Associations of Maternal and Paternal Multiple Metals Exposure with In Vitro Fertilization Outcomes

Yangqian Jiang

School of Public Health, Nanjing Medical University, Nanjing China

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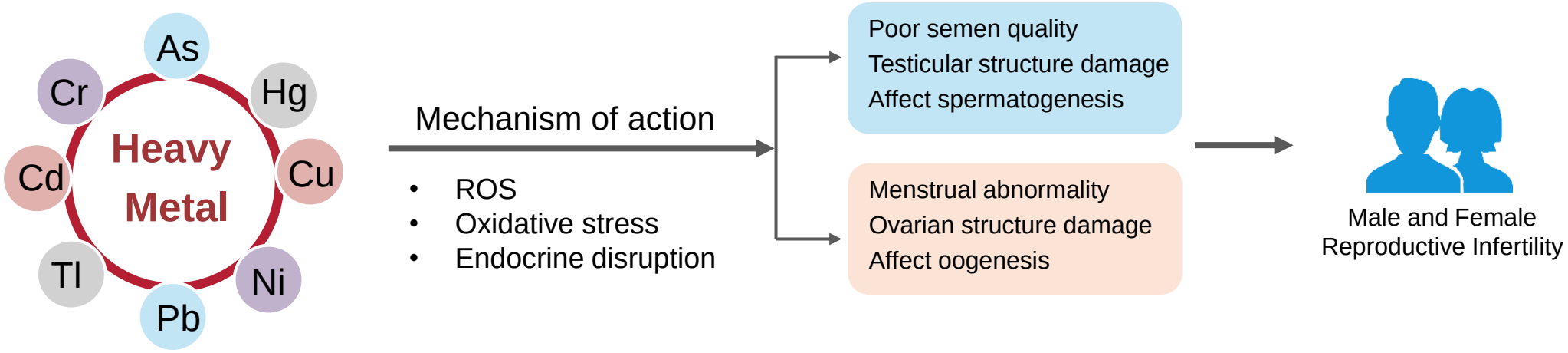
Background

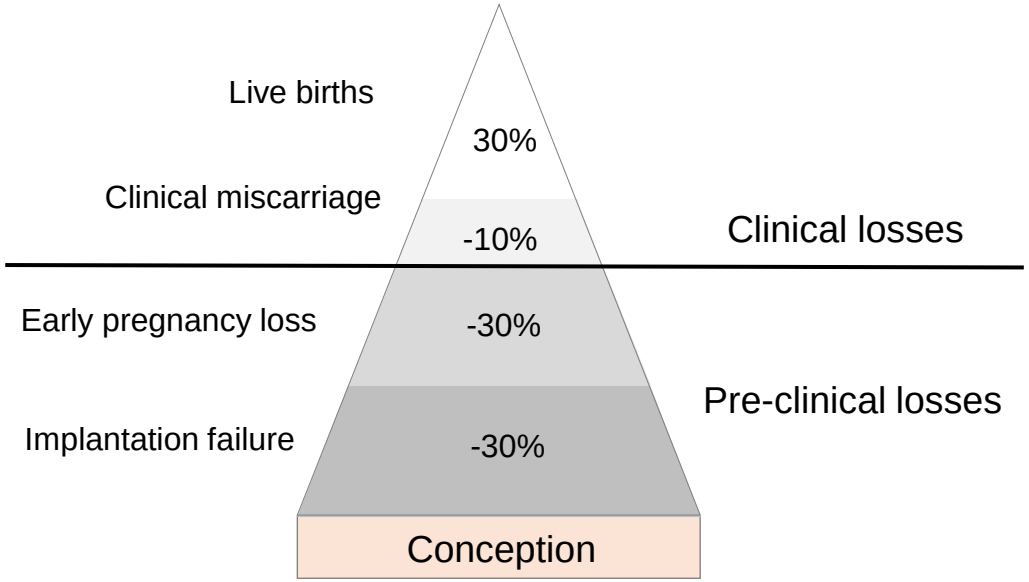
- Heavy metals are common environmental pollutants.
- Long-term, low-dose heavy metal exposure can damage reproductive systems of both male and female.



J Matern Fetal Neonatal Med 2016
Clin Med Insights Pediatr 2016
J Biochem Mol Toxicol 2021

Background

- Since 1978, assisted reproductive technology is widely used to treat infertility.
- In vitro fertilization (IVF) cycles provide a unique opportunity to investigate the effects of environment pollution on pregnancy outcomes.



