

# The only child

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## Motivation

- Worldwide there are more **only children** than ever before.
  - 22 percent of all US families are one-child families (Pew Research Center 2015).
  - 70 percent of all urban families in China are one-child families (NBS China 2007).
  - 21 percent of Danish families are one-child families (Statistics Denmark 2020).
- We call attention to these children, and want to know how they fare in school/life.

## **Impact of siblings**

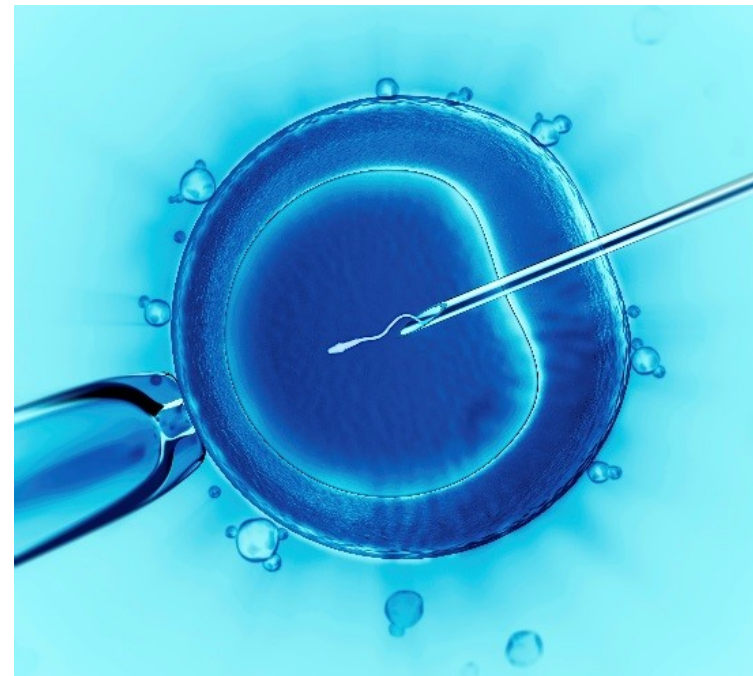
- Would only children do better or worse if they had siblings?
- On theoretical grounds, all answers are possible.
  - Only children do better because they do not have to share the family resources (Becker and Lewis 1973; Becker and Tomes 1976).
  - Only children do worse because they have no younger siblings to teach to/socialize with (Zajonc and Markus 1975; Zajonc 1976).

## Empirical challenge

- Most existing studies compare children with and without siblings.
- Such comparisons provide mixed results. But more importantly, they are not enough to make causal claims (Falbo 2012).
  - Families that decide to have only one child differ from those that decide to have more children: family values, education, economic background.
  - Many factors can impact both the child outcomes and the parents' decision to have more children: family financial stability, relationship stability, health of child and mother.
- What we need is a **natural experiment** that generates (conditionally) as-good-as-random variation in having siblings.

