

# Bio-social life-course factors associated with women's early marriage in rural India: The prospective longitudinal Pune Maternal Nutrition Study

## Supporting Information

**Figure S1.** Study profile.

**Table S1.** Baseline maternal pre-conception phenotype, household characteristics and girls' birthweight stratified by girls lost to follow-up and girls followed-up at 18-years

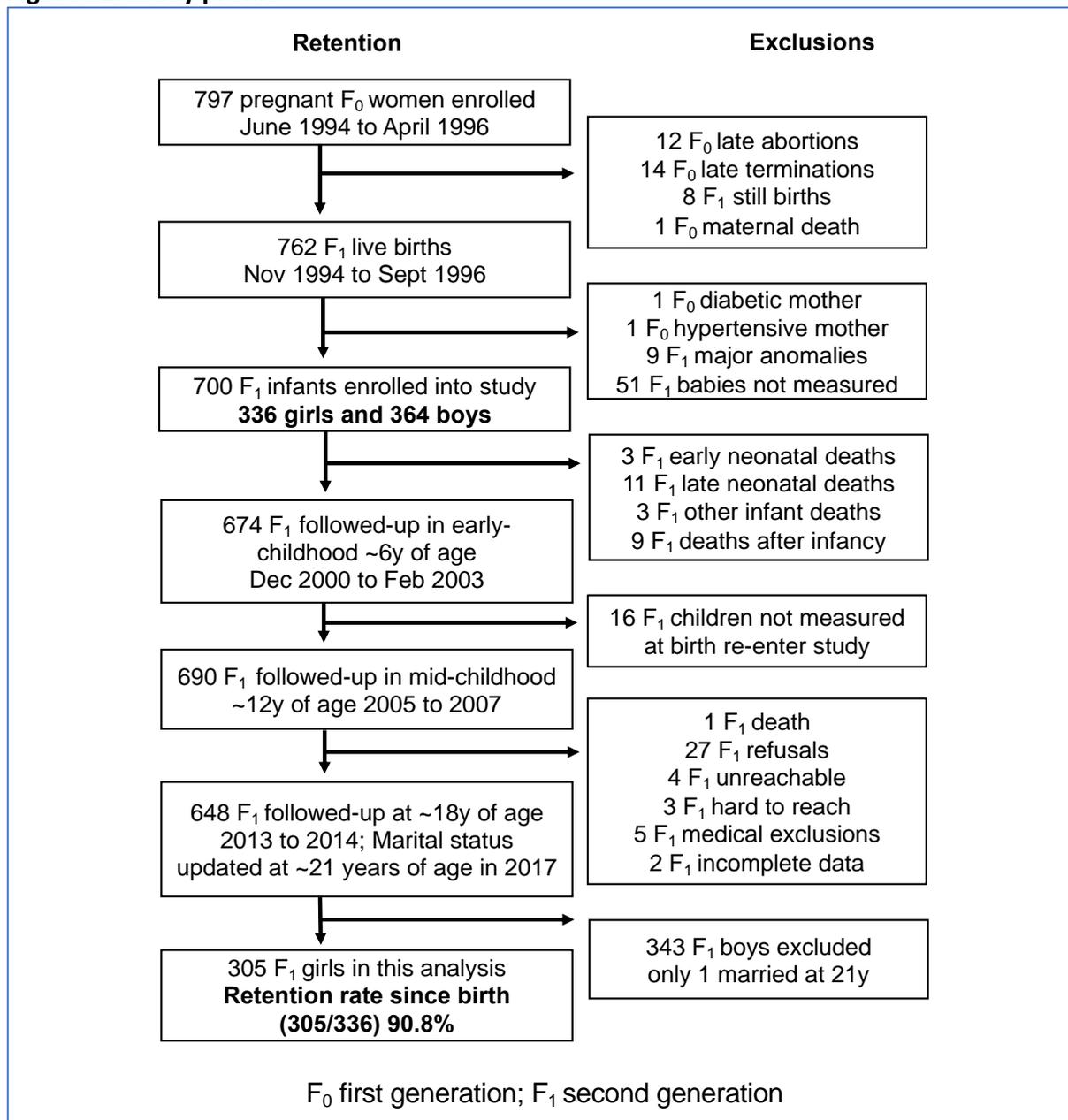
**Table S2.** Differences in markers of girls' size and nutritional status (z-scores) and conditional growth from birth to late-adolescence stratified by early married and unmarried girls

