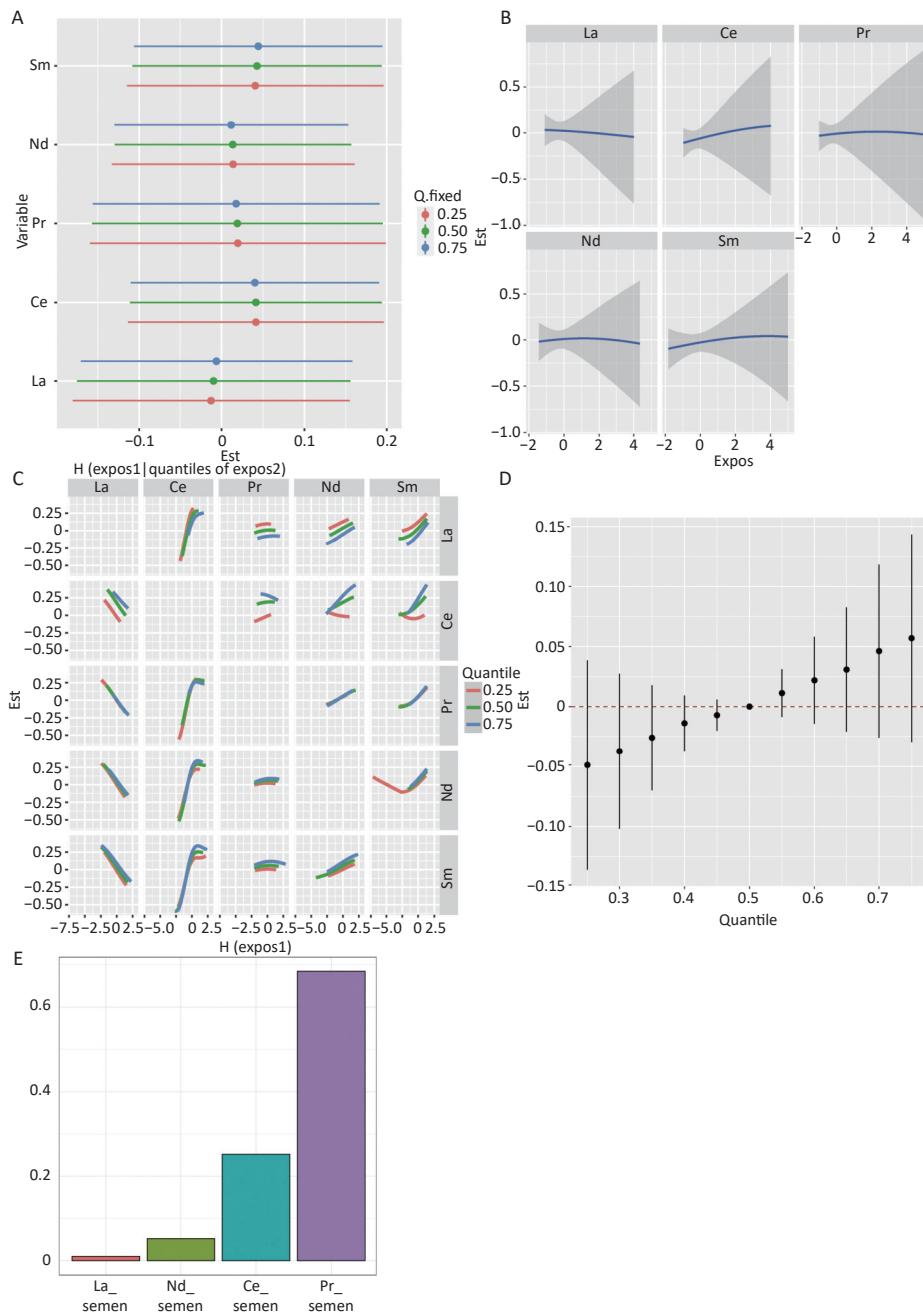
