**Supplementary Material**

**Twins Early Development Study: a genetically sensitive investigation into behavioural and cognitive development from infancy to emerging adulthood.**

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**Supplementary Figure**

Supplementary Figure S1. Timeline of TEDS assessments and major measures. More detailed information, including specific scales used, can be found in the TEDS data dictionary (www.teds.ac.uk/datadictionary/studies/measures/measures.htm).

**Supplementary Tables**

Supplementary Table S1. Mean scores and standard deviations for family socioeconomic factors at first contact, early childhood, middle childhood, adolescence and in emerging adulthood; Change in mean first contact SES measures families present across life stages

Supplementary Table S2. Mean scores and standard deviations for family socioeconomic factors for the sample with collected data and for missing data in terms of first contact SES measures

Supplementary Table S3. Logistic regression predicting missing data from socioeconomic measures in early childhood, middle childhood, adolescence and in emerging adulthood. Representativeness is provided separately for genotyped sample and genotyped DZ twin subsample

Supplementary Table S4. Representativeness of TEDS genotyped DZ subsample sample at first contact, early childhood, middle childhood, adolescence and emerging adulthood

**Supplementary Figure S1.** Timeline of TEDS assessments and major measures. More detailed information, including specific scales used, can be found in the TEDS data dictionary ([www.teds.ac.uk/datadictionary/studies/measures/measures.htm](http://www.teds.ac.uk/datadictionary/studies/measures/measures.htm)).

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**Supplementary Table S1.** Mean scores and standard deviations for family socioeconomic factors at first contact, early childhood, middle childhood, adolescence and in emerging adulthood; Change in mean first contact SES measures families present across life stages

