

Supplementary Information

Life-stage PFAS benchmarks reveal subgroup blind spots in population-wide mixture burden screening among Korean adults

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This file contains Supplementary Tables S1–S7 and Supplementary Figures S1–S2. All estimates preserve the KoNEHS Cycle 5 partial-sample survey design.

Supplementary Table S1. Corrected contextual benchmark comparisons

Benchmark	Population	Comparison	n	Events	Weighted % (95% CI)
PFOA HBM-I	All adults	2 ug/L	1515	1471	96.8 (95.3 to 98.1)
PFOS HBM-I	All adults	5 ug/L	1515	1356	87.3 (84.0 to 90.1)
PFOA HBM-II, general	All adults	10 ug/L	1515	491	27.2 (23.8 to 31.0)
PFOS HBM-II, general	All adults	20 ug/L	1515	379	20.1 (17.0 to 23.3)
PFOA HBM-II, life-stage	All adults	5/10 ug/L	1515	603	35.8 (31.4 to 40.3)
PFOS HBM-II, life-stage	All adults	10/20 ug/L	1515	455	25.6 (22.0 to 29.1)
Mercury HBM-I	All adults	5 ug/L whole blood	1515	256	16.2 (13.6 to 18.8)
Mercury HBM-II	All adults	15 ug/L whole blood	1515	11	0.6 (0.1 to 1.2)
Corrected PCB3 HBM-I	Women, nonmenopausal	3.5 ug/L; 2x sum	316	0	0.0 (0.0 to 0.0)
Corrected PCB3 HBM-II	Women, nonmenopausal	7 ug/L; 2x sum	316	0	0.0 (0.0 to 0.0)
EFSA TWI-equivalent model-derived maternal serum concentration	Women, nonmenopausal	Sum4 PFAS >6.9 ng/mL	316	291	92.4 (87.2 to 96.1)

Note. HBM comparisons are screening classifications rather than diagnoses. PCB3 uses twice the sum of congeners 138, 153, and 180. The EFSA comparison is contextual and is not treated as a universal adult action value.

Supplementary Table S2. Sensitivity to $\pm 10\%$ perturbation of numeric HBM-II values

Chemical	Population	Multiplier	Cutoff, $\mu\text{g/L}$	n	Events	Weighted % (95% CI)
PFOA	All adults	0.9	9.0	1515	589	32.8 (29.3 to 36.7)
PFOA	All adults	1.0	10.0	1515	491	27.2 (23.8 to 31.0)
PFOA	All adults	1.1	11.0	1515	420	23.0 (20.0 to 26.7)
PFOS	All adults	0.9	18.0	1515	460	24.5 (21.1 to 28.2)
PFOS	All adults	1.0	20.0	1515	379	20.1 (17.0 to 23.3)
PFOS	All adults	1.1	22.0	1515	313	16.2 (13.3 to 19.3)
PFOA	Women, nonmenopausal	0.9	4.5	316	170	51.1 (44.2 to 58.9)
PFOA	Women, nonmenopausal	1.0	5.0	316	140	42.1 (34.5 to 49.2)
PFOA	Women, nonmenopausal	1.1	5.5	316	120	35.8 (29.2 to 42.1)
PFOS	Women, nonmenopausal	0.9	9.0	316	102	31.3 (24.2 to 37.9)
PFOS	Women, nonmenopausal	1.0	10.0	316	86	25.4 (19.2 to 31.3)
PFOS	Women, nonmenopausal	1.1	11.0	316	69	21.0 (15.4 to 27.2)

Note. For nonmenopausal women, the perturbed values are centred on the life-stage HBM-II values; all-adult rows are centred on the general values.

