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Long term impacts of early life interventions

* with some notes borrowed from D. Almond.

Distinction in timing

- Fetal origins hypothesis
- Long term impacts of early childhood interventions

The Fetal Origins Hypothesis

- Prenatal period lays the foundation on which the rest of childhood is built
- Affects outcomes throughout childhood and the rest of life
- For example, heart disease comes from epidemiology, often associated with DJ Barker
- Reaction against earlier, perfect parasite view of the fetus: mother buffered against any insults

Origination of fetal origins

- Hypothesis originally focused on prenatal nutrition
- How much and what mother eats
- Evidence from famine episodes; especially the 1944-45 Dutch Famine

Fetal Origins Hypothesis; Nutrition

- Events in *early life* “program” body for the type of environment likely to face
- Example: Limited nutrition pre/post natal → expect future to be nutrition-deprived → body invokes (irreversible) biological mechanisms to adapt to predicted poor postnatal environment
- If future world is *not* nutrient-deficient, it is maladapted to environment
- Adverse effects for “metabolic syndrome”: Obesity, cardiovascular disease, high blood pressure, type 2 diabetes
- Negative consequences latent, show up later in life
- Unclear when “critical” period ends (post-natal exposure may matter too)

Evidence on the Fetal Origins Hypothesis

- Literature (largely correlational) in public health
- Experimental rat studies (pre- and post- natal matters)
- Interest in economics pioneered by Currie and Almond
  - Typically examine severe, short duration, negative shocks during pre-natal environment
  - Quasi experimental evidence
- The research finds that while birth weight is affected, the long term outcomes do not appear to operate only through birth weight
  - AND even though birthweight is our best “sufficient statistic” for possible long term effects; it may be the only thing we have UNTIL wait for decades after a shock to see impacts in LR

Outcomes that can be affected

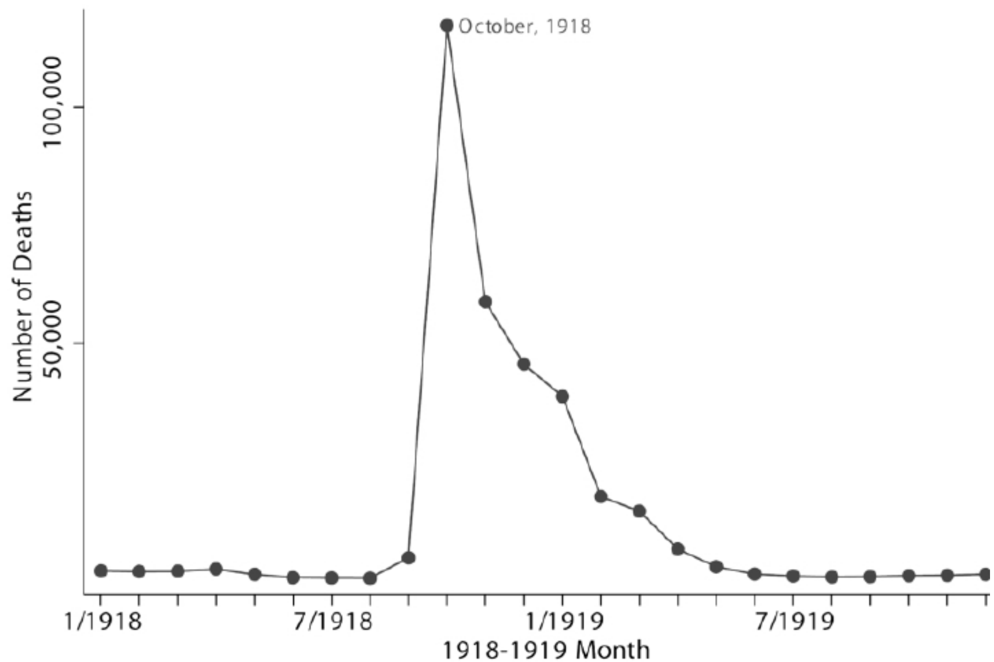
- Initially emphasis was on adult health (cardiovascular, metabolic syndrome)
- Also important for human capital outcomes
  - Test scores in childhood
  - Education attainment
  - Wages and incomes
  - Marriage