Lancet Planet Health 2019
Environ Int 2019
Hum Reprod Update 2002

Objective

Research Gaps

- Previous studies mainly focused on maternal metal exposure.
- Limited understanding of paternal exposure's impact on IVF outcomes.
- Combined effects of multiple metal exposures on IVF outcomes is scarce.

Objective

To investigate associations between maternal and paternal multiple metal exposures and adverse IVF outcomes

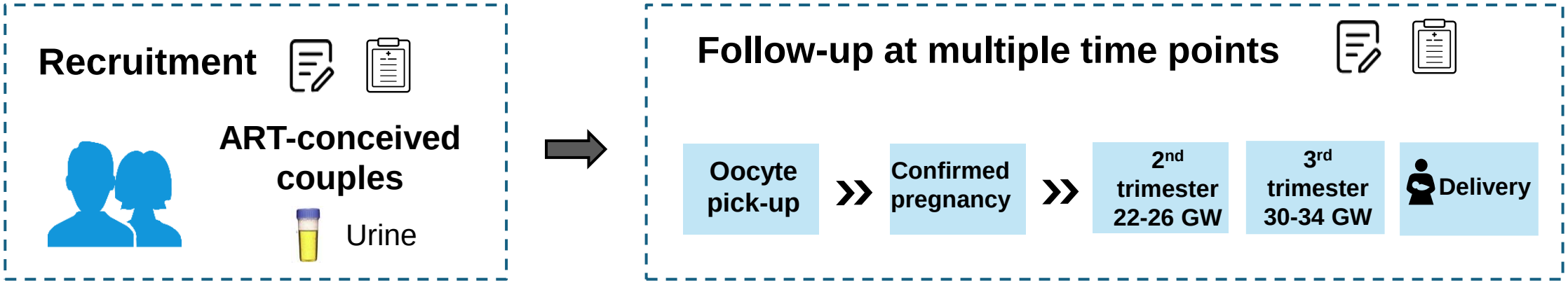
Reprod Toxicol. 2012; Eur J Obstet Gynecol Reprod Biol 2016; Ecotoxicol Environ Saf 2020;Ecotoxicol Environ Saf 2022

Methods

- Study participants

  Based on the Jiangsu birth cohort, 1,804 couples undergoing their first IVF treatment from 2015 to 2018.

- Study design



Questionnaires: demographic-economic characteristics , lifestyles, medical history, gravidity and parity history

Clinical information: infertility diagnoses, ART treatment factors, and pregnancy outcomes

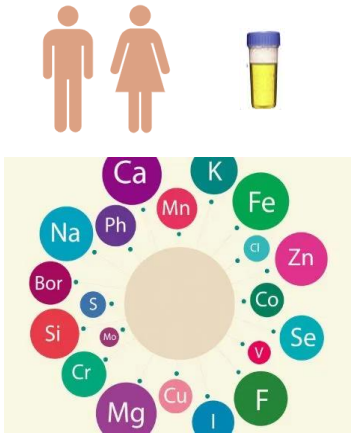
Methods

- Metal exposure assessment

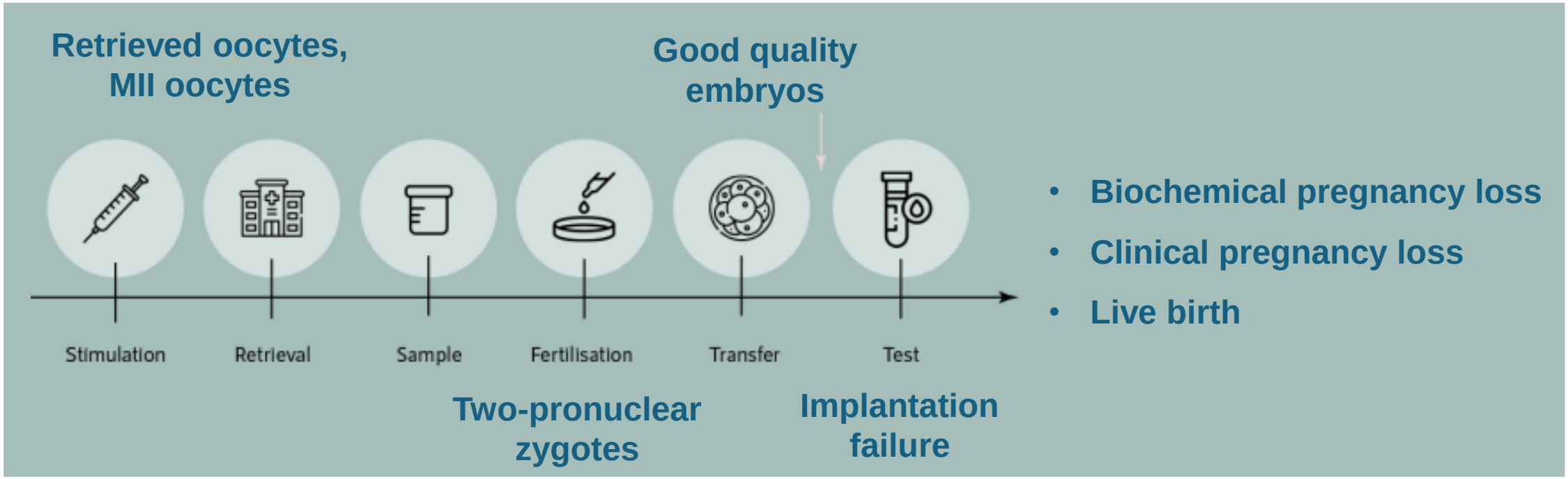
  23 metals (As, Ba, Cd, Pb, Ti, Tl, etc)

