Supplemental Material

METHODS

Site characterization and subject enrollment: Ambient daily PM_{10} levels of Srodmiescie–Old Podgorze and Krowodrza–Nowa Huta–New Podgorze were measured during 1990 – 1992, and observed the former location having higher ambient air pollution levels (Whyatt et al. 1998). According to the 1996 air monitoring data from U.S. EPA sites, the mean annual concentration of B(a)P was 2-fold higher in Srodmiescie (annual mean 13.3 ng/m^3; 22.4 ng/m^3 in winter; 4.6 ng/m^3 in summer) than Krowodrza (annual mean 6 ng/m^3; 11.2 ng/m^3 in winter; 0.9 ng/m^3 in summer). Approximately 38 – 41% of total births in Krakow are estimated to be from the women who live in either section (Whyatt et al. 1998). In the present study, those who lived within 0.5 km of the ambient air monitoring stations within Srodmiescie – Old Podgorze and Krowodrza – Nowa Huta –New Podgorze level were targeted for recruitment (Jedrychowski et al. 2004). Although the ambient PM_{10} levels were significantly higher in City center compared to the outer area between 1990- 1992 (Whyatt et al. 1998), the disparity in ambient pollution levels in the city decreased drastically since this period. Based recent Krakow EPA estimates, , the median PM_{10} level in City Center was 25.83 μg/m^3 while that for the outer area was 24.08 μg/m^3 between November 2000 and December 2002 (non-parametric p-value > 0.1).

Personal interview: During late 2nd trimester, a research worker administered an in-depth health, lifestyle, and environmental (HLE) questionnaire to 344 women in their homes. The questionnaire elicited information on demographic and socioeconomic status, outdoor environment (live in same building or next door to a dry-cleaning shop, an industrial plant, car repair shop, restaurant, bus depot, crossroad, or incinerator), quality of the indoor environment (intensity of outdoor traffic; types of industrial activity near home; frequency of opening window

in warmer months; the domestic heating method (by hot water pipe radiator, coal stove, electric heater, forced hot air vents); fuel types (coal stove at home, or coal stove in the basement, gas, wood, being supplied with town central heating, or electricity); amount of vehicular traffic outside the room in which the mothers spent the majority of time at home), active and passive smoking history (number persons who smoke cigarettes, cigars, pipes or marijuana, respectively, at home or at work; hours of exposure per day; months of exposure during pregnancy), dietary intake of PAH-containing foods (frequency of eating smoked, grilled, blackened items, respectively), as well as other daily activity patterns (burning candles at home, number of hours spent indoors, outdoors, and in mass transit, respectively; mode of transportation during pregnancy, cooking method including use of daily use of exhaust fan over cooking stove). The questions regarding and dietary PAH intake frequency, were asked only during the second and third trimester.

Personal PAH monitoring: The pump flow was split two ways to simultaneously collect particles ≤ 2.5 μm in aerodynamic diameter ($PM_{2.5}$) and PAHs. $PM_{2.5}$ was collected on precleaned Personal Exposure Monitor Sampler (PEMS) with teflon filter 37 mm in diameter and PAHs were collected on quartz microfiber filter (Palliflex Tissuquartz 2500 QAS, 25 mm in diameter) and semivolatile vapors and aerosols were collected on a polyurethane foam (PUF) plug backup (Kinney et al. 2002). The backpack was fitted with a lightweight URG-2000-25 Personal Air Sampler (URG, Chapel Hill, NC, USA). The sampling pump (BGI, Waltham, MA, USA) with split flow inlet drew in the air continuously at 2 L/min. Before each monitoring, flow rates were determined using DC-Lite Flow Meter (BIOS International Corporation) which was calibrated using Gilibrator^{TM}2 (Gilian®, SENSIDYNE Inc.) standards. The impactor inlet was tucked in the outside pocket of the backpack, proximal to the woman's breathing zone. Flow

rate after 24-hour and 48-hour of monitoring were determined by DC-Lite Flow Meter and two rotameters, which were calibrated using a Bubble meter. Average airflow was 1.99 ± 0.04 m^3/minute, reflecting an equal split of the flow to the personal exposure monitor (PEM) filter and PUF filter, respectively. Personal air monitoring data were given a Quality Assurance (QA) score (0-3) for flow rate, flow time, and completeness of documentation (Kinney et al. 2002).