Back to the Dutch Famine

- Well-nourished society experienced abrupt, severe famine
- Nazi occupation of the Netherlands: imposed strict rationing
- November 1944 - April 1945 (7 months)
- Average calorie intake fell almost overnight from ~1800 to 400-800.
- Post-war returned to normal almost instantaneously
- Studies of affected cohorts
- Lower birth weight if famine during 3rd trimester
- Middle age: more obesity, lower self-reported health, higher heart disease and worse mental health. Large effects.
- Analysis of conscription records (by place and date of birth): no effect on IQ
- China, Leningrad, Finland

Almond (2006) JPE; early paper in economics

- Flu arrived suddenly in fall 1918
- Millions died, but most victims got sick but recovered
- Pregnant mothers got sick too
- What if you were in utero in fall 1918?
- Appeal: severe, short duration



Almond (2006) cont

- Using 1960 Census, educational attainment for in utero flu births is much lower
- Departure from trend
- Using 1980 census, 20% more likely to be disabled, >5% reduction in wages, more welfare, etc

Important check needed for this type of design

1. Does the intervention lead to changes in fertility?
2. Does the intervention lead to changes in survival to life birth?

In this setting, the intervention happens after conception so fertility is not an issue.

But one also would need to examine the characteristics of the live births of the affected cohort to be sure that these results do not come from selective survival.

Fetal Origins Literature: Started with nutrition "interventions" and expanded to others

- Within family (and within-twin-pair) differences in birth outcomes and their relationship to differences in later life outcomes: Black, Devereaux & Salvanes 2007, Royer 2009
- Hookworm, malaria (Bleakley, Barreca)
- Prenatal improvements -- Field, Robles, and Torero (2009)
- Ramadan (dawn to dusk fasting) – Almond and Mazumder → 20% increase in disability
- Pollution – Sanders; recession → less pollution → higher test scores
- Banerjee, Duflo, Postel-Vinay & Watts 2010: blight to french vineyards (late 1800s) → military records show adult males shorter
- More … See Almond and Currie JEP 2012

Hoynes, Schanzenbach & Almond 2012
"Long Run Impacts of Childhood Access to the Safety Net"

<u>Contribution to the literature</u>

- Given the focus on *extreme*, *negative* shocks, a natural question to ask is – how generalizable are these linkages between early life and long run outcomes?
- There is little evidence that uses convincing research designs allowing for causal identification to analyze more commonplace treatments
- We are the first to look at the long term effects of a *positive* and *policy-driven* change in resources
- Further, we can explore <u>when</u> treatment matters; our policy affects resources *in utero* and through childhood

What does the fetal origins hypothesis predict for FSP introduction?

- Health: FSP leads to better nutrition in childhood → lower metabolic syndrome in adulthood
  - Expect lower incidence of obesity, cardiovascular disease, high blood pressure, type 2 diabetes
  - Both pre- and post-natal nutrition may matter
- Economic outcomes: increase in human capital (education, earnings)

What we do

- Use variation in childhood exposure to FSP based on county and year of birth during the FSP rollout period
  - Note that our treatment never "turns off" once it starts
- Use Panel Study of Income Dynamics
  - Data on economic outcomes, health conditions, general health status, and disability. Allows for measurement of metabolic syndrome.
  - Restricted use data allows for measurement of county of birth for cohorts affected by introduction of FSP.
- Explore when in childhood the intervention is most beneficial.
- Intent to treat analysis

Methodology

- Use variation across counties in difference-in-difference model:

$$y_{icbt} = \alpha + \delta FSP_{cb} + X_{icbt}\beta + \eta_c + \lambda_b + \gamma_t + \theta_s * b + \varphi CB60_c * b + \varepsilon_{icbt}$$

- Identification comes from variation across counties *c* and birth cohorts *b* in adoption of FSP
- Main results measure <u>FSP treatment as the percent of time between conception and age 5 that FSP was available in county of birth</u>
- Control include fixed effects for county, birth cohort and interview year state specific linear time trends
  - X_{icb} = *individual controls* (gender, marital status, race, age) and *family background* (female head, education of head, income to needs – all in first 5 years of life)
- *SE clustered by county* and use PSID weights

