Month of Birth and Children's Health in India

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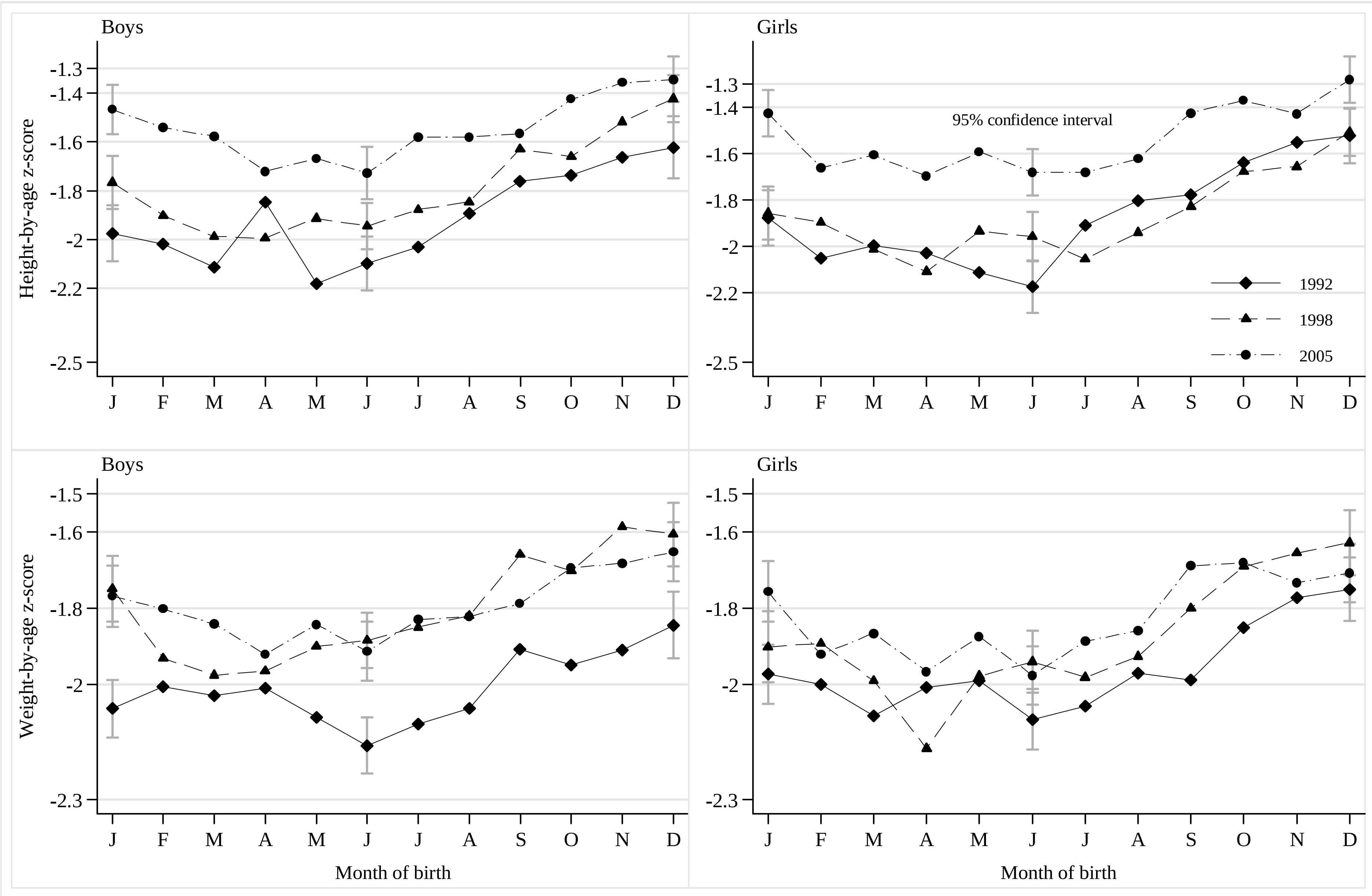
Outline

- Anthropometric Measures of children’s health
- Motivation, Research question
- Data
- Descriptive results
- Is there a month-of-birth effect: Measuring the impact of the month of birth on health
- Explaining the correlation of the month of birth and child heath outcomes
  - Hypothesis testing
  - Sensitivity Analysis
- Conclusions