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **Families present at life-stage** | | |
|  | **Measure** | **Life stage** | **Mean** | **SD** | **Mean change** |
| **Full sample** | Mother qualifications | First contact | 3.63 | 1.96 | .00 |
| Early Childhood | 3.76 | 1.99 | .13 |
| Middle Childhood | 3.86 | 2.00 | .23 |
| Adolescence | 3.89 | 2.00 | .26 |
| Emerging Adulthood | 3.92 | 2.01 | .29 |
| Father qualifications | First contact | 3.91 | 2.22 | .00 |
| Early Childhood | 4.00 | 2.23 | .09 |
| Middle Childhood | 4.08 | 2.24 | .17 |
| Adolescence | 4.13 | 2.25 | .22 |
| Emerging Adulthood | 4.17 | 2.24 | .26 |
| Aggregated parent qualifications | First contact | 3.81 | 1.84 | .00 |
| Early Childhood | 3.92 | 1.87 | .11 |
| Middle Childhood | 4.01 | 1.87 | .20 |
| Adolescence | 4.05 | 1.87 | .24 |
| Emerging Adulthood | 4.08 | 1.87 | .27 |
| Mother occupation | First contact | .43 | .50 | .00 |
| Early Childhood | .43 | .50 | .00 |
| Middle Childhood | .46 | .50 | .03 |
| Adolescence | .47 | .50 | .03 |
| Emerging Adulthood | .46 | .50 | .03 |
| Father occupation | First contact | .92 | .28 | .00 |
| Early Childhood | .92 | .27 | .01 |
| Middle Childhood | .93 | .26 | .01 |
| Adolescence | .93 | .26 | .01 |
| Emerging Adulthood | .94 | .25 | .02 |
| **Genotyped sample** | Mother qualifications | First contact | 3.83 | 1.99 | .00 |
| Early Childhood | 3.86 | 1.99 | .03 |
| Middle Childhood | 3.89 | 2.00 | .06 |
| Adolescence | 3.93 | 2.00 | .10 |
| Emerging Adulthood | 3.97 | 2.01 | .14 |
| Father qualifications | First contact | 4.05 | 2.22 | .00 |
| Early Childhood | 4.07 | 2.22 | .02 |
| Middle Childhood | 4.10 | 2.23 | .05 |
| Adolescence | 4.15 | 2.24 | .10 |
| Emerging Adulthood | 4.19 | 2.23 | .14 |
| Aggregated parent qualifications | First contact | 3.98 | 1.86 | .00 |
| Early Childhood | 4.00 | 1.86 | .02 |
| Middle Childhood | 4.04 | 1.86 | .06 |
| Adolescence | 4.08 | 1.87 | .10 |
| Emerging Adulthood | 4.12 | 1.87 | .14 |
| Mother occupation | First contact | .46 | .50 | .00 |
| Early Childhood | .45 | .50 | .00 |
| Middle Childhood | .47 | .50 | .01 |
| Adolescence | .47 | .50 | .01 |
| Emerging Adulthood | .47 | .50 | .01 |
| Father occupation | First contact | .93 | .26 | .00 |
| Early Childhood | .93 | .25 | .00 |
| Middle Childhood | .93 | .25 | .00 |
| Adolescence | .93 | .25 | .00 |
| Emerging Adulthood | .94 | .24 | .01 |
| **Genotyped DZ sample** | Mother qualifications | First contact | 3.94 | 2.04 | .00 |
| Early Childhood | 3.96 | 2.03 | .02 |
| Middle Childhood | 4.01 | 2.04 | .07 |
| Adolescence | 4.03 | 2.03 | .09 |
| Emerging Adulthood | 4.07 | 2.06 | .13 |
| Father qualifications | First contact | 4.12 | 2.25 | .00 |
| Early Childhood | 4.13 | 2.24 | .01 |
| Middle Childhood | 4.18 | 2.26 | .06 |
| Adolescence | 4.20 | 2.25 | .08 |
| Emerging Adulthood | 4.25 | 2.25 | .13 |
| Aggregated parent qualifications | First contact | 4.07 | 1.90 | .00 |
| Early Childhood | 4.07 | 1.89 | .01 |
| Middle Childhood | 4.13 | 1.90 | .06 |
| Adolescence | 4.15 | 1.90 | .08 |
| Emerging Adulthood | 4.19 | 1.90 | .13 |
| Mother occupation | First contact | .46 | .50 | .00 |
| Early Childhood | .45 | .50 | .00 |
| Middle Childhood | .46 | .50 | .01 |
| Adolescence | .47 | .50 | .01 |
| Emerging Adulthood | .47 | .50 | .01 |
| Father occupation | First contact | .93 | .25 | .00 |
| Early Childhood | .93 | .25 | .00 |
| Middle Childhood | .93 | .26 | .00 |
| Adolescence | .94 | .25 | .00 |
| Emerging Adulthood | .94 | .24 | .01 |

Note: Early childhood refers to families who provided any data when the twins were aged 2, 3, or 4 years; middle childhood refers to families who provided any data when the twins were aged 7, 8, 9, or 10 years; adolescence refers to families who provided any data when the twins were aged 12, 14, or 16; emerging adulthood refers to families who provided any data when the twins were aged 18 -23 years. Present families are those who have contributed to any of the waves of TEDS data collection within the assessed life stage. Mean change illustrates the change in a measure between the sample at first contact, and the sample at that assessed life stage. Positive values for ‘qualifications’ measures indicate that mean highest qualification or occupation level is higher in the sample at the assessed life stage.

**Supplementary Table S2.** Mean scores and standard deviations for family socioeconomic factors for the sample with collected data and for missing data in terms of first contact SES measures