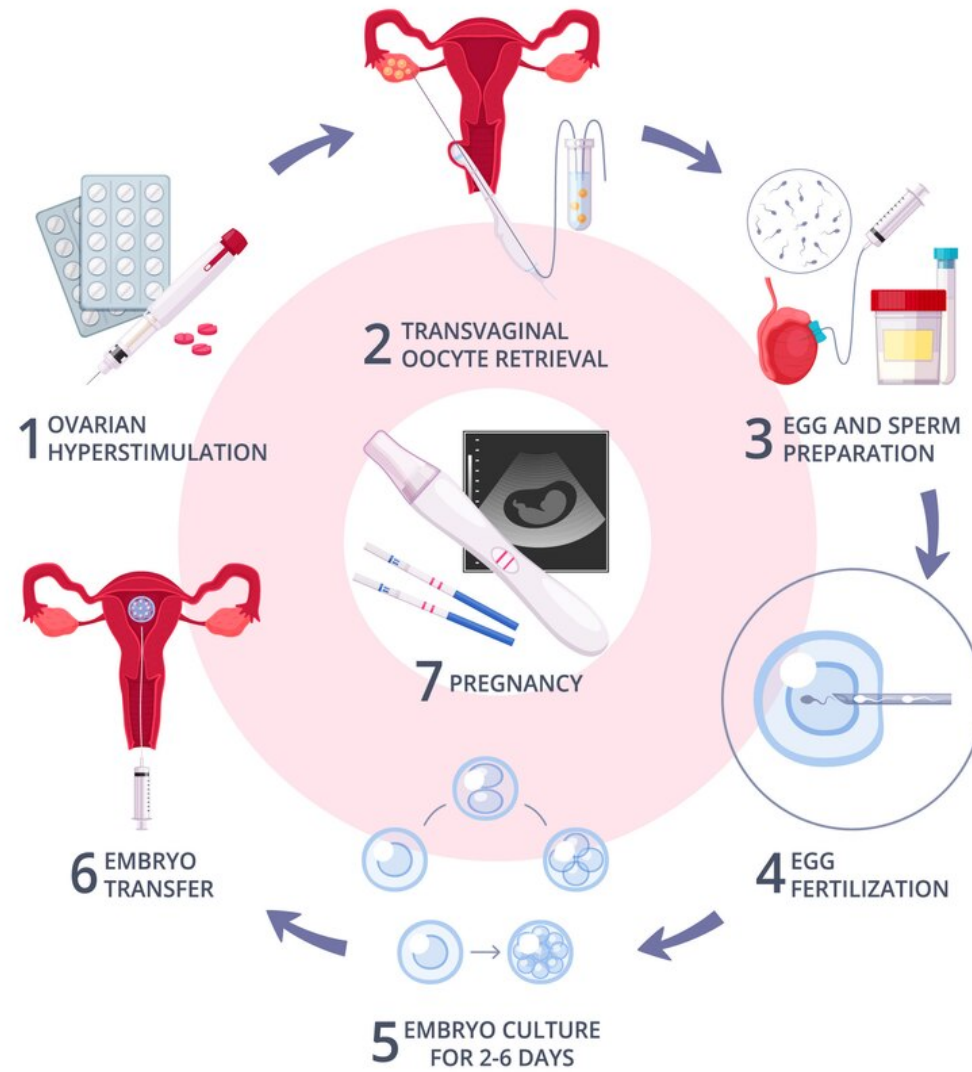
## In vitro fertilisation

- Couple that have trouble conceiving can attempt in vitro fertilisation.
- The treatment success has a random component.
- Intuition:
  - Consider families that attempt to conceive their second child via IVF.
  - First children whose parents have a successful treatment receive a sibling.
  - First children whose parents have an unsuccessful treatment are more likely to remain the only child.



source: CDC

# IN VITRO FERTILIZATION



source: Freepik

## Data

- IVF register containing records of Danish women who received IVF treatment from 1994 onwards.
- The main variables include the date of treatment, treatment outcome, and date of birth.
- Administrative registers to get information on parents (including education, age, marital status, number of children, labor market attachment, and annual earnings).
- Education registry with scores from nationwide school exams.
- Nationwide surveys of primary and secondary school students.

## **Our cognitive and noncognitive outcomes**

- **Cognitive outcomes:**

- Children take multiple nationwide tests (4 tests in reading, 2 tests in math).

- **Noncognitive outcomes:**

- Children respond to nationwide school survey questions that measure personality traits.

We standardize the outcomes by cohort and average per subject or trait.



## **Big 5 personality traits**

- A grouping of personality traits developed in psychology:
  - conscientiousness
  - agreeableness
  - emotional stability
  - openness to experience
  - extraversion
- Our data contains measures of the first three.
  - These personality traits have been identified as strong predictors for important economic outcomes (Plug and Mueller 2006; Almund et al 2011).

## Our sample

- We select all mothers with one child that receive IVF treatment for a second child.
- This leaves us with almost **12,000** and **8,500** first children with cognitive and non-cognitive outcomes, respectively.
- To compare them with a representative sample we select all mothers with first-born children born around the same time as the focal children in the IVF sample.
- This leaves us with about **375,000** and **250,000** representative children with cognitive and non-cognitive outcomes, respectively.

