Supporting Information

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SI Text

Associations between county IM and children's developmental outcomes at age 9 y (shown in Fig. 1) were estimated by regressing the outcome variable on county IM (average annual exposure from birth to age 9 y) using OLS regression; SEs of coefficients were adjusted for clustering of children in birth counties. Associations between county IM and children's development from age 3–9 y (shown in Fig. 2 and Table 2) were estimated by regressing the outcome variable on county IM using three-level HLM. The final model specification includes county IM (average annual exposure from birth to age of assessment), child age (in years, centered at 3 y), county IM × child age, and all family control variables. HLM models were estimated using restricted maximum likelihood estimation (REML) with random intercepts (for individuals and birth counties) and random coefficients for time (age in years). Full results, including all coefficients and variance components, are shown in Table S4.

All multivariate models include the following socio-demographic control variables measured at birth (or at the year 1 follow-up interview, if prior information was unavailable): the focal child's sex and low birth weight status (<2,500 g); annual household income in dollars, number of children in the household, home ownership, and welfare receipt in past year; and the child's biological mother's age, immigrant status, education, race/ethnicity, and relationship to the child's biological father (married, cohabiting, or other relationship). In addition, all multivariate models control for children's

residential mobility (since the past wave) and three maternal characteristics assessed when children were age 3 y: intelligence, evaluated by the Similarities subtest of the Wechsler Adult Intelligence Scale (26); impulsivity, based on an abbreviated form of Dikeman's dysfunctional impulsivity scale (27); and likelihood of depression over the past year, derived from the Composite International Diagnostic Interview - Short Form (28). Missing values for control variables were imputed using multiple imputations by chained equations (M = 20) (29). Refer to Table S1 for descriptive statistics on all control variables.

In a series of robustness checks, we tested various nonlinearities in our models. The longitudinal models presented in this paper assume a linear effect of time on the association between county IM and children's developmental outcomes. We tested this assumption by interacting county IM with wave of assessment (rather than child's age) for the two time-varying developmental outcomes (when children were approximately age 3, 5, and 9 y). Rather than stratifying analyses by family income (and interacting county IM with age of assessment), we also stratified models by wave and interacted county IM with family income. Finally, given the unbalanced sample of children across time, we replicated analyses predicting children's vocabulary test scores, restricting the sample to 1,181 children from low-income families who were assessed at all three waves. All results obtained from these alternative specifications were substantively similar to the results presented in Table 2.

Table S1. Means and SDs of independent variables by low- and high-income samples

Variable	Low-income	High-income
N	3,235	991
County characteristics		
IM, national z-score		
Birth to age 3 y, average annual exposure	−0.72 (0.73)	−0.35 (0.88)
Birth to age 5 y, average annual exposure	−0.70 (0.73)	−0.32 (0.87)
Birth to age 9 y, average annual exposure	−0.67 (0.73)	−0.29 (0.87)
Child characteristics		
Male	0.52	0.52
Low birth weight	0.10	0.08
Household characteristics		
Annual income in dollars	18,282 (10,728)	73,762 (33,166)
No. of children in household	2.4 (1.3)	2.0 (1.1)
Welfare recipient	0.32	0.05
Home ownership	0.08	0.46
Mother characteristics		
Age, y	24.2 (5.6)	28.1 (6.4)
Immigrant	0.15	0.14
Highest education		
No high school degree	0.41	0.12
High school degree	0.34	0.21
Some college	0.22	0.33
College graduate	0.03	0.34
Race/ethnicity		
White, non-Hispanic	0.14	0.43
Black, non-Hispanic	0.54	0.32
Hispanic, any race	0.30	0.19
Other race, non-Hispanic	0.03	0.06
Relationship to biological father		
Married	0.14	0.56
Cohabiting, not married	0.40	0.26
Other	0.46	0.19
Intelligence score [0–15]	6.3 (2.6)	7.9 (2.5)
Impulsivity score [0–18]	6.5 (3.7)	5.4 (3.5)
Depression	0.16	0.11

SDs are presented in parentheses. Scale ranges are shown in brackets.