Methodology (cont)

- Because of our many outcome variables, we follow Kling, Liebman and Katz (2007) and Anderson (2008) and estimate standardized indices that aggregate information over multiple outcomes.
- Aggregating multiple measures in a given area can improve statistical power
- We use two indices: *metabolic syndrome* and *economic self sufficiency*
- Each are an equal weighted average of the z-score of each component

$$y_i = \frac{1}{J}\sum_j \frac{y_{ij} - \mu_j}{\sigma_j}$$

- We use the mean and SD of "untreated cohorts" (born before 1962) in constructing the z-scores

Metabolic Syndrome

- Obese (=1)
- High blood pressure (=1)
- Diabetes (=1)
- Heart disease (=1)
- Heart attack (=1)

Economic self-sufficiency

- High school graduate (=1)
- Employed (=1)
- Not poor (=1)
- Not on TANF (=1)
- Not on food stamps (=1)
- Earnings
- Family income

- Our main estimates are for a high impact sample.
- Those raised in families where the head was low education (less than high school). This uses family background.

Metabolic Syndrome for High Impact Sample

	Metabolic syndrome (index)
FS share IU-5	-0.294***
	(0.107)
Mean of dep va	0.01
Observations	8,246
R-squared	0.26

Change from no exposure to full exposure (in utero to age 5) reduces metabolic syndrome by 0.3 standard deviations; significant at 1%

Includes fixed effects for birth year, county, interview year, state linear trends, 1960 county characteristics by linear time, individual demographics and family background. Clustered by county and weighted using PSID weights.

Main Results for High Impact Sample, by Gender

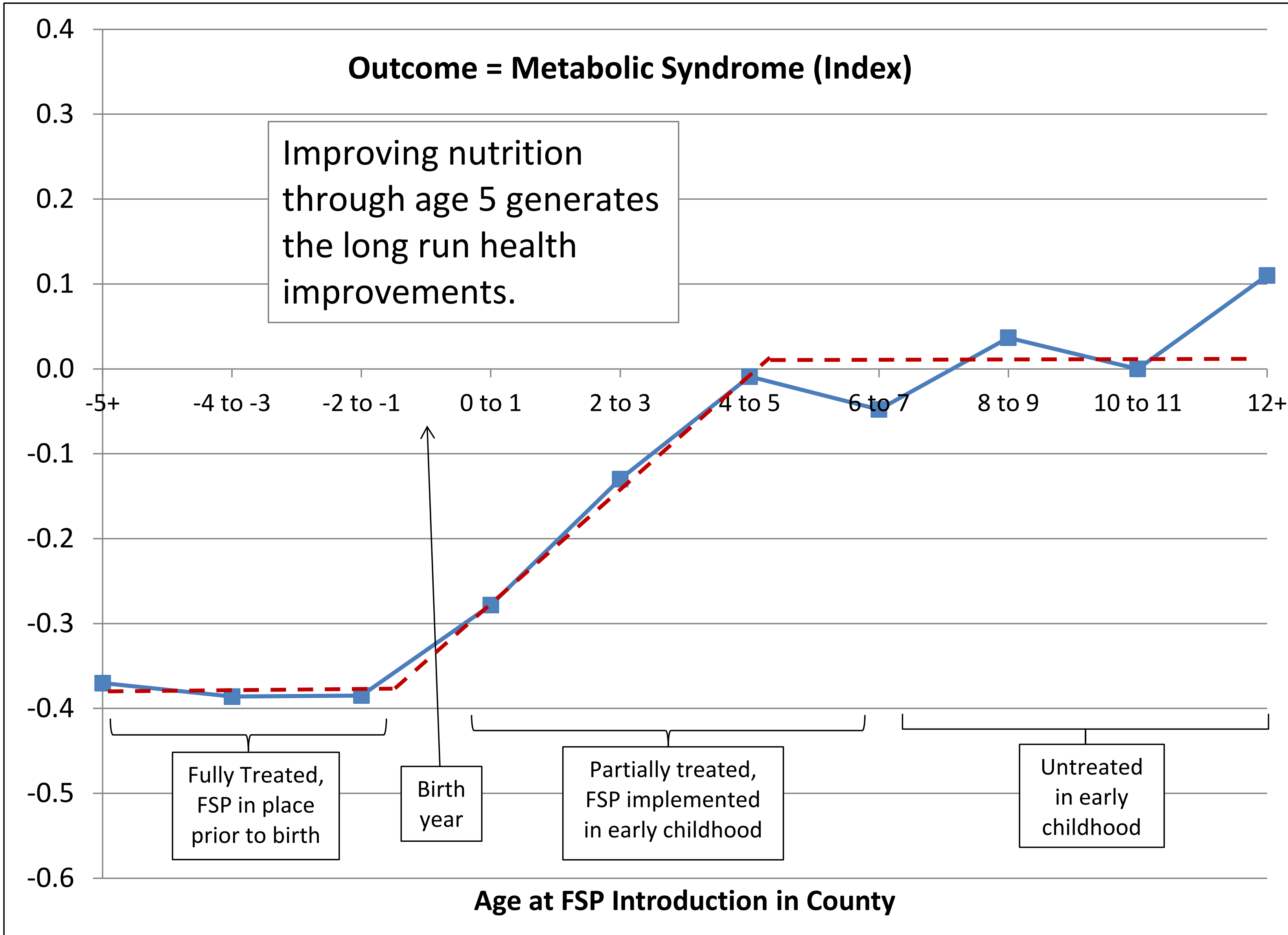
	Women			Men		
	Metabolic syndrome (index)	Good Health	Economic self sufficiency (index)	Metabolic syndrome (index)	Good Health	Economic self sufficiency (index)
FS Share IU-5	-0.312**	0.336***	0.306*	-0.526**	-0.077	0.005
	(0.130)	(0.100)	(0.164)	(0.251)	(0.112)	(0.168)
Mean of Dependent V	0.03	0.53	-0.37	-0.01	0.66	-0.11
Observations	5,062	15,702	12,208	3,184	10,036	7,907
R-squared	0.37	0.22	0.43	0.32	0.18	0.46