## IVF instrument

- We consider women's first IVF attempt to conceive their second child.
- If treatment success is to a large extent (conditionally) random, some children will end up having siblings for random reasons.
- We use the success of the IVF attempt as an instrument for whether the first child has a sibling.
- **Exogeneity (exclusion restriction):**
  - IVF success should only affect the first child through the presence/absence of the second child.
- **Relevance:**
  - IVF success should be strongly correlated with having a second child

**Table 1 - Some sample statistics**

	1st IVF failure	1st IVF success	difference
<i>Pre-treatment characteristics:</i>			
mother age at first treatment	32.765	32.121	-0.644
	4.309	3.971	0.185***
mother years of schooling	13.534	13.531	-0.004
	2.237	2.236	0.098
mother labor earnings (in 100,000 DKK)	2.538	2.555	0.017
	1.429	1.376	0.062
mother positive labor earnings (0/1)	0.921	0.924	0.003
	0.269	0.265	0.012
partner age at first treatment	35.060	34.381	-0.679
	5.095	4.298	0.221***
partner years of schooling	13.078	13.171	0.093
	2.437	2.441	0.107
partner labor earnings (in 100,000 DKK)	3.410	3.404	-0.006
	2.155	2.375	0.097
partner positive labor earnings (0/1)	0.878	0.884	0.006
	0.327	0.320	0.014

## IVF instrument

- Is treatment success exogenously determined?
- **Arguments in favor:**
- Mothers are comparable in their decision to enter the IVF treatment for a second child, regardless treatment success.
- Mothers (and fathers) are comparable in their educational attainment and pre-treatment earnings, which are both strong predictors of child test scores.
- **Arguments against:**
- But mothers (and fathers) differ in age.
- There is a medical literature arguing that age is the single most important variable influencing outcomes in assisted reproduction (Rosenwaks et al. 1995). These age effects are typically interpreted as evidence that egg quantity and quality fall with maternal age.
- **Our approach:**
  - We will control for age effects and continue as if **treatment success is conditionally as good as random.**

## Naive strategy

- Compare firstborns with siblings to firstborns without siblings

$$\mathbb{E}[Y_i|S_i = 1] - \mathbb{E}[Y_i|S_i = 0]$$

- $Y_i$  include standardized cognitive and noncognitive outcomes of focal children;
- $S_i$  is the endogenous sibling indicator (having any siblings);
- We estimate this on two samples: (i) the representative sample of first born children; and (ii) the sample of first born children whose parents undergo IVF treatment for a second child.
- The estimate reflects a blend of causal and selection effects.

**Table 3**  
**The relationship between having siblings and cognitive and non-cognitive outcomes**

	math test scores	reading test scores	agreeable	conscientious	emotional stability	overall school wellbeing
<i>Representative sample:</i>						
having siblings	0.170 0.004***	0.087 0.004***	0.075 0.005***	0.120 0.005***	0.109 0.005***	0.135 0.005***
observations	306,958	376,178	251,252	251,361	251,312	251,497
<i>IVF sample:</i>						
having siblings	0.097 0.021***	0.054 0.019***	0.036 0.020***	0.066 0.021***	0.055 0.021***	0.082 0.021***
observations	9,778	11,637	8,366	8,370	8,370	8,374

All outcomes are standardized. Standard errors below estimates.

## IVF strategy

- The **first-stage estimate** is:

$$\mathbb{E}[S_i|Z_i = 1] - \mathbb{E}[S_i|Z_i = 0]$$

- The **reduced-form estimate** is:

$$\mathbb{E}[Y_i|Z_i = 1] - \mathbb{E}[Y_i|Z_i = 0]$$

- The **second-stage estimate** is:

$$\frac{\mathbb{E}[Y_i|Z_i = 1] - \mathbb{E}[Y_i|Z_i = 0]}{\mathbb{E}[S_i|Z_i = 1] - \mathbb{E}[S_i|Z_i = 0]}$$

- $Y_i$  include standardized cognitive and noncognitive outcomes of focal children;
- $S_i$  is the endogenous sibling indicator (having any siblings);
- $Z_i$  is the instrument (success at first IVF treatment).



## IVF strategy controlling for parents' age

- The **first-stage estimate** is:

$$\mathbb{E} \left[ \frac{S_i Z_i}{p(X_i)} \right] - \mathbb{E} \left[ \frac{S_i (1 - Z_i)}{1 - p(X_i)} \right]$$

- The **reduced-form estimate** is:

$$\mathbb{E} \left[ \frac{Y_i Z_i}{p(X_i)} \right] - \mathbb{E} \left[ \frac{Y_i (1 - Z_i)}{1 - p(X_i)} \right]$$

- The **second-stage estimate** is the ratio of the two.
  - $Y_i$  include standardized cognitive and noncognitive outcomes of focal children;
  - $S_i$  is the endogenous sibling indicator (having any siblings);
  - $Z_i$  is the instrument (success at first IVF treatment).
  - $p(X_i)$  is the probability that IVF succeeds conditional on parents' ages at the time of treatment  $X_i$ .

