

# The Effects of Poor Neonatal Health on Children's Cognitive Development

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## ONLINE APPENDIX

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### Figures

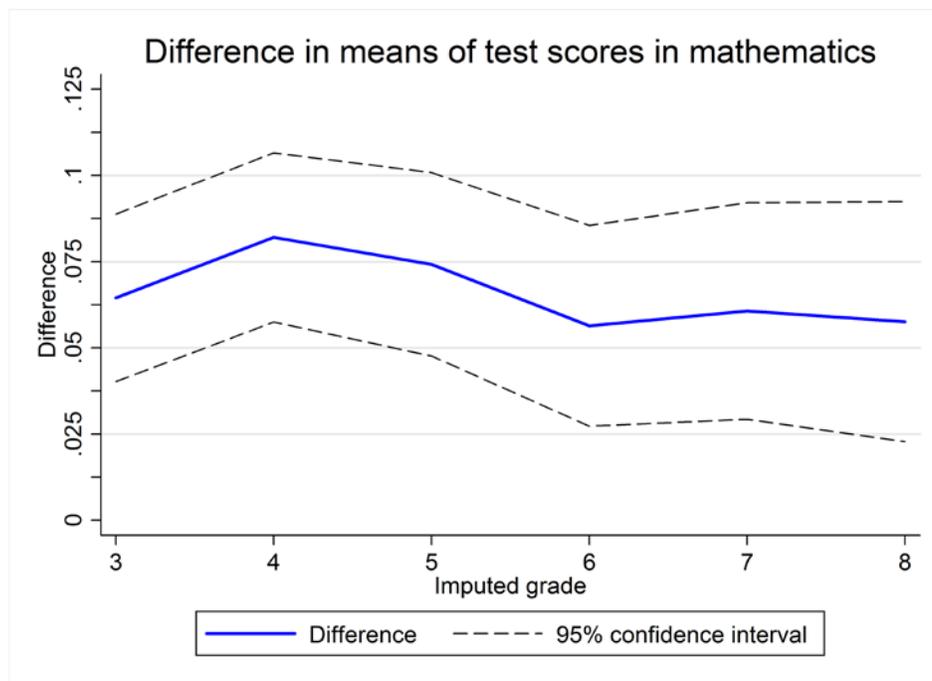


FIGURE A1. AVERAGE WITHIN-TWIN-PAIR DIFFERENCE IN MATHEMATICS BETWEEN HEAVIER AND LIGHTER TWINS

*Notes:* Figure A1 plots difference between the test score in mathematics of heavier and lighter twin from each pair in each grade and the respective 95% confidence interval of this difference. In each grade we create an average of scores for heavier and lighter twins and then calculate the difference between the two.