Supplementary Table S3. Full screening performance, including PPV

Population	Rule	Endpoint	n	Threshold	Prev., %	Selected, % (95% CI)	Capture, % (95% CI)	PPV, % (95% CI)	Δ capture, pp (95% CI)
All adults	Global MBTS top 20%	PFOA life-stage HBM-II	1515	0.800	35.8	20.0 (19.9 to 20.1)	36.2 (32.6 to 40.1)	64.9 (58.3 to 70.5)	
All adults	Global MBTS top 20%	PFOS life-stage HBM-II	1515	0.800	25.6	20.0 (19.9 to 20.1)	47.5 (43.3 to 53.1)	60.9 (53.1 to 70.2)	
All adults	Global MBTS top 20%	PFOA general HBM-II	1515	0.800	27.2	20.0 (19.9 to 20.1)	47.2 (42.4 to 52.6)	64.3 (58.0 to 70.2)	
All adults	Global MBTS top 20%	PFOS general HBM-II	1515	0.800	20.1	20.0 (19.9 to 20.1)	58.8 (53.0 to 65.3)	59.3 (51.3 to 68.3)	
All adults	Global MBTS top 20%	Mercury HBM-I	1515	0.800	16.2	20.0 (19.9 to 20.1)	38.0 (32.2 to 45.6)	30.7 (24.9 to 36.4)	
Men	Global MBTS top 20%	PFOA life-stage HBM-II	693	0.800	27.7	18.9 (17.3 to 20.9)	43.1 (35.8 to 52.3)	63.5 (53.4 to 71.6)	
Men	Global MBTS top 20%	PFOS life-stage HBM-II	693	0.800	20.0	18.9 (17.3 to 20.9)	57.2 (49.3 to 67.9)	60.6 (50.3 to 71.1)	
Men	Global MBTS top 20%	PFOA general HBM-II	693	0.800	27.7	18.9 (17.3 to 20.9)	43.1 (35.8 to 52.3)	63.5 (53.4 to 71.6)	
Men	Global MBTS top 20%	PFOS general HBM-II	693	0.800	20.0	18.9 (17.3 to 20.9)	57.2 (49.3 to 67.9)	60.6 (50.3 to 71.1)	
Men	Global MBTS top 20%	Mercury HBM-I	693	0.800	24.8	18.9 (17.3 to 20.9)	34.9 (28.7 to 43.4)	46.0 (37.2 to 53.9)	
Men	Within-subgroup MBTS top 20%	PFOA life-stage HBM-II	693	0.792	27.7	20.0 (19.8 to 20.2)	45.7 (38.8 to 52.9)	63.4 (52.8 to 71.9)	2.5 (-1.8 to 6.2)
Men	Within-subgroup MBTS top 20%	PFOS life-stage HBM-II	693	0.792	20.0	20.0 (19.8 to 20.2)	59.8 (51.8 to 68.9)	59.8 (49.3 to 70.4)	2.6 (-1.9 to 7.4)
Men	Within-subgroup MBTS top 20%	PFOA general HBM-II	693	0.792	27.7	20.0 (19.8 to 20.2)	45.7 (38.8 to 52.9)	63.4 (52.8 to 71.9)	2.5 (-1.8 to 6.2)
Men	Within-subgroup MBTS top 20%	PFOS general HBM-II	693	0.792	20.0	20.0 (19.8 to 20.2)	59.8 (51.8 to 68.9)	59.8 (49.3 to 70.4)	2.6 (-1.9 to 7.4)
Men	Within-subgroup MBTS top 20%	Mercury HBM-I	693	0.792	24.8	20.0 (19.8 to 20.2)	38.1 (30.7 to 44.2)	47.3 (37.2 to 53.8)	3.2 (-1.8 to 5.8)
All women	Global MBTS top 20%	PFOA life-stage HBM-II	822	0.800	43.8	21.1 (19.1 to 22.7)	31.8 (27.4 to 35.8)	66.1 (59.2 to 72.5)	
All women	Global MBTS top 20%	PFOS life-stage HBM-II	822	0.800	31.2	21.1 (19.1 to 22.7)	41.3 (36.0 to 47.9)	61.1 (52.7 to 73.3)	
All women	Global MBTS top 20%	PFOA general HBM-II	822	0.800	26.7	21.1 (19.1 to 22.7)	51.3 (43.8 to 57.7)	65.1 (57.8 to 71.5)	
All women	Global MBTS top 20%	PFOS general HBM-II	822	0.800	20.3	21.1 (19.1 to 22.7)	60.4 (52.6 to 71.3)	58.1 (49.0 to 70.1)	
All women	Global MBTS top 20%	Mercury HBM-I	822	0.800	7.5	21.1 (19.1 to 22.7)	48.1 (35.4 to 62.9)	17.2 (10.7 to 24.6)	

