ETS AND BIRTHWEIGHT

1. Over 90 studies, 30 up to 1990,[1-30] 36 from 1990 to 2000,[31-66] and 27 from 2001 to 2007,[67-93] have investigated the possible relationship of birthweight to ETS. Smoking by the father has been the most common index of ETS exposure, while other indices that have been used include smoking in the household, smoking at the workplace, the cotinine level of the mother, nicotine levels in the mother and offspring, and expired air carbon monoxide in the parents.

2. Three main endpoints have been used for studying possible effects of ETS exposure on birthweight. One endpoint, used in many of the studies, is the difference in average birthweight between exposed and unexposed mothers. Another endpoint, used in some of the studies, is the risk of having a low birthweight (LBW) infant. This is traditionally defined as less than 2500g.[94] A third endpoint is the risk of having an infant that is "small for gestational age" (SGA). This latter condition has been defined as a birthweight more than 2 SD below the expected age-related mean of birth weight.[72]

3. In view of the known associations between maternal smoking and low birthweight[53,95] and between maternal and paternal smoking[1,96] most of the studies have restricted attention to nonsmoking mothers. However some studies have based their analyses on all mothers, in most cases making statistical adjustment for smoking.

4. Numerous factors have been linked to low birthweight. These include the sex, parity and gestational age of the child, season of birth, maternal age, the height and weight of the mother and father, socioeconomic and employment status, maternal metabolic genotype, maternal alcohol consumption, low social participation and maternal stress, and exposure to air pollution, pesticides, organic solvents and related compounds.[62,69,72,73,78,82,92,93,97,98] Many of these factors are also related to smoking, and it has been suggested that their effects may explain up to half of the birthweight reduction that is apparently associated with active smoking.[69] The ETS/birthweight studies vary widely in

the extent to which these factors have been taken into account. While 18 studies[22,27,29,31,41,44,49,51,53,60,62,65-67,69,71,91,93] have adjusted for eight or more factors, some of the studies do not correct for any factors at all. Despite evidence that nutritional factors play a role in birthweight[99] only three ETS/birthweight studies[30,34,82] have reported taking diet into account as a potential confounder.

5. Of 39 studies relating ETS to the risk of having a LBW infant, eight[13,30,33,57,69,80,83,93] reported a significant ($p<0.05$) increase in risk, one reported a reduction that was marginally significant at this level,[5] with the rest reporting no significant association.

6. Of 21 studies relating ETS to the risk of having a SGA infant, six[33,51,54,71,74,76] reported significant increases in at least one analysis, and one[41] a significant decrease.

7. Most of the 71 studies looking for differences in birthweight associated with ETS exposure did not report a statistically significant relationship. However 24 studies[9,14,18,20,21,25,33,34,36,40,44,45,52,56,65,69,70,74,76,83,84,86,87,91] have reported a significantly reduced birthweight for at least one index of exposure and two studies[16,47] have reported a significant increase.

8. Interpretation of the reported associations is made difficult because:

   - although increases in risk of LBW or SGA or reductions in birthweight associated with ETS have been reported in seven[44,51,65,69,71,91,93] of the 18 studies that adjusted for eight or more potential confounding variables, these were generally only in isolated analyses for specific endpoints and exposure indices. In none of these studies did all analyses show a significant association. Of the remaining 11 studies, 10 did not find any significant relationship at all, and one[41] reported a significantly lower risk of SGA associated with ETS exposure.

- some of the studies that have reported significant associations have not restricted attention to nonsmoking mothers[14,18,51,83] or have accounted for no potential confounding variables.[9,21,25,33,45,52,56,57,70,76,80,83,86] In one further study,[93] maternal smoking has not been recorded at all.

- some of the ETS/birthweight studies[11,13,16,32,35,38,44,51,58,62,69,73,76,79,91] found that adjustment for potential confounding variables markedly weakened the strength of the reported relationship between ETS and reduced birthweight. In one study,[77] the association was strengthened after adjustment.

9. Almost 40 studies have presented data on the relationship between birthweight and extent of ETS exposure. Only 10 of these[14,20,30,39,40,70,76,77,84,91] found a statistically significant trend. In two studies[20,39] the claimed effect is limited to the highest ETS exposure group. In one study[91] only the adjusted data showed a significant dose-response relationship. Data by level of exposure were not shown in three of the other studies.[14,40,76]Confounding, and other sources of bias, may contribute to an observed dose-response relationship.

10. Meta-analyses[61,100] estimate that ETS exposure is, on average, associated with a decrease in birthweight of 25 to 40g. This modest difference, of about an ounce, does not necessarily imply harm to the infant, and can be compared with an estimate of 102g for the reduction in birthweight relating to an elevation in altitude of 1000m.[101]

11. The mechanisms by which ETS may affect birthweight remain unclear. Possibilities include changes in placental morphology and circulation, anti-oestrogenic effects, induction of P450 enzymes, DNA damage resulting in activation of apoptotic pathways, binding to receptors for placental growth factors resulting in decreased exchange of oxygen and nutrients, and direct effects of carbon monoxide.[82,87,93] It has also been suggested that the relationships between active and passive smoking and birthweight may be due to different mechanisms,[72,87] and this may explain the large reduction in birthweight apparently due to ETS exposure observed in some studies.

12. Reviewers have noted that in some studies the claimed effects of ETS on birthweight are far greater than would seem biologically plausible and are inconsistent with the results of the remaining studies.[102,103] One study, for example,[53] estimated, based on results for maternal smoking during pregnancy, that a 1000 ng increase in mean urinary cotinine was associated with a 59g reduction in birthweight, and that ETS exposure at home was associated with only a 21 ng increase in urinary cotinine. These results would suggest a birthweight reduction associated with ETS of about 1g. Similar conclusions have been drawn from other studies.[53,87] However, some studies,[9,17-20,45,52,56,70,74,76,77,84,86] have reported a reduction of 100g or more in some analyses, including one[70] that reported a reduction of almost 400g. However, it should be borne in mind that many of these studies are small and take no, or only a few, potential confounding variables into account, and there are also a few studies[16,47] which report birthweight increases of 100g or more associated with ETS exposure.

13. Lack of objective measures of actual ETS exposure during gestation, and reliance on unverified paternal smoking as a measure of exposure, are additional flaws in the existing studies, and increase the potential for recall bias. For instance, it has been shown in at least two studies[36,73] that serum cotinine level is a better predictor of low birthweight than self-reported smoking behaviour. Elsewhere, questionnaire responses have revealed that while qualitative information is generally reliable, quantitative data may be less so.[69] Failure to collect information on all sources of ETS exposure may also have led to an under-estimation of its prevalence and altered the apparent associations seen in the studies. Few of the studies collected information on ETS exposure on more than one occasion, which could have implications if the timing of exposure to ETS has an influence on birthweight. Several studies have reported that exposure early in pregnancy may have more pronounced effects than later exposure,[36,72] although elsewhere it has been reported that active smoking by the mother during the third trimester has a bigger effect on birthweight.[53,69] Whether the same is true for ETS exposure is unclear. Other factors that may have an effect on the actual level of fetal exposure include the

brand of cigarette smoked, depth of inhalation, and individual differences in the uptake and metabolism of cigarette smoke components.[53] None of the studies appear to have taken these factors into account.