Table S2. OLS regressions of outcomes at age 9 y for children from low-income families

| | Cognitive test scores | | | Externalizing behaviors | |
| | PPVT | WJ-9 | WJ-10 | CBCL | SSRS |
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
County IM	0.140 (0.025)	0.114 (0.044)	0.068 (0.044)	−0.036 (0.028)	−0.082 (0.036)
Child age	0.039 (0.052)	−0.096 (0.050)	−0.083 (0.057)	−0.037 (0.053)	−0.033 (0.065)
Child male	0.042 (0.025)	−0.228 (0.033)	−0.061 (0.026)	0.217 (0.039)	0.386 (0.053)
Child low birth weight	−0.083 (0.057)	−0.238 (0.056)	−0.257 (0.061)	0.043 (0.067)	0.019 (0.095)
Household income/$10,000	0.067 (0.013)	0.078 (0.017)	0.051 (0.018)	−0.040 (0.020)	−0.043 (0.033)
No. of children	−0.058 (0.011)	−0.058 (0.017)	−0.037 (0.013)	0.025 (0.017)	−0.013 (0.024)
Welfare recipient	−0.046 (0.034)	−0.035 (0.038)	−0.077 (0.034)	0.213 (0.049)	0.073 (0.050)
Home ownership	0.076 (0.066)	0.034 (0.061)	0.114 (0.068)	−0.160 (0.067)	−0.165 (0.102)
Residential mobility	−0.025 (0.028)	0.030 (0.037)	0.014 (0.036)	0.073 (0.055)	0.010 (0.052)
Mother age	0.009 (0.004)	0.003 (0.004)	0.002 (0.005)	−0.004 (0.004)	−0.006 (0.005)
Mother immigrant	−0.261 (0.073)	−0.106 (0.039)	0.095 (0.057)	−0.180 (0.048)	−0.325 (0.065)
Mother high-school degree	0.076 (0.035)	0.044 (0.041)	0.029 (0.042)	0.015 (0.057)	−0.012 (0.073)
Mother some college	0.288 (0.056)	0.193 (0.052)	0.214 (0.062)	−0.038 (0.053)	0.012 (0.064)
Mother college degree	0.504 (0.123)	0.423 (0.088)	0.476 (0.125)	0.119 (0.118)	−0.193 (0.136)
Mother black, non-Hispanic	−0.439 (0.048)	−0.224 (0.061)	−0.304 (0.075)	−0.151 (0.069)	0.360 (0.067)
Mother Hispanic, any race	−0.361 (0.039)	−0.310 (0.052)	−0.221 (0.063)	−0.171 (0.077)	−0.023 (0.073)
Mother other race, non-Hispanic	−0.160 (0.103)	−0.154 (0.112)	−0.217 (0.092)	0.067 (0.152)	0.091 (0.162)
Mother and father cohabiting	0.006 (0.073)	0.056 (0.049)	0.052 (0.052)	0.063 (0.056)	−0.008 (0.086)
Mother–father other relationship	0.023 (0.062)	0.050 (0.055)	0.027 (0.054)	0.067 (0.059)	0.000 (0.090)
Mother intelligence score [0–15]	0.037 (0.005)	0.031 (0.006)	0.031 (0.008)	0.022 (0.011)	−0.008 (0.010)
Mother impulsivity score [0–18]	−0.007 (0.006)	−0.005 (0.004)	−0.003 (0.005)	0.037 (0.008)	0.013 (0.010)
Mother depression	0.044 (0.039)	0.068 (0.045)	0.027 (0.041)	0.240 (0.057)	0.028 (0.075)
Constant	−0.576 (0.303)	0.450 (0.295)	0.238 (0.352)	−0.109 (0.426)	0.219 (0.529)
N	2,561	2,553	2,561	2,547	1,676

SEs of coefficients are presented in parentheses. The sample was restricted to children from low-income families.