Population	Rule	Endpoint	n	Threshold	Prev., %	Selected, % (95% CI)	Capture, % (95% CI)	PPV, % (95% CI)	Δ capture, pp (95% CI)
All women	Within-subgroup MBTS top 20%	PFOA life-stage HBM-II	822	0.808	43.8	20.0 (19.7 to 20.2)	30.0 (26.2 to 33.8)	65.8 (59.5 to 72.4)	-1.8 (-4.5 to 1.4)
All women	Within-subgroup MBTS top 20%	PFOS life-stage HBM-II	822	0.808	31.2	20.0 (19.7 to 20.2)	40.3 (35.5 to 46.5)	63.0 (53.1 to 73.2)	-0.9 (-3.9 to 1.4)
All women	Within-subgroup MBTS top 20%	PFOA general HBM-II	822	0.808	26.7	20.0 (19.7 to 20.2)	48.4 (42.1 to 55.4)	64.7 (58.4 to 71.5)	-2.9 (-6.9 to 2.0)
All women	Within-subgroup MBTS top 20%	PFOS general HBM-II	822	0.808	20.3	20.0 (19.7 to 20.2)	58.9 (51.5 to 69.1)	59.8 (49.7 to 70.7)	-1.4 (-4.9 to 1.9)
All women	Within-subgroup MBTS top 20%	Mercury HBM-I	822	0.808	7.5	20.0 (19.7 to 20.2)	46.8 (34.5 to 62.6)	17.6 (11.1 to 25.6)	-1.3 (-5.0 to 2.2)
Women, nonmenopausal	Global MBTS top 20%	PFOA life-stage HBM-II	316	0.800	42.1	1.8 (0.4 to 3.3)	4.2 (1.0 to 8.0)	100.0 (100.0 to 100.0)	
Women, nonmenopausal	Global MBTS top 20%	PFOS life-stage HBM-II	316	0.800	25.4	1.8 (0.4 to 3.3)	7.0 (1.8 to 13.2)	100.0 (100.0 to 100.0)	
Women, nonmenopausal	Global MBTS top 20%	PFOA general HBM-II	316	0.800	7.4	1.8 (0.4 to 3.3)	17.9 (2.5 to 36.0)	74.4 (19.5 to 100.0)	
Women, nonmenopausal	Global MBTS top 20%	PFOS general HBM-II	316	0.800	3.2	1.8 (0.4 to 3.3)	15.1 (0.0 to 46.9)	27.0 (0.0 to 78.2)	
Women, nonmenopausal	Global MBTS top 20%	Mercury HBM-I	316	0.800	5.9	1.8 (0.4 to 3.3)	7.7 (0.0 to 27.3)	25.5 (0.0 to 100.0)	
Women, nonmenopausal	Within-subgroup MBTS top 20%	PFOA life-stage HBM-II	316	0.458	42.1	20.0 (19.5 to 20.5)	36.7 (31.0 to 42.7)	77.2 (62.9 to 87.6)	32.5 (26.8 to 38.4)
Women, nonmenopausal	Within-subgroup MBTS top 20%	PFOS life-stage HBM-II	316	0.458	25.4	20.0 (19.5 to 20.5)	46.5 (37.3 to 59.7)	58.8 (46.1 to 72.3)	39.5 (30.3 to 54.0)
Women, nonmenopausal	Within-subgroup MBTS top 20%	PFOA general HBM-II	316	0.458	7.4	20.0 (19.5 to 20.5)	75.3 (62.5 to 96.1)	27.8 (16.8 to 41.8)	57.3 (41.8 to 81.9)
Women, nonmenopausal	Within-subgroup MBTS top 20%	PFOS general HBM-II	316	0.458	3.2	20.0 (19.5 to 20.5)	63.4 (24.3 to 100.0)	10.1 (2.9 to 19.2)	48.3 (13.4 to 100.0)
Women, nonmenopausal	Within-subgroup MBTS top 20%	Mercury HBM-I	316	0.458	5.9	20.0 (19.5 to 20.5)	48.7 (29.5 to 80.7)	14.4 (6.0 to 24.8)	41.0 (18.3 to 72.5)
Age 19-39 years	Global MBTS top 20%	PFOA life-stage HBM-II	340	0.800	19.8	0.3 (0.0 to 1.5)	0.0 (0.0 to 5.8)	0.0 (0.0 to 100.0)	
Age 19-39 years	Global MBTS top 20%	PFOS life-stage HBM-II	340	0.800	8.6	0.3 (0.0 to 1.5)	0.0 (0.0 to 10.8)	0.0 (0.0 to 100.0)	
Age 19-39 years	Global MBTS top 20%	PFOA general HBM-II	340	0.800	6.4	0.3 (0.0 to 1.5)	0.0 (0.0 to 18.7)	0.0 (0.0 to 100.0)	
Age 19-39 years	Global MBTS top 20%	PFOS general HBM-II	340	0.800	2.0	0.3 (0.0 to 1.5)	0.0 (0.0 to 51.1)	0.0 (0.0 to 100.0)	
Age 19-39 years	Global MBTS top 20%	Mercury HBM-I	340	0.800	12.2	0.3 (0.0 to 1.5)	0.0 (0.0 to 9.0)	0.0 (0.0 to 100.0)	
Age 19-39 years	Within-subgroup MBTS top 20%	PFOA life-stage HBM-II	340	0.365	19.8	20.1 (19.5 to 20.5)	31.3 (19.2 to 42.4)	30.8 (17.1 to 43.2)	31.3 (18.9 to 40.1)