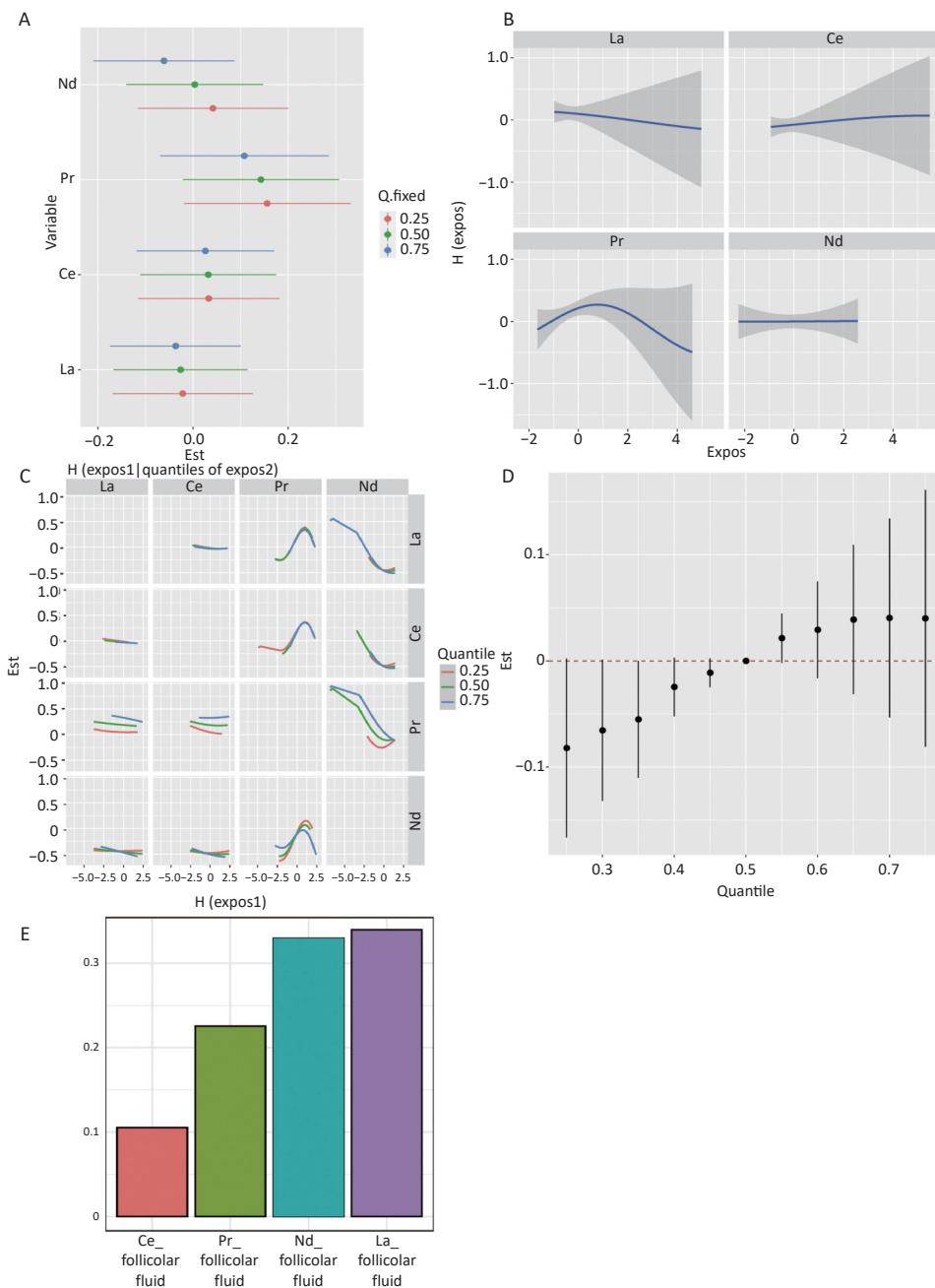