The pump (BGI, Waltham, MA, USA) was charged by 32-hour capacity battery. Women were not asked to keep a time-activity log, thus, our measurements reflect her cumulative exposure over 48-hour period in home, work and other microenvironments. The research staff visited each home during the second day of the monitoring to change the battery, to administer an additional environmental questionnaire, and to check for operating failures. Quality Assurance score of 0-1 indicated high quality, 2 indicated intermediate quality, and 3 indicated unacceptable quality. QA score was determined based on the quality of flow rate as percent deviation from the optimal rate of 2 liters per minute (LPM). Thus, deviation from 2 LPM within 10% was given a score of zero; 10 – 25% was given a QA score of one; and >25% deviation was given the score of two. >25% deviation and overall poor quality of monitoring was given a score of three. Flow time was checked in terms of whether the pump operated for 48 hours (2880 minutes). Flow time of 2880 ± 720 min (25%) was given a QA score of 0; deviation ranging between 25 – 50% (720 – 1440 minutes) of the total flow time was given a score of 1; deviation >50% of the total flow time with overall good quality of monitoring was given a score of 2; deviation >50% of the total flow time with poor monitoring quality was given a score of 3. If the original sampling log sheet was missing, the missing document flag was set to 1; if it was not missing the flag was set as 0. The final QA score was determined based on the highest value in any of the three items.

Laboratory analysis of PAHs in air monitoring samples: Most samples were shipped to the laboratory within 60 days of sample collection, and were extracted within 14 days after arrival. The samples were stored at subzero temperature until the extraction date. The URG personal air samplers were cleaned and rebuilt at SwRI, taking precautions to minimize laboratory-introduced contamination of PAHs. Large lots of PUF plugs and quartz fiber filters were sequentially precleaned in large Soxhlet extractors, first for 24 hours with high-purity acetone, next for 48 hours with high-purity hexane, again for 24 hours with acetone, and then dried with purified nitrogen. One PUF plug or filter from each lot were extracted and analyzed for the targeted PAHs as a quality control check to determine that the lot was sufficiently clean. All components of the URG cartridge were also solvent-rinsed and dried. Cleaned PUF and filters were loaded in the cleaned cartridges, sealed, and shipped for use in air sample collection. Glass and metal parts of the URG samplers and all glassware used during extraction was washed with detergent and water, sequentially rinsed with hot water, deionized water, acetone, and deionized water, and then oven-fired for 16 hours at 150°C. 50 μL of a 1% solution of Dow Corning 704 Diffusion Pump Fluid (tetraphenyltetramethyltrisiloxane) in toluene was applied as a coating solution to the impactor plate of each cleaned URG air sampling cartridge during assembly of the cleaned cartridge to prevent bounce-off of particles which impact the plate during air sampling. During GC/MS analysis, the GC temperature program was set so that tetraphenyltetramethyltrisiloxane (molecular weight 484) would not co-elute with targeted PAH (benzo[*b*]fluoranthene or benzo[*k*]fluoranthene) as an analytical interference.

GC/MS analysis was performed using an Agilent 6890 gas chromatograph / 5973 mass spectrometer (Agilent Technologies, Palo Alto, CA) in selected ion monitoring mode to achieve low-level detection. Extracts were injected into a 0.25 mm inner - diameter capillary analytical

GC column (a 30 m DB-5.625 or a 60 m DB-5MS (Agilent Technologies, Palo Alto, CA)). Deuterated PAHs were used as the internal standards for quantitation. As laboratory quality control, matrix blank, solvent blanks, and matrix spike samples were extracted and analyzed with each batch of samples. The estimated between- and within- person variance components were examined with geometric standard deviation (GSD). The ratio of the between –person variance to the sum of between- and within – person variance represents the correlation between repeated monitoring, adjusted for the season and spatial factors.