Population	Rule	Endpoint	n	Threshold	Prev., %	Selected, % (95% CI)	Capture, % (95% CI)	PPV, % (95% CI)	Δ capture, pp (95% CI)
Age 19-39 years	Within-subgroup MBTS top 20%	PFOS life-stage HBM-II	340	0.365	8.6	20.1 (19.5 to 20.5)	35.6 (14.9 to 54.4)	15.3 (5.6 to 25.4)	35.6 (14.4 to 52.2)
Age 19-39 years	Within-subgroup MBTS top 20%	PFOA general HBM-II	340	0.365	6.4	20.1 (19.5 to 20.5)	46.5 (25.9 to 70.8)	14.7 (6.7 to 24.1)	46.5 (21.6 to 68.7)
Age 19-39 years	Within-subgroup MBTS top 20%	PFOS general HBM-II	340	0.365	2.0	20.1 (19.5 to 20.5)	37.0 (0.0 to 100.0)	3.6 (0.0 to 9.6)	37.0 (0.0 to 79.3)
Age 19-39 years	Within-subgroup MBTS top 20%	Mercury HBM-I	340	0.365	12.2	20.1 (19.5 to 20.5)	58.7 (36.9 to 72.2)	35.5 (20.0 to 45.9)	58.7 (34.8 to 70.6)
Age 40-59 years	Global MBTS top 20%	PFOA life-stage HBM-II	571	0.800	38.6	12.4 (9.3 to 16.2)	23.0 (17.0 to 30.0)	71.6 (58.9 to 81.2)	
Age 40-59 years	Global MBTS top 20%	PFOS life-stage HBM-II	571	0.800	23.0	12.4 (9.3 to 16.2)	28.0 (20.9 to 38.4)	52.0 (40.0 to 65.8)	
Age 40-59 years	Global MBTS top 20%	PFOA general HBM-II	571	0.800	27.5	12.4 (9.3 to 16.2)	31.2 (23.3 to 39.7)	69.1 (56.1 to 80.1)	
Age 40-59 years	Global MBTS top 20%	PFOS general HBM-II	571	0.800	14.3	12.4 (9.3 to 16.2)	39.2 (29.9 to 53.7)	45.1 (33.3 to 61.6)	
Age 40-59 years	Global MBTS top 20%	Mercury HBM-I	571	0.800	19.9	12.4 (9.3 to 16.2)	34.7 (23.4 to 47.0)	55.6 (41.1 to 66.4)	
Age 40-59 years	Within-subgroup MBTS top 20%	PFOA life-stage HBM-II	571	0.728	38.6	19.9 (19.5 to 20.5)	34.8 (28.8 to 41.1)	67.5 (53.6 to 77.4)	11.8 (4.4 to 18.8)
Age 40-59 years	Within-subgroup MBTS top 20%	PFOS life-stage HBM-II	571	0.728	23.0	19.9 (19.5 to 20.5)	41.1 (34.6 to 52.2)	47.5 (36.5 to 61.5)	13.1 (5.3 to 23.0)
Age 40-59 years	Within-subgroup MBTS top 20%	PFOA general HBM-II	571	0.728	27.5	19.9 (19.5 to 20.5)	46.6 (38.8 to 54.3)	64.3 (52.3 to 72.8)	15.4 (6.1 to 24.4)
Age 40-59 years	Within-subgroup MBTS top 20%	PFOS general HBM-II	571	0.728	14.3	19.9 (19.5 to 20.5)	55.3 (46.9 to 71.0)	39.6 (30.7 to 52.2)	16.1 (5.8 to 30.8)
Age 40-59 years	Within-subgroup MBTS top 20%	Mercury HBM-I	571	0.728	19.9	19.9 (19.5 to 20.5)	50.5 (38.5 to 59.5)	50.5 (37.3 to 59.0)	15.9 (4.6 to 25.1)
Age 60+ years	Global MBTS top 20%	PFOA life-stage HBM-II	604	0.800	49.5	50.6 (46.1 to 54.9)	64.6 (56.6 to 70.4)	63.2 (56.3 to 69.7)	
Age 60+ years	Global MBTS top 20%	PFOS life-stage HBM-II	604	0.800	47.1	50.6 (46.1 to 54.9)	68.6 (62.0 to 75.3)	63.9 (55.2 to 74.4)	
Age 60+ years	Global MBTS top 20%	PFOA general HBM-II	604	0.800	49.4	50.6 (46.1 to 54.9)	64.8 (56.7 to 70.7)	63.2 (56.3 to 69.7)	
Age 60+ years	Global MBTS top 20%	PFOS general HBM-II	604	0.800	47.0	50.6 (46.1 to 54.9)	68.8 (62.2 to 75.5)	63.9 (55.2 to 74.4)	
Age 60+ years	Global MBTS top 20%	Mercury HBM-I	604	0.800	15.8	50.6 (46.1 to 54.9)	74.8 (64.0 to 87.2)	23.3 (17.7 to 29.7)	
Age 60+ years	Within-subgroup MBTS top 20%	PFOA life-stage HBM-II	604	0.925	49.5	20.0 (19.8 to 20.3)	27.2 (23.3 to 31.0)	67.4 (57.2 to 75.6)	-37.4 (-42.8 to -30.3)
Age 60+ years	Within-subgroup MBTS top 20%	PFOS life-stage HBM-II	604	0.925	47.1	20.0 (19.8 to 20.3)	35.2 (31.7 to 39.6)	83.1 (72.7 to 91.9)	-33.4 (-39.9 to -26.6)
Age 60+ years	Within-subgroup MBTS	PFOA general HBM-II	604	0.925	49.4	20.0 (19.8 to 20.3)	27.2 (23.4 to 31.1)	67.4 (57.2 to 75.6)	-37.5 (-42.8 to -30.3)