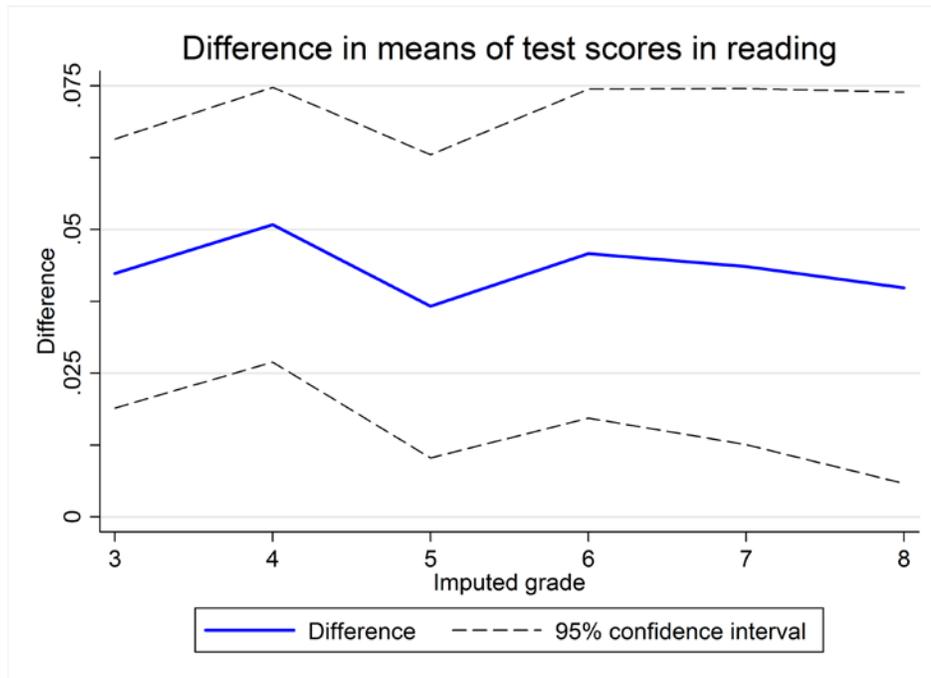


FIGURE A2. AVERAGE WITHIN-TWIN-PAIR DIFFERENCE IN READING BETWEEN HEAVIER AND LIGHTER TWINS

*Notes:* Figure A2 plots difference between the test score in reading of heavier and lighter twin from each pair in each grade and the respective 95% confidence interval of this difference. In each grade we create an average of scores for heavier and lighter twins and then calculate the difference between the two.

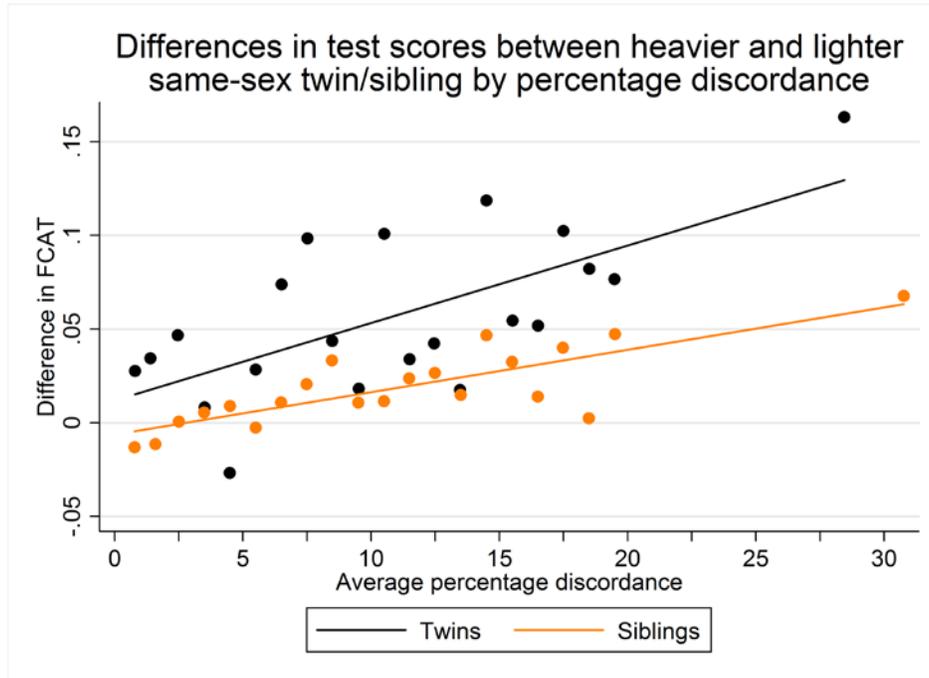


FIGURE A3: WITHIN TWIN-PAIR DIFFERENCES IN TEST SCORES BY DISCORDANCE

*Notes.* Figure A3 plots mean differences in test scores between heavier and lighter twin for twin pairs of given discordance as well as for heavier and lighter sibling among the first two siblings we observe in our data. Discordance levels are recorded every percent from 0 to 20 and then the last bin groups all twin (sibling) pairs with discordance greater than 20 percent. Discordance is measured as difference in birth weight between heavier and lighter twin (sibling) over the birth weight of heavier twin (sibling). Solid line fits a linear regression using the differences for each discordance bin as data.