14. The evidence, taken as a whole, does not convincingly demonstrate that ETS exposure decreases birthweight or increases risk of LBW or SGA.

EPIDEMIOLOGICAL EVIDENCE ON ENVIRONMENTAL TOBACCO SMOKE AND BIRTHWEIGHT

THE DATA

The tables that follow summarize the key evidence relating birthweight to paternal smoking (Table 1), other questionnaire indices of ETS exposure (Table 2) and biochemical markers of ETS exposure (Table 3). The tables show, for each study providing data, estimates of the birthweight decrease, the relative risk of low birthweight or the relative risk of small for gestational age associated with ETS exposure. 95% confidence levels are also shown, where available, as well as details of statistical significance. The tables, supplemented by Appendix A, also give details of the year each paper was published, the study size, the study design, and how smoking by the mother and potential confounding variables were taken into account.

In each table, results are shown first for those studies restricted to nonsmoking mothers, then for studies of ex-smoking mothers, then for studies which have considered both smoking and nonsmoking mothers and adjusted for maternal smoking in analysis, and finally for studies which have ignored maternal smoking. Within each category of maternal smoking, results are shown in order of the number of potential confounding variables taken into account.

For some studies, the birthweight decrements or the relative risks of low birthweight or of small for gestational age, as well as their 95% confidence intervals, have been estimated from data provided in the source papers.

It should be noted that most of the studies record smoking status and ETS exposure during pregnancy. However for some studies the data collected relate to the period before conception or to the time of interview after birth. The nonsmoking mothers generally include both never and former smokers.

TABLE 1: Relationship between paternal smoking and birthweight

Ref	Author	Year	Size[a]	Mother smokes[b]	No. of conf.[c]	End-point[d]	Result[e]	Sig.[f]
71	Mitchell	2002	3	NSM	12	RRS	0.99 (0.72 to 1.37)	No
22	Nakamura	1988	3	NSM	11	RRL	1.40 (0.90 to 2.20)	No
31	Ahlborg	1991	3	NSM	10	RRL	0.84 (0.32 to 2.24)	No
44	Rebagliato	1995	2	NSM	9	BWD	-53g (-110g to 4g)	No
65	Matsubara	2000	3	NSM	9	BWD	11g	No
					9	RRL	0.92 (0.71 to 1.20)	No
					8	RRS	0.95 (0.72 to 1.26)	No
66	Windham	2000	3	NSM	9	BWD	32g (-18g to 81g)	No
					0[g]	RRL[h]	1.4 (0.9 to 2.2)	No
67	Jaakkola	2001	2	NSM	8	RRL	1.92 (0.79 to 4.70)	No
					8	RRS	1.41 (0.52 to 3.82)	No
91	Ward	2007	4	NSM	8	BWD	36g (5g to 67g)	Yes
					8	RRL	1.23 (0.96 to 1.58)	No
30	Yan	1990	2	NSM	7	RRL	1.89 (1.23 to 2.91)	Yes
40	Martinez	1994	2	NSM	6	BWD	34g (5g to 63g) per unit[j]	Yes
37	Zhang	1993	3	NSM	4	BWD	30g (-7g to 66g)	No
					0	RRL	1.07 (0.58 to 1.97)	No
					0	RRS	1.11 (0.83 to 1.48)	No
35	Pan	1992	2	NSM	3	RRS	1.68 (0.69 to 4.10)	No
61	Windham	1999	2	NSM	3	RRS	1.5[k] (0.64 to 3.4)	No
83	Alonso	2005	3	NSM	0	BWD	70g (16g to 124g)	Yes
	Ojembarrena			AS	3	RRL	1.37 (1.014 to 1.863)	Yes
2	MacMahon	1966	3	NSM	1	BWD	21g (-4g to 47g)	No
3	Ravenholt	1966	3	NSM	1	BWD	33g	No
7	Yerushalmy	1971	3	NSM	1	RRL	0.95	No
63	Haug	2000	4	NSM	1	BWD	1g (-15g to 17g)	No
89	Lee	2007	3	NSM	?[l]	BWD	7g (-19g to 32g) per hour/day	No
1	Yerushalmy	1962	2	NSM	0	RRL	1.09 (0.58 to 2.07)	No
4	Comstock	1967	2	NSM	0	BWD	42g	No
5	Underwood	1967	4	NSM	0	BWD	5g	No
					0	RRL	0.90 (0.82 to 1.00)	p≈0.05
8	Mau	1974	3	NSM	0	RRL	1.27 (0.99 to 1.62)	No
9	Borlee	1978	2	NSM	0	BWD[m]	228g (17g to 439g)	Yes
12	Karakostov	1985	2	NSM	0	BWD	84g (-114g to 282g)	No
17	Schwartz-B.	1987	1	NSM	0	BWD	205g (-32g to 442g)	No
19	Drozdz	1988	1	NSM	0	BWD	190g (-160g to 540g)	No
24	Chen	1989	3	NSM	0[g]	BWD	10g (-89g to 109g)	No
					0[g]	RRL	1.51 (0.79 to 2.90)	No
26	Kikuchi	1990	2	NSM	0	RRL	1.39 (0.63 to 3.04)	No
33	Saito	1991	3	NSM	0	BWD	33g (0.5g to 66g)	Yes
					0	RRS	1.26 (1.09 to 1.46)	Yes
68	Kukla	2001	3	NSM	0	BWD	4g[n]	No
							49g[o]	No
16	MacArthur	1987	2	ESM	4	BWD	-123g (-242g to -4g)	Yes
29	Rantakallio	1990	3	AS	20+	RRL	1.18 (0.98 to 1.41)	No
51	Horta	1997	3	AS	7	RRL	1.18 (0.94 to 1.48)	No
					10	RRS	1.33 (1.05 to 1.68)	Yes
11	Magnus	1984	3	AS	7	BWD	5g (-13g to 23g) per unit[p]	No
14	Rubin	1986	2	AS	7	BWD	6.1g (0.2g to 12.0g)/cig	Yes
18	Campbell	1988	2	AS	4	BWD	113g (8g to 216g)	Yes
46	Wilcox	1995	2	AS	2	IBRD	0.046 (-0.042 to 0.134)	No
43	Jadsri	1995	1	AS	2	RRL	1.46 (0.79 to 2.69)	No
15	Little	1987	2	AS	0	BWD	No sig. effect	No
6	Terris	1969	2	I	0	RRL	0.81 (0.43 to 1.53)	No

[a] 1,2,3,4 = <100, 100-999, 1000-9999, >10000 infants (see Appendix A)
[b] NSM = nonsmoking mothers ; ESM = ex smoking mothers; AS = adjusted for maternal smoking; I = ignoring smoking
[c] See Appendix A for the confounders considered
[d] BWD = birthweight decrement; IBRD = individual birth ratio decrement; RRL = relative risk of low birthweight; RRS = relative risk of small for gestational age
[e] 95% confidence intervals shown in brackets where available

[f] Yes = significant at $p<0.05$
[g] Adjustment for confounders stated to have little effect
[h] Data came from reference[104]
[j] Units are 0,1,2,3 = 0,1-10,11-20,21+ cigarettes/day
[k] RR is for >10 cigs/day. Results for lower amounts and low birthweight showed weaker associations and not presented
[l] Analysis using multiple linear regression but no details of factors included in the model
[m] Includes over 50% malformed births
[n] Husband smokes less than 15 cigarettes daily
[o] Husband smokes more than 15 cigarettes daily (unclear into which category men smoking 15 cigarettes per day were included)
[p] Units are 1,2,3,4 = 0, <10,10-20 and 21 cigarettes/day