Population	Rule	Endpoint	n	Threshold	Prev., %	Selected, % (95% CI)	Capture, % (95% CI)	PPV, % (95% CI)	Δ capture, pp (95% CI)
	top 20%								
Age 60+ years	Within-subgroup MBTS top 20%	PFOS general HBM-II	604	0.925	47.0	20.0 (19.8 to 20.3)	35.3 (31.8 to 39.6)	83.1 (72.7 to 91.9)	-33.5 (-40.1 to -26.6)
Age 60+ years	Within-subgroup MBTS top 20%	Mercury HBM-I	604	0.925	15.8	20.0 (19.8 to 20.3)	51.3 (39.2 to 64.1)	40.5 (28.7 to 52.1)	-23.5 (-30.9 to -15.2)

Note. PPV is retained only in this supplementary table because it is highly prevalence-dependent. Blank differences identify the global reference rule. MBTS, mixture-burden trajectory score; pp, percentage points; PPV, positive predictive value.

Supplementary Table S4. Cohort-selection sensitivity

Cohort	Endpoint	n	Events	Weighted % (95% CI)
Primary 17-chemical complete-case cohort	PFOA general HBM-II	1515	491	27.2 (23.8 to 31.0)
Primary 17-chemical complete-case cohort	PFOA life-stage HBM-II	1515	603	35.8 (31.4 to 40.3)
Primary 17-chemical complete-case cohort	PFOS general HBM-II	1515	379	20.1 (17.0 to 23.3)
Primary 17-chemical complete-case cohort	PFOS life-stage HBM-II	1515	455	25.6 (22.0 to 29.1)
Primary 17-chemical complete-case cohort	Mercury HBM-I	1515	256	16.2 (13.6 to 18.8)
Expanded endpoint-complete cohort	PFOA general HBM-II	1517	492	27.3 (24.2 to 30.8)
Expanded endpoint-complete cohort	PFOA life-stage HBM-II	1517	605	35.9 (31.9 to 40.0)
Expanded endpoint-complete cohort	PFOS general HBM-II	1517	379	20.1 (17.0 to 23.5)
Expanded endpoint-complete cohort	PFOS life-stage HBM-II	1517	456	25.6 (21.8 to 29.7)
Expanded endpoint-complete cohort	Mercury HBM-I	1517	257	16.2 (13.5 to 18.9)

Note. The expanded cohort required endpoint and survey-design data but did not require complete measurement of all 17 mixture components.

Supplementary Table S5. Leave-one-chemical-out internal validation

Endpoint	Omitted	n	Events	AUC base	AUC aug.	Δ AUC (95% CI)	Brier base	Brier aug.	Δ Brier (95% CI)
Mercury HBM-I	BHg	1515	256	0.771	0.764	-0.008 (-0.016 to -0.001)	0.113	0.114	0.001 (-0.001 to 0.003)
PFOA general HBM-II	PFOA	1515	491	0.812	0.890	0.078 (0.055 to 0.103)	0.151	0.116	-0.035 (-0.046 to -0.025)
PFOA life-stage HBM-II	PFOA	1515	603	0.757	0.870	0.114 (0.088 to 0.147)	0.188	0.139	-0.049 (-0.062 to -0.038)
PFOS general HBM-II	PFOS	1515	379	0.867	0.908	0.041 (0.025 to 0.056)	0.110	0.091	-0.019 (-0.028 to -0.011)
PFOS life-stage HBM-II	PFOS	1515	455	0.818	0.877	0.059 (0.037 to 0.080)	0.142	0.118	-0.025 (-0.035 to -0.014)

Note. The target chemical was removed before relearning magnitude and composition. Estimates are conditional internal validation because the unsupervised representation was learned in the analytic sample. Lower Brier scores indicate less prediction error.