Table S3. OLS regressions of outcomes at age 9 y for children from high-income families

| | Cognitive test scores | | | Externalizing behaviors | |
| | PPVT | WJ-9 | WJ-10 | CBCL | SSRS |
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
County IM	−0.037 (0.028)	0.007 (0.033)	0.071 (0.040)	0.004 (0.033)	−0.027 (0.027)
Child age	−0.004 (0.085)	−0.029 (0.090)	−0.030 (0.071)	−0.078 (0.081)	0.007 (0.110)
Child male	0.011 (0.073)	−0.174 (0.072)	−0.027 (0.074)	0.137 (0.055)	0.173 (0.061)
Child low birth weight	−0.248 (0.100)	−0.309 (0.104)	−0.327 (0.131)	−0.011 (0.088)	−0.163 (0.118)
Household income/$10,000	0.027 (0.009)	0.013 (0.012)	0.008 (0.008)	−0.007 (0.009)	0.000 (0.008)
No. of children	−0.087 (0.023)	−0.070 (0.025)	−0.024 (0.026)	0.009 (0.023)	0.010 (0.035)
Welfare receipt	0.065 (0.164)	−0.032 (0.138)	0.069 (0.159)	0.184 (0.154)	0.099 (0.227)
Home ownership	0.044 (0.078)	−0.003 (0.081)	0.094 (0.105)	0.056 (0.083)	−0.047 (0.075)
Residential mobility	0.097 (0.058)	0.086 (0.048)	0.053 (0.047)	0.054 (0.065)	0.062 (0.087)
Mother age	−0.005 (0.006)	−0.003 (0.006)	−0.007 (0.006)	−0.006 (0.004)	−0.010 (0.006)
Mother immigrant	0.111 (0.088)	−0.066 (0.093)	0.183 (0.100)	0.067 (0.080)	0.081 (0.089)
Mother HS degree	0.146 (0.130)	0.193 (0.112)	0.068 (0.109)	0.073 (0.144)	0.002 (0.112)
Mother some college	0.419 (0.137)	0.321 (0.098)	0.283 (0.106)	−0.139 (0.116)	0.056 (0.156)
Mother college degree	0.512 (0.179)	0.680 (0.122)	0.491 (0.119)	−0.146 (0.101)	−0.086 (0.158)
Mother black, non-Hispanic	−0.435 (0.074)	0.048 (0.099)	−0.073 (0.089)	−0.190 (0.083)	0.194 (0.087)
Mother Hispanic, any race	−0.227 (0.090)	−0.026 (0.079)	−0.175 (0.095)	−0.212 (0.072)	−0.087 (0.090)
Mother other race, non-Hispanic	0.062 (0.127)	0.157 (0.147)	0.230 (0.131)	−0.112 (0.165)	−0.070 (0.171)
Mother and father cohabiting	−0.140 (0.074)	−0.179 (0.081)	−0.091 (0.082)	−0.093 (0.066)	−0.128 (0.101)
Mother–father other relationship	−0.149 (0.103)	−0.180 (0.110)	−0.177 (0.088)	0.056 (0.092)	0.069 (0.094)
Mother intelligence score [0–15]	0.046 (0.010)	0.025 (0.014)	0.024 (0.015)	−0.011 (0.015)	−0.015 (0.013)
Mother impulsivity score [0–18]	−0.002 (0.012)	−0.002 (0.010)	0.000 (0.011)	0.033 (0.010)	−0.013 (0.012)
Mother depression	0.043 (0.091)	−0.113 (0.105)	0.089 (0.091)	0.209 (0.108)	0.065 (0.109)
Constant	0.028 (0.573)	0.225 (0.592)	0.259 (0.450)	0.505 (0.472)	0.064 (0.708)
N	785	780	782	788	571

SEs of coefficients are presented in parentheses. Scale ranges are shown in brackets. The sample was restricted to children from high-income families.