TABLE 2: Relationship between other questionnaire indices of ETS exposure and birthweight

Ref	Author	Year	Size[a]	Mother smokes[b]	No.of conf.[c]	ETS exposure[d]	End-point[e]	Result[f]	Sig.[g]
[60]	Sadler	1999	3	NSM	18	Any	BWD	1g (-43g to 41g)	No
					13	Any	RRS	0.82 (0.51 to 1.33)	No
[27]	Lazzaroni	1990	2	NSM	15	Home or work	BWD	38g (-31g to 107g)	No
[62]	Chen	2000	2	NSM	14	Home or work	BWD	36g (-19g to 92g)	No
[71]	Mitchell	2002	3	NSM	12	Home(not father)	RRS	0.83 (0.57 to 1.22)	No
					12	Workplace/social	RRS	1.48 (1.03 to 2.12)	Yes
[69]	Dejmek	2002	3	NSM	11	Any (5+ cpd)	BWD	53g (24g to 82g)	Yes
							RRL	1.51 (1.02 to 2.26)	Yes
							RRS	1.08 (0.82 to 1.43)	No
[31]	Ahlborg	1991	3	NSM	10	Home only	RRL	0.69 (0.21 to 2.27)	No
					10	Work	RRL	1.09 (0.33 to 3.62)	No
					10	Home or work	RRL	0.99 (0.45 to 2.21)	No
[49]	Ahluwalia	1997	4	NSM	10	Home	BWD	4g (-29g to 37g)	No
					10	Home	RRL	1.17 (0.95 to 1.45)	No[h]
[41]	Chen	1995	2	NSM	9	Any	RRS	0.54 (0.30 to 0.96)	Yes
					9	Work only	RRS	1.02 (0.39 to 2.68)	No
					9	Home only	RRS	0.47 (0.12 to 1.89)	No
					9	Car only	RRS	1.15 (0.22 to 6.00)	No
					9	All three	RRS	0.51 (0.17 to 1.50)	No
[44]	Rebagliato	1995	2	NSM	9	Work	BWD	61g (3g to 119g)	Yes
					9	Public places	BWD	66g (7g to 126g)	Yes
					9	Others at home	BWD	-43g (-127g to 42g)	NS
					9	Any source	BWD	52g (-36g to 141g)	NS
[65]	Matsubara	2000	3	NSM	9	Any	BWD	19g	Yes
					9	Any	RRL	0.99 (0.75 to 1.30)	No
					8	Any	RRS	0.95 (0.71 to 1.26)	No
[66]	Windham	2000	3	NSM	9	Home or work	BWD	-2g (-45g to 41g)	No
					5	Home or work	RRL	1.1 (0.71 to 1.7)	No
					5	Home or work	RRS	1.01 (0.72 to 1.42)	No
[67]	Jaakkola	2001	2	NSM	8	Home only	RRL	1.13 (0.34 to 3.78)	No
					8	Work only	RRL	1.43 (0.50 to 4.12)	No
					8	Home and work	RRL	2.08 (0.44 to 9.73)	No
					8	Home only	RRS	1.06 (0.30 to 3.73)	No
					8	Work only	RRS	1.02 (0.31 to 3.31)	No
					8	Home and work	RRS	1.47 (0.23 to 9.32)	No
[78]	Jedrychowski	2004	2	NSM	5	Home	BWD	32g (-91.5g to 155.6g)	No
[34]	Mathai	1992	2	NSM	7	Home	BWD	63g (12g to 114g)	Yes
					0	Home	RRL	0.99 (0.46 to 2.14)	No
[32]	Ogawa	1991	3	NSM	6	Any >2hr/day	RRL	1.0 (0.7 to 1.5)	No
					6	Any >2hr/day	BWD	11g (-11g to 32g)	No
[73]	Hong	2003	2	NSM	6	Any (1+hr/day)	BWD	52g (-76g to 180g)	No
[76]	Goel	2004	2	NSM	0	Home	BWD	138g (30g to 246g)	Yes
					6	Home	RRL	1.03 (0.65 to 1.65)	No
					6	Home	RRS	2.10 (1.27 to 3.48)	Yes
[54]	Dejin-Karlsson	1998	2	NSM	5	Home or work	RRS	3.9 (1.4 to 10.7)	Yes
					0	Home or work	RRL	1.3 (0.7 to 2.5)	No
[74]	Rashid	2003	2	NSM	5	Home or work	BWD	130g (40g to 220g)	Yes
					5	Home or work	RRS	3.21 (1.06 to 9.67)	Yes
[82]	Perera	2004	2	NSM	5	Home	RRL	0.98 (0.94 to 1.02)	No
[87]	Hegaard	2006	3	NSM	5	Outside home only	BWD	23.6g (-29.4g to 76.7g)	No
					5	Home only	BWD	-49.3g (-184.9g to 86.3g)	No
					5	Both	BWD	78.9g (14.1g to 143.7g)	Yes
					5	Any (<2 hr/day)	BWD	23.2g (-31.0g to 77.4g)	No
					5	Any (>2 hr/day)	BWD	54.9 (-4.0g to 113.9g)	No

TABLE 2: Relationship between other questionnaire indices of (cont/d. 1) ETS exposure and birthweight

