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Supplemental Material

Plasma Perfluoroalkyl and Polyfluoroalkyl Substances Concentration and Menstrual Cycle Characteristics in Preconception Women

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Table S1. Characteristics of the study population(n=950) and preconception women without PFASs levels (n=232) in Shanghai, China, 2013-2015

Characteristics	n=950	n=232	P
Age (years), median (p25; p75)	30 (28, 32)	30 (28, 32)	0.72
missing, n (%)	10 (1.1)	10 (4.3)	
Age at menarche (years), median (p25; p75)	13 (13, 14)	13 (13, 14)	0.08
missing, n (%)	143 (15.1)	28 (12.1)	
Parity, n (%)			0.31
Nulliparous	859 (91.0)	215 (93.1)	
Parous	85 (9.0)	16 (6.9)	
missing, n (%)	6 (0.6)	1 (0.4)	
BMI, median (p25; p75)	20.5 (19.1, 22.5)	20.5 (19.4, 22.4)	0.59
missing, n (%)	13 (1.4)	11 (4.7)	
Income (10 ³ CNY), n(%)			0.52
1	67 (7.5)	19 (9.1)	
2	155 (17.3)	35 (16.7)	
3	503 (56.2)	108 (51.7)	
4	170 (19.0)	47 (22.5)	
missing, n (%)	55 (5.8)	23 (9.9)	
Irregular cycle, n (%)	190 (20.1)	37 (16.4)	0.22
missing, n (%)	3 (0.3)	7 (3.0)	
Short cycle (<21 days), n (%)	14 (1.5)	1 (0.4)	0.20
Long cycle (>35 days), n (%)	189 (20.1)	41 (18.3)	0.49
missing, n (%)	12 (1.3)	8 (3.4)	
menorrhagia, n (%)	63 (6.7)	16 (7.2)	0.67
hypomenorrhea, n (%)	76 (8.0)	26 (11.7)	0.08
missing, n (%)	3 (0.3)	9 (3.9)	

Table S2. Associations between PFASs (ng/mL) and irregular cycles in preconception women in Shanghai, China, 2013-2015.

PFASs	N	Number of cycle characteristics	Crude OR (95%CI)	Adjusted OR (95%CI) ^a
PFDeA				
Continuous ^b	947	190	1.03 (0.81, 1.33)	1.07 (0.82, 1.39)
Q1(≤0.91)	235	44	ref	ref
Q2(0.91-1.31)	240	52	1.20 (0.77, 1.88)	1.21 (0.76, 1.92)
Q3(1.31-1.92)	232	51	1.22 (0.78, 1.92)	1.18 (0.74, 1.88)
Q4(>1.92)	240	43	0.95 (0.60, 1.51)	0.97 (0.60, 1.58)
PFUA				
Continuous ^b	947	190	1.13 (0.84, 1.53)	1.19 (0.87, 1.64)
Q1(≤0.85)	238	41	ref	ref
Q2(0.85-1.18)	236	56	1.50 (0.95, 2.35)	1.56 (0.98, 2.48)
Q3(1.18-1.63)	234	45	1.14 (0.72, 1.83)	1.11 (0.69, 1.81)
Q4(>1.63)	239	48	1.21 (0.76, 1.92)	1.23 (0.76, 1.99)
PFBS				
Continuous ^b	947	190	1.14 (0.74, 1.75)	1.12 (0.71, 1.77)
Q1(≤0.226)	242	52	ref	ref
Q2(0.226-0.241)	232	39	0.74 (0.47, 1.17)	0.81 (0.50, 1.31)
Q3(0.241-0.266)	232	46	0.90 (0.58, 1.41)	0.97 (0.61, 1.55)
Q4(>0.266)	241	53	1.03 (0.67, 1.59)	1.09 (0.69, 1.72)
PFDoA				
Continuous ^b	947	190	1.12 (0.75, 1.66)	1.25 (0.82, 1.89)
Q1(≤0.162)	240	49	ref	ref
Q2(0.162-0.203)	237	43	0.86 (0.55, 1.36)	0.96 (0.60, 1.53)
Q3(0.203-0.266)	235	49	1.03 (0.66, 1.60)	1.07 (0.67, 1.71)
Q4(>0.266)	235	49	1.03 (0.66, 1.60)	1.10 (0.69, 1.76)
PFHpA				
Continuous ^b	947	190	0.89 (0.61, 1.31)	0.89 (0.60, 1.32)
Q1(≤0.184)	237	45	ref	ref
Q2(0.184-0.221)	236	51	1.18 (0.75, 1.84)	1.19 (0.75, 1.89)
Q3(0.221-0.271)	237	51	1.17 (0.75, 1.83)	1.10 (0.69, 1.75)
Q4(>0.271)	237	43	0.95 (0.60, 1.50)	0.91 (0.56, 1.47)
PFOSA				
Continuous ^b	947	190	0.76 (0.32, 1.76)	0.81 (0.34, 1.96)
Q1(≤0.2065)	240	44	ref	ref
Q2(0.2065-0.2120)	241	56	1.35 (0.87, 2.10)	1.39 (0.87, 2.22)
Q3(0.2120-0.2174)	232	38	0.87 (0.54, 1.41)	0.93 (0.57, 1.53)
Q4(>0.2174)	234	52	1.27 (0.81, 2.00)	1.39 (0.87, 2.21)