Anthropometric Measures of Health

- The growth in height and weight of healthy children under 5 years of age from different ethnic backgrounds and different continents are reasonably similar.
- Child growth and health can be assessed by comparing his/her height or weight with age- and sex-specific growth reference groups and calculating the corresponding Z-scores.
- Z-Scores: How many standard deviations away from the mean is this child?
- Height-for-Age Z-score (***HAZ***), Weight-for-Age Z-score (***WAZ***), and Weight-for-Height (***WHZ***).
- A child is considered to be ***mildly underweight*** if WAZ is from -1 to -2 SD, ***moderately underweight*** if WAZ is from -2 to -3 and ***severely underweight*** if WAZ is less than -3 SD.

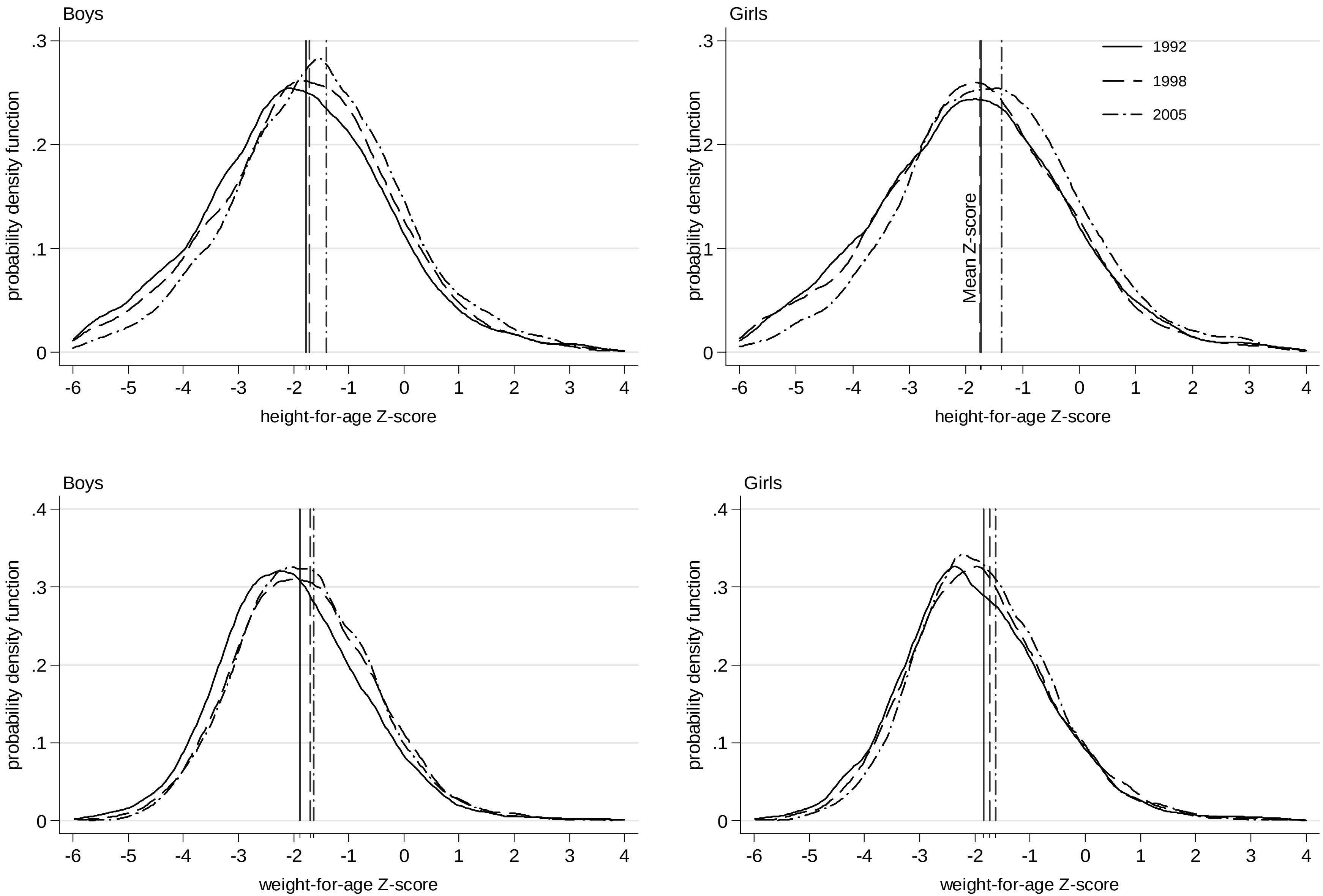
Health outcomes (WAZ and HAZ) by month of birth



