Prenatal Fasting During Ramadan and Cognitive Abilities

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Research Question

- Does mild nutrition shock have long lasting impact on cognitive skills?

Research Framework

- Uses natural experiment provided by the Ramadan fasting month.

Motivation

- Fetal origin hypothesis: nine months the baby spends in the womb is a critical period.
- Prenatal environment influence susceptibility to disease, appetite, metabolism, mental health, and cognitive abilities.
- Maternal stress increases cortisol level, hormone associated with cognitive impairment in children.
- Most literature on this subject focus on large shock, e.g. Dutch famine and China famine.
- This paper examines mild shock in nutritional intake.

Growing Literature

- Almond (2006), Almond and Mazumder (2010), and Currie et. al. (2010) provide the first evidence on long-term impact of prenatal exposure to shocks, focusing on developed countries.
- Chen and Zhou (2007), Fung (2009), and Almond et. al. (2010) provide evidence on long-term effects of prenatal malnutrition in developing countries.
- Almond and Mazumder (2011) are the first to look into mild prenatal malnutrition using Ramadan as a natural experiment.
- Van Ewijk (2011) and Majid (2013) examined long-term impact on health and labor market outcomes in Indonesia.

The Mechanism

- Barker and Osmond (1987) and Gluckman and Hanson (2005): Women's exposure to adverse condition during pregnancy can induce developmental changes that have intergenerational effects.
- Ibanez et. al. (2000): women who are born small and not exhibiting catch-up growth will fail to attain height as predicted by their genetic code.
- This would reduced their uterine and ovarian size, which means lower birth height of their children.
- It appears that prenatal malnutrition shock can have long lasting impact.
- Does this exposure have long-lasting cognitive effects?

Theoretical Framework

- Based on Heckman (2007) model on human capability formation.

$$\theta_{t+1} = f_t(\theta_t, h_t, I_t)$$

- θ is genetic and environmental initial condition.
- h denotes parental capabilities (IQ, education, income)
- I denotes investments.
- Two of investments: prenatal investments and postnatal investments.
- "Good start" is defined as higher level of capacity in one period create higher levels of capacity in the next period.
- Currie et. al. (2010): health at birth have larger effects on educational attainment and wealth than health in early adolescence.

Data

- Indonesian Family Life Survey (IFLS), 1993 and 2007 waves.
- IFLS compiles a wide range of data on economic, demographic, and health measures required for this study.
- More importantly, it has data on exact birth dates.
- Assign cognitive and mathematics test for children and adults in 2007.

Identification Strategy

- Sample are children who are 7 to 14 years old in 1993.
- Identify individuals who are exposed to Ramadan fasting while in-utero.
- Examine individuals exact birth dates and determine if gestation period falls inside Ramadan.
- Use exact birth dates, average length of human pregnancy (266 days), and Ramadan dates to determine exposure.
- Classify exposure into four categories
  - Exposed during Ramadan.
  - Exposed in first trimester.
  - Exposed in second trimester.
  - Exposed in third trimester.
- Pregnant women can skip fasting during Ramadan.
- No direct method to obtain mother's fasting behavior.
- IFLS data can provide this information.
- Use individual's religiosity to proxy for mother's fasting behavior.
- Cognitive deficit would be larger in individuals whose parents are religious.

Estimation Strategy

- Estimate the following equation:

$$outcome_i = \beta_0 + \beta_1 exposure_i + \beta_2 female_i + \beta_2 age_i + \beta_3 age_i^2 + SFE + \sum_{m=2}^{12} \beta_m month_{mi} + \varepsilon_i$$

- Outcome is the set of scores from cognitive test and mathematics test.
- Female is gender dummy, 0 for male and 1 for female.
- Age is measured in days.
- Month is calendar month of birth fixed effects.
- SFE is sibling fixed effects.
- First step is to estimate using OLS.
- Second step is to estimate using sibling fixed effects.
- To check for robustness, use height in cm as the dependent variable.
- Case and Paxson (2008) found that height is a marker for cognitive ability, that is taller children have higher cognitive ability.
- Exposure is predicted to have negative impact on height.
- Standard errors are clustered at the mother level.

Summary Statistics

	Variable	Mean	Std. Dev.
Non exposed	Cognitive Score	75.72	24.07
	Math Score	47.05	29.06
	Height	128.22	17.24
	N = 1246		
Exposed Ramadan	Cognitive Score	76.19	22.36
	Math Score	46.56	29.78
	Height	127.06	16.49
	N = 1296		
Exposed 1st trimester	Cognitive Score	74.14	23.25
	Math Score	47.41	29.74
	Height	125.92	17.25
	N = 375		
Exposed 2nd trimester	Cognitive Score	78.17	21.21
	Math Score	46.92	30.02
	Height	127.02	16.99
	N = 604		
Exposed 3rd trimester	Cognitive Score	74.88	23.16
	Math Score	44.86	29.38
	Height	128.50	14.42
	N = 317		

Regression Results

	Cognitive Score		Mathematics Score		Height in cm	
	OLS	SFE	OLS	SFE	OLS	SFE
Exposed Ramadan	0.021	0.033	-0.014	0.003	-0.294	1.226
	(0.041)	(0.073)	(0.045)	(0.084)	(0.553)	(1.117)
R^2	0.027	0.847	0.013	0.857	0.476	0.942
N	2128	2128	2128	2128	1597	1597
Exposed 1st trimester	-0.105	-0.134	-0.065	-0.115	-0.835	0.031
	(0.064)	(0.117)	(0.074)	(0.144)	(0.862)	(2.607)
R^2	0.028	0.847	0.012	0.858	0.476	0.942
N	2128	2128	2128	2128	1597	1597
Exposed 2nd trimester	0.181***	0.226**	0.024	0.056	-1.208	-1.411
	(0.056)	(0.104)	(0.065)	(0.117)	(0.987)	(2.781)
R^2	0.032	0.849	0.012	0.857	0.476	0.942
N	2128	2128	2128	2128	1597	1597
Exposed 3rd trimester	-0.075	-0.061	-0.003	0.055	1.580	5.269
	(0.064)	(0.106)	(0.069)	(0.144)	(0.928)	(3.356)
R^2	0.028	0.847	0.012	0.857	0.477	0.943
N	2128	2128	2128	2128	1597	1597

Heights are in cm.
Fixed effects are sibling fixed effects.
Sample is restricted to Muslim children who were 7-14 in 1993 and religious.
*p<0.05, **p<0.01, ***p<0.001

Conclusion

- The paper examines the impact of mild shock to cognitive skills.
- No strong evidence that mild nutrition shock affect cognitive skills.
- Robustness check using height in cm confirmed the results.
- Two possible explanations:
  - Mild shocks does indeed have no impact on cognitive abilities.
  - Mild shocks have an effect on cognitive skills but were later mitigated later in life due to "catch-up" effect.
    - Children who are exposed catch-up to their non-exposed cohorts through parents' investment by providing good nutrition, and clean and good environment for the children to grow.