

Supplementary material

Supplement to: Minello, A., Tosi, F., Vettoretto, E., Comolli, C. L., Dalla-Zuanna, G., and Ortensi, L. E. (2026). Not all births are equal. Delivery type and fertility intentions by age at first childbirth. *Vienna Yearbook of Population Research*, 24. <https://doi.org/10.1553/p-9mzp-nm56>

S1 Supplementary tables

Table S.1 Sample characteristics by maternal age (percentages and means). Weighted observations.

	Under 35	Over 35	Total sample
Type of delivery (three categories)			
<i>Spontaneous vaginal delivery</i>	54.41	34.79	45.05
<i>Planned caesarean section</i>	9.76	11.67	10.67
<i>Unplanned interventional birth</i>	35.83	53.53	44.27
Type of delivery (five categories)			
<i>Vaginal</i>	54.41	34.79	45.05
<i>Planned caesarean</i>	9.76	11.67	10.67
<i>Emergency caesarean</i>	12.85	18.14	15.37
<i>Induced vaginal</i>	15.58	22.81	19.03
<i>Operative vaginal</i>	7.40	12.59	9.87
Age of the mother (mean)	30.59	39.80	34.98
Higher education	36.06	48.60	42.04
Employment: Permanent contract	41.56	57.99	49.40
Partner's employment: Permanent contract	60.34	72.15	65.97
Area of residence			
<i>North</i>	39.43	56.60	47.60
<i>Centre</i>	17.21	20.54	18.80
<i>South</i>	43.39	22.86	33.60
Place of first childbirth			
<i>Public hospital</i>	82.97	91.02	86.81
<i>Private hospital</i>	17.03	8.98	13.19
Years since first childbirth	4.43	2.72	3.58
ART	2.53	11.82	6.96

Source: FORTIES data (2024). Data are weighted.

Table S.2 Regression model with interaction between type of delivery and age at first childbirth

	Model 3
Interaction: Type of delivery X Age at first birth (ref. Vaginal X Under 35)	
Vaginal X 35 and over	-0.990** (0.391)
Planned caesarean X Under 35	-0.604 (0.391)
Planned caesarean X 35 and over	-1.784*** (0.516)
Delivery with intervention X Under 35	-0.258 (0.250)
Delivery with intervention X 35 and over	-1.407*** (0.377)
Age of the mother	
	-0.068*** (0.026)
Education: Higher education (ref. Medium/low education)	0.474*** (0.160)
Employment status: permanent contract (ref. Other condition)	0.211 (0.176)
Partner's employment status: Permanent contract (ref. Other condition)	0.337* (0.179)
Area of residence (ref. North)	
Centre	0.078 (0.224)
South	0.559*** (0.196)
Place of first childbirth (ref. Public hospital)	
Private hospital	0.463** (0.242)
Years since first childbirth	-0.137*** (0.034)
ART (ref. No)	
Yes	0.143 (0.338)
Constant	9.373*** (0.783)
Observations	2,375
R-squared	0.093

Note: Robust standard errors in parentheses. Significance at *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: FORTIES data (2024). Weighted estimates.

Table S.3 Regression model with interaction between detailed type of delivery and age at first childbirth

	Model 4
Interaction: detailed type of delivery and age at first birth (ref. Vaginal X under 35 public)	
Vaginal 35 and over	-1.013** (0.389)
Emergency caesarean section X 35 and over	-1.865*** (0.442)
Planned caesarean section X Under 35	-0.603 (0.392)
Planned caesarean section X 35 and over	-1.805*** (0.515)
Induced vaginal X Under 35	-0.572 (0.317)
Induced vaginal X 35 and over	-1.359*** (0.420)
Operative vaginal X Under 35	-0.772* (0.458)
Operative vaginal X 35 and over	-1.192** (0.474)
Age of the mother	-0.067*** (0.026)
Education: Higher education (ref. Medium/low education)	0.501*** (0.160)
Employment status: Permanent contract (ref. Other condition)	0.224 (0.176)
Partner's employment status: Permanent contract (ref. Other condition)	0.333* (0.177)
Area of residence (ref. North)	
Centre	0.074 (0.224)
South	0.563*** (0.195)
Place of first childbirth (ref. Public hospital)	
Private hospital	0.497** (0.238)
Years since first childbirth	-0.140*** (0.034)
ART (ref. No)	
Yes	0.113 (0.332)
Constant	9.336*** (0.782)
Observations	2,375
R-squared	0.091

Robust standard errors in parentheses. Significance at *** p<0.01, ** p<0.05, * p<0.1.