  Inductively Coupled Plasma Mass Spectrometry (ICP-MS)

  Urine specific gravity correction for urinary dilution

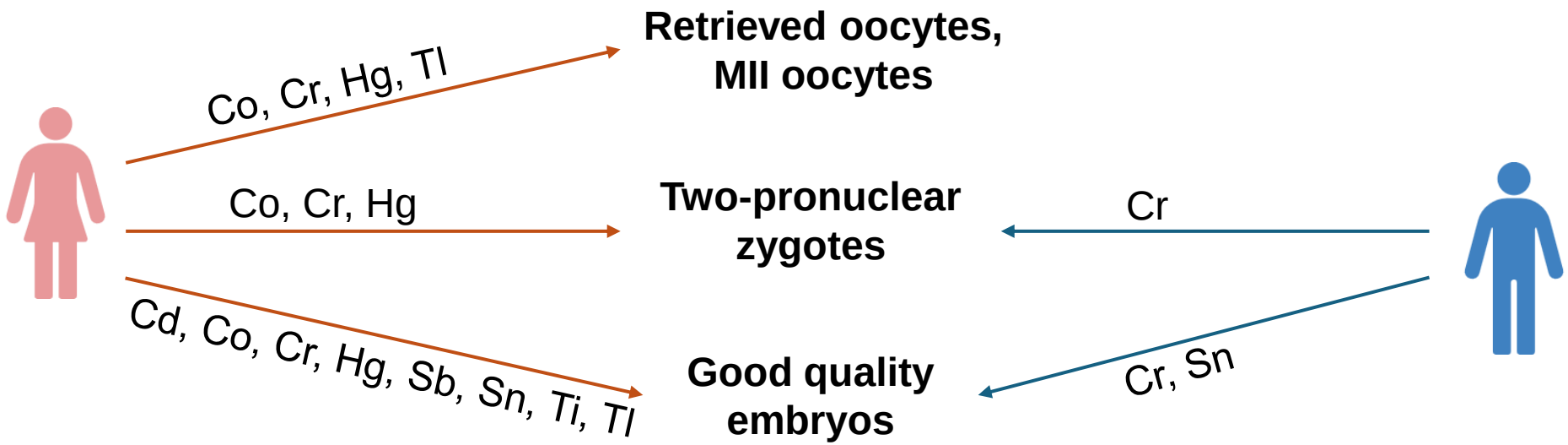


- IVF Outcomes



Results

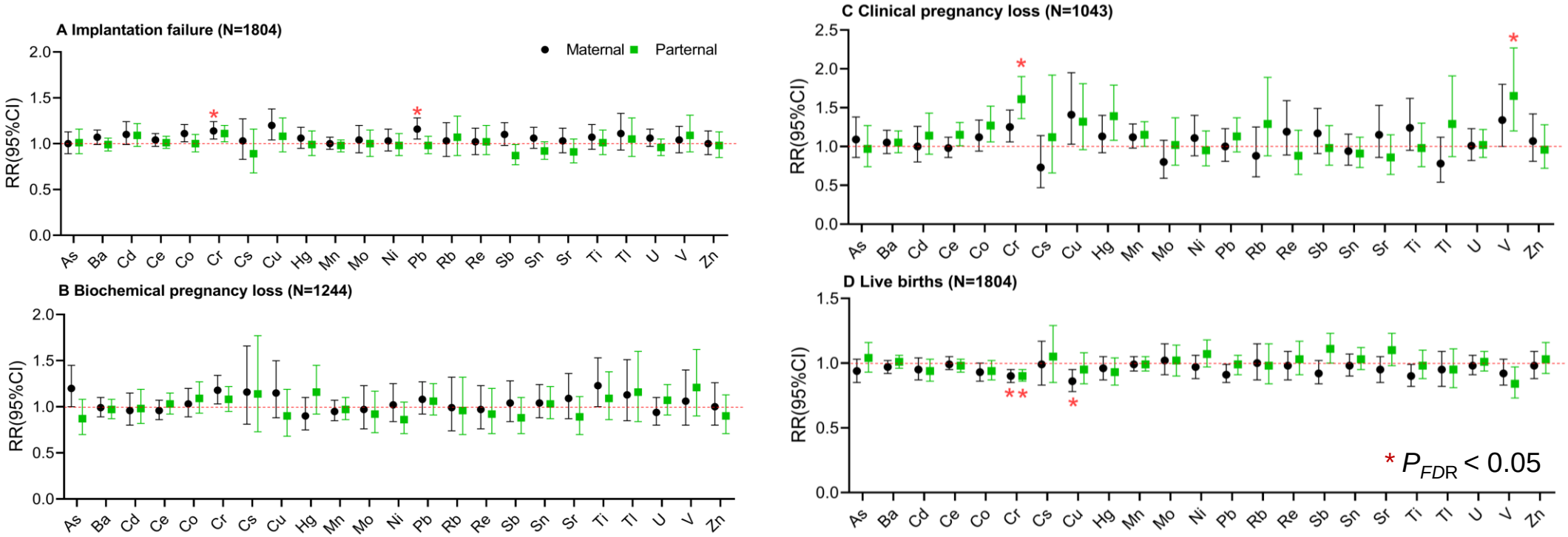
- Individual metal exposure
  - ✓ Maternal exposure to specific metals were negatively associated with the number of retrieved and qualified oocytes, MII oocytes, two-pronuclear zygotes, and good quality embryos.
  - ✓ Paternal exposure to Cr were negatively associated with two-pronuclear zygotes and good quality embryos.



Multivariate Poisson Regression, $P_{FDR} < 0.05$

Results

- Individual metal exposure
  - ✓ **Maternal Exposure**: Implantation Failure: Cr, RR = 1.14; Pb, RR = 1.16; Live Births: Cr, RR = 0.90; Cu, RR = 0.86
  - ✓ **Paternal Exposure**: Clinical Pregnancy Loss: Cr, RR = 1.61; V: RR = 1.65; Live Births: Cr: RR = 0.90



Results

- Multiple metal exposure

Maternal multiple metal exposure was negatively associated with live birth.

Quantile G-computation mixture analysis

IVF outcome	% change (95% CI)	*P*
Retrieved oocytes		
Maternal	-7.27 (-10.57, -3.85)	<0.001