Economic impacts strong for women, nonexistent for men. Consistent with other studies finding stronger impacts for girls (Anderson 2008, Bleakley 2007, Dahl/Lochner 201, Milligan/Stabile 2009, MTO; less evidence from fetal origins/nutritional studies)

Exploring the timing of treatment

- Event study approach
- Traces out the treatment effect for years prior to and after the treatment
- Advantages: (1) can test for absence of pre-treatment trends, and (2) can examine impacts of treatment over time, and (3) can explore when in childhood the treatment matters
- The tricky thing about our treatment is that:
  - We do not have a strong prior about *when* treatment matters (and hence when to assign someone as treated)
  - Treatment turns on, and then never turns off
- Solution: make event time = age when food stamps introduced in your county

Event Study: by age when FSP introduced, high impact group



2. Long term impacts of early childhood interventions

- Head Start
- Perry Preschool
- Class size reduction

Anderson JASA 2008

- Why this paper?
  - Good demonstration of positive LR benefits of high quality early childhood interventions
  - Multiple inference problem: with many measured outcomes, significant coefficients may emerge by chance.

His interventions; all randomly assigned kids

- Abecedarian Project: NC 4 cohorts 1972-1977
  - Intense intervention: age 4 mo – school age, 50 weeks a year 8 hrs/day
  - Cognitive, language, social skills
  - 57 T, 54 C children
- Perry Preschool: MI 5 cohorts 1962-1967
  - Enter at age 3 (4) and received 2 (1) year of treatment
  - Language, socialization; 5 mornings per week
  - 58 T, 65 C children
- Early Training Project: TN 3 cohorts 1962-1964
  - 2-3 summers of preschool, RA
  - Focused on motivation and persistence; home visit
  - 45 treated, 21 control children (!!)