Supplementary Table S6. LOCO profile-by-burden cells with small cells suppressed

Endpoint	Omitted	Burden tertile	Profile	n	Weighted %	Status
Mercury HBM-I	BHg	T1	P1	224	8.1	Reported
Mercury HBM-I	BHg	T1	P2	39	3.6	Reported
Mercury HBM-I	BHg	T1	P3	37	18.3	Reported
Mercury HBM-I	BHg	T1	P4	83	8.5	Reported
Mercury HBM-I	BHg	T1	P5	122	6.6	Reported
Mercury HBM-I	BHg	T2	P1	76	15.2	Reported
Mercury HBM-I	BHg	T2	P2	138	19.0	Reported
Mercury HBM-I	BHg	T2	P3	87	14.1	Reported
Mercury HBM-I	BHg	T2	P4	134	27.6	Reported
Mercury HBM-I	BHg	T2	P5	70	7.8	Reported
Mercury HBM-I	BHg	T3	P1	36	38.4	Reported
Mercury HBM-I	BHg	T3	P2	112	23.3	Reported
Mercury HBM-I	BHg	T3	P3	86	23.4	Reported
Mercury HBM-I	BHg	T3	P4	193	29.4	Reported
Mercury HBM-I	BHg	T3	P5	78	27.8	Reported
PFOA general HBM-II	PFOA	T1	P1	56	10.0	Reported
PFOA general HBM-II	PFOA	T1	P2	301	8.0	Reported
PFOA general HBM-II	PFOA	T1	P3	36	3.6	Reported
PFOA general HBM-II	PFOA	T1	P4	107	0.2	Reported
PFOA general HBM-II	PFOA	T1	P5	5		Suppressed: n<20
PFOA general HBM-II	PFOA	T2	P1	160	37.0	Reported
PFOA general HBM-II	PFOA	T2	P2	140	33.0	Reported
PFOA general HBM-II	PFOA	T2	P3	100	39.9	Reported
PFOA general HBM-II	PFOA	T2	P4	101	5.2	Reported
PFOA general HBM-II	PFOA	T2	P5	4		Suppressed: n<20
PFOA general HBM-II	PFOA	T3	P1	113	66.3	Reported
PFOA general HBM-II	PFOA	T3	P2	117	73.1	Reported
PFOA general HBM-II	PFOA	T3	P3	87	61.3	Reported
PFOA general HBM-II	PFOA	T3	P4	187	42.9	Reported
PFOA general HBM-II	PFOA	T3	P5	1		Suppressed: n<20
PFOA life-stage HBM-II	PFOA	T1	P1	56	31.2	Reported
PFOA life-stage HBM-II	PFOA	T1	P2	301	23.3	Reported