Source: FORTIES data (2024). Weighted estimates.

Table S.4. Regression model with interaction between type of delivery, age at first childbirth and private/public hospital

	Model 5
Interaction: detailed type of delivery, age at first birth, place of first childbirth	
Ref. Emergency c-section under 35 X Public hospital	
Emergency c-section under 35 X Private hospital	1.016 (0.928)
Emergency c-section 35 and over X Public hospital	-2.264*** (0.563)
Emergency c-section 35 and over X Private hospital	-0.809 (0.837)
Planned c-section under 35 X Public hospital	-0.744 (0.571)
Planned c-section under 35 X Private hospital	-0.976 (0.798)
Planned c-section 35and over X Public hospital	-2.084*** (0.631)
Planned c-section 35 and over X Private hospital	-1.972* (1.141)
Induced vaginal under 35 X Public hospital	-0.765 (0.499)
Induced vaginal under 35 X Private hospital	-1.110 (0.683)
Induced vaginal 35 and over X Public hospital	-1.895*** (0.552)
Induced vaginal 35 and over X Private hospital	0.478 (0.752)
Operative vaginal under 35 X Public hospital	-1.193** (0.603)
Operative vaginal under 35 X Private hospital	-0.377 (1.09)
Operative vaginal 35 and over X Public hospital	-1.658*** (0.590)
Operative vaginal 35 and over X Private hospital	0.630 (0.899)
Vaginal under 35 X Public hospital	-0.295 (0.417)
Vaginal under 35 X Private hospital	-0.109 (0.503)
Vaginal 35 and over X Public hospital	-1.289** (0.522)
Vaginal 35 and over X Private hospital	-1.613* (0.890)
Age of the mother	-0.067***

	Model 5
	(0.026)
Education: Higher education (ref. Medium/low education)	0.536***
	(0.160)
Employment status: Permanent contract (ref. Other condition)	0.201
	(0.175)
Partner's employment status: Permanent contract (ref. Other condition)	0.349*
	(0.176)
Area of residence (ref. North)	
Centre	0.046
	(0.224)
South	0.558***
	(0.195)
Years since first childbirth	-0.138***
	(0.034)
ART (ref. No)	0.165
Yes	(0.333)
	9.643***
Constant	(0.869)
Observations	2,375
R-squared	0.106

Note: Robust standard errors in parentheses. Significance at *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: FORTIES data (2024). Weighted estimates.

Table S.5 Marginal effect of age (≥ 35 vs < 35) on fertility intentions by delivery type

Delivery type	Marginal effect (dy/dx)	Std. err.	p-value
Vaginal	-0.998**	(0.391)	0.011
Planned caesarean	-1.180*	(0.614)	0.055
Delivery with intervention	-1.213***	(0.374)	0.001

Note: Marginal effects from linear regression models. Robust standard errors in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Pairwise comparisons test differences in age gradients across delivery types.

Source: FORTIES data (2024). Weighted estimates.

Table S.6 Pairwise differences in marginal effects

Comparison	Difference	Std. err.	95% CI
Planned caesarean vs Vaginal	-0.189	(0.583)	[-1.333, 0.955]
Delivery with intervention vs Vaginal	-0.222	(0.364)	[-0.936, 0.492]
Delivery with intervention vs Planned	-0.033	(0.586)	[-1.182, 1.115]

Note: Marginal effects from linear regression models. Robust standard errors in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Pairwise comparisons test differences in age gradients across delivery types.

Source: FORTIES data (2024). Weighted estimates.