Ref	Author	Year	Size[a]	Mother smokes[b]	No.of conf.[c]	ETS exposure[d]	End-point[e]	Result[f]	Sig.[g]
[59]	Hanke	1999	3	NSM	3	Any	BWD	13g (-37g to 63g)	No
					5	Any	RRS	0.98 (0.67 to 1.45)	No
[13]	Martin	1986	3	NSM	3	Home/wk>2hr/day	BWD	24g (-13g to 60g)	No
					4	Home/wk>2hr/day	RRLT	2.17 (1.05 to 4.50)	Yes
[23]	Brooke	1989	3	NSM	4	Home	BWD	18g	No
[28]	Mathai	1990	2	NSM	0	Home	BWD	66g (-79g to 211g)	No
					4	Home	BPD	4.1% (-4.8% to 13.0%)	No
[38]	Fortier	1994	3	NSM	4	Home only	RRS	0.98 (0.67 to 1.44)	No
					4	Work only	RRS	1.18 (0.90 to 1.56)	No
					4	Home and work	RRS	0.94 (0.60 to 1.49)	No
					4	Home or work	RRS	1.09 (0.85 to 1.39)	No
[39]	Mainous	1994	3	NSM	0	Any	BWD	37g (-6g to 80g)[j]	No
					4	Any	RRL	1.39 (0.98 to 1.95)	No
[61]	Windham	1999	2	NSM	4	Home or work	BWD	-14g (-81g to 54g)	No
					3	Home or work	RRL	1.0 (0.52 to 2.1)	No
					3	Home or work	RRLT	1.8 (0.64 to 4.8)	No
					3	Home or work	RRS	1.4 (0.79 to 2.5)	No
[35]	Pan	1992	2	NSM	3	Home	RRS	0.87 (0.42 to 1.78)	No
					3	Work	RRS	0.63 (0.31 to 1.31)	No
[47]	Eliopoulos	1996	1	NSM	0	Home or work	BWD	-260g (-505g to -15g)	Yes
					1	Home or work	BPD	-15.2%(-29.7% to -0.7%)	Yes
[89]	Lee	2007	3	NSM	?[k]	Any	BWD	-8g (-16g to 1g) per hour/day	No
[21]	Hamada	1988	2	NSM	0	Home or work	BWD	182g (110g to 254g)	Yes
					0	Home or work	RRS	0.89 (0.35 to 2.25)	No
[24]	Chen	1989	3	NSM	0[l]	Home	BWD	11g (-79g to 101g)	No
					0[l]	Home	RRL	1.33 (0.64 to 2.75)	No
[25]	Ueda	1989	2	NSM	0	Any	BWD	No association	No
[45]	Roquer	1995	1	NSM	0	Home or work	BWD	192g (19g to 365g)	Yes
					0	Home or work	RRS	1.86 (0.57 to 6.06)	No
[52]	Lodrup	1997	2	NSM	0	Home	BWD	100g (-3g to 208g)	Yes
[56]	Luciano	1998	1	NSM	0	Home or work[m]	BWD	253g (68g to 438g)	Yes
[57]	Nafstad	1998	2	NSM	0[l]	Home or work	RRL	0.82 (0.35 to 1.95)	No
					0[l]	Home and work	RRL	1.39 (0.44 to 4.41)	No
[55]	Janghorbani	1998	2	NSM	0	Home or work	BWD	22g (-52g to 96g)	No
					0	Home or work	RRL	0.75 (0.44 to 1.18)	No
[64]	Hrubá	2000	3	NSM	0	Any	BWD	46g (-31g to 124g)	No
					0	Home only	BWD	45g (-68g to 158g)	No
					0	Work only	BWD	52g (-55g to 159g)	No
					0	Home and work	BWD	35g (-162g to 233g)	No
					0	Any	RRL	0.95 (0.63 to 1.45)	No
					0	Home only	RRL	1.09 (0.61 to 1.93)	No
					0	Work only	RRL	0.88 (0.48 to 1.61)	No
					0	Home and work	RRL	0.84 (0.32 to 2.21)	No
[70]	Kutlu	2002	1	NSM	0	Not stated	BWD	397g (256g to 538g)	Yes
[75]	Adamek	2004	3	NSM	0	Not stated	BWD	27g	No
[80]	Nakamura	2004	2	NSM	0	Home or work	BWD	70g (-12g to 152g)	No
					0	Home or work	RRL	2.13 (1.06 to 4.26)	Yes
[86]	Gomolka	2006	2	NSM	0	Not stated	BWD	281g (90g to 472g)	Yes
[88]	Steyn	2006	3	NSM	0	Home	BWD	12.2g (-39.7g to 64.1g)	No
					0	Home	RRS	0.81 (0.53 to 1.23)	No
[93]	Wu I	2007	2	NSM	0	Home or work	BWD	18g (-65 to 101g)	No

TABLE 2: Relationship between other questionnaire indices of (cont/d. 2) ETS exposure and birthweight

Ref	Author	Year	Size[a]	Mother smokes[b]	No.of conf.[c]	ETS exposure[d]	End-point[e]	Result[f]	Sig.[g]
[50]	Frisbie	1997	3	AS	17	Not stated	RRS	1.10 (0.90 to 1.20)	No
[81]	Ojima	2004	2	AS	7	Home	RRL	1.25 (0.86 to 1.82)	No
						Work	RRL	1.09 (0.66 to 1.82)	No
[72]	Dejin-Karlsson	2003	2	AS	4	Home or work	RRS	2.60 (0.99-6.86)[n]	No
							RRS	1.27 (0.64-2.49)[n]	No
[48]	Jedrychowski	1996	3	AS	3	Home or work	BWD	58g (-3g to 119g)	No[p]
					3	Home or work	RRL	1.46 (0.83 to 2.60)	No
[92]	Wu II	2007	3	I	11	Home only	BWD	30g (-20g to 80g)	No
					0	Home only	RRL	1.54 (1.03 to 2.28)	Yes
[85]	Ramesh	2005	2	I	1	Home or work	BWD	80g (-57g to 217g)	NS
[90]	Sanyal	2007	1	I	0	Not stated	BWD	No association	NS

[a] 1,2,3,4 = <100, 100-999, 1000-9999, >10000 infants (see Appendix A for numbers)
[b] NSM = nonsmoking mothers; AS = adjusted for maternal smoking, I = ignoring smoking
[c] See Appendix A for the confounders considered
[d] Exposures relate to period of pregnancy except for Ueda where this is unclear
[e] BPD = adjusted birthweight percentile decrement; BWD = birthweight decrement; RRL = relative risk of low birthweight; RRLT = relative risk of low birthweight at term; RRS = relative risk of small for gestational age
[f] 95% confidence intervals shown in brackets where available
[g] Yes = significant at $p<0.05$
[h] Ahluwalia reported that in mothers aged 30+ there was a significant ($p<0.001$) RRL of 2.42 (1.51 to 3.87); results cited are for all ages
[j] For high and moderate versus low and very low ETS exposure
[k] Analysis using multiple linear regression but no details of factors included in model were given
[l] Adjustment for confounders stated to have little effect
[m] Significant exposure (1+ packs per day)
[n] ETS exposure in early pregnancy
[o] ETS exposure in late pregnancy
[p] Stated as significant at $p = 0.004$ but data given as 57.9 with SE 31.1 which is not significant even at $p<0.05$

TABLE 3: Relationship between birthweight and biochemical markers of ETS exposure in nonsmoking mothers