MII oocytes		
Maternal	-7.54 (-10.98, -3.97)	<0.001
2-PN zoosperms		
Maternal	-9.54 (-13.33, -5.58)	<0.001
Paternal	1.08 (-3.32, 5.70)	0.634
Couples	-7.78 (-12.92, -2.33)	0.005
Good quality embryos		
Maternal	-19.70 (-24.03, -15.12)	<0.001
Paternal	1.90 (-3.79, 7.93)	0.520
Couples	-16.56 (-22.51, -10.14)	<0.001

IVF outcome	RR (95% CI)	*P*
Implantation failure		
Maternal	1.26 (1.02, 1.57)	0.035
Paternal	1.01 (0.80, 1.27)	0.932
Couples	1.22 (0.92, 1.63)	0.173
Clinical pregnancy loss		
Maternal	1.43 (0.89, 2.29)	0.136
Paternal	1.56 (0.97, 2.52)	0.068
Couples	2.04 (1.06, 3.95)	0.033
Live births		
Maternal	0.82 (0.68, 0.98)	0.027
Paternal	0.93 (0.77, 1.11)	0.410
Couples	0.82 (0.65, 1.05)	0.116

Conclusions

- Maternal & paternal metal exposure linked to poor IVF outcomes.
- Maternal exposure to multiple metals associated with lower live birth rates.
- Reducing toxic metal exposure may improve live birth rates in IVF treatments.
- Further research needed on biological mechanisms.

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Thanks to our team

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