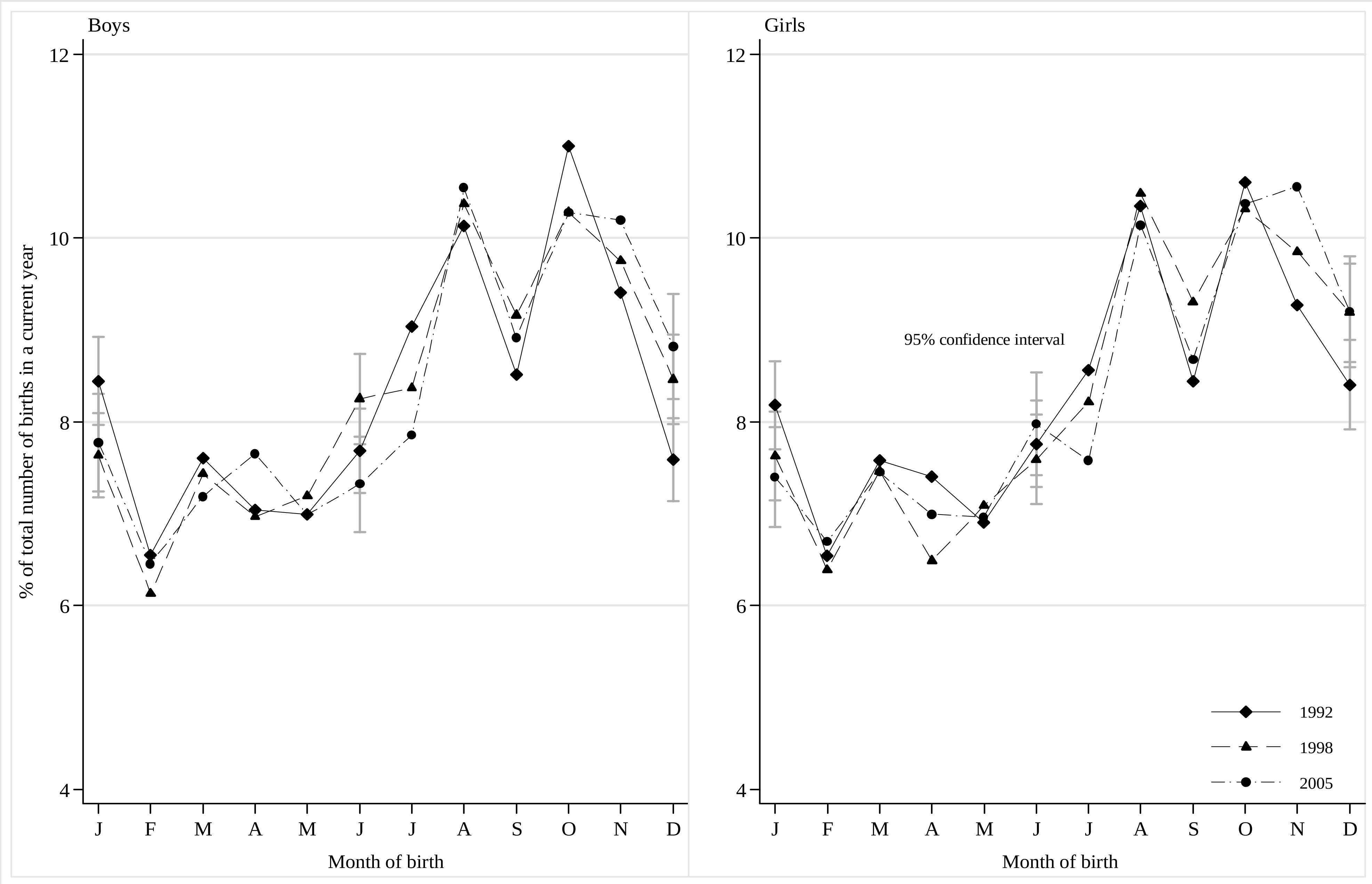
Data

- **National Family Health Survey of India (NFHS)**
- **3 waves of the survey:**
  - 1992/1993: 45,279 children in 33,032 households
  - 1998/1999: 30,984 children in 26,056 households
  - 2005/2006: 48,679 children in 33,968 households
- **Three questionnaires:**