Irregular cycle is defined as ≥ 7 days of variation.

^aAdjusted for Age (continuous), BMI (continuous), Income (categorical), Age at menarche (continuous) and Parity (categorical). ^b Log-transformed PFASs as continuous variables.

Table S3. Associations between PFASs (ng/mL) and long cycles in preconception women in Shanghai, China, 2013-2015.

PFASs	N	Number of cycle characteristics	Crude OR (95%CI)	Adjusted OR (95%CI) ^a
PFDeA				
continuous ^b	924	189	1.10 (0.86, 1.41)	1.12 (0.86, 1.45)
Q1 (≤0.91)	229	43	ref	ref
Q2 (0.91-1.31)	238	53	1.24 (0.79, 1.95)	1.22 (0.77, 1.93)
Q3 (1.31-1.92)	224	47	1.15 (0.72, 1.82)	1.17 (0.73, 1.87)
Q4 (>1.92)	233	46	1.06 (0.67, 1.69)	1.05 (0.65, 1.69)
PFUA				
continuous ^b	924		1.16 (0.85, 1.57)	1.19 (0.87, 1.63)
Q1 (≤0.85)	232	39	ref	ref
Q2 (0.85-1.18)	232	59	1.69 (1.07, 2.66)	1.71 (1.08, 2.72)
Q3 (1.18-1.63)	228	43	1.15 (0.71, 1.86)	1.15 (0.71, 1.88)
Q4 (>1.63)	232	48	1.29 (0.81, 2.06)	1.28 (0.79, 2.08)
PFBS				
continuous ^b	924	189	1.13 (0.74, 1.73)	1.08 (0.69, 1.69)
Q1 (≤0.226)	234	51	ref	ref
Q2 (0.226-0.241)	224	36	0.69 (0.43, 1.10)	0.70 (0.43, 1.14)
Q3 (0.241-0.266)	230	52	1.05 (0.68, 1.62)	1.05 (0.67, 1.64)
Q4 (>0.266)	236	50	0.97 (0.62, 1.50)	0.97 (0.61, 1.52)
PFDoA				
continuous ^b	924	189	1.16 (0.78, 1.72)	1.18 (0.78, 1.78)
Q1 (≤0.162)	236	46	ref	ref
Q2 (0.162-0.203)	232	50	1.14 (0.72, 1.78)	1.19 (0.75, 1.87)
Q3 (0.203-0.266)	228	47	1.07 (0.68, 1.69)	1.09 (0.69, 1.74)
Q4 (>0.266)	228	46	1.04 (0.66, 1.65)	1.03 (0.64, 1.64)
PFHpA				
continuous ^b	924	189	0.84 (0.57, 1.23)	0.81 (0.55, 1.21)
Q1 (≤0.184)	232	49	ref	ref
Q2 (0.184-0.221)	232	49	1.00 (0.64, 1.56)	1.00 (0.63, 1.58)
Q3 (0.221-0.271)	231	52	1.09 (0.70, 1.69)	1.03 (0.66, 1.62)
Q4 (>0.271)	229	39	0.77 (0.48, 1.22)	0.73 (0.45, 1.18)
PFOSA				
continuous ^b	924	189	1.35 (0.48, 3.77)	1.47 (0.51, 4.21)
Q1 (≤0.2065)	233	44	ref	ref
Q2 (0.2065-0.2120)	233	52	1.23 (0.79, 1.94)	1.31 (0.82, 2.09)
Q3 (0.2120-0.2174)	229	41	0.94 (0.59, 1.50)	1.01 (0.63, 1.64)
Q4 (>0.2174)	229	52	1.26 (0.80, 1.98)	1.33 (0.84, 2.12)

Long cycle is defined as >35 days and is compared with normal cycle as reference (21–35 days).