Endpoint	Omitted	Burden tertile	Profile	n	Weighted %	Status
PFOA life-stage HBM-II	PFOA	T1	P3	36	14.3	Reported
PFOA life-stage HBM-II	PFOA	T1	P4	107	7.0	Reported
PFOA life-stage HBM-II	PFOA	T1	P5	5		Suppressed: n<20
PFOA life-stage HBM-II	PFOA	T2	P1	160	47.7	Reported
PFOA life-stage HBM-II	PFOA	T2	P2	140	37.3	Reported
PFOA life-stage HBM-II	PFOA	T2	P3	100	45.0	Reported
PFOA life-stage HBM-II	PFOA	T2	P4	101	13.2	Reported
PFOA life-stage HBM-II	PFOA	T2	P5	4		Suppressed: n<20
PFOA life-stage HBM-II	PFOA	T3	P1	113	66.3	Reported
PFOA life-stage HBM-II	PFOA	T3	P2	117	73.1	Reported
PFOA life-stage HBM-II	PFOA	T3	P3	87	61.3	Reported
PFOA life-stage HBM-II	PFOA	T3	P4	187	46.0	Reported
PFOA life-stage HBM-II	PFOA	T3	P5	1		Suppressed: n<20
PFOS general HBM-II	PFOS	T1	P1	246	3.1	Reported
PFOS general HBM-II	PFOS	T1	P2	29	2.3	Reported
PFOS general HBM-II	PFOS	T1	P3	32	0.0	Reported
PFOS general HBM-II	PFOS	T1	P4	97	0.4	Reported
PFOS general HBM-II	PFOS	T1	P5	101	3.1	Reported
PFOS general HBM-II	PFOS	T2	P1	80	29.2	Reported
PFOS general HBM-II	PFOS	T2	P2	124	23.3	Reported
PFOS general HBM-II	PFOS	T2	P3	93	21.4	Reported
PFOS general HBM-II	PFOS	T2	P4	136	12.5	Reported
PFOS general HBM-II	PFOS	T2	P5	72	0.0	Reported
PFOS general HBM-II	PFOS	T3	P1	34	59.1	Reported
PFOS general HBM-II	PFOS	T3	P2	108	62.0	Reported
PFOS general HBM-II	PFOS	T3	P3	79	44.0	Reported
PFOS general HBM-II	PFOS	T3	P4	177	55.1	Reported
PFOS general HBM-II	PFOS	T3	P5	107	42.5	Reported
PFOS life-stage HBM-II	PFOS	T1	P1	246	10.1	Reported
PFOS life-stage HBM-II	PFOS	T1	P2	29	5.9	Reported
PFOS life-stage HBM-II	PFOS	T1	P3	32	5.1	Reported
PFOS life-stage HBM-II	PFOS	T1	P4	97	10.4	Reported
PFOS life-stage HBM-II	PFOS	T1	P5	101	6.5	Reported
PFOS life-stage HBM-II	PFOS	T2	P1	80	38.7	Reported

Endpoint	Omitted	Burden tertile	Profile	n	Weighted %	Status
PFOS life-stage HBM-II	PFOS	T2	P2	124	33.2	Reported
PFOS life-stage HBM-II	PFOS	T2	P3	93	26.0	Reported
PFOS life-stage HBM-II	PFOS	T2	P4	136	17.2	Reported
PFOS life-stage HBM-II	PFOS	T2	P5	72	3.8	Reported
PFOS life-stage HBM-II	PFOS	T3	P1	34	69.5	Reported
PFOS life-stage HBM-II	PFOS	T3	P2	108	62.0	Reported
PFOS life-stage HBM-II	PFOS	T3	P3	79	44.9	Reported
PFOS life-stage HBM-II	PFOS	T3	P4	177	58.4	Reported
PFOS life-stage HBM-II	PFOS	T3	P5	107	43.1	Reported

Note. Weighted percentages are blank where the unweighted cell count was below 20. LOCO, leave one chemical out.

Supplementary Table S7. Comparison of operational life-stage definitions

Panel A. Overlap between definitions among 822 women

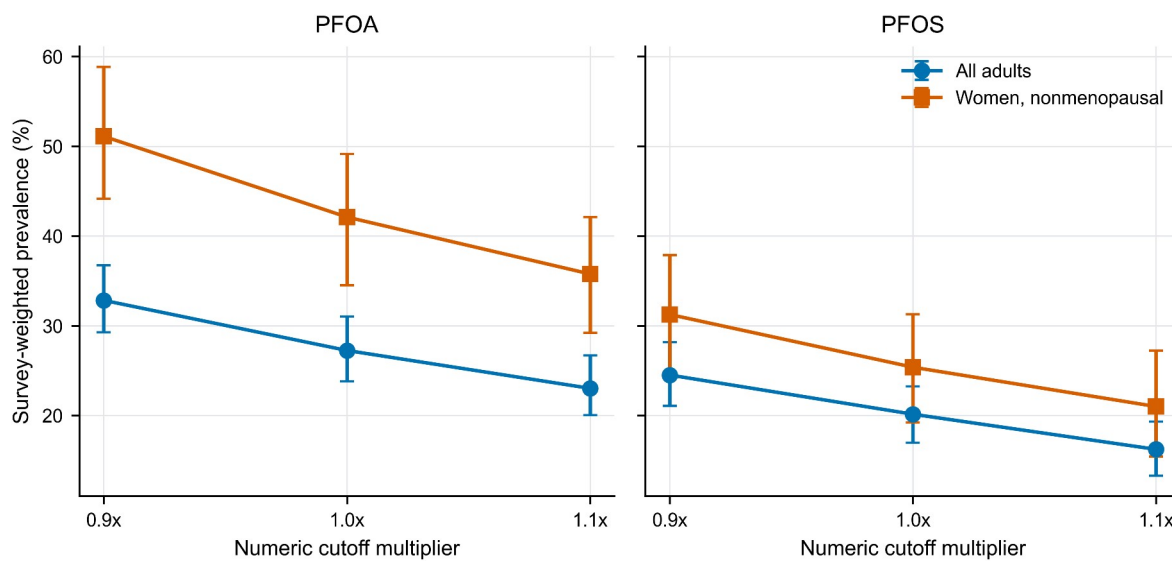
Definition overlap	Unweighted n
Nonmenopausal definition	316
Age 19–49 definition	296
Met both definitions	285
Age definition only	11
Nonmenopausal definition only	31
Neither definition	495