Back in Jagiellonian University, the samples were inventoried and stored at -18 °C, and then shipped in dry ice to Southwestern Research Institute, Texas, US, via Columbia University, New York. Moderate loss (< 30%) of pyrene, chrysene, and benz[*a*]anthracene was observed in the duplicates during the storage and transport process between Krakow, New York City, and San Antonio spanning 107 days

Cross Validation: Each model was developed with one observation deleted. The deleted observation was included in the test sample to calculate the prediction error, defined as the squared term of the difference between the observed and the predicted exposure level. The prediction error was calculated for each observation, and mean prediction error was determined. That is,

$$\mathrm{CV} = n^{-1}\sum_{i=1}^{n}\{Y_i - \hat{Y}_i^{(-i)}\}^2 \qquad (1)$$

where Y_i denoted the observed outcome of the i^{th} observation and $\hat{Y}_i^{-(i)}$ denoted the predicted outcome of that observation with regression applied to the data with (X_i, Y_i) deleted.

Reference

Jedrychowski W, Bendkowska I, Flak E, Penar A, Jacek R, Kaim I, et al. (2004). Estimated risk for altered fetal growth resulting from exposure to fine particles during pregnancy: an epidemiologic prospective cohort study in Poland. Environ Health Perspect, 112:1398-1402.

Kinney PL, Chillrud SN, Ramstrom S, Ross J, Spengler JD. Exposures to multiple air toxics in New York City. Environ Health Perspect. 2002;110 Suppl 4:539-46.

Whyatt RM, Santella RM, Jedrychowski W, Garte SJ, Bell DA, **et al. 1998**. Relationship between ambient air pollution and DNA damage in Polish mothers and newborns. Environ Health Perspect 106 Suppl 3:821-6.

Supplemental Material, Table 1: Exposure and behavior pattern of the cohort based on repeated interviews.

	First trimester no. (%)	Second trimester no. (%)	Third trimester no. (%)
Daily home ETS exposure			
≤ 4 hrs/day	45 (13 %)	46 (13 %)	64 (19 %)
5+ hrs/day	12 (4 %)	12 (4 %)	18 (5 %)
Non-smoker home	287 (83 %)	286 (83 %)	262 (76 %)
Time spent outdoor ≤ 3 hrs/day [a]		307 (89%)	307 (89%)
Time spent at home [a]			
≤ 3 hrs/day		34 (10 %)	11 (3 %)
4 – 10 hrs/day		271 (79 %)	214 (62 %)
10 – 16 hrs/day		39 (11 %)	119 (35 %)
Time spent in transit [a]			
< 1 hrs/day		11 (3 %)	23 (7 %)
1 - 2 hrs/day		289 (84 %)	261 (76 %)
≥ 3 hrs/day		44 (13 %)	60 (17 %)
Dietary PAH intake > 2 times/week [a]			
Smoked meat [b]		15 (4 %)	48 (14 %)
Grilled meat		21 (6 %)	45 (13 %)
Barbecued meat		0 (0 %)	0 (0 %)
Blackened meat		7 (2 %)	7 (2 %)
Burn candle at home [yes]		222 (65 %)	100 (29 %)
Burn incense at home [yes]		79 (23 %)	36 (11 %)

[a] While the subjects were asked to estimate their first trimester ETS exposure, they were not asked about other behavior during first trimester.

[b] Meat includes poultry, beef, pork, and sausage.

Supplemental Material, Table 2: Personal exposure, indoor and outdoor levels (ng/m^3), according to the season* at time of monitoring.