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | **Family missingness status** | | | | **Difference between missingness groups** | | |
| **Present** | | **Missing** | |
|  | **Measure** | **Life stage** | **Mean** | **SD** | **Mean** | **SD** | **F** | **R2** | **Mean difference** |
| **Full sample** | Mother qualifications | First contact | 3.63 | 1.96 | - | - | - | - | - |
| Early Childhood | 3.76 | 1.99 | 3.24 | 1.82 | 183.40\*\*\* | .01 | .52 |
| Middle Childhood | 3.86 | 2.00 | 3.19 | 1.79 | 360.73\*\*\* | .03 | .67 |
| Adolescence | 3.89 | 2.00 | 3.18 | 1.80 | 414.87\*\*\* | .03 | .71 |
| Emerging Adulthood | 3.92 | 2.01 | 3.17 | 1.78 | 485.47\*\*\* | .04 | .75 |
| Father qualifications | First contact | 3.91 | 2.22 | - | - | - | - | - |
| Early Childhood | 4.00 | 2.23 | 3.61 | 2.13 | 70.24\*\*\* | <.01 | .39 |
| Middle Childhood | 4.08 | 2.24 | 3.56 | 2.12 | 148.47\*\*\* | .01 | .52 |
| Adolescence | 4.13 | 2.25 | 3.49 | 2.09 | 231.29\*\*\* | .02 | .64 |
| Emerging Adulthood | 4.17 | 2.24 | 3.47 | 2.10 | 283.30\*\*\* | .02 | .70 |
| Aggregated parent qualifications | First contact | 3.81 | 1.84 | - | - | - | - | - |
| Early Childhood | 3.92 | 1.87 | 3.46 | 1.73 | 137.93\*\*\* | .01 | .46 |
| Middle Childhood | 4.01 | 1.87 | 3.41 | 1.72 | 283.48\*\*\* | .02 | .60 |
| Adolescence | 4.05 | 1.87 | 3.37 | 1.71 | 373.85\*\*\* | .03 | .68 |
| Emerging Adulthood | 4.08 | 1.87 | 3.36 | 1.70 | 440.07\*\*\* | .04 | .72 |
| Mother occupation | First contact | .43 | .50 | - | - | - | - | - |
| Early Childhood | .43 | .50 | .43 | .49 | .25 | <.01 | .00 |
| Middle Childhood | .46 | .50 | .38 | .48 | 87.25\*\*\* | <.01 | .08 |
| Adolescence | .47 | .50 | .37 | .48 | 116.52\*\*\* | <.01 | .09 |
| Emerging Adulthood | .46 | .50 | .38 | .49 | 98.22\*\*\* | <.01 | .09 |
| Father occupation | First contact | .92 | .28 | - | - | - | - | - |
| Early Childhood | .92 | .27 | .90 | .30 | 15.82\*\*\* | <.01 | .02 |
| Middle Childhood | .93 | .26 | .89 | .31 | 50.74\*\*\* | <.01 | .04 |
| Adolescence | .93 | .26 | .89 | .31 | 57.45\*\*\* | <.01 | .04 |
| Emerging Adulthood | .94 | .25 | .88 | .32 | 97.66\*\*\* | <.01 | .05 |
| **Genotyped sample** | Mother qualifications | First contact | 3.83 | 1.99 | - | - | - | - | - |
| Early Childhood | 3.86 | 1.99 | 3.59 | 1.94 | 12.30\*\*\* | <.01 | .27 |
| Middle Childhood | 3.89 | 2.00 | 3.32 | 1.87 | 55.01\*\*\* | <.01 | .57 |
| Adolescence | 3.93 | 2.00 | 3.10 | 1.77 | 128.58\*\*\* | .02 | .83 |
| Emerging Adulthood | 3.97 | 2.01 | 3.11 | 1.71 | 182.02\*\*\* | .03 | .86 |
| Father qualifications | First contact | 4.05 | 2.22 | - | - | - | - | - |
| Early Childhood | 4.07 | 2.22 | 3.89 | 2.27 | 3.72 | <.01 | .18 |
| Middle Childhood | 4.10 | 2.23 | 3.62 | 2.12 | 28.39\*\*\* | <.01 | .48 |
| Adolescence | 4.15 | 2.24 | 3.30 | 2.01 | 91.85\*\*\* | .01 | .85 |
| Emerging Adulthood | 4.19 | 2.23 | 3.31 | 2.03 | 133.52\*\*\* | .02 | .88 |