Supplementary Figure S1. Spearman correlation coefficients for REE concentrations. (A) Spearman correlation coefficients among REEs of serum and follicular fluid. (B) Spearman correlation coefficients among REEs of seminal plasma.



Supplementary Figure S2. Mixture exposure analysis of WQS model regression models and BKMR models for clinical pregnancy in serum. (A) Single REEs association. The plot compares the changes in clinical pregnancy [$h(\text{expo})$] when the LREE is at its 75th vs 25th percentile and other elements are fixed at their 25th, 50th, or 75th percentile, respectively. (B) Univariate exposure-response for the associations between each REEs and clinical pregnancy. Univariate exposure-response function and 95% confidence intervals for the associations between each REEs and clinical pregnancy, with other elements fixed at their median concentrations. (C) Bivariate exposure-response functions for a kind of REE fixed at either the 25th, 50th, or 75th percentile and the rest of REEs are fixed at the median. (D) Associations between the mixed exposure to REEs and clinical pregnancy. The plot compares the estimated risk change [$h(\text{expo})$] when all the REEs are at their specific quantile compared to those that are all at their 50th percentile. (E) The weights of REEs in clinical pregnancy based on WQS regression analysis. Models adjusted age, BMI, fertilization mode, infertility type, and smoking status.



Supplementary Figure S3. Mixture exposure analysis of WQS model regression models and BKMR models for clinical pregnancy in follicular fluid. (A) Single REEs association. The plot compares the changes in clinical pregnancy [$h(\text{expo})$] when the LREE is at its 75th vs 25th percentile and other elements are fixed at their 25th, 50th, or 75th percentile, respectively. (B) Univariate exposure-response for the associations between each REEs and clinical pregnancy. Univariate exposure-response function and 95% confidence intervals for the associations between each REEs and clinical pregnancy, with other elements fixed at their median concentrations. (C) Bivariate exposure-response functions for a kind of REE fixed at either the 25th, 50th, or 75th percentile and the rest of REEs are fixed at the median. (D) Associations between the mixed exposure to REEs and clinical pregnancy. The plot compares the estimated risk change [$h(\text{expo})$] when all the REEs are at their specific quantile compared to those that are all at their 50th percentile. (E) The weights of REEs in clinical pregnancy based on WQS regression analysis. Models adjusted age, BMI, fertilization mode, infertility type, and smoking statu.

Supplementary Table S1. Relative risk of the LREE concentrations associated with the clinical pregnancy of IVF-embryo transfer

Elements	Sample	Model-1 ^a			Model-2 ^b				
		OR	95% CI	P	OR	95% CI	P		
Ce	serum	1.11	0.80	1.56	0.53	1.13	0.90	1.43	0.30
	follicular fluid	1.02	0.73	1.42	0.92	0.95	0.78	1.14	0.57
	seminal plasma	0.93	0.66	1.30	0.66	1.01	0.87	1.17	0.87
La	serum	0.92	0.66	1.29	0.63	0.86	0.65	1.14	0.28
	follicular fluid	0.96	0.68	1.34	0.81	0.99	0.80	1.22	0.90
	seminal plasma	1.09	0.78	1.52	0.63	1.13	0.86	1.47	0.39
Nd	serum	0.95	0.68	1.33	0.77	1.02	0.89	1.17	0.79
	follicular fluid	0.95	0.68	1.33	0.77	0.93	0.75	1.15	0.52
	seminal plasma	1.01	0.72	1.42	0.94	1.09	0.86	1.37	0.48
Pr	serum	1.11	0.79	1.56	0.56	1.12	0.89	1.41	0.34
	follicular fluid	1.27	0.94	1.72	0.12	1.31	1.00	1.72	0.05
	seminal plasma	1.13	0.85	1.52	0.40	1.23	0.92	1.66	0.17
Sm	serum	1.17	0.87	1.57	0.29	1.23	0.94	1.61	0.13

Note. ^aModel-1 uses log-binomial regression without adjusting confounders. ^bModel-2 uses log-binomial regression with adjusting age, BMI, fertilization mode, infertility type and smoking status.

