Table S1. Weighted Geometric mean urinary biomarker concentrations (creatinine adjusted) by tobacco use status

Biomarkers of Exposure		Never users of tobacco products (*n* = 1,655)	% Above LOD	Exclusive, established, past 30 day hookah user (*n* = 98)	% Above LOD
Urinary Nicotine Metabolites					
Cotinine (COTT) (ug/g)	*N*	1644		98	
		0.42 (0.36, 0.48)	99%	5.45^ (2.81, 10.58)	100%
Total Nicotine Equivalents (2) (nmol/g)	*N*	1633		97	
		6.29 (5.42, 7.30)	-	86.50^ (44.44, 168.37)	–
Cotinine N-oxide (COXT) (ng/g)	*N*	88		33	
		13869.70^ (6861.91, 28034.27)	99%	19394.30 (11679.58, 32204.58)	97%
trans-3'-hydroxycotinine (HCTT) (ng/g)	*N*	1641		97	
		689.87 (593.67,801.65)	98%	9180.74^ (4572.89,18431.67)	99%
Norcotinine (NCTT) (ng/g)	*N*	88		33	
		4269.73 ^ (2272.44,8021.89)	95%	5613.07 (3516.60,8959.37)	97%
Nicotine (NICT) (ng/g)	*N*	88		33	
		31186.49 ^ (12303.26,79052.00)	64%	26121.71 ^ (13758.13,49595.66)	66%
Nornicotine (NNCT)^ (ng/g)	*N*	88		33	
		3391^ (1846.85,6226.22)	35%	3118.67 (2068.60,4701.80)	55%
Nicotine N-oxide (NOXT) (ng/g)	*N*	88		33	
		11489.28 ^ (4238.72,31142.33)	76%	6949.05 ^ (3625.81,13318.22)	66%
Minor Tobacco Alkaloids					
Anabasine (ANBT)^(ng/g)	*N*	88		33	
		604.72 (347.15, 1053.40)	29%	306.75 (226.76, 414.96)	32%
Anatabine (ANTT)^(ng/g)	*N*	88		33	
		615.08^ (306.53, 1234.21)	37%	265.16 (187.68, 374.63)	32%
Arsenic and Arsenic Compounds (ug/L)					
Arsenous Acid (UAS3) (ng/g)	*N*	1653		98	
		0.33 (0.31,0.36)	73%	0.41 (0.34,0.5)	91%
Arsenic Acid (UAS5)^ (ng/g)	*N*	1653		98	
		0.53 (0.51,0.57)	3%	0.43 (0.38,0.48)	8%
Dimethylarsinic acid (UDMA) (ng/g)	*N*	1653		98	
		3.69 (3.48,3.92)	81%	3.6 (3.09,4.2)	90%
Monomethylarsonic acid (ng/g)	*N*	1653		98	
		0.48 (0.45,0.52)	78%	0.46 (0.38,0.54)	87%
Total Inorganic Arsenic (ug/g)	*N*	1653	-	98	
		5360.23 (5078.07,5658.04)	-	5221.98 (4532.44,6016.41)	-
Tobacco Specific Nitrosamines (TSNAs)					
4-methylnitrosamino)-4-(3-pyridyl)-1-butanol (NNAL) (ng/g)	*N*	1653		98	
		0.92 (0.82,1.04)	51%	2.21 (1.59,3.08)	83%
N'-nitrosoanatabine (NAT) ^ (ng/g)	*N*	1648		98	
		2.92 (2.74,3.11)	1%	2.61 (2.19,3.11)	13%
N'-nitrosoanabasine (NAB) ^ (ng/g)	*N*	1655		98	
		1.07 (1,1.14)	2%	0.91 (0.78,1.07)	11%