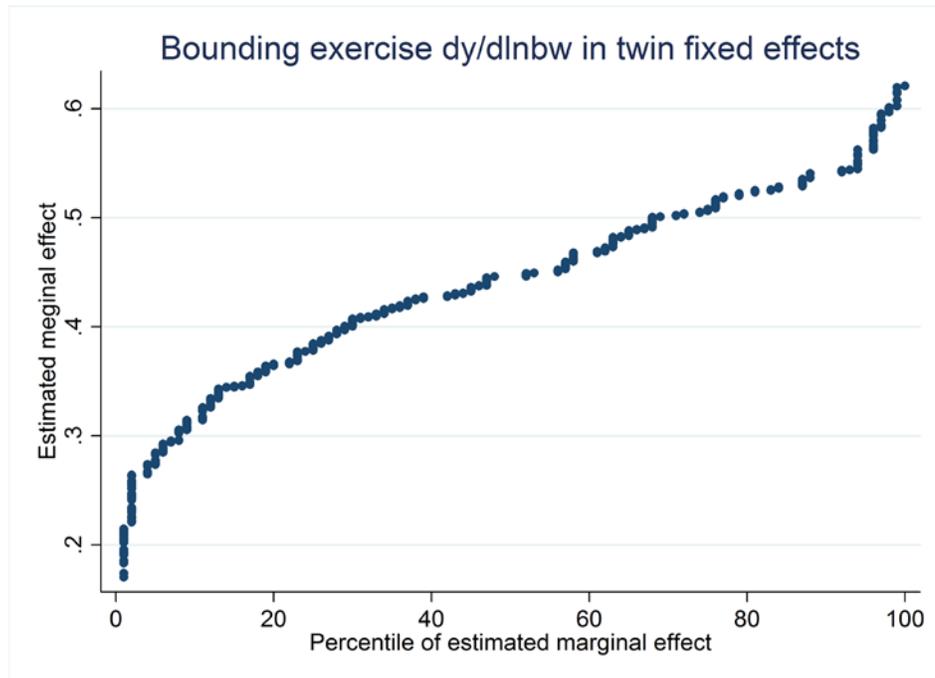


FIGURE A4: RANGE OF ESTIMATES OF MARGINAL EFFECT OF LOG BIRTH WEIGHT IN FULLY INTERACTED MODEL, TWIN FE

*Notes:* Figure A4 plots the range of estimated marginal effect of log birth weight on test scores coming from a regression of test scores on log birth weight and its interactions with education, age and income categories as well as race, ethnicity, immigration and marital status dummies. This model is run in a twin fixed effects framework as in table 2. The percentile distribution of the estimated marginal effect of birth weight is on the X axis.