Supplementary Table S2. Posterior inclusion probabilities (PIPs) for semen concentrations of REEs and clinical pregnancy using BKMR

Elements	PIPs
La	0.53
Ce	0.37
Pr	0.49
Nd	0.40

Supplementary Table S3. Concentrations of rare earth elements in previous studies

References	Region	Sample type (ng/ml)	Population	Subgroup	La	Ce	Pr	Nd	Sm
This study	Beijing, China	Serum	Women	—	0.080 (0.048, 0.124)	0.097 (0.061, 0.167)	0.026 (0.017, 0.040)	0.144 (0.097, 0.199)	0.050 (0.031, 0.067)
	Beijing, China	Follicular fluid	Women	—	0.016 (0.009, 0.027)	0.034 (0.020, 0.055)	0.009 (0.007, 0.012)	0.069 (0.054, 0.101)	< MDL (< MDL, 0.0004)
	Shandong/Beijing, China	seminal plasma	Man	—	0.089 (0.054, 0.128)	0.246 (0.168, 0.374)	0.023 (0.013, 0.036)	0.118 (0.080, 0.171)	< MDL (< MDL, 0.0004)
[1]	Beijing, China	Serum	Women	—	0.035 (0.027, 0.047)	0.058 (0.044, 0.094)	0.010 (0.008, 0.016)	0.051 (0.038, 0.090)	—
[2]	Beijing, China	Serum	Women	—	0.076 (0.054, 0.099)	0.137 (0.091, 0.179)	0.029 (0.023, 0.035)	0.178 (0.134, 0.226)	0.123 (0.092, 0.164)
[3]	Beijing, China	Plasma	Women	First trimester	0.073 (0.059, 0.096)	0.121 (0.088, 0.162)	0.031 (0.023, 0.039)	0.162 (0.114, 0.225)	0.047 (0.022, 0.077)
[4]	Shanxi, China	Serum	Women	Third trimester	0.071 (0.054, 0.083)	0.103 (0.072, 0.138)	0.030 (0.023, 0.039)	0.176 (0.116, 0.238)	0.053 (0.025, 0.093)
[5]	Shanxi, China	Serum	Women	Cases	0.072 (0.052, 0.107)	0.116 (0.080, 0.233)	0.030 (0.023, 0.043)	0.212 (0.156, 0.265)	0.132 (0.098, 0.173)
[6]	Serbia	Umbilical cord plasma	Women	Controls	0.059 (0.045, 0.083)	0.090 (0.063, 0.130)	0.028 (0.022, 0.037)	0.195 (0.150, 0.252)	0.127 (0.096, 0.168)
[7]	Hubei, China	Urine (ug/g creatinine)	Women	First trimester	0.047 (0.036, 0.061)	0.066 (0.049, 0.090)	0.020 (0.016, 0.024)	0.125 (0.103, 0.155)	0.094 (0.076, 0.116)
[8]	Hubei, China	Urine (ug/g creatinine)	Women	Second trimester	0.049 (0.038, 0.066)	0.069 (0.056, 0.093)	0.021 (0.017, 0.025)	0.140 (0.109, 0.173)	0.094 (0.078, 0.115)
[9]	Shanxi, China	Umbilical cord tissue (ng/g)	Women	Beginning of the delivery	0.67 ± 0.24 ^a	0.17 ± 0.12 ^a	0.25 ± 0.09 ^a	0.78 ± 0.32 ^a	0.33 ± 0.16 ^a
				—	0.091 ± 0.077 ^a	0.16 ± 0.08 ^a	0.059 ± 0.028 ^a	0.16 ± 0.09 ^a	0.12 ± 0.06 ^a