N'-nitrosonornicotine (NNN)^ (ng/g)	*N*	1647		98	
		1.92 (1.81,2.04)	1%	1.58 (1.36,1.85)	6%
Metals (ng/L)					
Beryllium (UBE) ^ (ng/g)	*N*	1653		98	
		10.53 (9.94,11.15)	3%	8.17 (7.22,9.23)	6%
Cadmium (UCD) (ng/g)	*N*	1652		98	
		148.77 (139.59,158.55)	93%	70.23 (60.29,81.8)	82%
Cobalt (UCO) (ng/g)	*N*	1653		98	
		563.81 (537.49,591.41)	100%	488.91 (431.58,553.85)	100%
Manganese (UMN) (ng/g)	*N*	1652		98	
		130.73 (123.58,138.29)	47%	94.52 (82.36,108.47)	45%
Lead (UPB) (ng/g)	*N*	1653		98	
		351.14 (330.28,373.31)	100%	271.85 (226.73,325.96)	100%
Strontium (USR) (ug/L)	*N*	1653		98	
		112.71 (106.77,118.97)	100%	109.14 (95.15,125.17)	100%
Thallium (UTL) (ng/g)	*N*	1652		98	
		171.75 (163.62,180.28)	100%	159.95 (143,178.9)	100%
Uranium (UUR) (ng/g)	*N*	1653		98	
		5.36 (4.85,5.93)	85%	4.93 (4.08,5.95)	92%
Polycyclic Aromatic Hydrocarbons (ng/mL)					
1-Naphthol or 1-hydroxynaphthalene (1-NAP) (ng/g)	*N*	1649		98	
		1.4 (1.28,1.53)	99%	1.13 (0.92,1.4)	100%
2-Naphthol or 2-hydroxynaphthalene (2-NAP) (ng/g)	*N*	1652		98	
		4.63 (4.34,4.94)	100%	5.07 (4.25,6.05)	100%
3-Hydroxyfluorene (3-FLU) (ng/g)	*N*	1655		98	
		63.98 (60.32,67.86)	99%	74.22 (60.65,90.82)	100%
2-Hydroxyfluorene (2-FLU) (ng/g)	*N*	1655		98	
		167.22 (158.06,176.9)	100%	183.01 (153.91,217.62)	100%
1-Hydroxyphenanthrene (1-PHE) (ng/g)	*N*	1655		98	
		106.27 (101.09,111.72)	100%	93.86 (80.95,108.84)	100%
1-Hydroxypyrene (1-PYR) (ng/g)	*N*	1655		98	
		128.14 (120.67,136.07)	85%	148.3 (126.43,173.94)	92%
2- and 3-Hydroxyphenanthrene (2-3PHE) (ng/g)	*N*	1655		98	
		128.96 (123.03,135.18)	100%	124.1 (106.77,144.24)	100%
Volatile Organic Compounds					
2-Methylhippuric acid (2MHA)(ng/g)	*N*	1589		96	
		22251.79 (20614.48,24019.14)	92%	17164.55 (13641.45,21597.53)	87%
3, 4-Methylhippuric acid (34MH)(ng/g)	*N*	1651		98	
		152323 (143737.5,161421.3)	100%	130491.1 (106198.0,160341.4)	100%
N-Acetyl-S-(2-carbamoylethyl)-Lcysteine (AAMA)(ng/g)	*N*	1645		95	
		45308.74 (43132.9,47594.3)	99%	59693.49 (50328.3,70801.3)	100%

N-Acetyl-S-(N-methylcarbamoyl)-Lcysteine (AMCA)(ng/g)	*N*	1653		97	
		104264 (98332.0,110553.9)	100%	87601.85 (75633.4,101464.2)	100%
N-Acetyl-S-(benzyl)-L-cysteine (BMA)(ng/g)	*N*	1653		97	
		6124.5 (5781.5,6487.8)	100%	5509.2 (4661.9,6510.4)	100%
N-Acetyl-S-(2-carboxyethyl)-Lcysteine (CEMA)(ng/g)	*N*	1599		90	
		93970.34 (89669.2,98477.8)	99%	93779.5 (80648.35,109048.7)	100%
N-Acetyl-S-(1-cyano-2-hydroxyethyl)-L-cysteine (CYHA)^(ng/g)	*N*	1653		98	
		1817.7 (1710.1,1932.1)	3%	1882.9 (1498.8,2365.4)	16%
N-Acetyl-S-(2-cyanoethyl)-L-cysteine (CYMA)(ng/g)	*N*	1653		98	
		1271.5(1192.5,1355.7)	85%	2804.31 (1978.0,3975.8)	96%
N-Acetyl-S-(3,4-dihydroxybutyl)-Lcysteine(DHBM)(ng/g)	*N*	1481		80	
		347491.4 (335695.0,359702.2)	89%	309586.9 (288111.0,332663.6)	100%
N-Acetyl-S-(2-carbamoyl-2-hydroxyethyl)-L-cysteine (GAMA)(ng/g)	*N*	1581		95	
		8580.9 (8097.4,9093.3)	38%	9113.8 (7833.1,10603.9)	61%
N-Acetyl-S-(2-hydroxyethyl)-Lcysteine (HEMA)(ng/g)	*N*	1508		80	
		961.5 (891.3,1037.3)	53%	876.12 (712.38,1077.5)	72%
N-Acetyl-S-(2-hydroxypropyl)-Lcysteine(HPM2)(ng/g)	*N*	1605		98	
		32201.7 (29217.3,35490.6)	95%	31126.08 (24362.1,39768.1)	99%
N-Acetyl-S-(3-hydroxypropyl)-Lcysteine(HPMA)(ng/g)	*N*	1653		97	
		262065.0 (247449.6,277543.6)	100%	257819.9 (216169.8,307494.7)	100%
N-Acetyl-S-(3-hydroxypropyl-1-methyl)-L-cysteine (HPMM)(ng/g)	*N*	1653		98	
		440941.7 (416424.2,466899.6)	100%	377453.6 (333472.3,427228.0)	100%
N-Acetyl-S-(4-hydroxy-2-methyl-2-buten-1-yl)-L-cysteine (IPM3)(ng/g)	*N*	1637		97	
		3222.5 (3015.5,3443.6)	89%	2421.7 (2004.9,2925.1)	91%
Mandelic acid (MADA)(ng/g)	*N*	1464		89	
		127971.2 (122327.3,133875.4)	89%	113739.1 (102282.7,126478.6)	99%
N-Acetyl-S-(4-hydroxy-2-buten-1-yl)-L-cysteine (MHB3)(ng/g)	*N*	1653		98	
		4438.3 (4241.1,4644.6)	99%	3532.6(3047.5,4094.9)	100%
Phenylglyoxylic acid (PGHA)	*N*	1550		94	