Summary of the existing analyses of these studies

- He reviews the available evidence
- Results are all of the place; apparently inconsistent
- No consensus by gender

His approach

- Reduce number of outcomes by creating <u>indices</u>
  - Robust to over-testing: adding outcome variables does not add to the number of test (so won't get one significant by chance)
  - Statistical test for whether a program has a general effect on a set of outcomes
  - More power than sing tests: multiple outcomes that are borderline significant may aggregate into a single index that attains statistical significance
- Adjust the p values to reflect the multiple tests

3 groupings: preteen, adolescent, adult OR

Economic, academic, social

Table 2. Summary index components

Project	Stage	Summary index components
ABC	Preteen	IQ (5, 6.5, 12), Retained in Grade (12), Special Education (12)
Perry	Preteen	IQ (5, 6, 10), Repeat Grade (17), Special Education (17)
ETP	Preteen	IQ (5, 7, 10), Retained in Grade (17), Special Help (17)
ABC	Teen	IQ (15), HS Grad (18), Teen Parent (19)
Perry	Teen	IQ (14), HS Grad (18), Unemployed (19), Transfers (19), Teen Parent (19), Arrested (19)
ETP	Teen	IQ (17), HS Dropout (18), Worked (18)
ABC	Adult	College (21), Employed (21), Convicted (21), Felon (21), Jailed (21), Marijuana (21)
Perry	Adult	College (27), Employed (27, 40), Income (27, 40), Criminal Record (27), Arrests (27), Drugs (27), Married (27)
ETP	Adult	College (21), Receive Income (21), On Welfare (21)

NOTE: Age of measurement in parentheses. For Perry and Early Training grade repetition and special education variables, it was not possible to isolate pre-9th grade outcomes in the data.

A summary index test can be implemented through the following steps (see App. A for a formal definition):

1. For all outcomes, switch signs where necessary so that the positive direction always indicates a "better" outcome.
2. Demean all outcomes and convert them to effect sizes by dividing each outcome by its control group standard deviation. Call the transformed outcomes $\tilde{y}$. This conversion normalizes outcomes to be on a comparable scale.
3. Define J groupings of outcomes (also referred to as areas or domains). Each outcome y_{jk} is assigned to one of these J areas, giving K_j outcomes in each area j, with k indexing outcomes within an area.
4. Create a new variable, $\overline{s}_{ij}$, that is a weighted average of $\tilde{y}_{ijk}$ for individual i in area j. When constructing $\overline{s}_{ij}$, weight its inputs—outcomes $\tilde{y}_{ijk}$—by the inverse of the covariance matrix of the transformed outcomes in area j. A simple way to do this is to set the weight on each outcome equal to the sum of its row entries in the inverted covariance matrix for area j. Formally, $\overline{s}_{ij} = (\mathbf{1}'\hat{\mathbf{\Sigma}}_j^{-1}\mathbf{1})^{-1}(\mathbf{1}'\hat{\mathbf{\Sigma}}_j^{-1}\tilde{\mathbf{y}}_{ij})$, where $\mathbf{1}$ is a column vector of 1's, $\hat{\mathbf{\Sigma}}_j^{-1}$ is the inverted covariance matrix, and $\tilde{\mathbf{y}}_{ij}$ is a column vector of all outcomes for individual i in area j. Note that this is an efficient generalized least squares (GLS) estimator.
5. Regress the new variable, $\overline{s}_{ij}$, on treatment status to estimate the effect of treatment on area j. A standard t test assesses the significance of the coefficient.

Table 3. Summary index effects

Project	Age	Female Effect	Female Naive p value	Female FWER p value	Female n	Male Effect	Male Naive p value	Male FWER p value	Male n	Gender difference t statistic
ABC	Preteen	.445 (.194)	.026	.125	54	.417 (.181)	.026	.184	51	.11
Perry	Preteen	.537 (.177)	.004	.028	51	.150 (.172)	.387	.943	72	1.53
ETP	Preteen	.362 (.251)	.160	.349	30	.148 (.245)	.552	.958	34	.61
ABC	Teen	.422 (.202)	.042	.156	53	.162 (.194)	.407	.943	51	.93
Perry	Teen	.613 (.156)	0	.003	51	.035 (.096)	.716	.977	72	3.32
ETP	Teen	.456 (.299)	.138	.349	29	.123 (.377)	.747	.977	32	.68
ABC	Adult	.452 (.144)	.003	.024	53	.312 (.166)	.066	.372	51	.64
Perry	Adult	.353 (.150)	.022	.125	51	−.012 (.130)	.927	.977	72	1.83
ETP	Adult	−.069 (.186)	.714	.701	29	−.710 (.260)	.011	.090	31	1.98

NOTE: Parentheses contain OLS standard errors. Naive p values are unadjusted p values based on the t distribution. FWER p values adjust for multiple testing at the summary index level and are computed as described in Section 3.2.2. The t statistics test the difference between female and male treatment effects. See Table 2 for the components of each summary index.