Continued

References	Region	Sample type (ng/mL)	Population	Subgroup	La	Ce	Pr	Nd	Sm
[10]	Canary Islands, Spain	umbilical cord blood	–	–	0.01 (0.01, 0.03)	0.03 (0.02, 0.06)	<MDL (<MDL, 0.01)	0.01 (<MDL, 0.01)	<MDL (<MDL, 0.01)
[11]a	Bangladesh	umbilical cord blood	–	–	0.056	5.536	0.013	0.039	0.015
[12]	Caucasus	placental tissues (ng/g)	–	–	0.41 (0.25, 0.61)	0.42 (0.27, 0.80)	0.043 (0.029, 0.061)	0.135 (0.087, 0.196)	0.010 (0.006, 0.020)
[12]	Henan, China	Plasma	Woman and man	Exposure (job) Control	0.138 ± 0.161 0.092 ± 0.115	0.320 ± 0.350 0.240 ± 0.357	0.031 ± 0.047 0.016 ± 0.019	0.056 ± 0.087 0.035 ± 0.051	0.0167 ± 0.029 0.0087 ± 0.013
[13]	Poland	Semen (ng/g)	Man	Control Abnormal semen	21.5 ^b (2.27–269) 17.5 ^b	44.0 ^b (4.52–140) 37.9 ^b	– –	– –	– –
[14]	Baotou, China	Whole blood	Non-pregnant women	–	(2.58–79.0) 0.834	(4.63–167) 1.724	0.132 (0.110, 0.165)	0.839 (0.587, 0.815)	–

Note. Most of the data are presented as “median (IQR)”.^a; Data are presented as “mean \pm S”.^b; Data are presented as “median (minimum–maximum)”.^c

Supplementary Table S4. The LOD and detection rate of the rest rare earth elements

Elements	Sample	Median (IQR)	LOD	Detection ratio
Eu	Serum	0.001 (0.001, 0.002)	0.0010	52.5%
	Follicular fluid	0.002 (0.000, 0.004)	0.0010	63.8%
	Seminal plasma	0.004 (0.000, 0.007)	0.0010	68.8%
Gd	Serum	0.004 (0.003, 0.007)	0.0020	75.9%
	Follicular fluid	0.013 (0.007, 0.020)	0.0020	61.7%
	Seminal plasma	0.024 (0.014, 0.039)	0.0020	66.0%
Tb	Serum	0.001 (0.000, 0.001)	0.0004	45.4%
	Follicular fluid	0.001 (0.000, 0.002)	0.0004	39.7%
	Seminal plasma	0.002 (0.000, 0.005)	0.0004	73.0%
Dy	Serum	0.006 (0.001, 0.009)	0.0010	64.5%
	Follicular fluid	0.008 (0.002, 0.014)	0.0010	53.2%
	Seminal plasma	0.012 (0.004, 0.025)	0.0010	74.5%
Ho	Serum	0.002 (0.001, 0.002)	0.0020	55.3%
	Follicular fluid	0.002 (0.002, 0.005)	0.0020	65.2%
	Seminal plasma	0.003 (0.002, 0.004)	0.0020	68.8%
Er	Serum	0.003 (0.001, 0.005)	0.0012	65.2%
	Follicular fluid	0.004 (0.001, 0.007)	0.0012	70.9%
	Seminal plasma	0.005 (0.000, 0.011)	0.0012	73.8%
Tm	Serum	0.000 (0.000, 0.000)	0.0040	33.3%
	Follicular fluid	-0.002 (-0.003, -0.001)	0.0040	0.0%
	Seminal plasma	-0.002 (-0.003, -0.001)	0.0040	2.1%
Yb	Serum	0.002 (0.001, 0.003)	0.0010	53.9%
	Follicular fluid	0.001 (-0.001, 0.005)	0.0010	50.4%
	Seminal plasma	0.001 (-0.001, 0.005)	0.0010	51.1%
Lu	Serum	0.000 (-0.002, 0.001)	0.0001	30.5%
	Follicular fluid	-0.004 (-0.004, -0.003)	0.0001	1.4%
	Seminal plasma	-0.004 (-0.005, -0.003)	0.0001	5.7%

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