	March – May		June – August		September – November		December – February	
	mean	SD	mean	SD	mean	SD	mean	SD
B(*a*)A $_{\text{personal (1st)}}$	3.32	3.10	0.49	0.22	10.01	12.40	12.63	10.15
B(*a*)A $_{\text{personal (2nd)}}$	4.28	6.49	0.64	0.40	4.24	5.02	12.73	8.26
B(*a*)A $_{\text{personal (3rd)}}$	2.32	3.00	0.46	0.08	2.37	1.16	8.16	7.17
B(*a*)A $_{\text{indoor}}$	3.94	4.68	0.63	0.36	2.30	2.17	10.67	8.65
B(*a*)A $_{\text{outdoor}}$	7.11	11.54	0.65	0.40	4.59	5.56	18.85	11.42
B(*b*)F $_{\text{personal (1st)}}$	4.64	4.26	1.27	0.69	12.56	13.04	12.66	9.23
B(*b*)F $_{\text{personal (2nd)}}$	5.93	7.71	1.33	1.02	7.76	9.00	17.52	10.95
B(*b*)F $_{\text{personal (3rd)}}$	3.47	5.82	0.68	0.35	4.49	1.96	13.56	10.69
B(*b*)F $_{\text{indoor}}$	4.91	4.39	1.17	0.78	4.49	3.77	14.59	10.08
B(*b*)F $_{\text{outdoor}}$	8.25	7.94	1.32	0.78	7.26	6.37	21.63	14.20
B(*k*)F $_{\text{personal (1st)}}$	1.88	1.89	0.46	0.32	4.07	4.88	4.30	3.15
B(*k*)F $_{\text{personal (2nd)}}$	1.95	2.42	0.49	0.40	2.27	2.70	5.76	3.68
B(*k*)F $_{\text{personal (3rd)}}$	1.23	1.62	0.23	0.13	1.32	0.65	5.18	5.74
B(*k*)F $_{\text{indoor}}$	1.57	1.44	0.42	0.23	1.33	1.03	4.41	3.27
B(*k*)F $_{\text{outdoor}}$	2.47	2.70	0.44	0.28	2.03	1.56	6.75	4.32
B(*g*,*h*,*i*)P $_{\text{personal (1st)}}$	3.31	3.43	0.70	0.40	7.06	8.17	9.14	7.58
B(*g*,*h*,*i*)P $_{\text{personal (2nd)}}$	3.74	4.87	0.79	0.37	4.30	5.01	8.61	5.55
B(*g*,*h*,*i*)P $_{\text{personal (3rd)}}$	2.38	3.61	0.47	0.20	2.52	1.08	6.52	5.02
B(*g*,*h*,*i*)P $_{\text{indoor}}$	3.71	4.23	0.76	0.36	2.46	1.88	7.01	5.16
B(*g*,*h*,*i*)P $_{\text{outdoor}}$	4.91	6.15	0.83	0.44	3.27	2.82	9.13	7.19
B(*a*)P$_{\text{personal (1st)}}$	3.87	4.42	0.53	0.31	11.20	15.12	10.98	8.56
B(*a*)P$_{\text{personal (2nd)}}$	4.60	6.71	0.62	0.33	5.18	6.04	13.67	9.04
B(*a*)P$_{\text{personal (3rd)}}$	2.86	4.52	0.44	0.11	2.88	1.31	8.35	6.54
B(*a*)P$_{\text{indoor}}$	3.99	4.77	0.56	0.37	2.83	2.65	10.47	7.94
B(*a*)P$_{\text{outdoor}}$	4.84	6.07	0.58	0.41	3.75	4.20	13.19	9.26
Chrysene $_{\text{personal (1st)}}$	2.70	2.24	0.64	0.35	7.87	9.04	8.61	6.43
Chrysene $_{\text{personal (2nd)}}$	3.64	5.22	0.75	0.49	3.93	4.55	10.10	6.43
Chrysene $_{\text{personal (3rd)}}$	1.81	2.30	0.43	0.22	2.22	1.05	7.15	6.33
Chrysene $_{\text{indoor}}$	3.34	3.60	0.71	0.46	2.18	1.92	8.27	6.38
Chrysene $_{\text{outdoor}}$	6.52	7.88	0.88	0.54	4.88	4.65	15.34	10.15
D(*a*,*h*)A $_{\text{personal (1st)}}$	0.73	0.77	0.10	0.05	1.58	1.79	2.37	2.15
D(*a*,*h*)A $_{\text{personal (2nd)}}$	0.86	1.28	0.14	0.08	0.93	1.16	2.14	1.58
D(*a*,*h*)A $_{\text{personal (3rd)}}$	0.53	0.96	0.10	0.04	0.52	0.21	1.56	1.19