  - Household questionnaire
  - Women’s questionnaire
  - Village questionnaire
- Measures of heigh and weight are available for children younger than 36 months of age

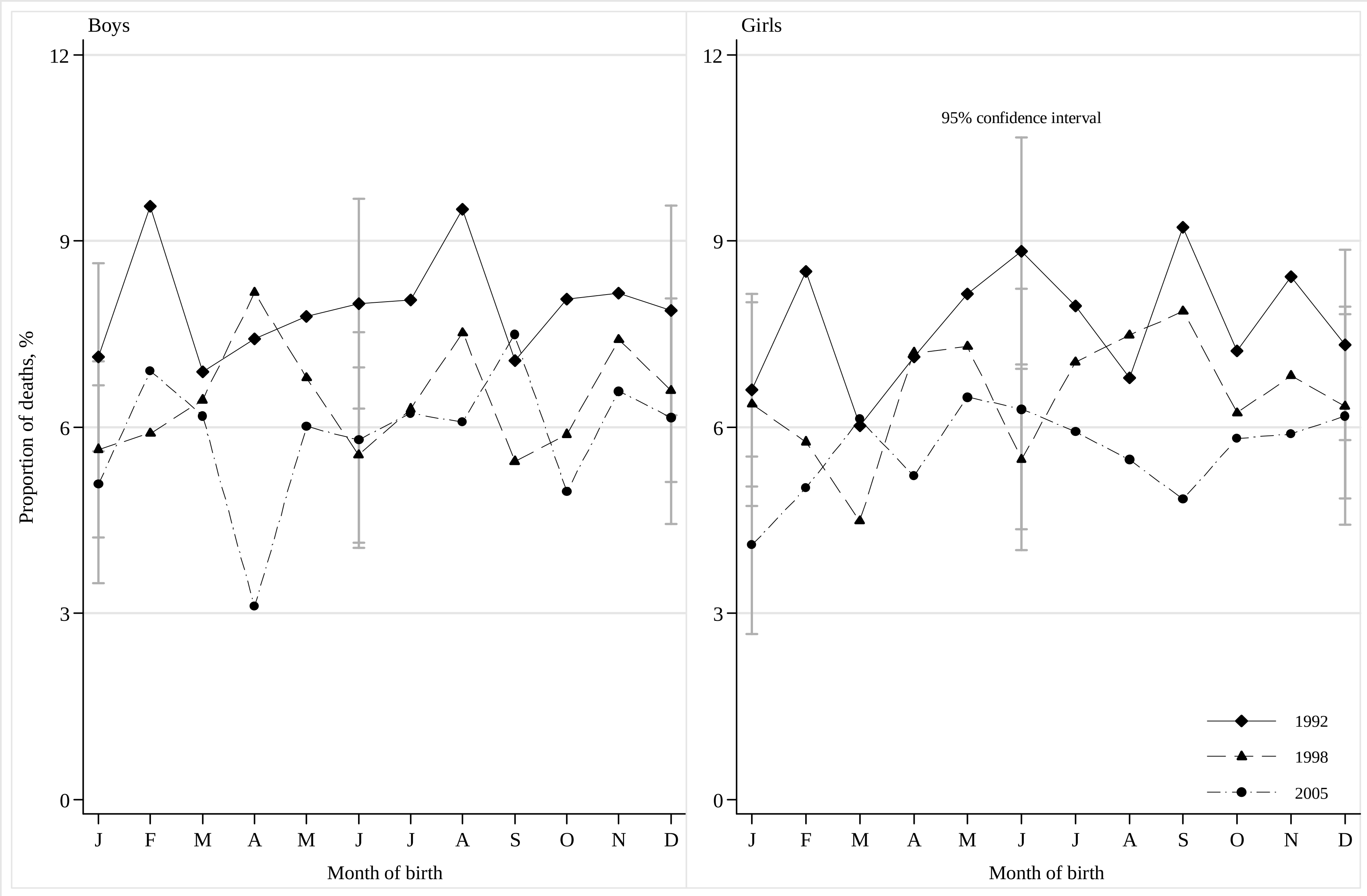
Distribution of WAZ and HAZ by gender



Share of the total number of births in a current year by month of birth.



