1.22)	3.20E-10
First vs. fourth born or higher	1.37	(1.30 to 1.45)	1.60E-30
HIGH MYOPIA (N=57,188^b)			
First vs. second born	1.18	(1.09 to 1.29)	8.50E-05
First vs. third born	1.27	(1.13 to 1.42)	5.00E-05
First vs. fourth born or higher	1.42	(1.24 to 1.61)	1.40E-07

^a Model 1; Adjusted for age and sex only.

^b Sample size reduced since participants with mild/moderate myopia were excluded.

eTable 5. Relative Risk of Myopia by Birth Order

Relationship	RR	95%CI	P-value	N
First vs. second born	1.06	(1.04 to 1.09)	3.30E-07	69,259
First vs. third born	1.08	(1.05 to 1.12)	9.30E-07	53,389
First vs. fourth born or higher	1.23	(1.18 to 1.27)	7.00E-28	50,910
First vs. not first born	1.09	(1.07 to 1.12)	1.10E-18	89,120

eTable 6. Relative Risk of High Myopia by Birth Order

Relationship	RR	95%CI	P-value	N
First vs. second born	1.15	(1.07 to 1.24)	2.80E-04	50,492
First vs. third born	1.20	(1.08 to 1.33)	5.20E-04	38,839
First vs. fourth born or higher	1.35	(1.20 to 1.52)	4.30E-07	37,279
First vs. not first born	1.19	(1.12 to 1.27)	5.90E-08	65,500

eFigure. Relationship Between Refractive Error and Birth Order

The residual refractive error in UK Biobank participants (N=89,120) was plotted after adjusting for age and sex (Model 1) or after adjusted for age, sex, and highest educational qualification (Model 2). Error bars denote 95% confidence intervals.