| Aggregated parent qualifications | First contact | 3.98 | 1.86 | - | - | - | - | - |
| Early Childhood | 4.00 | 1.86 | 3.78 | 1.85 | 7.76\*\* | <.01 | .22 |
| Middle Childhood | 4.04 | 1.86 | 3.50 | 1.80 | 49.39\*\*\* | <.01 | .54 |
| Adolescence | 4.08 | 1.87 | 3.21 | 1.64 | 137.69\*\*\* | .02 | .87 |
| Emerging Adulthood | 4.12 | 1.87 | 3.25 | 1.63 | 186.55\*\*\* | .03 | .87 |
| Mother occupation | First contact | .46 | .50 | - | - | - | - | - |
| Early Childhood | .45 | .50 | .48 | .50 | 1.17 | <.01 | -.02 |
| Middle Childhood | .47 | .50 | .38 | .49 | 19.61\*\*\* | <.01 | .08 |
| Adolescence | .47 | .50 | .35 | .48 | 42.72\*\*\* | <.01 | .12 |
| Emerging Adulthood | .47 | .50 | .39 | .49 | 27.77\*\*\* | <.01 | .08 |
| Father occupation | First contact | .93 | .26 | - | - | - | - | - |
| Early Childhood | .93 | .25 | .91 | .29 | 4.70\* | <.01 | .02 |
| Middle Childhood | .93 | .25 | .91 | .28 | 3.79 | <.01 | .02 |
| Adolescence | .93 | .25 | .89 | .31 | 19.104\*\*\* | <.01 | .04 |
| Emerging Adulthood | .94 | .24 | .88 | .33 | 54.73\*\*\* | <.01 | .06 |
| **Genotyped DZ sample** | Mother qualifications | First contact | 3.94 | 2.04 | - | - | - | - | - |
| Early Childhood | 3.96 | 2.03 | 3.79 | 2.10 | 1.97 | <.01 | .17 |
| Middle Childhood | 4.01 | 2.04 | 3.36 | 1.95 | 30.24\*\*\* | <.01 | .65 |
| Adolescence | 4.03 | 2.03 | 3.17 | 1.94 | 54.31\*\*\* | .02 | .86 |
| Emerging Adulthood | 4.07 | 2.06 | 3.09 | 1.71 | 90.71\*\*\* | .03 | .98 |
| Father qualifications | First contact | 4.12 | 2.25 | - | - | - | - | - |
| Early Childhood | 4.13 | 2.24 | 4.08 | 2.32 | .12 | <.01 | .05 |
| Middle Childhood | 4.18 | 2.26 | 3.58 | 2.08 | 19.46\*\*\* | <.01 | .60 |
| Adolescence | 4.20 | 2.25 | 3.33 | 2.03 | 38.70\*\*\* | .01 | .87 |
| Emerging Adulthood | 4.25 | 2.25 | 3.24 | 2.04 | 70.21\*\*\* | .02 | 1.01 |
| Aggregated parent qualifications | First contact | 4.07 | 1.90 | - | - | - | - | - |
| Early Childhood | 4.07 | 1.89 | 3.97 | 1.96 | .72 | <.01 | .10 |
| Middle Childhood | 4.13 | 1.90 | 3.51 | 1.82 | 28.27\*\*\* | <.01 | .61 |
| Adolescence | 4.15 | 1.90 | 3.24 | 1.72 | 57.92\*\*\* | .02 | .91 |
| Emerging Adulthood | 4.19 | 1.90 | 3.20 | 1.63 | 94.56\*\*\* | .03 | 1.00 |
| Mother occupation | First contact | .46 | .50 | - | - | - | - | - |
| Early Childhood | .45 | .50 | .48 | .50 | .97 | <.01 | -.03 |
| Middle Childhood | .46 | .50 | .40 | .49 | 4.98\* | <.01 | .06 |
| Adolescence | .47 | .50 | .36 | .48 | 13.29\*\*\* | <.01 | .10 |
| Emerging Adulthood | .47 | .50 | .37 | .48 | 16.22\*\*\* | <.01 | .10 |
| Father occupation | First contact | .93 | .25 | - | - | - | - | - |
| Early Childhood | .93 | .25 | .93 | .26 | .10 | <.01 | .00 |
| Middle Childhood | .93 | .26 | .95 | .21 | 2.65\* | <.01 | -.02 |
| Adolescence | .94 | .25 | .90 | .31 | 6.47\* | <.01 | .04 |
| Emerging Adulthood | .94 | .24 | .88 | .32 | 16.96\*\*\* | <.01 | .06 |