**Table S3.** Girls' educational attainment and performance from pre-primary to late-adolescence stratified by early married and unmarried girls

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**Table S5.** Multivariable logistic regression model showing confounders and independent associations of conventional risk factors, and of maternal phenotype, household and girls' characteristics with girls' early marriage

**Figure S1. Study profile**



Flow diagram of study participants retained and excluded in the Pune Maternal Nutrition Study from recruitment at maternal pre-conception, and F<sub>1</sub> offspring at subsequent follow-ups.

**Table S1. Baseline maternal pre-conception phenotype, household characteristics and girls' birthweight stratified by girls lost to follow-up and girls followed-up at 18-years**

	Lost to follow-up (n=31)	Followed-up at 18 years (n=305)	Difference <sup>1</sup>
	Mean (SD)	Mean (SD)	Δ (SE), p-value
<b>Maternal phenotype, at baseline</b>			
Age (years) <sup>3</sup> (n=331)	20.9 (1.15)	20.9 (1.17)	0.99 (1.03), 0.893
Marriage age (years) (n=323)	17.4 (3.02)	17.5 (2.70)	-0.07 (0.52), 0.886
Parity (n=331)	1.12 (0.95)	1.19 (1.14)	-0.07 (0.23), 0.757
Height (cm) (n=331)	151.9 (4.69)	152.0 (4.78)	-0.08 (0.98), 0.937
Gestation (weeks) (n=331)	39.0 (1.53)	39.0 (1.61)	-0.02 (0.33), 0.946
<b>Girls' birthweight (kg) (n=311)</b>	<b>2.54 (0.36)</b>	<b>2.56 (0.37)</b>	
	n (%)	n (%)	p-value <sup>2</sup>
<b>Maternal phenotype, at baseline</b>			
Aggregate adiposity score (n=327)			<b>0.037</b>
Low	5 (20.0)	108 (35.8)	
Mid	6 (24.0)	100 (33.1)	
High	14 (56.0)	94 (31.1)	
Education (n=319)			0.063
None to primary (0-5 years)	16 (61.5)	125 (42.7)	
Upper primary + (≥6 years)	10 (38.5)	168 (57.3)	
<b>Household characteristics, at baseline</b>			
Caste (n=330)			<b>0.007</b>
Low (tribal, scheduled)	6 (23.1)	19 (6.3)	
Mid (artisan, agrarian)	4 (15.4)	69 (22.7)	
High (prestige, dominant)	16 (61.5)	216 (71.1)	
Religion (n=331)			0.549
Hindu	25 (96.2)	299 (98.0)	
Muslim	1 (3.8)	4 (1.3)	
Buddha	0 (0)	2 (0.7)	
Family type (n=330)			0.240
Joint	6 (23.1)	44 (14.5)	
Nuclear	20 (76.9)	260 (85.5)	
Family size (n=330)			0.738
<6 adults	16 (61.5)	197 (64.8)	
≥6 adults	10 (38.5)	107 (35.2)	
Socio-economic Status at baseline			0.206
Low (<25)	11 (42.3)	80 (26.2)	
Mid (25-29)	8 (30.8)	112 (36.7)	
High (≥30)	7 (26.9)	113 (37.1)	
Agrarian land size (n=312)			0.200
Low (<3 acres)	11 (50.0)	101 (34.8)	
Mid (3 to 5 acres)	3 (13.6)	87 (30.0)	
High (≥6 acres)	8 (36.4)	102 (35.2)	
Paternal education (n=319)			0.134
None to primary (0-5 years)	11(42.3)	83 (28.3)	
Upper primary + (≥6 years)	15 (57.7)	210 (71.7)	

SD, standard deviation; <sup>1</sup>Independent samples *t*-test. Δ, difference (standard error, SE) between lost to follow-up and followed-up at 18-years. *n*, number. <sup>2</sup>Chi-square test. <sup>3</sup>Maternal age was positively skewed and natural log-transformed, but reported in original scale in Table. Boldface values indicate statistically significant differences at  $p \leq 0.05$ .