^aAdjusted for Age (continuous), BMI (continuous), Income (categorical), Age at menarche (continuous) and Parity (categorical). ^bLog-transformed PFASs as continuous variables.

Table S4. Associations between PFASs (ng/mL) and short cycles in preconception women in Shanghai, China, 2013-2015.

PFASs ^b	N	Number of cycle characteristics	Crude OR (95%CI)	Adjusted OR (95%CI) ^a
PFOA	749	14	0.51 (0.17, 1.55)	0.39 (0.10, 1.45)
PFOS	749	14	0.62 (0.25, 1.51)	0.52 (0.19, 1.42)
PFNA	749	14	0.62 (0.19, 2.03)	0.51 (0.12, 2.05)
PFHxS	749	14	0.82 (0.18, 3.73)	0.50 (0.08, 3.27)
PFDeA	749	14	0.69 (0.29, 1.67)	0.66 (0.24, 1.82)
PFUA	749	14	0.69 (0.24, 1.94)	0.64 (0.19, 2.12)
PFBS	749	14	0.98 (0.31, 3.06)	0.90 (0.28, 2.84)
PFDoA	749	14	0.71 (0.18, 2.76)	0.82 (0.18, 3.69)
PFHpA	749	14	0.84 (0.24, 2.96)	0.75 (0.21, 2.68)
PFOSA	749	14	3.52 (0.01, >999.9)	5.79 (0.001, >999.9)

Short cycle is defined as <21 days and is compared with normal cycle as reference (21– 35 days).

^aAdjusted for Age (continuous), BMI (continuous), Income (categorical), Age at menarche (continuous) and Parity (categorical). ^b Log-transformed PFASs as continuous variables.

Table S5. Associations between PFASs (ng/mL) and menorrhagia in preconception women in Shanghai, China, 2013-2015.

PFASs	N	Number of cycle characteristics	Crude OR (95%CI)	Adjusted OR (95%CI) ^a
PFDeA				
continuous ^b	871	63	0.74 (0.48, 1.13)	0.76 (0.50, 1.17)
Q1 (≤0.91)	220	17	ref	ref
Q2 (0.91-1.31)	223	24	1.44 (0.75, 2.76)	1.55 (0.79, 3.03)
Q3 (1.31-1.92)	209	12	0.73 (0.34, 1.56)	0.81 (0.37, 1.76)
Q4 (>1.92)	219	10	0.57 (0.26, 1.28)	0.62 (0.27, 1.41)
PFUA				
continuous ^b	871	63	0.70 (0.43, 1.16)	0.76 (0.45, 1.26)
Q1 (≤0.85)	223	19	ref	ref
Q2 (0.85-1.18)	215	14	0.75 (0.37, 1.53)	0.80 (0.39, 1.67)
Q3 (1.18-1.63)	213	17	0.93 (0.47, 1.84)	1.02 (0.51, 2.05)
Q4 (>1.63)	220	13	0.67 (0.32, 1.40)	0.75 (0.35, 1.60)
PFBS				
continuous ^b	871	63	1.37 (0.53, 3.56)	1.30 (0.54, 3.12)
Q1 (≤0.226)	218	18	ref	ref
Q2 (0.226-0.241)	217	16	0.88 (0.44, 1.78)	0.88 (0.43, 1.79)
Q3 (0.241-0.266)	215	16	0.89 (0.44, 1.80)	0.90 (0.45, 1.84)
Q4 (>0.266)	221	13	0.70 (0.33, 1.46)	0.61 (0.28, 1.30)
PFDoA				
continuous ^b	871	63	0.74 (0.39, 1.42)	0.80 (0.41, 1.56)
Q1 (≤0.162)	224	18	ref	Ref
Q2 (0.162-0.203)	217	19	1.10 (0.56, 2.15)	1.05 (0.53, 2.10)
Q3 (0.203-0.266)	212	12	0.69 (0.32, 1.46)	0.74 (0.34, 1.58)
Q4 (>0.266)	218	14	0.79 (0.38, 1.62)	0.86 (0.41, 1.80)
PFHpA				
continuous ^b	871	63	1.55 (0.80, 3.01)	1.57 (0.79, 3.11)
Q1 (≤0.184)	222	13	ref	ref
Q2 (0.184-0.221)	219	13	1.02 (0.46, 2.24)	1.09 (0.49, 2.43)
Q3 (0.221-0.271)	219	20	1.62 (0.78, 3.34)	1.54 (0.74, 3.21)
Q4 (>0.271)	211	17	1.41 (0.67, 2.98)	1.37 (0.64, 2.95)
PFOSA				
continuous ^b	871	63	0.58 (0.19, 1.79)	0.61 (0.20, 1.89)
Q1 (≤0.2065)	219	19	ref	ref
Q2 (0.2065-0.2120)	224	18	0.92 (0.47, 1.80)	0.97 (0.49, 1.93)
Q3 (0.2120-0.2174)	218	14	0.72 (0.35, 1.48)	0.74 (0.36, 1.54)
Q4 (>0.2174)	210	12	0.64 (0.30, 1.35)	0.67 (0.31, 1.43)