		202278.7 (194312.3,210571.8)	94%	175571.8 (153871.0,200333.2)	100%
N-Acetyl-S-(phenyl)-L-cysteine (PMA)(ng/g)	*N*	1653		98	
		1006.7 (935.6,1083.3)	68%	810.5 (656.9,1000.1)	72%
2-Thioxothiazolidine-4-carboxylic acid (TTCA)(ng/g)	*N*	1369		87	
		20662.5 (18334.9,23285.6)	69%	15518.6 (11085.9,21723.7)	66%

Weighted estimates; geometric mean calculated by exp (mean of log transformed [biomarker value/creatinine value]).Total Nicotine Equivalents (TNE2) calculated by taking molar sum of trans-3'-hydroxycotinine and cotinine divided by urinary creatinine. ^Estimate should be interpreted with caution because of low reliability. It is based on a sample size of less than 50, or the coefficient of variation is greater than 30%, or the proportion of results below the limit of detection (LOD) is greater than 40%.

Table S2. Linear regression results for biomarkers of exposure by tobacco use status

Biomarker	**Exclusive, established, past 30 day hookah user (*n* = 98)**			Never users of tobacco products (*n* = 1655) (Ref)
	exp (Coef)	95% confidence interval lower	upper	
Urinary Nicotine Metabolites				
Urinary cotinine (COTT)	10.57 ^	4.94	22.61	1.00
Total Nicotine Equivalents (2)	11.64 ^	5.49	24.68	1.00
Cotinine N-oxide (COXT)	1.09 ^	0.41	2.86	1.00
trans-3'-hydroxycotinine (HCTT)	11.69 ^	5.35	25.51	1.00
Norcotinine (NCTT)	1.05 ^	0.42	2.64	1.00
Nicotine (NICT)	0.46 ^	0.10	2.03	1.00
Nornicotine (NNCT)	0.71 ^	0.27	1.84	1.00
Nicotine N-oxide (NOXT)	0.3 ^	0.07	1.19	1.00
Minor Tobacco Alkaloids				
Anabasine (ANBT)	0.42 ^	0.19	0.91	1.00
Anatabine (ANTT)	0.3 ^	0.11	0.81	1.00
Arsenic and Arsenic Compounds (ug/L)				
Arsenous Acid (UAS3)	1.16	0.91	1.49	1.00
Arsenic Acid (UAS5)	1.02	0.98	1.06	1.00
Dimethylarsinic acid (UDMA)	1.17	0.99	1.39	1.00
Monomethylarsonic acid	0.99	0.80	1.23	1.00
Total Inorganic Arsenic	1.09	0.92	1.28	1.00
Tobacco Specific Nitrosamines (TSNAs)				
4-methylnitrosamino)-4-(3-pyridyl)-1-butanol (NNAL)	2.29	1.52	3.46	1.00
N′-nitrosoanatabine (NAT)	1.11	0.95	1.29	1.00
N′-nitrosoanabasine (NAB)	1.09	0.98	1.21	1.00
N'-nitrosonornicotine (NNN)	1.06	0.97	1.16	1.00
Metals (ng/L)				
Beryllium (UBE)	1.01	0.97	1.04	1.00
Cadmium (UCD)	0.93	0.76	1.14	1.00
Cobalt (UCO)	0.98	0.88	1.09	1.00