**Table S2. Differences in markers of girls' size and nutritional status (z-scores) and conditional growth from birth to late-adolescence stratified by early married and unmarried girls**

	Early married (n=71)	Unmarried (n=234)	Difference <sup>1</sup>
<b>Size and nutritional status</b>			
<b>Birth</b>	<b>Mean (SD)</b>	<b>Mean (SD)</b>	<b>Δ (SE), p-value</b>
Height z-score (n=301)	-1.00 (0.79)	-1.16 (0.98)	0.16 (0.13), 0.206
Weight z-score (n=287)	-1.52 (0.89)	-1.66 (0.92)	0.13 (0.13), 0.294
<b>Early-childhood (~2y)</b>			
Height z-score (n=286)	-1.70 (0.79)	-1.67 (1.09)	-0.03 (0.12), 0.819
Weight z-score (n=287)	-1.91 (0.79)	-1.83 (1.04)	-0.08 (0.12), 0.504
BMI z-score (n=286)	-1.23 (0.94)	-1.11 (1.04)	-0.12 (0.14), 0.393
<b>Mid-childhood (~6y)</b>			
Height z-score	-1.50 (0.70)	-1.39 (0.86)	-0.11 (0.11), 0.340
Weight z-score	-2.39 (0.82)	-2.16 (0.94)	-0.23 (0.12), 0.061
BMI z-score	-2.01 (0.77)	-1.78 (0.84)	-0.23 (0.11), <b>0.041</b>
<b>Early-adolescence (~12y)</b>			
Age at menarche (n=301)	13.69 (1.00)	13.41 (1.61)	0.28 (0.15), 0.066
Height z-score	-1.12 (0.80)	-0.98 (0.90)	-0.15 (0.12), 0.219
Weight z-score	-1.85 (1.09)	-1.69 (1.16)	-0.16 (0.15), 0.292
BMI z-score	-1.96 (1.24)	-1.83 (1.32)	-0.13 (0.18), 0.473
<b>Late-adolescence (~18y)</b>			
Height z-score (n=292)	-1.06 (0.84)	-1.07 (0.94)	0.01 (0.13), 0.924
Weight z-score (n=292)	-1.66 (1.32)	-1.78 (1.22)	0.11 (0.18), 0.534
BMI z-score (n=292)	-1.11 (1.30)	-1.24 (1.33)	0.12 (0.19), 0.517
<b>Growth</b>			
<b>Conditional height gain</b>	<b>Mean (SD)</b>	<b>Mean (SD)</b>	<b>Δ (SE), p-value</b>
Birth to 2 years z-score (n=282)	-0.06 (0.88)	0.08 (0.98)	-0.14 (0.13), 0.312
2 to 6 years z-score (n=286)	-0.19 (0.75)	-0.01 (0.92)	-0.18 (0.12), 0.135
6 to 12 years z-score	0.07 (1.12)	0.19 (1.08)	-0.11(0.15), 0.444
12 to 18 years z-score (n=292)	0.14 (1.02)	-0.09 (1.15)	0.23 (0.16), 0.152
<b>Conditional weight gain</b>			
Birth to 2 years z-score (n=270)	-0.07 (0.80)	0.05 (1.09)	-0.12 (0.13), 0.346
2 to 6 years z-score (n=287)	-0.19 (0.95)	0.12 (0.91)	-0.31 (0.13), <b>0.017</b>
6 to 12 years z-score	0.05 (1.10)	-0.03 (1.07)	0.08 (0.15), 0.582
12 to 18 years z-score (n=292)	0.15 (1.03)	-0.20 (0.98)	0.35 (0.14), <b>0.015</b>
<b>Conditional BMI gain</b>			
Birth to 2 years z-score (n=269)	-0.09 (0.88)	0.05 (1.06)	-0.14 (0.15), 0.325
2 to 6 years z-score (n=286)	-0.13 (0.88)	0.09 (0.94)	-0.22 (0.13), 0.091
6 to 12 years z-score	-0.09 (1.03)	-0.20 (1.05)	0.11 (0.14), 0.446
12 to 18 years z-score (n=292)	0.20 (0.90)	-0.06 (0.90)	0.26 (0.13), <b>0.045</b>