D(*a,h*)A $_{\text{indoor}}$	0.96	1.24	0.17	0.11	0.50	0.41	1.78	1.36
D(*a,h*)A $_{\text{outdoor}}$	1.26	1.73	0.19	0.12	0.71	0.67	2.29	1.78
I(*1,2,3-cd*)P $_{\text{personal (1st)}}$	3.99	4.17	0.69	0.35	9.41	10.66	12.08	9.59
I(*1,2,3-cd*)P $_{\text{personal (2nd)}}$	5.04	7.24	0.81	0.37	5.06	5.83	11.15	7.22
I(*1,2,3-cd*)P $_{\text{personal (3rd)}}$	3.00	5.08	0.51	0.20	2.95	1.37	7.80	5.96
I(*1,2,3-cd*)P $_{\text{indoor}}$	5.28	6.79	0.86	0.44	2.90	2.52	8.96	6.34
I(*1,2,3-cd*)P $_{\text{outdoor}}$	6.19	6.64	0.95	0.55	3.95	3.75	11.81	8.68
Pyrene $_{\text{personal (1st)}}$	6.15	5.08	1.56	0.58	9.75	9.87	16.50	12.31
Pyrene $_{\text{personal (2nd)}}$	6.45	7.29	2.63	2.52	6.08	6.68	18.14	12.42
Pyrene $_{\text{personal (3rd)}}$	4.48	3.32	2.17	1.07	3.68	1.41	11.93	9.91
Pyrene $_{\text{indoor}}$	5.95	6.51	1.96	0.66	3.27	2.49	12.64	9.96
Pyrene $_{\text{outdoor}}$	11.93	16.15	2.64	1.18	8.33	6.98	27.67	17.32
Σ8c-PAHs $_{\text{personal (1st)}}$	24.43	23.77	4.89	2.52	63.74	74.19	72.78	55.11
Σ8c-PAHs $_{\text{personal (2nd)}}$	30.04	41.24	5.57	2.84	33.67	38.93	81.67	50.74
Σ8c-PAHs $_{\text{personal (3rd)}}$	17.60	26.71	3.31	1.14	19.28	8.50	58.29	46.39
Σ8c-PAHs $_{\text{indoor}}$	27.69	30.84	5.27	2.82	2.30	2.17	66.15	48.28
Σ8c-PAHs $_{\text{outdoor}}$	7.11	11.54	0.65	0.40	4.59	5.56	18.85	11.42

B(*a*)A – benz(*a*)anthracene; B(*b*)F – benzo(*b*)fluoranthene; B(*k*)F – benzo(*k*)fluoranthene; B(a)P– benzo(*a*)pyrene; I(*1,2,3-cd*)P – indeno(*1,2,3-cd*)pyrene; D(*a,h*)A – dibenz(*a,h*)anthracene; B(*g,h,i*)P – benzo(*g,h,i*)perylene; Σ8 c-PAHs – summed eight carcinogenic PAHs. * Season is determined at the time of monitoring, thus, season for serial monitoring constitute different calendar period.

Supplemental Material, Table 3: Personal exposure concentration (GM and 95 % confidence interval) of Σ 8 c-PAHs (ng/m^3) of the pregnant women.