Ref	Author	Year	Size[a]	No. of conf.[b]	Marker/ restriction[c]	End-point[d]	Result[e]		Sig.[f]
53	Wang	1997	2	12	URC (none)	BWD	0.0-30.9 ng/ml:	comparison group	
							31-100 ng/ml:	57g (-29g to 143g)	No
44	Rebagliato	1995	2	9	SAC (<14 ng/ml)	BWD	0.0 to 0.5 ng/ml:	comparison group	
							0.6 to 0.8 ng/ml:	42g (-39g to 122g)	No
							0.9 to 1.1 ng/ml:	53g (-37g to 143g)	No
							1.2 to 1.7 ng/ml:	-54g (-142g to 35g)	No
							>1.7 ng/ml	87g (1g to 174g)	Yes
67	Jaakkola	2001	2	8	MHN (none)	RRL	<0.75 μg/g	comparison group	
							0.75 to <4.00 μg/g	1.28 (0.59 to 2.60)	No
							>=4.00 μg/g	1.55 (0.55 to 4.43)	No
							per μg/g	1.06 (0.96 to 1.17)	No
						RRS	<0.75 μg/g	comparison group	
							0.75 to <4.00 μg/g	1.05 (0.44 to 2.49)	No
							>=4.00 μg/g	1.18 (0.34 to 4.19)	No
							per μg/g	1.04 (0.92 to 1.19)	No
42	Eskenazi	1995	3	7	SEC (<10 ng/ml)	BWD	<2.0 ng/ml:	comparison group	
							2.0+ ng/ml:	45g(-36g to 126g)	No
				0		RRL	<2.0 ng/ml:	comparison group	
							2.0+ ng/ml:	1.35 (0.60 to 3.03)	No
20	Haddow	1988	3	6	SEC (<10 ng/ml)	BWD	<0.5 ng/ml:	-4g (-73g to 65g)	No
							0.5-1.0 ng/ml:	comparison group	
							>1.0 ng/ml:	104g (35g to 173g)	Yes
						RRL	≤1.0 ng/ml:	comparison group	
							>1.0 ng/ml:	1.29	?
73	Hong	2003	2	6	URC (none)	BWD	<120 μg/ml:	comparison group	
							≥120 μg/ml:	76g (-92g to 243g)	No
79	Kharrazi	2004	3	6	SEC (<10ng/ml)	BWD	<0.026ng/ml:	comparison group	
							0.026 to 0.053 ng/ml:	-22.9g (-76.6g to 30.8g)	No
							0.054 to 0.096 ng/ml:	16.1g (-37.7g to 69.9g)	No
							0.097 to 0.235 ng/ml:	18.2g (-36.1g to 72.5g)	No
							0.236+ ng/ml:	39.7g (-16.3g to 95.7g)	No
				5		RRL	<0.026 ng/ml:	comparison group	
							0.026 to 0.053 ng/ml:	1.18 (0.40 to 3.44)	No
							0.054 to 0.096 ng/ml:	1.76 (0.66 to 4.75)	No
							0.097 to 0.235 ng/ml:	1.40 (0.51 to 3.88)	No
							0.236+ ng/ml:	1.76 (0.65 to 4.81)	No
82	Perera	2004	2	5	PLC (≤15ng/ml)	RRL	0.0 to 0.0435 ng/ml:	comparison group	
							>0.0435 ng/ml:	0.98 (0.93 to 1.03)	No
58	Peacock	1998	2	4	SEC (<15 ng/ml)	BRD[g]	0 to 0.180 ng/ml:	comparison group	
							0.180 to 0.291 ng/ml:	0.001 (-0.025 to 0.027)	No
							0.292 to 0.480 ng/ml:	0.003 (-0.022 to 0.028)	No
							0.481 to 0.795 ng/ml:	-0.004 (-0.030 to 0.022)	No
							0.796+ ng/ml:	0.002 (-0.024 to 0.028)	No
36	Bardy	1993	3	3	SEC (none)	BWD	Per 1 μg/l:	1.29g (0.55g to 2.02g)	Yes
77	Hanke	2004	2	3	SEC (<10ng/ml)	BWD	0.0 to <2 μg/ml:	comparison group	
							2 to <10 ng/ml:	100g (-17.5g to 218.5g)	No
				0	URC[h] (<100μg/ml)	BWD	0.0 to <2 μg/ml:	comparison group	
							2 to 100 μg/ml:	negative relationship	?

TABLE 3: (cont/d.) Relationship between birthweight and biochemical markers of ETS exposure in nonsmoking mothers

Ref	Author	Year	Size[a]	No. of conf.[b]	Marker/ restriction[c]	End-point[d]	Result[e]		Sig.[f]
84	Gomez	2005	2	3	MCM	BWD	0 to 5 ppm:	comparison group	
					(none)		6 to 10 ppm:	451g (367g to 535g)	Yes
					PCM		0 to 5 ppm:	comparison group	
					(none)		6 to 10 ppm:	62g (-52g to 176g)	No
							11 to 20 ppm:	237g (131g to 343g)	Yes
							>20 ppm:	356g (232g to 480g)	Yes
10	Hauth	1984	2	0	UCT	BWD	No relationship of UCT to birthweight in women exposed to ETS at home or work (r = 0.02) or those unexposed to ETS (r = 0.15)		No
					(none)				
25	Ueda[j]	1989	2	0	SEC	RBW	<9 ng/ml:	102.4%	
					(none)		>9 ng/ml:	96.2%	Yes
57	Nafstad	1998	2	0[k]	MHN	RRL	<0.75 μg/g	comparison group	
					(none)		0.75 to 4.00 μg/g	3.35 (1.31 to 8.60)	Yes
							>4.00 μg/g	2.08 (0.43 to 10.1)	No
					OHN	RRL	undetectable	comparison group	
					(none)		detectable	2.62 (0.85 to 8.08)	No
90	Sanyal	2007	1	0	URC	BWD	No relationship of URC to birthweight in women exposed to ETS		No
					(none)				
					URN	BWD	No relationship of URN to birthweight in women exposed to ETS		No
					(none)				

[a] 1,2,3,4 = <100, 100-999, 1000-9999, >10000 infants (see Appendix A)
[b] See Appendix A for the confounders considered
[c] MCM = maternal expired air carbon monoxide, MHN = maternal hair nicotine, OHN = offspring hair nicotine, PCM = paternal expired air carbon monoxide, PLC = plasma cotinine, SAC = saliva cotinine, SEC = serum cotinine, UCT = umbilical cord thiocyanate, URC = urinary cotinine, URN = urinary nicotine; analysis limited to those with levels below cut-point stated in brackets
[d] BRD = decrement in adjusted birthweight ratio; BWD = birthweight decrement; RBW = birthweight relative to national standard for gestational age; RRL = relative risk of low birthweight; RRS = relative risk of small for gestational age
[e] 95% confidence limits shown in brackets where available
[f] Yes = significant at $p<0.05$; ? = significance can not be estimated
[g] A BRD of 0.001 corresponds to a BWD of about 3.35g in this study
[h] Data came from reference [105]
[j] It is unclear whether active smokers were excluded from this analysis
[k] Adjustment for confounders stated to have little effect

APPENDIX A : Further details of studies

Ref	Author	Year	Location	Study type[a]	Sample size[b]	Dose-resp.[c]	Confounders accounted for[d] PA	SX	GE	MA	MH	MW	MB	PH	PW	PE	SES	EM	AC	Others[d]
1	Yerushalmy	1962	USA	PC	606	-														
2	MacMahon	1966	USA	RC	5935	No		+												
3	Ravenholt	1966	USA	RC	1240	No		+												
4	Comstock	1967	USA	RC	238	-														
5	Underwood	1967	USA	RC	24773	No														
6	Terris	1969	USA	CC	214	No														
7	Yerushalmy	1971	USA	PC	6015	-														ET
8	Mau	1974	Germany	PC	3696	Yes														
9	Borlee	1978	Belgium	RC	238	-														
10	Hauth	1984	USA	RC	134	-														
11	Magnus	1984	Norway	PC	3130	No		+			+	+		+	+	+	+			
12	Karakostov	1985	Bulgaria	RC	118	-														
13	Martin	1986	USA	PC	2473	-	+		+	+[e]										ET
14	Rubin	1986	Denmark	RC	500	Yes	+	+		+							+		+	CP,MS
15	Little	1987	USA	PC	377	-														
16	MacArthur	1987	England	RC	180	No	+	+	+		+									
17	Schwartz-B.	1987	Germany	RC	54	-														
18	Campbell	1988	England	RC	518	-	+			+							+		+	
19	Drozdz	1988	Poland	RC	54	-														
20	Haddow	1988	USA	PC	1231	Yes	+	+		+	+	+				+				
21	Hamada	1988	Japan	RC	734	-														
22	Nakamura	1988	Japan	PC	2005	-	+			+							+	+	+	BP,CP,GR, MD,MS,RH
23	Brooke	1989	UK	PC	1018	-	+	+	+		+									
24	Chen	1989	China	RC	1163	No	+	+		+						+	+			
25	Ueda	1989	Japan	RC	242	-														
26	Kikuchi	1990	Japan	RC	778	-														
27	Lazzaroni	1990	Italy	RC	647	No	+	+	+	+	+	+		+	+	+		+	+	BP,CC,CP,WG, Others
28	Mathai	1990	England	PC	187	-	+[f]	+[f]	+[f]				+[f]							