**Table 4 (first stage)**  
**The effect of having siblings on cognitive and non-cognitive outcomes**

	<b>math test scores</b>	<b>reading test scores</b>	<b>agreeable</b>	<b>conscientious</b>	<b>emotional stability</b>	<b>overall school wellbeing</b>
first stage	0.339 <i>0.006***</i>	0.341 <i>0.006***</i>	0.332 <i>0.005***</i>	0.332 <i>0.005***</i>	0.332 <i>0.006***</i>	0.332 <i>0.007***</i>
reduced form	-0.027 <i>0.019</i>	-0.024 <i>0.017</i>	-0.013 <i>0.017</i>	0.006 <i>0.019</i>	-0.024 <i>0.017</i>	-0.017 <i>0.020</i>
second stage	-0.079 <i>0.057</i>	-0.072 <i>0.050</i>	-0.041 <i>0.052</i>	-0.018 <i>0.059</i>	-0.072 <i>0.052</i>	-0.051 <i>0.061</i>
observations	9,778	11,637	8,366	8,370	8,370	8,374

Estimation sample contains all focal children whose parents enter treatment for second child.  
Propensity for treatment success estimated controlling for parents' ages at time of treatment.  
All outcomes are standardized. Standard errors below estimates.

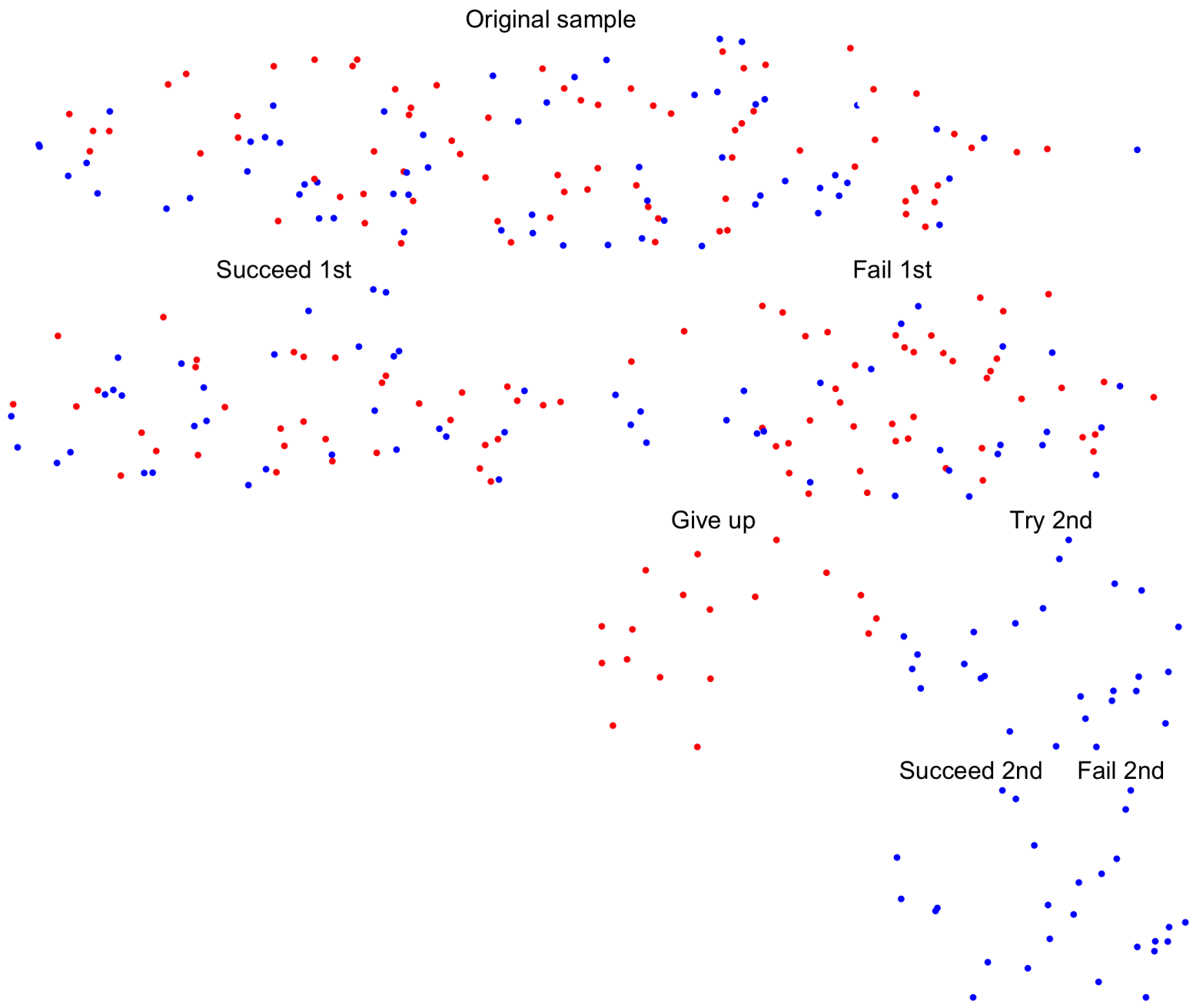
**Table 4 (second stage)**  
**The effect of having siblings on cognitive and non-cognitive outcomes**