Table S4. HLM regressions of outcomes between ages 3 and 9 y for children from low-income families

Variable	Vocabulary test scores		Externalizing behaviors	
	Model 1	Model 2	Model 3	Model 4
Regression coefficients				
County IM, z-score	0.100 (0.025)	0.027 (0.030)	−0.053 (0.025)	−0.053 (0.029)
Child age, y, centered at 3 y	−0.008 (0.003)	0.008 (0.005)	−0.008 (0.004)	−0.008 (0.006)
County IM × child age		0.022 (0.005)		0.000 (0.005)
Child male	−0.038 (0.026)	−0.038 (0.026)	0.188 (0.031)	0.188 (0.031)
Child low birth weight	−0.121 (0.045)	−0.122 (0.045)	0.085 (0.052)	0.085 (0.052)
Household income/$10,000	0.071 (0.014)	0.071 (0.014)	−0.031 (0.016)	−0.031 (0.016)
No. of children	−0.040 (0.010)	−0.040 (0.010)	0.023 (0.012)	0.023 (0.012)
Welfare receipt	−0.075 (0.031)	−0.075 (0.031)	0.136 (0.037)	0.136 (0.037)
Home ownership	0.102 (0.052)	0.104 (0.052)	−0.033 (0.061)	−0.033 (0.061)
Residential mobility	−0.025 (0.021)	−0.025 (0.021)	0.030 (0.024)	0.030 (0.024)
Mother age	0.006 (0.003)	0.006 (0.003)	−0.006 (0.003)	−0.006 (0.003)
Mother immigrant	−0.313 (0.048)	−0.313 (0.048)	−0.164 (0.054)	−0.164 (0.054)
Mother HS degree	0.039 (0.032)	0.038 (0.032)	−0.013 (0.038)	−0.013 (0.038)
Mother some college	0.228 (0.039)	0.228 (0.039)	−0.058 (0.046)	−0.058 (0.046)
Mother college degree	0.411 (0.092)	0.414 (0.092)	−0.037 (0.102)	−0.037 (0.102)
Mother black, non-Hispanic	−0.437 (0.045)	−0.438 (0.045)	−0.117 (0.051)	−0.117 (0.051)
Mother Hispanic, any race	−0.400 (0.050)	−0.400 (0.050)	−0.060 (0.056)	−0.060 (0.056)
Mother other race, non-Hispanic	−0.162 (0.090)	−0.162 (0.090)	0.154 (0.104)	0.154 (0.104)
Mother and father cohabiting	0.027 (0.045)	0.029 (0.045)	0.111 (0.051)	0.111 (0.051)
Mother–father other relationship	0.062 (0.046)	0.065 (0.046)	0.146 (0.053)	0.146 (0.053)
Mother intelligence score [0–15]	0.039 (0.006)	0.039 (0.006)	0.007 (0.007)	0.007 (0.007)
Mother impulsivity score [0–18]	−0.006 (0.004)	−0.006 (0.004)	0.046 (0.004)	0.046 (0.004)
Mother depression	0.033 (0.037)	0.034 (0.037)	0.248 (0.044)	0.248 (0.044)
Constant	−0.214 (0.107)	−0.273 (0.108)	−0.287 (0.122)	−0.287 0.123
Random-effects parameters (SD)				
County at birth intercept	0.087	0.087	0.049	0.049
Child intercept	0.533	0.534	0.657	0.657
Child age	<0.001	<0.001	0.064	0.064
Child age	0.634	0.632	0.768	0.768
N				
Birth counties	123	123	132	132
Children	2,967	2,967	3,229	3,229
Observations	6,243	6,243	7,350	7,350

SEs of coefficients are presented in parentheses. The sample was restricted to children from low-income families.

Table S5. Regressions of developmental outcomes of children from low-income families by measure of county IM (coefficients and SEs)

Variable	Model 1, controls = race + immigrant	Model 2, controls = all SES age 0–1 y	Model 3, controls = mother traits age 3 y
Panel A: vocabulary test scores			
OLS regression, age 9 y			
County IM, z-score	0.180 (0.027)	0.136 (0.025)	0.140 (0.024)
HLM regression, ages 3–9 y			
County IM, z-score	0.072 (0.031)	0.023 (0.030)	0.027 (0.029)
Child age, y, centered at 3 y	0.007 (0.005)	0.008 (0.005)	0.008 (0.005)
County IM × child age	0.021 (0.005)	0.021 (0.005)	0.022 (0.005)
Panel B: externalizing behaviors			
OLS regression, age 9 y			
County IM, z-score	−0.050 (0.029)	−0.034 (0.029)	−0.036 (0.028)
HLM regression, ages 3–9 y			
County IM, z-score	−0.077 (0.032)	−0.052 (0.030)	−0.053 (0.029)
Child age, y, centered at 3 y	−0.006 (0.006)	−0.007 (0.006)	−0.008 (0.006)
County IM × child age	0.000 (0.005)	0.000 (0.005)	0.000 (0.005)

SEs of coefficients are presented in parentheses. Model 1 controls only for the mother's race/ethnicity and immigrant status. Model 2 includes all control variables except mother's intelligence, impulsivity, and depression. Model 3 includes all control variables.