Perry Girls HS graduation +

Table 6. Effects on teenage academic outcomes

			Female					Male					Gender difference
Outcome	Age	Project	Effect	CM	Naive p value	FDR q value	n	Effect	CM	Naive p value	FDR q value	n	t statistic
IQ	15	ABC	4.22 (2.85)	89.50	.144	.281	53	4.66 (2.79)	92.48	.094	.674	51	−.11
IQ	14	Perry	2.64 (2.57)	76.77	.311	.359	46	−.96 (3.03)	83.26	.755	1.000	64	.91
IQ	17	ETP	2.08 (6.80)	76.11	.739	.524	25	1.64 (5.09)	76.78	.741	1.000	28	.05
High school graduate	18	ABC	.226 (.122)	.607	.081	.216	52	−.096 (.131)	.739	.468	1.000	51	1.80
High school graduate	18	Perry	.494 (.121)	.346	0	.001	51	−.061 (.115)	.667	.575	1.000	72	3.32
Ever dropout of high school	18	ETP	−.289 (.190)	.500	.101	.245	29	−.095 (.193)	.545	.654	1.000	31	−.72

NOTE: Parentheses contain robust standard errors. CM refers to control mean. Sample size varies within experiments due to attrition for some variables. The p and q values are computed as described in Section 3; t statistics test the difference between female and male treatment effects.

Girls college +

Table 8. Effects on adult academic outcomes

			Female					Male					Gender difference
Outcome	Age	Project	Effect	CM	Naive p value	FDR q value	n	Effect	CM	Naive p value	FDR q value	n	t statistic
In college	21	ABC	.293 (.116)	.107	.016	.077	53	.148 (.121)	.174	.267	1.000	51	.87
Any college	27	Perry	.160 (.137)	.280	.260	.336	50	−.005 (.110)	.308	.971	1.000	72	.94
In post–high school education	21	ETP	.121 (.191)	.300	.524	.453	29	−.486 (.171)	.636	.004	.082	31	2.37

NOTE: Parentheses contain robust standard errors. CM refers to control mean. Sample size varies within experiments due to attrition for some variables. The p and q values are computed as described in Section 3; t statistics test the difference between female and male treatment effects.

More benefits for girls

Table 10. Effects on adult social outcomes

Outcome	Age	Project	Female Effect	Female CM	Female Naive p value	Female FDR q value	Female n	Male Effect	Male CM	Male Naive p value	Male FDR q value	Male n	Gender difference t statistics
Convicted	21	ABC	−.101 (.079)	.143	.240	.318	52	−.089 (.133)	.348	.532	1.000	50	−.08
Felony	21	ABC	NA					−.113 (.117)	.261	.364	1.000	50	
Jailed	21	ABC	−.030 (.065)	.071	.761	.529	52	−.177 (.131)	.391	.165	1.000	51	1.01
Marijuana user	21	ABC	−.317 (.101)	.357	.003	.048	53	−.127 (.140)	.435	.376	1.000	49	−1.10
Criminal record	27	Perry	−.146 (.125)	.346	.268	.336	51	−.021 (.109)	.718	.828	1.000	72	−.75
Lifetime arrests	27	Perry	−1.95 (.83)	2.27	.011	.069	49	−2.31 (1.50)	6.10	.126	.771	72	.21
Ever used drugs	27	Perry	−.157 (.131)	.300	.213	.304	41	.198 (.110)	.189	.070	.560	68	−2.08
Married	27	Perry	.317 (.115)	.083	.009	.066	49	.002 (.107)	.256	.969	1.000	70	2.01

NOTE: Parentheses contain robust standard errors. CM refers to control mean. Sample size varies within experiments due to attrition for some variables. The p and q values are computed as described in Section 3; t statistics test the difference between female and male treatment effects. No female in the Abecedarian treatment or control group was arrested for a felony.