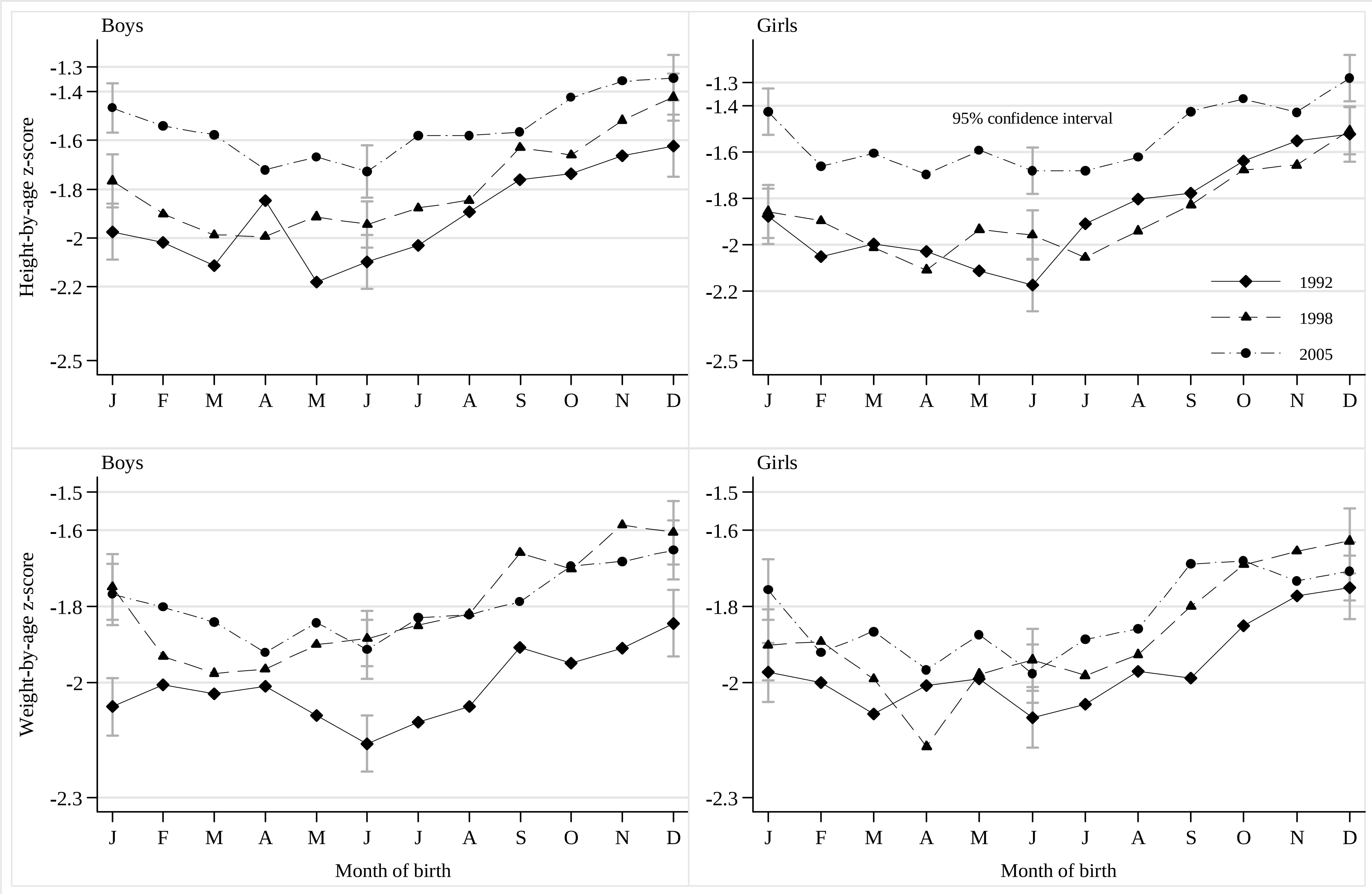
Proportion of children who died before the age of 36 months among all children born in a particular month



Is there a month-of-birth effect?