Potential predictor	N	GM	(95%,	CI)	p-value
Season					<0.001
April - September	160	6.97	(6.23,	7.79)	
October - March	181	47.03	(41.45,	53.35)	
Residence					0.012
Outer city area	270	17.61	(15.23,	20.37)	
City center	71	26.63	(19.60,	36.18)	
ETS (hrs/day)					0.003
non-smoker home	283	19.27	(16.70,	22.23)	
< 5 hrs/day	46	14.18	(9.83,	20.48)	
5+ hrs/day	12	56.01	(26.06,	120.40)	
Coal/wood heating					0.841
Yes	22	20.21	(11.73,	34.83)	
No	319	19.13	(16.68,	21.94)	
Home fuel type					0.096
unknown	8	19.44	(5.78,	65.41)	
gas	74	13.04	(10.03,	16.95)	
electricity	40	26.48	(18.11,	38.73)	
oil	1	21.48	--	--	
coal	18	19.32	(10.14,	36.80)	
wood	4	24.78	(5.20,	118.20)	
town central heating	196	20.66	(17.28,	24.69)	
Heating method					0.164
radiator	299	18.47	(16.02,	21.29)	
tile stove	13	37.32	(18.76,	74.23)	
electric heater	20	18.31	(11.09,	30.23)	
other	9	29.41	--	--	
Number of gas heater					0.578
one	3	28.56	(0.33,	2491.79)	
none	338	19.13	(16.75,	21.84)	
Outdoor traffic level					0.841
light	84	22.18	(16.80,	29.27)	
medium	51	23.03	(16.27,	32.61)	
heavy	20	26.74	(14.01,	51.05)	
Industrial plant					0.010
Yes	15	42.92	(21.32,	86.37)	
No	326	18.50	(16.18,	21.15)	
Bus depot					0.203
Yes	35	14.90	(9.59,	23.14)	
No	306	19.76	(17.20,	22.71)	
Live near cross-road					0.318
Yes	256	18.47	(15.87,	21.49)	
No	85	21.57	(16.39,	28.39)	

Height of apartment/house					0.894
Live on 1st – 3rd floor	193	19.04	(15.97,	22.71)	
Live on 4th or higher	148	19.39	(15.83,	23.76)	
Time spent outdoors					0.011
≤ 3 hrs/day	271	20.93	(18.06,	24.26)	
> 3 hrs/day	70	13.74	(10.26,	18.39)	
Commute time					0.317
≤ 2 hrs/day	297	19.70	(17.11,	22.69)	
> 2 hrs/day	44	16.11	(10.93,	23.73)	
Time spent in home					0.551
≤ 3 hrs/day	33	15.63	(10.23,	23.88)	
4 – 10 hrs/day	269	19.39	(16.67,	22.56)	
10 – 16 hrs/day	39	21.31	(14.64,	31.03)	
Commuting method					0.005
tram	58	26.95*	(19.37,	37.51)	
bus	71	20.70	(15.52,	27.62)	
drive/taxi	121	19.57	(15.66,	24.46)	
walk/bike	90	13.96	(10.85,	17.94)	
Exhaust fan use					0.017
Never or No fan	176	23.06*	(19.23,	27.64)	
Sometimes	57	17.05	(12.25,	23.74)	
≥ half time	108	15.16	(11.97,	19.20)	

*P<0.05 compared to walking/biking based on Bonferroni's test of multiple comparisons.

Supplemental Material, Table 4: Initial random effects model* of (ln) Σ 8 c-PAHs at each gestational month.

	slope	s.e.	p-value
y-intercept	2.4083	0.2887	<0.0001
Gestational age			
Second trimester	(reference)		
First trimester	-0.1476	0.1082	0.1737
Third trimester	-0.4241	0.1073	<0.0001
Household member behavior			
ETS at home [hour]	0.0671	0.0294	0.0234
Residence Location			
Outer area	(reference)		
	0.0663	0.1387	0.6331
May – August	(reference)		
September	0.4427	0.1220	0.0003
October	1.3576	0.1263	<0.0001
November	1.7536	0.1592	<0.0001
December	2.3240	0.9901	0.0196
January	2.4641	0.1673	<0.0001
February	2.0845	0.1330	<0.0001
March	1.6435	0.1270	<0.0001
April	1.2645	0.1249	<0.0001
year 2000	(reference)		
year 2001	-0.6034	0.3174	0.0583
year 2002	-0.8343	0.2260	0.0003
Interaction terms			
December 2001	-0.5742	1.1200	0.6086
January 2002	--		
December and City center	-0.3068	0.8921	0.7312
January 2001	-0.3449	0.2501	0.1690
City center 2001	0.0078	0.1827	0.9662
December, 2001 and City center	0.5653	0.9888	0.5680