n, number of participants; SD, standard deviation; <sup>1</sup>Independent samples t-test. Δ, difference (standard error, SE) between early married girls and unmarried girls. Boldface values indicate statistically significant differences at p<0.05.

**Table S3. Girls' educational attainment and performance from pre-primary to late-adolescence stratified by early married and unmarried girls**

	Early married (n=71)	Unmarried (n=234)	p-value <sup>1</sup>
	n (%)	n (%)	
<b>Participation in early childhood education</b>			
Nursery school attendance			0.873
Yes	63 (88.7)	206 (88.0)	
No	8 (11.3)	28 (12.0)	
<b>Age-related progression in school</b>			
Age at entry, 1 <sup>st</sup> standard (n=301)			0.768
Below or at expected age (<7 years)	7 (10.0)	26 (11.3)	
Higher than expected age (≥7 years)	63 (90.0)	205 (88.7)	
Standard/age, early-adolescence			0.957
Below expected age	23 (32.4)	75 (32.1)	
At or higher than expected age	48 (67.6)	159 (67.9)	
<b>School performance</b>			
Failing school standard			0.359
Did not fail a school standard	62 (87.3%)	213 (91.0%)	
Failed in school between standards 1 to 9	9 (12.7%)	21 (9.0%)	
<b>School completion</b>			
Lower-secondary school (10 <sup>th</sup> standard)			<b>&lt;0.001</b>
Completed	51 (71.8)	220 (94.0)	
Not completed	20 (28.2)	14 (6.0)	
Attending school in late-adolescence, 18 years of age			<b>&lt;0.001</b>
Yes	21 (29.6)	212 (90.6)	
No	50 (70.4)	22 (9.4)	

n, number of participants. <sup>1</sup>Chi-square test. Boldface values indicate statistically significant differences at p≤0.05.

**Table S4. Univariable logistic regression testing associations of maternal phenotype, household and girls' characteristics with girls' early marriage**