S2 Use of calibration weights

This Appendix describes the procedure used to construct and apply the sample weights adopted in the analyses. Because the study relies on a non-probabilistic sample that displays imbalances along some sociodemographic dimensions relative to the reference population, a calibration weighting approach was implemented to enhance the comparability between the sample and the population. The resulting weights are therefore calibration weights, and should not be interpreted as probabilities of selection. The aim of the weighting procedure was to adjust for sample imbalances by aligning the marginal distributions of the weighted sample with those of the reference population for a selected set of sociodemographic characteristics. To this end, weights were constructed using an iterative proportional fitting (IPF) raking algorithm, which iteratively updates individual weights until the weighted sample margins match the specified population margins (Deville and Särndal, 1992). Raking is particularly well suited to non-probabilistic survey data, as it helps correct for selectivity and compositional distortions with respect to key population variables (Battaglia et al., 2009). The procedure was implemented using the *survey* package in R. The reference population was defined on the basis of official CeDAP 2024 data on Italian mothers (ref. CeDAP 2025), considering three dimensions: (i) geographical area of residence, (ii) age group and (iii) educational attainment (see Table S7).

For each of these variables, population margins derived from the harmonised CeDAP data were used as calibration constraints, consistent with the coding adopted in the analytical sample.

Table S.7 Distribution of the reference population (CeDAP) and the study sample by selected sociodemographic characteristics

	CeDAP data		Our sample
	Geographic area		
Northeast	24.26		29.21
Northwest	22.24		21.98
Centre	18.40		19.95
South	24.19		18.95
Islands	10.92		9.91
Total	100.00		100.00
	Age		
<20	0.71		0.06
20 - 29	21.31		12.71
30 - 39	66.40		43.21
>40	11.57		44.02
Total	100.00	100.00	
	Educational attainment		
No tertiary education	59.4		38.77
Tertiary education	40.6		61.23
Total	100.00		100.00

As a first step, the raking procedure was applied starting from equal initial unit weights, so that all sample units contributed uniformly prior to calibration. Under this approach, differences in the final weights exclusively reflected the adjustment to the population margins induced by the raking algorithm. Although the resulting weights successfully reproduce the target population distributions, they displayed substantial variability, with extreme values being concentrated among poorly represented combinations of characteristics. The emergence of very large weights is a well-documented issue in the survey methodology literature, particularly in non-probabilistic samples that are highly unbalanced relative to the reference population or that contain sparse cells

for certain characteristic profiles (Battaglia et al., 2009). To limit the influence of extreme weights and reduce the variance of the estimates, a weight trimming procedure was implemented following established methodological recommendations (Kalton and Flores-Cervantes, 2003). Specifically, weights were constrained to lie within a predefined interval, with a lower bound of 0.3 and an upper bound of 10. Trimming reduced the impact of highly influential observations and improved the stability of the estimates, while introducing only limited bias. Because trimming disrupted the exact alignment between the weighted sample and the population margins, a second calibration step was subsequently carried out. This re-raking procedure was applied to the same population margins, restoring consistency between the weighted sample and the reference population while keeping weight variability within acceptable limits, as suggested in the literature (Kalton and Flores-Cervantes, 2003). Finally, the recalibrated weights were normalised to have a mean equal to one. This normalisation facilitated their use in descriptive analyses and regression models while preserving the effective sample size. The quality of the final weights was evaluated through two complementary checks: (i) comparing the marginal distributions of the weighted sample with the corresponding population margins; and (ii) inspecting the distribution of the weights in terms of minimum, maximum, quartiles and mean. These diagnostics indicated that the calibration procedure produced a stable set of weights without extreme values that were suitable for use in subsequent statistical analyses.

After normalisation, the final weights had a mean of one and ranged from 0.17 to 2.70. The median weight was 0.95, with the first and third quartiles being equal to 0.21 and 1.26, respectively, thus indicating that most observations received weights close to unity. Overall, the limited dispersion of the weights suggested that the calibration procedure effectively corrected sample imbalances relative to the reference population while avoiding instability in the estimates.

References

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