	<b>math test scores</b>	<b>reading test scores</b>	<b>agreeable</b>	<b>conscientious</b>	<b>emotional stability</b>	<b>overall school wellbeing</b>
first stage	0.339 <i>0.006***</i>	0.341 <i>0.006***</i>	0.332 <i>0.005***</i>	0.332 <i>0.005***</i>	0.332 <i>0.006***</i>	0.332 <i>0.007***</i>
reduced form	-0.027 <i>0.019</i>	-0.024 <i>0.017</i>	-0.013 <i>0.017</i>	0.006 <i>0.019</i>	-0.024 <i>0.017</i>	-0.017 <i>0.020</i>
second stage	-0.079 <i>0.057</i>	-0.072 <i>0.050</i>	-0.041 <i>0.052</i>	-0.018 <i>0.059</i>	-0.072 <i>0.052</i>	-0.051 <i>0.061</i>
observations	9,778	11,637	8,366	8,370	8,370	8,374

Estimation sample contains all focal children whose parents enter treatment for second child.  
Propensity for treatment success estimated controlling for parents' ages at time of treatment.  
All outcomes are standardized. Standard errors below estimates.

## **Treat to exclusion restriction**

- How can IVF success impact first child outcomes other than through the presence of a sibling?
- Some women whose first IVF attempt failed might conceive later:
  - Some first children remain only children.
  - Some receive a sibling at a later time.
- IVF also impacts the age gap between siblings (in families that would eventually conceive a second child independent of IVF first success)
- If the age gap between siblings has an effect on first child outcomes, then the exclusion restriction is violated.
- To mitigate this we exploit randomness in later treatments, which allows us to estimate the impact of conceiving a second child through IVF relative to not conceiving a second child through IVF.



**Table 5**  
**The effect of having siblings on cognitive and non-cognitive outcomes**

	<b>math test scores</b>	<b>reading test scores</b>	<b>agreeable</b>	<b>conscientious</b>	<b>emotional stability</b>	<b>overall school wellbeing</b>
first stage	0.566 <i>0.009***</i>	0.570 <i>0.009***</i>	0.559 <i>0.009***</i>	0.559 <i>0.009***</i>	0.559 <i>0.010***</i>	0.559 <i>0.010***</i>
reduced form	-0.017 <i>0.023</i>	-0.020 <i>0.013</i>	0.006 <i>0.021</i>	0.009 <i>0.028</i>	-0.002 <i>0.021</i>	-0.003 <i>0.023</i>
second stage	-0.030 <i>0.040</i>	-0.036 <i>0.040</i>	0.012 <i>0.038</i>	-0.016 <i>0.049</i>	-0.005 <i>0.039</i>	-0.006 <i>0.042</i>
observations	6,870	8,178	5,802	5,804	5,805	5,807

Estimation sample contains all focal children whose parents enter treatment for second child.  
Propensity for treatment success estimated controlling for parents' ages at time of treatment.  
All outcomes are standardized. Standard errors below estimates.

## Summary

- There seems to be little value of having siblings for personality traits and school performance.
- All our effect estimates are small and statistically insignificant
- When we test for possible only child effect heterogeneity, we find that our estimates are remarkably stable. The only child effect does not vary by family income, fertility-related health disparities, age of the mothers, and age and gender of the child.
- Observed differences in outcomes between only children and the rest likely result from selection rather than the impact of having siblings.