Panel B. PFOA and PFOS classification prevalence across all adults

Chemical	Operational definition	Events	Weighted % (95% CI)	Difference vs general, pp (95% CI)
PFOA	General value for all adults	491	27.2 (23.8 to 31.0)	Reference
PFOA	Lower value for nonmenopausal women	603	35.8 (31.4 to 40.3)	8.6 (6.8 to 10.3)
PFOA	Lower value for women aged 19–49	595	35.5 (31.3 to 39.9)	8.3 (6.5 to 9.9)
PFOS	General value for all adults	379	20.1 (17.0 to 23.3)	Reference
PFOS	Lower value for nonmenopausal women	455	25.6 (22.0 to 29.1)	5.5 (4.0 to 7.1)
PFOS	Lower value for women aged 19–49	442	25.2 (21.6 to 28.6)	5.1 (3.6 to 6.7)

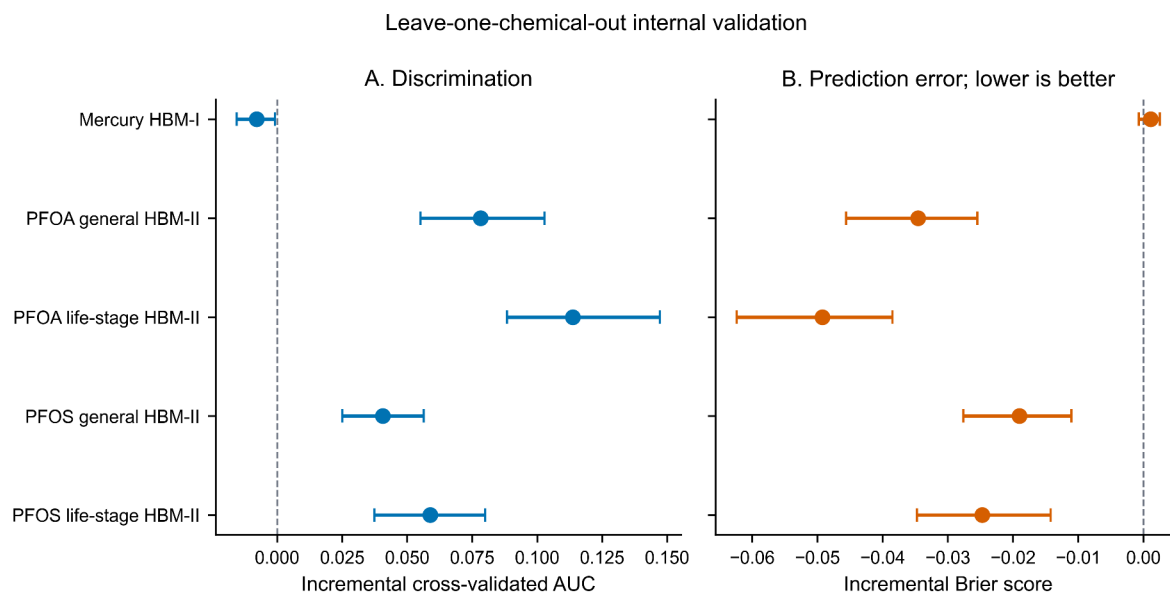
Note. The primary definition identified nonmenopausal women after excluding pregnancy. The alternative definition identified women aged 19–49 years. All confidence intervals use 500 Rao–Wu bootstrap replicates. pp, percentage points.

Supplementary Figure S1. Cutoff perturbation



Supplementary Figure S1. Sensitivity of PFOA and PFOS benchmark classifications to a 10% downward or upward perturbation of the numeric HBM-II comparison values. Error bars denote 95% Rao–Wu bootstrap confidence intervals.

Supplementary Figure S2. LOCO internal validation



Supplementary Figure S2. Secondary leave-one-chemical-out internal validation. The chemical defining each outcome was removed before the exposure manifold was learned. Changes compare magnitude-only models with models additionally containing composition coordinates and profiles. Lower Brier scores indicate less prediction error. These estimates do not constitute external validation.