Notes: \*\*\* = p <.001, \*\* = p <.01, \* = p <.05. Early childhood refers to families who provided any data when the twins were aged 2, 3, or 4 years; middle childhood refers to families who provided any data when the twins were aged 7, 8, 9, or 10 years; adolescence refers to families who provided any data when the twins were aged 12, 14, or 16; emerging adulthood refers to families who provided any data when the twins were aged 18 -23 years. Mean change illustrates the change in a measure between the sample at first contact, and the sample at that assessed life stage. Positive values for ‘qualifications’ measures indicate that mean highest qualification or occupation level is higher in the sample at the assessed life stage.

**Supplementary Table S3.** Logistic regression predicting missing data from socioeconomic measures in early childhood, middle childhood, adolescence and in emerging adulthood. Representativeness is provided separately for genotyped sample and genotyped DZ twin subsample

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Measure** | **Life stage** | **χ2** | **Nagelkerke R2** |
| **Full sample** | Mother qualifications | Early childhood | 190.21\*\*\* | .02 |
| Middle childhood | 368.96\*\*\* | .04 |
| Adolescence | 421.52\*\*\* | .04 |
| Emerging adulthood | 490.53\*\*\* | .05 |
| Father qualifications | Early childhood | 71.16\*\*\* | <.01 |
| Middle childhood | 149.46\*\*\* | .02 |
| Adolescence | 232.09\*\*\* | .03 |
| Emerging adulthood | 283.20\*\*\* | .03 |
| Aggregated parent qualifications | Early childhood | 141.57\*\*\* | .02 |
| Middle childhood | 287.72\*\*\* | .03 |
| Adolescence | 377.80\*\*\* | .04 |
| Emerging adulthood | 442.33\*\*\* | .05 |
| Mother occupation | Early childhood | 0.25 | <.01 |
| Middle childhood | 87.28\*\*\* | <.01 |
| Adolescence | 116.32\*\*\* | .01 |
| Emerging adulthood | 98.04\*\*\* | .01 |
| Father occupation | Early childhood | 15.19\*\*\* | <.01 |
| Middle childhood | 48.64\*\*\* | <.01 |
| Adolescence | 55.30\*\*\* | <.01 |
| Emerging adulthood | 93.84\*\*\* | .01 |
| **Genotyped sample** | Mother qualifications | Early childhood | 12.68\*\*\* | <.01 |
| Middle childhood | 58.72\*\*\* | .02 |
| Adolescence | 141.53\*\*\* | .04 |
| Emerging adulthood | 197.72\*\*\* | .05 |
| Father qualifications | Early childhood | 3.76 | <.01 |
| Middle childhood | 29.15\*\*\* | <.01 |
| Adolescence | 96.22\*\*\* | .03 |
| Emerging adulthood | 138.57\*\*\* | .04 |
| Aggregated parent qualifications | Early childhood | 7.92\* | <.01 |
| Middle childhood | 51.85\*\*\* | .02 |
| Adolescence | 149.30\*\*\* | .05 |
| Emerging adulthood | 198.96\*\*\* | .05 |
| Mother occupation | Early childhood | 1.17 | <.01 |
| Middle childhood | 19.78\*\*\* | <.01 |
| Adolescence | 43.22\*\*\* | .01 |
| Emerging adulthood | 27.94\*\*\* | <.01 |
| Father occupation | Early childhood | 4.37\*\*\* | <.01 |
| Middle childhood | 3.56 | <.01 |
| Adolescence | 16.83\*\*\* | <.01 |
| Emerging adulthood | 46.80\*\*\* | .01 |
| **Genotyped DZ sample** | Mother qualifications | Early childhood | 2.00 | <.01 |
| Middle childhood | 32.32\*\*\* | .02 |
| Adolescence | 59.64\*\*\* | .04 |
| Emerging adulthood | 99.67\*\*\* | .06 |
| Father qualifications | Early childhood | 0.12 | <.01 |
| Middle childhood | 20.05\*\*\* | .01 |
| Adolescence | 40.56\*\*\* | .03 |
| Emerging adulthood | 73.43\*\*\* | .05 |
| Aggregated parent qualifications | Early childhood | 0.73 | <.01 |
| Middle childhood | 29.74\*\*\* | .02 |
| Adolescence | 62.82\*\*\* | .05 |
| Emerging adulthood | 102.01\*\*\* | .06 |
| Mother occupation | Early childhood | 0.97 | <.01 |
| Middle childhood | 5.01\* | <.01 |
| Adolescence | 13.45\*\*\* | <.01 |
| Emerging adulthood | 16.37\*\*\* | <.01 |
| Father occupation | Early childhood | 0.10 | <.01 |
| Middle childhood | 2.94 | <.01 |
| Adolescence | 5.71\* | <.01 |
| Emerging adulthood | 14.56\*\*\* | <.01 |