Variable	OR (95%CI), <i>p</i> -value	NK	<i>n</i>
<b>Maternal and household characteristics</b>			
Maternal education (≥6 years=Ref)	1.00	0.025	<i>n</i> =293
None to primary (0-5 years)	1.86 (1.07, 3.21), <b>0.026</b>		<i>n</i> =68 married girls
Constant	0.23, <0.001		<i>n</i> =225 unmarried girls
Gestational age (Term, ≥40 weeks=Ref)	1.00	0.037	<i>n</i> =305
Pre-term (<37 weeks)	3.30 (1.29, 8.46), <b>0.013</b>		<i>n</i> =71 married girls
Early term (37-39.99 weeks)	2.07 (1.06, 4.07), <b>0.034</b>		<i>n</i> =234 unmarried girls
Constant	0.17, <0.001		
Maternal parity (0 births=Ref)	1.00	0.017	<i>n</i> =305
1 birth	0.56 (0.28, 1.10), 0.091		<i>n</i> =71 married girls
≥2 births	0.94 (0.50, 1.77), 0.587		<i>n</i> =234 unmarried girls
Constant	0.37, <0.001		
Family type (Joint=Ref)	1.00	0.030	<i>n</i> =304
Nuclear	2.40 (1.22, 4.73), <b>0.011</b>		<i>n</i> =71 married girls
Constant	0.26, <0.001		<i>n</i> =233 unmarried girls
Paternal education (≥6 years=Ref)	1.00	0.052	<i>n</i> =293
None to primary (0-5 years)	2.56 (1.45, 4.53), <b>&lt;0.001</b>		<i>n</i> =68 married girls
Constant	0.22, <0.001		<i>n</i> =225 unmarried girls
Agrarian land ownership (≥6 acres=Ref)	1.00	0.055	<i>n</i> =290
<3 acres	3.05 (1.51, 6.15), <b>0.002</b>		<i>n</i> =70 married girls
3 to 5.99 acres	2.26 (1.08, 4.73), <b>0.031</b>		<i>n</i> =220 unmarried girls
Constant	0.16, <0.001		
Caste (Low: tribal, scheduled=Ref)	1.00	0.007	<i>n</i> =304
Mid (artisan, agrarian)	1.36 (0.35, 5.32), 0.661		<i>n</i> =71 married girls
High (prestige, dominant)	1.78 (0.50, 6.34), 0.375		<i>n</i> =233 unmarried girls
Constant	0.19, 0.008		
SES <sup>3</sup> at baseline (high=Ref)	1.00	0.009	<i>n</i> =305
Low	1.57 (0.80, 3.09), 0.192		<i>n</i> =71 married girls
Mid	1.31 (0.70, 2.48), 0.400		<i>n</i> =234 unmarried girls
Constant	242, <0.001		
SES <sup>3</sup> 6 years (high=Ref)	1.00	0.037	<i>n</i> =290
Low	2.20 (1.15, 4.22), <b>0.017</b>		<i>n</i> =70 married girls
Mid	2.19 (1.08, 4.44), <b>0.030</b>		<i>n</i> =220 unmarried girls
Constant	0.19, <0.001		
SES <sup>3</sup> 12 years (high=Ref)	1.00	0.027	<i>n</i> =283
Low	2.23 (1.06, 4.70), <b>0.034</b>		<i>n</i> =63 married girls
Mid	1.78 (0.91, 3.50), 0.094		<i>n</i> =220 unmarried girls
Constant	0.18, <0.001		
<b>Girls' characteristics</b>			
Conditional weight gain z-score, 2-6y (>1=Ref)	1.00	0.039	<i>n</i> =287
<-1 z-score	4.20 (1.40, 12.64), <b>0.011</b>		<i>n</i> =67 married girls
-1 to 1 z-score	1.72 (0.68, 4.33), 0.250		<i>n</i> =220 unmarried girls
Constant	0.17, <0.001		
Age at menarche (≥13 years=Ref)	1.00	0.023	<i>n</i> =301
<13 years	0.52 (0.28, 0.96), <b>0.036</b>		<i>n</i> =71 married girls
Constant	0.37, <0.001		<i>n</i> =230 unmarried girls
10 <sup>th</sup> school standard (Completed=Ref)	1.00	0.109	<i>n</i> =305
Not completed	6.16 (2.92, 13.02), <b>&lt;0.001</b>		<i>n</i> =71 married girls
Constant	0.23, <0.001		<i>n</i> =225 unmarried girls

*n*, number of participants. OR, Odds Ratio. 95% CI, Confidence Interval. NK, Nagelkerke *pseudo R*<sup>2</sup>. <sup>3</sup>SES, Socio-economic status. Boldface values indicate statistically significant associations at *p*≤0.05.

**Table S5.** Multivariable logistic regression model showing confounders and independent associations of conventional risk factors, and of maternal phenotype, household and girls' characteristics with girls' early marriage