APPENDIX A : Further details of studies (Continued/1)

Ref	Author	Year	Location	Study type[a]	Sample size[b]	Dose-resp.[c]	Confounders accounted for[d] PA	SX	GE	MA	MH	MW	MB	PH	PW	PE	SES	EM	AC	Others[d]
29	Rantakallio	1990	Finland	PC	9478	-	+	+		+	+	+		+	+	+	+	+	+	AB,CP,MD,MS, PB,PP,PR,RH, SB,Others
30	Yan	1990	China	CC	385	Yes			+		+[g]			+[g]						CP,CX,DI,MM
31	Ahlborg	1991	Sweden	PC	2940	No	+	+	+	+						+		+	+	AB,PP,PR
32	Ogawa	1991	Japan	PC	5336	-	+		+	+	+							+	+	
33	Saito	1991	Japan	RC	2713	-														
34	Mathai	1992	India	RC	994	-	+[h]	+[h]	+[h]	+[h]	+[h]						+[h]			DI[h]
35	Pan	1992	China	PC	253	-														CB,CK,HT
36	Bardy	1993	Finland	PC	1237	-	+	+	+											
37	Zhang	1993	China	RC	1785	No	+[h]		+[h]	+[h]								+[h]		
38	Fortier	1994	Canada	RC	4644	No	+					+								CC,PB
39	Mainous	1994	USA	RC	3253	Yes	+[e]			+[e]							+[e]			ET[e]
40	Martinez	1994	USA	RC	907	Yes	+	+	+	+						+				ET
41	Chen	1995	USA	CC	235	No	+			+			+			+	+	+	+	PC,WG
42	Eskenazi	1995	USA	PC	2243	No	+[h]		+[h]	+[h]			+[h]			+[h]				ET[h],WG[h]
43	Jadsri	1995	Thailand	PC?	77	-														CP,PT
44	Rebagliato	1995	Spain	PC	710	No	+	+	+	+	+	+				+	+			CP
45	Roquer	1995	Spain	RC	74	-														
46	Wilcox	1995	UK	RC	571	-								+	+					
47	Eliopoulos	1996	Canada	RC	58	-			+											
48	Jedrychowski	1996	Poland	RC	1165	-	+	+	+											
49	Ahluwalia	1997	USA	RC	13497	-	+			+			+			+			+	AL,ET,MS,PR, WG
50	Frisbie	1997	USA	RC	8424	-	+	+		+			+			+	+			BP,CP,ET,MAS, MS,PC,SB,SPP, WG
51	Horta	1997	Brazil	RC	5166	-	+			+[j]	+	+[j]				+[j]	+			BI,MS[j],PB,PC, SC[j]
52	Lodrup	1997	Norway	RC	588	-														
53	Wang	1997	USA	PC	740	-	+	+	+	+	+	+				+			+	CP,ET,PT,SB

APPENDIX A : Further details of studies (Continued/2)

Ref	Author	Year	Location	Study type[a]	Sample size[b]	Dose-resp.[c]	Confounders accounted for[d] PA	SX	GE	MA	MH	MW	MB	PH	PW	PE	SES	EM	AC	Others[d]
54	Dejin-Karlsson	1998	Sweden	PC	575	-				+[j]	+[j]	+[j]				+[j]				MN[j]
55	Janghorbani	1998	Iran	RC	702	-	[k]													
56	Luciano	1998	Italy	PC	89	-														
57	Nafstad	1998	Norway	CC	122	No														
58	Peacock	1998	UK	PC	818	No	+	+	+		+									
59	Hanke	1999	Poland	RC	1751	No	+[j]		+[h]	+	+							+[j]		MS[j]
60	Sadler	1999	USA	PC	2283	No	+	+	+[h]	+			+			+		+[h]	+[h]	ET,HT,MS[h],PB, PD[h],PE,PM,RE, WG,XS
61	Windham	1999	USA	RC	992	No			+[h]										+	CC,ET
62	Chen	2000	China	PC	792	-	+	+	+	+	+		+			+				OE
63	Haug	2000	Norway	RC	16430	-				+										
64	Hrubá	2000	Czech Republic	RC	1097	-														
65	Matsubara	2000	Japan	PC	6335	No	+	+	+[l]	+	+		+			+		+	+	
66	Windham	2000	USA	PC	4454	No	+			+[h]			+			+			+[h]	CC[h],ET,LE,MS[h]
67	Jaakkola	2001	Finland	RC	389	No	+	+		+			+				+	+	+	MS
68	Kukla	2001	Czech Republic	RC	4165	No														
69	Dejmek	2002	Czech Republic	RC	4309	-	+	+		+	+	+				+			+	ET,PR,SE
70	Kutlu	2002	Turkey	RC	40	Yes														
71	Mitchell	2002	New Zealand	CC	1248	-	+	+	+	+	+	+				+		+		HT,MF,MJ,MS
72	Dejin-Karlsson	2003	Sweden	PC	747	-				+	+					+				MAS,MN
73	Hong	2003	Korea	RC	266	-		+	+	+	+	+								PR
74	Rashid	2003	Saudi Arabia	RC	868	No	+	+	+	+	+									
75	Adamek	2004	Poland	PC	1081	-														
76	Goel	2004	India	RC	576	Yes	+[m]			+[m]						+[m]				AN[m],LI,[m]OCC[m]

APPENDIX A : Further details of studies (Continued/3)

Ref	Author	Year	Location	Study type[a]	Sample size[b]	Dose-resp.[c]	Confounders accounted for[d] PA	SX	GE	MA	MH	MW	MB	PH	PW	PE	SES	EM	AC	Others[d]
77	Hanke	2004	Poland	PC	183	Yes		+[e]				+[e]								GU[e]
78	Jedrychowski	2004	USA/ Poland	PC	362	-	+	+	+		+	+				+				AP,SE,???
79	Kharrazi	2004	USA	PC	2777	No	+	+	+[h]	+										ET,SPP
80	Nakamura	2004	Brazil	RC	608	-														
81	Ojima	2004	Japan	CC	690	-				+							+	+		CP,MAS,PB,TI,
82	Perera	2004	USA	PC	214	-		+	+				+							DI,ET
83	Alonso Ojembarrena	2005	Spain	CC	2370	-		+[e]	+[e]											MAS[e]
84	Gomez	2005	France	PC	630	Yes	+	+		+										
85	Ramesh	2005	Malaysia	PC	154	-						+								
86	Gomolka	2006	Poland	PC	157	-														
87	Hegaard	2006	Denmark	PC	1612	No	+	+	+	+			+							
88	Steyn	2006	South Africa	PC	1376	No														
89	Lee	2007	China	RC	2770	No														No details of adjustment factors given
90	Sanyal	2007	USA	PC	43	-														
91	Ward	2007	UK	RC	10347	Yes	+			+			+			+	+		+	CP,ET
92	Wu I	2007	Taiwan	PC	358	-														
93	Wu II	2007	China	PC	1388	-		+		+	+	+				+				AB,CK,OE