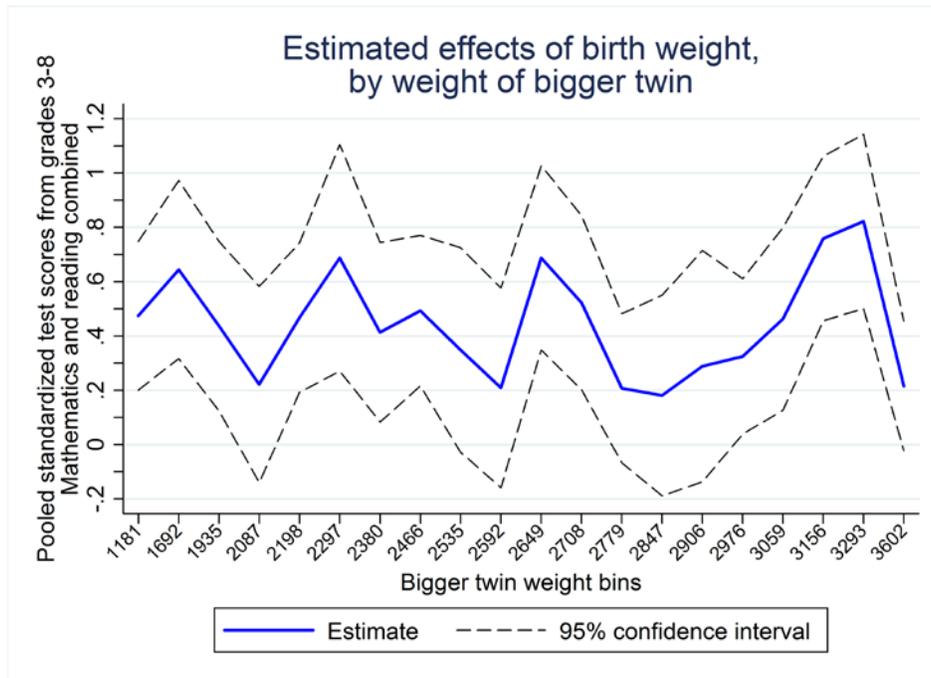


FIGURE A5. ESTIMATED EFFECTS OF BIRTH WEIGHT, BY WEIGHT OF BIGGER TWIN

*Notes:* Figure A5 plots coefficients and 95% confidence intervals from a twin FE regression where the dependent variable is the mean of pooled grades three to eight combined mathematics and reading test scores for each individual and the independent variables are 20 interactions corresponding to the product of log birth weight with indicators for 20 bins reflecting heavier twin percentiled birth weight. The regression additionally controls for infant gender and birth order within-twin pair. Heteroskedasticity robust standard errors are used to calculate the 95% confidence interval. Numbers on the x-axis correspond to the mean birth weight in each bin of heavier twin birth weight.