Manganese (UMN)	0.97	0.89	1.07	1.00
Lead (UPB)	1.19	0.99	1.43	1.00
Strontium (USR) (ug/L)	1.00	0.84	1.18	1.00
Thallium (UTL)	1.08	0.96	1.21	1.00
Uranium (UUR)	1.02	0.78	1.33	1.00
Polycyclic Aromatic Hydrocarbons (ng/mL)				
1-Naphthol or 1-hydroxynaphthalene (1-NAP)	1.00	0.60	1.64	1.00
2-Naphthol or 2-hydroxynaphthalene (2-NAP)	1.19	0.95	1.50	1.00
3-Hydroxyfluorene (3-FLU)	1.28	1.01	1.63	1.00
2-Hydroxyfluorene (2-FLU)	1.22	0.99	1.49	1.00
1-Hydroxyphenanthrene (1-PHE)	1.11	0.91	1.35	1.00
1-Hydroxypyrene (1-PYR)	1.33	1.09	1.63	1.00
2- and 3-Hydroxyphenanthrene (2–3PHE)	1.15	0.95	1.38	1.00
VOC's				
2-Methylhippuric acid (2MHA)	0.97	0.73	1.30	1.00
3,4-Methylhippuric acid (34MH)	1.10	0.86	1.40	1.00
N-Acetyl-S-(2-carbamoylethyl)-Lcysteine (AAMA)	1.39	1.15	1.68	1.00
N-Acetyl-S-(N-methylcarbamoyl)-Lcysteine (AMCA)	1.25	1.04	1.50	1.00
N-Acetyl-S-(benzyl)-L-cysteine (BMA)	1.23	1.01	1.51	1.00
N-Acetyl-S-(2-carboxyethyl)-Lcysteine(CEMA)	1.22	1.05	1.42	1.00
N-Acetyl-S-(1-cyano-2-hydroxyethyl)-L-cysteine(CYHA)	1.21	0.95	1.55	1.00
N-Acetyl-S-(2-cyanoethyl)-L-cysteine(CYMA)	1.81	1.17	2.81	1.00
N-Acetyl-S-(3,4-dihydroxybutyl)-Lcysteine(DHBM)	1.08	0.98	1.20	1.00
N-Acetyl-S-(2-carbamoyl-2-hydroxyethyl)-L-cysteine(GAMA)	1.26	1.06	1.51	1.00
N-Acetyl-S-(2-hydroxyethyl)-Lcysteine(HEMA)	1.05	0.84	1.30	1.00
N-Acetyl-S-(2-hydroxypropyl)-Lcysteine(HPM2)	1.12	0.84	1.49	1.00
N-Acetyl-S-(3-hydroxypropyl)-Lcysteine(HPMA)	1.09	0.89	1.33	1.00
N-Acetyl-S-(3-hydroxypropyl-1-methyl)-L-cysteine(HPMM)	1.08	0.95	1.23	1.00
N-Acetyl-S-(4-hydroxy-2-methyl-2-buten-1-yl)-L-cysteine(IPM3)	0.91	0.71	1.15	1.00
Mandelic acid (MA)	1.00	0.86	1.17	1.00
N-Acetyl-S-(4-hydroxy-2-buten-1-yl)-L-cysteine(MHB3)	0.96	0.81	1.13	1.00
Phenylglyoxylic acid (PGHA)	1.09	0.95	1.26	1.00
N-Acetyl-S-(phenyl)-L-cysteine (PMA)	1.03	0.84	1.26	1.00
2-Thioxothiazolidine-4-carboxylic acid(TTCA)	0.92	0.62	1.35	1.00

Analyses are weighted and models adjusted for transformed creatinine level (g/mL), age, sex, race/ethnicity, education attainment, past 30 day marijuana use and level of SHS exposure.^Estimate should be interpreted with caution because of low reliability. It is based on a sample size of less than 50, or the coefficient of variation is greater than 30%.