[a] CC = case control, PC = prospective cohort (i.e. smoking and ETS data obtained before birth), RC = retrospective cohort (i.e. data obtained after birth)

[b] Sample size is of nonsmoking mothers except for studies which included smoking mothers in the analysis where sample size is of all mothers

[c] Yes = significant dose response seen, No = dose response investigated but not significant, - = dose response not investigated

[d] Abbreviations used for main confounders:
PA = parity/previous pregnancies/birth order, SX = sex of child, GE = gestation time at delivery, MA = maternal age, MH = maternal height, MW = maternal weight, MB = maternal body mass, PH = paternal height, PW = paternal weight, PE = parental education, SES = socioeconomic status/income, EM = employment status, AC = alcohol consumption
Abbreviations used for other confounders:
AB = previous abortions, AL = altitude, AN = anaemia, BI = birth interval, BP = birth place of mother, CB = coal burning, CC = coffee consumption of mother, CK = cooking time spent, CP = complications of pregnancy/illness of mother, CX = chemical exposures of parents, DI = diet of mother, ET = ethnicity/race, FA = received financial/other assistance, GR = gestational week at report of pregnancy, GU = gestational week at time of ultrasound, HT = hypertension, LE = life events, LI = number of 'live issues', MAS = maternal active smoking, MD = medical history of mother, MF = maternal age at first pregnancy, MJ = marijuana use of mother, MM = maternal medication use in pregnancy, MN = maternal nationality, MS = marital status, OCC = occupation, OE = occupational exposures, PB = previous birthweights, PC = prenatal care, PD = placental disorders, PE = preeclampsia/eclampsia, PM = passive marijuana, PP = pregnancy planned, PR = place of residence, PT = preterm birth, RE = religion, RH = reproductive history, SB = previous still births, SC = skin colour, SE = season, SPP = source of payment for prenatal care, TI = treatment for infertility, WG = weight gain in pregnancy, XS = past smoking

[e] Only accounted for in analyses of low birthweight

[f] Only accounted for in analyses of birthweight percentile decrement

[g] Maternal and paternal height were considered as a single variable

[h] Only accounted for in analyses of birthweight decrement

[j] Only accounted for in analyses of small-for-gestational-age

[k] Multivariate analyses carried out but inappropriately included variables such as cranial circumference and length at birth so only unadjusted analyses included in Table 2

[l] Only accounted for in analyses of low birthweight and birthweight decrement

[m] Only accounted for in analyses of low birthweight and small-for-gestational age

REFERENCES

1. Yerushalmy J. Statistical considerations and evaluation of epidemiological evidence. In: James G, Rosenthal T, editors. *Tobacco and health*. Springfield, Illinois, USA: Charles C Thomas, 1962;208-30.

2. MacMahon B, Alpert M, Salber EJ. Infant weight and parental smoking habits. *Am J Epidemiol* 1966;**82**:247-61.

3. Ravenholt RT, Levinski MJ, Nellist DJ, Takenaga M. Effects of smoking upon reproduction. *Am J Obstet Gynecol* 1966;**96**:267-81.

4. Comstock GW, Lundin FE, Jr. Parental smoking and perinatal mortality. *Am J Obstet Gynecol* 1967;**98**:708-18.

5. Underwood PB, Kesler KF, O'Lane JM, Callaghan DA. Parental smoking empirically related to pregnancy outcome. *Obstet Gynecol* 1967;**29**:1-8.

6. Terris M, Gold EM. An epidemiologic study of prematurity. I. Relation to smoking, heart volume, employment, and physique. *Am J Obstet Gynecol* 1969;**103**:358-70.

7. Yerushalmy J. The relationship of parents' cigarette smoking to outcome of pregnancy - implications as to the problem of inferring causation from observed associations. *Am J Epidemiol* 1971;**93**:443-56.

8. Mau G, Netter P. Die Auswirkungen des väterlichen Zigarettenkonsums auf die perinatale Sterblichkeit und die Mißbildungshäufigkeit. (The effects of paternal cigarette smoking on perinatal mortality and the incidence of malformation). *Dtsch Med Wochenschr* 1974;**99**:1113-8.

9. Borlee I, Bouckaert A, Lechat MF, Misson CB. Smoking patterns during and before pregnancy: weight, length and head circumference of progeny. *Eur J Obstet Gynecol Reprod Biol* 1978;**8**:171-7.

10. Hauth JC, Hauth J, Drawbaugh RB, Gilstrap LC, Pierson WP. Passive smoking and thiocyanate concentrations in pregnant women and newborns. *Obstet Gynecol* 1984;**63**:519-22.

11. Magnus P, Berg K, Bjerkedal T, Nance WE. Parental determinants of birth weight. *Clin Genet* 1984;**26**:397-405.

12. Karakostov K. Passive smoking among pregnant women and its effect on the weight and height of the newborn [Abstract]. *Akusherstvo i Ginekologiia* 1985;**24**:31.

13. Martin TR, Bracken MB. Association of low birth weight with passive smoke exposure in pregnancy. *Am J Epidemiol* 1986;**124**:633-42.

14. Rubin DH, Kraskilnikoff PA, Leventhal JM, Weile B, Berget A. Effect of passive smoking on birth weight. *Lancet* 1986;**ii**:415-7.

15. Little RE, Sing CF. Father's drinking and infant birth weight: report of an association. *Teratology* 1987;**36**:59-65.

16. MacArthur C, Knox EG. Passive smoking and birthweight [Letter]. *Lancet* 1987;**i**:37-8.

17. Schwartz-Bickenbach D, Schulte-Hobein B, Abt S, Plum C, Nau H. Smoking and passive smoking during pregnancy and early infancy: effects on birth weight, lactation period, and cotinine concentrations in mother's milk and infant's urine. *Toxicol Lett* 1987;**35**:73-81.

18. Campbell MJ, Lewry J, Wailoo M. Further evidence for the effect of passive smoking on neonates. *Postgrad Med J* 1988;**64**:663-5.

19. Dróżdż M, Strzelczak Z, Jendryczko A. Palenie papierosów i palenie bierne w czasie ciąży i po porodzie: wpływ nà mase urodzeniową, długość okresu laktacji oraz steżenie kotyniny w mleku matki i wydalanie kotyniny w moczu dziecka. (Smoking and passive smoking during pregnancy and after delivery: its influence on the birth weight, lactation period length and concentration of cotinine in mother's milk and cotinine excretion in the urine of a baby). *Ginekol Pol* 1988;**59**:528-33.

20. Haddow JE, Knight GJ, Palomaki GE, McCarthy JE. Second-trimester serum cotinine levels in non-smokers in relation to birth weight. *Am J Obstet Gynecol* 1988;**159**:481-4.

21. Hamada H, Oka H, Sadatsuki M, Fujii H. The effect of maternal active and passive smoking on pregnancy and delivery. *Shusanki Igaku* 1988;**18**:1585-90.

22. Nakamura M, Oshima A, Hiyama T, Kubota N, Wada K, Yano K. Effect of passive smoking during pregnancy on birth weight and gestation: A population-based prospective study in Japan. In: Aoki M, Hisamichi S, Tominaga S, editors. *Smoking and health 1987, Proceedings of the 6th World Conference on Smoking and Health, Tokyo, 9-12 November 1987*. Amsterdam: Elsevier Science Publishers B.V. (Biomedical Division), 1988;267-9. International Congress Series No. 780.