^aAdjusted for Age (continuous), BMI (continuous), Income (categorical), Age at menarche (continuous) and Parity (categorical). ^b Log-transformed PFASs as continuous variables.

Table S6. Associations between PFASs (ng/mL) and hypomenorrhea in preconception women in Shanghai, China, 2013-2015.

PFASs	N	Number of cycle characteristics	Crude OR (95%CI)	Adjusted OR (95%CI) ^a
PFDeA				
continuous ^b	884	76	1.32 (0.92, 1.88)	1.34 (0.92, 1.95)
Q1 (≤0.91)	218	15	ref	ref
Q2 (0.91-1.31)	216	17	1.16 (0.56, 2.38)	1.12 (0.54, 2.33)
Q3 (1.31-1.92)	220	23	1.58 (0.80, 3.12)	1.51 (0.75, 3.05)
Q4 (>1.92)	230	21	1.36 (0.68, 2.71)	1.38 (0.67, 2.81)
PFUA				
continuous ^b	884	76	1.20 (0.77, 1.86)	1.24 (0.78, 1.95)
Q1 (≤0.85)	219	15	ref	ref
Q2 (0.85-1.18)	223	22	1.49 (0.75, 2.95)	1.52 (0.76, 3.05)
Q3 (1.18-1.63)	216	20	1.39 (0.69, 2.79)	1.38 (0.67, 2.83)
Q4 (>1.63)	226	19	1.25 (0.62, 2.52)	1.27 (0.61, 2.65)
PFBS				
continuous ^b	884	76	0.96 (0.58, 1.58)	1.48 (0.54, 4.03)
Q1 (≤0.226)	224	24	ref	ref
Q2 (0.226-0.241)	217	16	0.66 (0.34, 1.29)	0.68 (0.34, 1.36)
Q3 (0.241-0.266)	215	16	0.67 (0.35, 1.30)	0.70 (0.36, 1.40)
Q4 (>0.266)	228	20	0.80 (0.43, 1.50)	0.80 (0.42, 1.53)
PFDOA				
continuous ^b	884	76	1.05 (0.58, 1.88)	1.11 (0.62, 2.01)
Q1 (≤0.162)	222	16	ref	ref
Q2 (0.162-0.203)	218	20	1.30 (0.66, 2.58)	1.25 (0.62, 2.52)
Q3 (0.203-0.266)	223	23	1.48 (0.76, 2.89)	1.48 (0.74, 2.96)
Q4 (>0.266)	221	17	1.07 (0.53, 2.18)	1.21 (0.58, 2.50)
PFHpA				
continuous ^b	884	76	2.03 (1.11, 3.71)	1.92 (1.04, 3.54)
Q1 (≤0.184)	225	16	ref	ref
Q2 (0.184-0.221)	223	17	1.08 (0.53, 2.19)	1.16 (0.56, 2.41)
Q3 (0.221-0.271)	216	17	1.12 (0.55, 2.27)	1.09 (0.53, 2.26)
Q4 (>0.271)	220	26	1.75 (0.91, 3.36)	1.70 (0.87, 3.31)
PFOSA				
continuous ^b	884	76	4.73 (0.23, 96.18)	5.66 (0.20, 160.92)
Q1 (≤0.2065)	221	21	ref	ref
Q2 (0.2065-0.2120)	223	17	0.79 (0.40, 1.53)	0.89 (0.45, 1.79)
Q3 (0.2120-0.2174)	218	14	0.65 (0.32, 1.32)	0.69 (0.33, 1.43)
Q4 (>0.2174)	222	24	1.15 (0.62, 2.14)	1.31 (0.68, 2.51)

^a Adjusted for Age (continuous), BMI (continuous), Income (categorical), Age at menarche (continuous) and Parity (categorical). ^b Log-transformed PFASs as continuous variables.