## Tables

TABLE A1—BIRTH WEIGHT DIFFERENCE AND TEST SCORES ACROSS IMPUTED GRADES AND GROUPS: COEFFICIENTS ON LOG BIRTH WEIGHT

Sample		(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Pooled	3	4	Imputed grade			
					5	6	7	8
Total sample		0.443*** (0.039)	0.444*** (0.043)	0.526*** (0.045)	0.431*** (0.047)	0.428*** (0.053)	0.390*** (0.057)	0.376*** (0.061)
(1) Gender	Boys	0.454*** (0.068)	0.474*** (0.073)	0.573*** (0.079)	0.383*** (0.080)	0.483*** (0.094)	0.416*** (0.096)	0.300*** (0.101)
	Girls	0.449*** (0.052)	0.453*** (0.067)	0.492*** (0.070)	0.439*** (0.068)	0.456*** (0.071)	0.387*** (0.078)	0.435*** (0.085)
(2) Maternal medical history	No medical problems	0.449*** (0.048)	0.462*** (0.055)	0.509*** (0.056)	0.454*** (0.060)	0.437*** (0.063)	0.382*** (0.073)	0.384*** (0.077)
	Medical problems	0.422*** (0.066)	0.404*** (0.071)	0.539*** (0.077)	0.389*** (0.077)	0.399*** (0.095)	0.390*** (0.090)	0.348*** (0.103)
(3) Maternal race	White	0.464*** (0.045)	0.502*** (0.051)	0.541*** (0.053)	0.438*** (0.054)	0.416*** (0.060)	0.418*** (0.065)	0.392*** (0.068)
	Black	0.392*** (0.082)	0.303*** (0.087)	0.489*** (0.090)	0.417*** (0.098)	0.462*** (0.119)	0.312*** (0.118)	0.347*** (0.137)
(4) Maternal ethnicity	Non-Hispanic	0.436*** (0.044)	0.446*** (0.049)	0.520*** (0.052)	0.438*** (0.053)	0.396*** (0.060)	0.381*** (0.064)	0.362*** (0.070)
	Hispanic	0.480*** (0.079)	0.443*** (0.095)	0.561*** (0.093)	0.399*** (0.103)	0.583*** (0.110)	0.437*** (0.115)	0.438*** (0.125)
(5) Maternal immigration history	Non-immigrant	0.441*** (0.044)	0.471*** (0.049)	0.518*** (0.052)	0.437*** (0.053)	0.408*** (0.061)	0.371*** (0.065)	0.350*** (0.070)
	Immigrant	0.456*** (0.077)	0.328*** (0.090)	0.562*** (0.090)	0.404*** (0.096)	0.520*** (0.105)	0.482*** (0.111)	0.494*** (0.122)
(6) Maternal education	Below 12	0.358*** (0.094)	0.253*** (0.110)	0.482*** (0.125)	0.430*** (0.121)	0.258*** (0.127)	0.375*** (0.146)	0.325*** (0.152)
	12-15	0.439*** (0.050)	0.470*** (0.055)	0.497*** (0.055)	0.414*** (0.060)	0.448*** (0.070)	0.370*** (0.070)	0.374*** (0.078)
	Above 15	0.523*** (0.079)	0.516*** (0.089)	0.648*** (0.099)	0.483*** (0.096)	0.495*** (0.099)	0.476*** (0.123)	0.430*** (0.129)
(7) Zip code median income	Bottom	0.388*** (0.076)	0.427*** (0.083)	0.441*** (0.085)	0.303*** (0.091)	0.340*** (0.110)	0.408*** (0.110)	0.376*** (0.133)
	Middle	0.445*** (0.072)	0.397*** (0.081)	0.525*** (0.089)	0.472*** (0.086)	0.491*** (0.101)	0.368*** (0.116)	0.341*** (0.126)
	Top	0.447*** (0.078)	0.514*** (0.085)	0.549*** (0.088)	0.371*** (0.098)	0.370*** (0.108)	0.332*** (0.120)	0.440*** (0.143)
(8) Maternal marital status	Non-married	0.372*** (0.076)	0.341*** (0.083)	0.415*** (0.086)	0.419*** (0.090)	0.386*** (0.113)	0.379*** (0.113)	0.234*** (0.115)
	Married	0.482*** (0.044)	0.498*** (0.050)	0.581*** (0.053)	0.443*** (0.055)	0.452*** (0.058)	0.398*** (0.064)	0.456*** (0.072)
(9) Maternal age at birth of children	Below 22	0.372*** (0.115)	0.376*** (0.116)	0.408*** (0.130)	0.495*** (0.136)	0.240 (0.172)	0.396** (0.168)	0.231 (0.177)
	22-29	0.444*** (0.059)	0.417*** (0.067)	0.509*** (0.066)	0.374*** (0.071)	0.532*** (0.082)	0.419*** (0.085)	0.388*** (0.093)
	30-35	0.490*** (0.069)	0.473*** (0.080)	0.590*** (0.082)	0.501*** (0.085)	0.477*** (0.090)	0.398*** (0.101)	0.430*** (0.113)
	Above 35	0.410*** (0.104)	0.531*** (0.114)	0.560*** (0.135)	0.385*** (0.125)	0.181 (0.135)	0.271* (0.155)	0.364** (0.155)

Notes: Column (1) present pooled grade three through eight results for twin-FE model. Columns (3) to (8) present twin-FE estimates separately for each of the 6 grades. Models are the same as used in columns (2) and (3) to (8) in table 2. Sample size is 126 636 individual observations in pooled regressions in column (1) except for race, maternal medical history, marital status and mean zip code income. In the case of race this discrepancy is caused by existence of other races with minor representation in Florida, in the case of income, maternal medical history and marital status we do not have complete data for all mothers and residential locations. In all these cases the modified sample sizes are used. Each coefficient comes from a separate regression.

\*\*\* Significant at the 1 percent level

\*\* Significant at the 5 percent level.

\* Significant at the 10 percent level.