- Raw data
- Conditioning on a child’s, mother’s, household’s and village observed characteristics.
- Conditioning on unobserved characteristics
- Size of the month-of-birth effect: comparison with the effect of nutritional programs.

Health outcomes (WAZ and HAZ) by month of birth: Unconditional means



Month-of-birth effect: conditioning on observable characteristics.

$$Z_i^s = \sum_{k=1}^{11} \boldsymbol{\alpha}_{\boldsymbol{k}}^s M_{ik} + \pi^s \overline{X}_i + \varepsilon_i^s \quad s = WAZ, HAZ$$

- Z_i – z-scores
- M_{ik} – 11 month-of birth dummies
- X_i – vector of characteristics of a child, a mother, a household and a village
- ε_i - error term

Regressions of health outcomes on month of birth with controls

		Height-for-Age Z-score				Weight-for-Age Z-score			
		Boys		Girls		Boys		Girls	
		Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
1992	January	-0.372***	*0.078*	-0.324***	*0.080*	-0.212***	*0.053*	-0.181***	*0.055*
	February	-0.362***	*0.083*	-0.487***	*0.085*	-0.122**	*0.056*	-0.175***	*0.058*
	March	-0.489***	*0.079*	-0.364***	*0.080*	-0.166***	*0.053*	-0.228***	*0.056*
	April	-0.281***	*0.082*	-0.410***	*0.083*	-0.140**	*0.055*	-0.145***	*0.056*
	May	-0.588***	*0.082*	-0.586***	*0.084*	-0.243***	*0.055*	-0.183***	*0.057*
	June	-0.492***	*0.079*	-0.602***	*0.079*	-0.311***	*0.053*	-0.264***	*0.055*
	July	-0.443***	*0.075*	-0.400***	*0.077*	-0.268***	*0.051*	-0.277***	*0.054*
	August	-0.311***	*0.073*	-0.253***	*0.073*	-0.233***	*0.050*	-0.189***	*0.052*
	September	-0.222***	*0.076*	-0.208***	*0.078*	-0.115**	*0.052*	-0.188***	*0.054*
	October	-0.126*	*0.072*	-0.074	*0.073*	-0.127***	*0.049*	-0.071	*0.051*
	November	-0.072	*0.075*	0.020	*0.076*	-0.078	*0.051*	0.024	*0.053*
	December	*Reference month*							
	N Obs.	10,341		9,946		13,725		13,284	
	R^2	0.167		0.181		0.170		0.158	

Potential endogeneity of the month of birth

- Month of birth could be correlated with some unobservable characteristics. This will result in biased estimates of $\boldsymbol{\alpha}$'s.

$$Z_{ij}^{s} = \sum_{k=1}^{11} \boldsymbol{\alpha}_{\boldsymbol{k}}^{\boldsymbol{s}} M_{ijk} + \pi^{s} \overline{X}_{ij} + (\mu_{ij}^{s} + v_{j}^{s}) \quad s = WAZ, HAZ$$

$$s.t.\ Corr(M_{ijk}, \mu_{ij}^{s}) = 0;\ Corr(M_{ijk}, v_{j}^{s}) \neq 0.$$

- Can remove the household-specific, time-invariant effect $\boldsymbol{v_j}$ by estimating a fixed effect regression on a sample of siblings.

Fixed-effect Regression on a sample of siblings 0 to 3 years of age.