	<b>Model 1: Conventional risk factors</b> NK=0.144, (n=266) <sup>1</sup>	<b>Model 2: Conventional risk factors &amp; confounders</b> NK=0.194, (n=266) <sup>1</sup>	<b>Model 3: Conventional risk factors, confounders &amp; broader bio-social factors</b> NK=0.350, (n=242) <sup>2</sup>
<b>Risk factors</b>	<b>aOR (95%CI), p-value</b>	<b>aOR (95%CI), p-value</b>	<b>aOR (95%CI), p-value</b>
<b>Conventional risk factors</b>			
SES <sup>4</sup> baseline (high=Ref)	1.00	1.00	1.00
Low	1.50 (0.64, 3.53), 0.351	1.53 (0.55, 4.23), 0.412	1.56 (0.42, 5.73), 0.502
Mid	1.16 (0.54, 2.48), 0.705	1.10 (0.49, 2.46), 0.820	1.10 (0.41, 2.97), 0.844
SES <sup>4</sup> 6y (high=Ref)	1.00	1.00	1.00
Low	1.79 (0.72, 4.45), 0.208	1.56 (0.60, 4.02), 0.358	1.32 (0.41, 4.27), 0.648
Mid	2.10 (0.86, 5.13), 0.104	2.01 (0.79, 5.13), 0.143	1.63 (0.52, 5.14), 0.401
SES <sup>4</sup> 12y (high=Ref)	1.00	1.00	1.00
Low	0.95 (0.34, 2.67), 0.927	0.91 (0.31, 2.62), 0.855	0.64 (0.17, 2.40), 0.508
Mid	1.17 (0.53, 2.59), 0.702	1.00 (0.44, 2.29), 0.998	0.70 (0.25, 1.96), 0.493
Girls' 10 <sup>th</sup> school standard (Completed=Ref)	1.00	1.00	1.00
Not completed	5.32 (2.27, 12.47), <b>&lt;0.001</b>	5.71 (2.32, 14.06), <b>&lt;0.001</b>	9.20 (2.78, 30.44), <b>&lt;0.001</b>
Girls' age at menarche (≥13y =Ref)	1.00	1.00	1.00
Early (<13y)	0.48 (0.24, 0.97), <b>0.042</b>	0.53 (0.25, 1.10), 0.090	0.62 (0.26, 1.47), 0.277
<b>Potential confounders</b>			
Agrarian land (≥6 acres=Ref)		1.00	1.00
Mid (<3 acres)		2.48 (1.03, 6.00), <b>0.043</b>	1.43 (0.51, 3.97), 0.494
High (3 to 5 acres)		1.53 (0.65, 3.60), 0.325	1.25 (0.48, 3.28), 0.648
Caste (Low: tribal, scheduled=Ref)		1.00	1.00
Mid (artisan, agrarian)		4.19 (0.67, 26.07), 0.125	4.15 (0.55, 31.40), 0.168
High (prestige, dominant)		5.60 (0.94, 33.39), 0.059	6.31 (0.85, 46.78), 0.072
Maternal parity (0 births=Ref)		1.00	1.00
1 birth		0.65 (0.30, 1.42), 0.283	0.45 (0.17, 1.20), 0.110
≥2 births		1.10 (0.51, 2.37), 0.802	0.86 (0.35, 2.10), 0.746
<b>Broader bio-social factors</b>			
Family type (Joint=Ref)			1.00

Nuclear household			3.38 (1.14, 10.03), <b>0.028</b>
Paternal educ. ( $\geq 6y$ =Ref)			1.00
None to primary (0-5y)			2.19 (0.95, 5.05), 0.065
Maternal educ. ( $\geq 6y$ =Ref)			1.00
None to primary (0-5y)			1.02 (0.44, 2.38), 0.955
Gestational age (Term, $\geq 40$ wks=Ref)			1.00
Pre-term (<37 wks)			7.17 (1.99, 25.80), <b>0.003</b>
Early-term (37-39.99 wks)			3.12 (1.22, 7.98), <b>0.017</b>
Girls' infant weight gain z- score ( $>1$ =Ref)			1.00
<-1 z-score			9.36 (2.05, 42.69), <b>0.004</b>
-1 to 1 z-score			2.06 (0.61, 6.90), 0.243
Constant	0.16, <0.001	0.01, <0.001	0.01, <0.001

*n*, number of participants. aOR, adjusted Odds Ratio. 95% CI, Confidence Interval. NK, Nagelkerke *pseudo* R<sup>2</sup>.  
<sup>1</sup>*n*=62 early married girls vs. *n*=204 unmarried girls. <sup>2</sup>*n*=56 early married girls vs. *n*=186 unmarried girls. <sup>4</sup>SES, Socio-economic status. Boldface values indicate statistically significant associations at  $p \leq 0.05$ .