TABLE A2—SENSITIVITY OF RESULTS TO MODEL SPECIFICATION

Sample	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Pooled	Imputed grade					
		3	4	5	6	7	8
(1)	0.443***	0.442***	0.528***	0.429***	0.429***	0.389***	0.375***
ln(birth weight)	(0.039)	(0.043)	(0.045)	(0.047)	(0.053)	(0.057)	(0.061)
(2)	0.526***	0.574***	0.666***	0.469***	0.517***	0.400***	0.426***
Smaller twin weight above 2500g	(0.098)	(0.110)	(0.115)	(0.121)	(0.126)	(0.144)	(0.152)
(3)	0.428***	0.417***	0.505***	0.422***	0.418***	0.389***	0.364***
Smaller twin weight below 2500g	(0.042)	(0.047)	(0.049)	(0.051)	(0.059)	(0.062)	(0.067)
(4)	0.431***	0.375***	0.485***	0.407***	0.451***	0.473***	0.402***
Smaller twin weight 1500g-2499g	(0.049)	(0.055)	(0.057)	(0.060)	(0.066)	(0.071)	(0.077)
(5)	0.432***	0.503***	0.550***	0.460***	0.360***	0.211*	0.283**
Smaller twin weight below 1500g	(0.082)	(0.089)	(0.094)	(0.096)	(0.122)	(0.118)	(0.134)
(6)	0.187***	0.186***	0.223***	0.178***	0.181***	0.171***	0.157***
Birth weight in 1000g	(0.017)	(0.019)	(0.019)	(0.020)	(0.023)	(0.024)	(0.026)
(7)	0.198***	0.197***	0.234***	0.191***	0.194***	0.179***	0.173***
Birth weight	(0.017)	(0.019)	(0.020)	(0.021)	(0.023)	(0.025)	(0.027)
Birth weight x (birth weight - mean twin pair birth weight)	-0.106***	-0.117***	-0.105***	-0.116***	-0.108**	-0.060	-0.114**
	(0.032)	(0.036)	(0.037)	(0.039)	(0.045)	(0.047)	(0.051)

Notes: Column (1) present pooled grade three through eight results for the twin-FE model. Columns (2) to (7) present twin-FE estimates separately for each of the 6 grades. All standard errors are clustered at twin pair level. Each coefficient estimate comes from a separate regression (except for the last row where there are two coefficients from the same regression reported). Models are identical to these estimated in columns (2) and (3) to (8) in table 2 but the variable of interest is substituted and the sample excludes non-discordant twin pairs. For the sake of clarity we carry over the main analysis from table 2 to the first row in this table. The second row presents the baseline model for the sample of twin pairs where smaller twin is above 2500g. The third row presents the baseline model for the sample of twin pairs where smaller twin is below 2500g. The fourth row presents the baseline model for the sample of twin pairs where smaller twin has birth weight between 1500g and 2499g. The fifth row presents the baseline model for the sample of twin pairs where smaller twin has birth weight below 1500g. The sixth row substitutes ln(birth weight) with birth weight measured in 1000g. The seventh row substitutes ln(birth weight) by birth weight in grams as the first variable and the interaction between birth weight in grams and the difference of birth weight in grams and mean twin pair birth weight in grams as the second variable.

\*\*\* Significant at the 1 percent level

\*\* Significant at the 5 percent level.

\* Significant at the 10 percent level.