		Height-for-Age Z-score		Weight-for-Age Z-score	
		Coeff.	SE	Coeff.	SE
1992	January	-0.192	*0.158*	-0.038	*0.107*
	February	-0.692***	*0.165*	-0.171	*0.114*
	March	-0.580***	*0.163*	-0.149	*0.111*
	April	-0.502***	*0.167*	-0.153	*0.113*
	May	-0.704***	*0.165*	-0.307***	*0.110*
	June	-0.482***	*0.154*	-0.264**	*0.108*
	July	-0.366**	*0.157*	-0.157	*0.109*
	August	-0.447***	*0.144*	-0.290***	*0.099*
	September	-0.341**	*0.149*	-0.126	*0.103*
	October	-0.109	*0.145*	-0.123	*0.099*
	November	-0.081	*0.145*	0.119	*0.100*
	December	*Reference month*			
	N Obs.	3,686		4,926	
	R^2	0.291		0.237	

Size of the month-of-birth effect

- The estimated month-of-birth effect for Indian children ranges from 0.2 to 0.4 standard deviation for different specifications/years.
- These effects are similar to the differnces in Z-scores between children of illiterate mothers and of mothers with secondary education.
- Supplementary feeding and provision of micronutrients result in 0.1 to 0.5 SD improvements in WAZ and HAZ in Pakistan, Vietnam and Mexico.
- The magnitudes of the effects are comparable to the effects found in by Alderman et al. (2005) for Tanzania.

Explaining the correlation of the month of birth and health outcomes

- **Nutrition-disease hypothesis**: relates a month-of birth variation in children's health to higher prevalence of diseases and malnutrition during the monsoon season.
- **Socio-economic hypothesis:** assumes different seasonality of birth for different socio-economic groups.
- **Selective survival hypothesis:** postulates heterogeneity in the health composition of surviving children.
- **Unplanned pregnancy hypothesis:** explains seasonal differences in children's health by the differences in outcomes between planned and unplanned children

Nutrition-Disease Hypothesis

- Children living in households with higher incomes and household with educated mothers should be better insulated from seasonal shocks in nutrition and diseases. I.e., the relative "month-of-birth" effect should be smaller for such children.
- Linear regression of Z-scores on a set of controls
- Hypothesis testing: Test joint significance of the coefficients on the interactions of month-of-birth dummies with household wealth and maternal education.

$$Z_i^s = \sum_{k=1}^{11} M_{ik}[\alpha_k^s + \boldsymbol{\beta_k^s} I_i + \boldsymbol{\gamma_k^s} E_i] + \pi^s \bar{X}_i + \varepsilon_i^s \quad s = WAZ, HAZ$$

- We expect that $\beta_k^s > 0$ and $\gamma_k^s > 0$.

Nutrition-Disease Hypothesis
F- and χ^2 tests

		Specification 1		Specification 2		Specification 3
		Boys	Girls	Boys	Girls	Boys & Girls
Height-for-age	Wealth					
	1992	2.313^{***}	1.992^{**}	1.263	1.353	21.476^{**}
	1998	2.944^{***}	3.478^{***}	1.467	1.890^{**}	36.454^{***}
	2005	3.091^{***}	2.070^{**}	–	–	15.274
	Education					
	1992	1.457	1.922^{**}	1.582^{*}	1.689^{*}	27.169^{***}
	1998	3.156^{***}	2.595^{***}	2.395^{***}	1.641^{*}	19.100^{*}
	2005	2.818^{***}	2.584^{***}	–	–	15.654
	Wealth and education					
	1992	1.794^{**}	1.664^{**}	1.359	1.351	35.285^{**}
	1998	2.350^{***}	2.458^{***}	1.589^{**}	1.565^{**}	45.753^{***}
	2005	2.463^{***}	2.632^{***}	–	–	32.968^{*}

Socio-Economic Hypothesis

- Rich and poor households are more likely to have children during different seasons: involvement in agricultural work and rural-urban migration of males
- Hypothesis testing: test the significance of household wealth and maternal education in determining the month of birth.
- Multinomial logit estimation:

$$\text{Prob}(M_{ik} = 1) = f(\boldsymbol{\beta_k} I_i + \boldsymbol{\gamma_k} E_i + \pi_k \bar{X}_i + \varepsilon_{ik}), \;\; k = 1, \ldots, 12$$

- Test the significance of β_k and γ_k

MLogit of the probability of a child to be born in a certain month of the year.