Table S6. Regressions of developmental outcomes of children from low-income families by measure of county IM (coefficients and SEs)

Variable	Model 1 county IM = household income	Model 2 county IM = Individual income	Model 3 county IM = college attendance
Panel A: vocabulary test scores			
OLS regression, age 9 y			
County IM, z-score	0.140 (0.024)	0.106 (0.023)	0.087 (0.044)
HLM regression, ages 3–9 y			
County IM, z-score	0.027 (0.029)	−0.005 (0.031)	0.017 (0.056)
Child age, y, centered at 3 y	0.008 (0.005)	0.000 (0.004)	−0.002 (0.005)
County IM × child age	0.022 (0.005)	0.021 (0.005)	0.018 (0.010)
Panel B: externalizing behaviors			
OLS regression, age 9 y			
County IM, z-score	−0.036 (0.028)	−0.021 (0.025)	−0.027 (0.053)
HLM regression, ages 3–9 y			
County IM, z-score	−0.053 (0.029)	−0.060 (0.029)	−0.070 (0.055)
Child age, y, centered at 3 y	−0.008 (0.006)	−0.007 (0.004)	−0.006 (0.005)
County IM × child age	0.000 (0.005)	0.004 (0.006)	0.006 (0.011)

SEs of coefficients are presented in parentheses. Model 1 uses the county measure of IM based on the causal effect on household income. Model 2 uses the county measure of IM based on the causal effect on individual income. Model 3 uses the county measure of IM based on causal effect on college attendance.

Table S7. Regressions of alternative developmental outcomes of children from low-income families (coefficients and SEs)

Variable	Regression coefficient (SE)
Panel A: attention problems	
OLS regression, age 9 y	
County IM, z-score	−0.034 (0.025)
HLM regression, ages 3–9 y	
County IM, z-score	−0.048 (0.026)
Child age, y, centered at 3 y	−0.013 (0.006)
County IM × child age	0.003 (0.005)
Panel B: self-control social skills	
OLS regression, age 9 y	
County IM, z-score	0.064 (0.038)
Panel C: oppositional behaviors	
OLS regression, age 9 y	
County IM, z-score	−0.070 (0.030)

SEs of coefficients are presented in parentheses.

Table S8. Means and SDs of dependent variables by wave

Variable	Year 3	Year 5	Year 9
Picture vocabulary test score			
Age-adjusted standard score [60–159]	86.6 (15.1)	93.2 (15.2)	92.7 (14.9)
N	2,421	2,330	3,346
Passage comprehension test score			
Age-adjusted standard score [60–159]	N/A	N/A	93.0 (13.0)
N			3,333
Applied problems test score			
Age-adjusted standard score [60–152]	N/A	N/A	98.3 (14.8)
N			3,343
Externalizing behaviors (parent-rated)			
Total score [0–50]	11.0 (7.2)	8.2 (5.9)	5.0 (5.6)
N	3,316	2,978	3,335
Externalizing behaviors (teacher-rated)			
Total score [0–18]	N/A	N/A	3.4 (4.1)
N			2,247
Attention problems (parent-rated)			
Total score [0–12]	4.8 (2.5)	2.1 (2.0)	2.3 (2.4)
N	2,880	2,810	3,327
Oppositional behaviors (teacher-rated)			
Total score [0–15]	N/A	N/A	2.1 (3.4)
N			2,251
Self-control social skills (teacher-rated)			
Total score [0–30]	N/A	N/A	19.1 (7.2)
N			2,246

SDs are presented in parentheses. Scale ranges are shown in brackets. N/A, the dependent variable was not assessed.