Note: \*\*\* = p <.001, \*\* = p <.01, \* = p <.05; χ2 = Chi-square statistic; Nagelkerke R2= variance explained by predictor variable in missing data; Early childhood refers to families who provided any data when the twins were aged 2, 3, or 4 years; middle childhood refers to families who provided any data when the twins were aged 7, 8, 9, or 10 years; adolescence refers to families who provided any data when the twins were aged 12, 14, or 16; emerging adulthood refers to families who provided any data when the twins were aged 18 -23 years.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Returned data (N families)** | **% Response rate** | **Full twin pairs (N)** | **% White** | **% Sample with 3+ full A-levels** | **% Mothers with A-levels or higher** | **% Fathers with A-levels or higher** | **% Mother employed** | **% Father employed** | **% Female** | **%**  **MZ** |
| Genotyped DZ sample | First contact | 3320 | 100 | 3320 | 100 | - | 41.9 | 48.4 | 45.7 | 93.2 | 51.2 | 0.0 |
| Early childhood | 3000 | 91.0 | 3000 | 100 | - | 42.2 | 48.2 | 45.4 | 93.2 | 51.0 | 0.0 |
| Middle childhood | 2975 | 90.1 | 2966 | 100 | - | 42.9 | 49.4 | 46.3 | 92.9 | 51.2 | 0.0 |
| Adolescence\* | 2978 | 90.9 | 2953 | 100 | - | 44.0 | 49.6 | 46.7 | 93.5 | 52.0 | 0.0 |
| Emerging adulthood\* | 2865 | 89.7 | 2750 | 100 | 50.7 | 44.6 | 50.8 | 47.0 | 93.9 | 52.8 | 0.0 |
| National equivalents (for cohort of parents with small children born in late 1990s, early 2000s) | |  |  |  | 931 |  | 352 | 472 | 503\*\* | 913 |  | 334 |
| National equivalents (for twins themselves) | |  |  |  |  | 42.15 |  |  |  |  |  |  |

**Supplementary Table S4.** Representativeness of TEDS genotyped DZ subsample sample at first contact, early childhood, middle childhood, adolescence and emerging adulthood

Notes: Early childhood refers to families who provided any data when the twins were aged 2, 3, or 4 years; middle childhood refers to families who provided any data when the twins were aged 7, 8, 9, or 10 years; adolescence refers to families who provided any data when the twins were aged 12, 14, or 16; emerging adulthood refers to families who provided any data when the twins were aged 18 - 23 years.

\*Only active families were contacted

\*\*50% national equivalent refers to working mothers with their youngest child under the age of 2 in the UK; this is slightly higher than at TEDS, which is expected because TEDS families have multiple births

1. <https://www.ons.gov.uk/ons/rel/ghs/general-household-survey/2001-edition/living-in-britain--full-report.pdf>
2. <https://webarchive.nationalarchives.gov.uk/20130320225719/https://media.education.gov.uk/assets/files/pdf/sfr092000pdf.pdf>
3. https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/articles/moremotherswithyoungchildrenworkingfulltime/2017-09-26
4. http://www.multiplebirths.org.uk/media.asp
5. <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/502158/SFR03_2016__A_level_and_other_level_3_results_in_England_SFR_revised.pdf>