	1992 Boys		1992 Girls	
	Coeff.	SE	Coeff.	SE
January	0.113	*0.086*	-0.011	*0.086*
February	0.161*	*0.092*	-0.155	*0.092*
March	0.120	*0.088*	-0.097	*0.089*
April	0.147	*0.090*	-0.030	*0.090*
May	0.163*	*0.091*	-0.018	*0.090*
June	0.189**	*0.088*	-0.058	*0.090*
July	0.230***	*0.086*	-0.055	*0.087*
August	0.097	*0.084*	-0.069	*0.083*
September	0.147*	*0.086*	-0.095	*0.088*
October	0.332***	*0.083*	-0.095	*0.083*
November	0.085	*0.085*	-0.094	*0.085*
LR Test	22.313**		5.510	

Selective survival hypothesis

- If robust children born in certain months of the year are more likely to survive at birth and during infancy then later in life children born during these months would appear healthier.
- We use weight of a child at birth as a proxy for its health at birth.
- Probability to survive past age of 3 as a function of controls and interactions of the month-of-birth dummies with weight at birth $\boldsymbol{W_i}$:

$$S_i^* = \sum_{k=1}^{11} M_{ik}[\alpha + \boldsymbol{\gamma_k} W_i] + \beta W_i + \pi X_i + \varepsilon_i$$

$$S_i = 1 \ if \ S_i^* > 0; \ S_i = 0 \ if \ S_i^* \leq 0$$

- Hypothesis testing: test the significance of the coefficients on interaction terms γ_k. Probit estimation.

Probit estimates of probability of survival till age of one. Coefficients on interaction terms.

	1992 Boys		1992 Girls	
	Coeff.	SE	Coeff.	SE
January	-0.182	*0.196*	0.173	*0.195*
February	-0.227	*0.205*	-0.270	*0.201*
March	-0.235	*0.202*	0.096	*0.206*
April	-0.289	*0.201*	0.163	*0.202*
May	-0.273	*0.206*	0.064	*0.202*
June	-0.057	*0.203*	0.177	*0.197*
July	-0.524***	*0.196*	0.166	*0.197*
August	-0.283	*0.188*	-0.077	*0.184*
September	-0.291	*0.198*	0.173	*0.187*
October	-0.391**	*0.186*	0.104	*0.186*
November	-0.228	*0.192*	0.183	*0.187*
N Obs.	12,531		11,889	

“Unplanned pregnancy” hypothesis

- Suppose parents <u>*believe*</u> that certain months are “bad” for their children to be born in. Then children born during these “bad” months are more likely to be a result of unplanned pregnancies.
- We use the “desirability of pregnancy” question:

  In the time you became pregnant with (Name) did you want 1) to become pregnant then 2) to wait until later 3) no more children at all?

- Multinomial logit of a probability of a child to be born in a certain month as a function of “desirability” of a child $\boldsymbol{D_i}$ and a set of controls:

$$\text{Prob}(M_{ik}=1)=f(\boldsymbol{\eta}_k D_i+\pi_k \bar{X}_i+\varepsilon_{ik}),\ \ k=1,\ldots,12$$

- Hypothesis testing: test the significance of the coefficients on the “desirability” dummies η_k. IV estimation using gender composition of siblings in the family.

Probability to be born in a certain month as a function of “child desirability”. Coefficients on “desirability dummy”.

	1992 Boys		1992 Girls	
	Coeff.	SE	Coeff.	SE
January	0.049	*0.096*	-0.001	*0.092*
February	0.004	*0.102*	0.079	*0.099*
March	0.058	*0.099*	0.036	*0.095*
April	-0.004	*0.100*	0.126	*0.097*
May	-0.028	*0.102*	-0.078	*0.097*
June	0.105	*0.100*	0.111	*0.098*
July	-0.009	*0.096*	0.022	*0.094*
August	-0.043	*0.093*	0.049	*0.089*
September	0.096	*0.098*	-0.117	*0.093*
October	0.055	*0.093*	-0.028	*0.088*
November	0.028	*0.095*	-0.056	*0.091*

Conclusions:

- Children’s anthropometric scores (WAZ and HAZ) vary significantly with the month of birth. The “month-of-birth” effect persists after controlling on observable and unobservable characteristics.
- The month-of-birth effect is is comparable to the effects of maternal education and nutritional supplementation programs on children’s health.
- The most likely explanation for the observed patterns of the changes in children health by the month of their birth is higher prevalence of malnutrition and wider exposure to diseases in the lean season of monsoon.