Table A3—Results by school quality measures and predicted SES

Predicted SES	School quality	(1) (2) Mean test score		(3)	(4) (5) (6) Singletons			(7) (8) (9) Sibling FE		
		Twins	Singletons	Pooled twin FE estimate	Birth weight	Birth weight   gestation	Gestation	Birth weight	Birth weight   gestation	Gestation
(1) Bottom	A	-0.303 [2332]	-0.200 [3227]	0.310*** (0.088)	0.261*** (0.008)	0.360*** (0.016)	0.013*** (0.001)	0.212*** (0.028)	0.272*** (0.060)	0.007*** (0.003)
	B	-0.436 [2335]	-0.345 [3219]	0.438*** (0.098)	0.256*** (0.008)	0.343*** (0.017)	0.013*** (0.001)	0.213*** (0.033)	0.307*** (0.067)	0.008*** (0.003)
	C & D & F	-0.608 [2321]	-0.501 [3196]	0.421*** (0.096)	0.257*** (0.008)	0.330*** (0.016)	0.014*** (0.001)	0.218*** (0.026)	0.237*** (0.052)	0.010*** (0.002)
(2) Middle	A	0.210 [2457]	0.206 [3374]	0.403*** (0.068)	0.275*** (0.007)	0.424*** (0.014)	0.011*** (0.001)	0.213*** (0.027)	0.306*** (0.052)	0.005*** (0.002)
	B	0.031 [2461]	0.032 [3367]	0.571*** (0.101)	0.282*** (0.009)	0.444*** (0.018)	0.010*** (0.001)	0.203*** (0.045)	0.283*** (0.081)	0.002 (0.004)
	C & D & F	-0.103 [2468]	-0.114 [3353]	0.616*** (0.123)	0.268*** (0.011)	0.407*** (0.022)	0.011*** (0.001)	0.315*** (0.049)	0.366*** (0.085)	0.009*** (0.004)
(3) Top	A	0.648 [2474]	0.570 [3428]	0.459*** (0.067)	0.262*** (0.007)	0.405*** (0.014)	0.011*** (0.001)	0.237*** (0.025)	0.386*** (0.046)	0.003 (0.002)
	B	0.397 [2466]	0.347 [3424]	0.460*** (0.135)	0.302*** (0.012)	0.436*** (0.024)	0.013*** (0.001)	0.318*** (0.061)	0.393*** (0.113)	0.010* (0.005)
	C & D & F	0.218 [2483]	0.186 [3415]	0.314 (0.246)	0.313*** (0.017)	0.466*** (0.034)	0.016*** (0.002)	0.224* (0.119)	0.320* (0.180)	-0.001 (0.011)

Notes: Descriptive statistics for each group for the whole populations are reported in columns (1) to (2). These present mean combined mathematics and reading test scores as well as mean birth weight for twins and singletons respectively. Column (3) presents pooled grades three through eight twin-FE model estimates corresponding to model outlined in column (2) in table 2. Columns (4) to (6) present estimates for singleton population. Column (4) presents the correlation between pooled grades three through eight test scores and birth weight for all singletons. Column (5) presents the correlation between pooled grades three through eight test scores and birth weight conditional on gestation for the sample of singletons that overlap in birth weight with twin population, i.e. birth weight in range 847 to 3600 grams. Column (6) presents the correlation between pooled grades three through eight test scores and gestation weeks for all singletons. Columns (7) to (9) present estimates for sibling population. Twin fixed effects regressions control for child gender and birth order. All singleton models include the following controls: gender, month and year of birth dummies, marital and immigrant status, race and ethnicity, dummies for maternal education (3 categories), age and number of births. Sibling models further control for birth order within a family. Standard errors in column (3) are clustered at twin-pair level, in columns (4) to (6) at individual level while in columns (7) to (9) at mother level. Sample sizes in column (3) are 17048, 8948 and 14803 for each row in panel 1 and 29828, 8623 and 6245 for each row in panel 2 and 32290, 4069 and 2032 for each row in panel 3, respectively. Sample sizes in columns (4) and (6) are 755625, 413473 and 713174 for each row in panel 1 and 11155268, 388848 and 328444 for each row in panel 2 and 1494864, 256092 and 144748 for each row in panel 3, respectively. Sample sizes in column (5) are 504096, 286141 and 520441 for each row in panel 1 and 798310, 282105 and 253623 for each row in panel 2 and 1021119, 180881 and 105926 for each row in panel 3, respectively. Sample sizes in columns (7) and (9) are 132139, 75578 and 149756 for each row in panel 1 and 228687, 69317 and 65592 for each row in panel 2 and 307723, 37662 and 18166 for each row in panel 3, respectively. Sample size in column (8) are 71991, 44170 and 92742 for each row in panel 1 and 121474, 42450 and 48051 for each row in panel 2 and 175215, 23335 and 12697 for each row in panel 3, respectively.

\*\*\* Significant at the 1 percent level

\*\* Significant at the 5 percent level.

\* Significant at the 10 percent level.