23. Brooke OG, Anderson HR, Bland JM, Peacock JL, Stewart CM. Effects on birth weight of smoking, alcohol, caffeine, socioeconomic factors, and psychosocial stress. *BMJ* 1989;**298**:795-801.

24. Chen Y, Pederson LL, Lefcoe NM. Passive smoking and low birthweight [Letter]. *Lancet* 1989;**ii**:54-5.

25. Ueda Y, Morikawa H, Funakoshi T, Kobayashi A, Yamasaki A, Takeuchi K, *et al*. Estimation of passive smoking during pregnancy by cotinine measurement and its effect on fetal growth. *Acta Obstet Gynaecol Jpn* 1989;**41**:454-60.

26. Kikuchi S, Takahashi T. Effect of paternal smoking on fetuses. In: Kasuga H, editor. *Indoor air quality, International Conference on Indoor Air Quality, Tokyo, November 4-6, 1987*. Berlin Heidelberg: Springer-Verlag, 1990;

27. Lazzaroni F, Bonassi S, Manniello E, Morcaldi L, Repetto E, Ruocco A, *et al*. Effect of passive smoking during pregnancy on selected perinatal parameters. *Int J Epidemiol* 1990;**19**:960-6.

28. Mathai M, Skinner A, Lawton K, Weindling AM. Maternal smoking, urinary cotinine levels and birth-weight. *Aust N Z J Obstet Gynaecol* 1990;**30**:33-6.

29. Rantakallio P, Hartikainen-Sorri A-L, Leino T. The effect of parental smoking and industrial pollution on birth weight. In: Kasuga H, editor. *Indoor air quality, International Conference on Indoor Air Quality, Tokyo, November 4-6, 1987*. Berlin Heidelberg: Springer-Verlag, 1990;219-25.

30. Yan Y. Study on the risk factors of low birth weight. *Zhonghua Liu Xing Bing Xue Za Zhi* 1990;**11**:92-5.

31. Ahlborg G, Jr., Bodin L. Tobacco smoke exposure and pregnancy outcome among working women. A prospective study at prenatal care centers in Örebro County, Sweden. *Am J Epidemiol* 1991;**133**:338-47.

32. Ogawa H, Tominaga S, Hori K, Noguchi K, Kanou I, Matsubara M. Passive smoking by pregnant women and fetal growth. *J Epidemiol Community Health* 1991;**45**:164-8.

33. Saito R. The smoking habits of pregnant women and their husbands, and the effect on their infants. *Nippon Koshu Eisei Zasshi* 1991;**38**:124-31.

34. Mathai M, Vijayasri R, Babu S, Jeyaseelan L. Passive maternal smoking and birthweight in a South Indian population. *Br J Obstet Gynaecol* 1992;**99**:342-3.

35. Pan M, Zhang Z, Wang C, He X. The influence of passive smoking on the fetus during pregnancy. *Zhonghua Fu Chan Ke Za Zhi* 1992;**27**:348-50.

36. Bardy AH, Seppälä T, Lillsunde P, Kataja JM, Koskela P, Pikkarainen J, *et al*. Objectively measured tobacco exposure during pregnancy: neonatal effects and relation to maternal smoking. *Br J Obstet Gynaecol* 1993;**100**:721-6.

37. Zhang J, Ratcliffe JM. Paternal smoking and birthweight in Shanghai. *Am J Public Health* 1993;**83**:207-10.

38. Fortier I, Marcoux S, Brisson J. Passive smoking during pregnancy and the risk of delivering a small-for-gestational-age infant. *Am J Epidemiol* 1994;**139**:294-301.

39. Mainous AG, III, Hueston WJ. Passive smoke and low birth weight. Evidence of a threshold effect. *Arch Fam Med* 1994;**3**:875-8.

40. Martinez FD, Wright AL, Taussig LM, the Group Health Medical Associates. The effect of paternal smoking on the birthweight of newborns whose mothers did not smoke. *Am J Public Health* 1994;**84**:1489-91.

41. Chen LH, Petitti DB. Case-control study of passive smoking and the risk of small-for-gestational-age at term. *Am J Epidemiol* 1995;**142**:158-65.

42. Eskenazi B, Prehn AW, Christianson RE. Passive and active maternal smoking as measured by serum cotinine: the effect on birthweight. *Am J Public Health* 1995;**85**:395-8.

43. Jadsri S, Jadsri C. Parental smoking habits and infant birth weight. *Asia Pac J Public Health* 1995;**8**:134-7.

44. Rebagliato M, Florey CdV, Bolumar F. Exposure to environmental tobacco smoke in nonsmoking pregnant women in relation to birth weight. *Am J Epidemiol* 1995;**142**:531-7.

45. Roquer JM, Figueras J, Botel F, Jiménez R. Influence on fetal growth of exposure to tobacco smoke during pregnancy. *Acta Paediatr* 1995;**84**:118-21.

46. Wilcox MA, Newton CS, Johnson IR. Paternal influences on birthweight. *Acta Obstet Gynecol Scand* 1995;**74**:15-8.

47. Eliopoulos C, Klein J, Chitayat D, Greenwald M, Koren G. Nicotine and cotinine in maternal and neonatal hair as markers of gestational smoking. *Clin Invest Med* 1996;**19**:231-42.

48. Jedrychowski W, Flak E. Confronting the prenatal effects of active and passive tobacco smoking on the birth weight of children. *Cent Eur J Public Health* 1996;**4**:201-5.

49. Ahluwalia IB, Grummer-Strawn L, Scanlon KS. Exposure to environmental tobacco smoke and birth outcome: increased effects on pregnant women aged 30 years or older. *Am J Epidemiol* 1997;**146**:42-7.

50. Frisbie WP, Biegler M, de Turk P, Forbes D, Pullum SG. Racial and ethnic differences in determinants of intrauterine growth retardation and other compromised birth outcomes. *Am J Public Health* 1997;**87**:1977-83.

51. Horta BL, Victora CG, Menezes AM, Halpern R, Barros FC. Low birthweight, preterm births and intrauterine growth retardation in relation to maternal smoking. *Paediatr Perinat Epidemiol* 1997;**11**:140-51.

52. Lødrup Carlsen KC, Jaakkola JJK, Nafstad P, Carlsen K-H. *In utero* exposure to cigarette smoking influences lung function at birth. *Eur Respir J* 1997;**10**:1774-9.

53. Wang X, Tager IB, Van Vunakis H, Speizer FE, Hanrahan JP. Maternal smoking during pregnancy, urine cotinine concentrations, and birth outcomes. A prospective cohort study. *Int J Epidemiol* 1997;**26**:978-88.

54. Dejin-Karlsson E, Hanson BS, Östergren P-O, Sjöberg N-O, Marsal K. Does passive smoking in early pregnancy increase the risk of small-for-gestational-age infants? *Am J Public Health* 1998;**88**:1523-6.

55. Janghorbani M, Nakhai HR. Effect of passive smoking during pregnancy on weight, length and cranial circumference at birth in Kerman, Iran. *Medical Journal of the Islamic Republic of Iran* 1998;**12**:31-6.

56. Luciano A, Bolognani M, Biondani P, Ghizzi C, Zoppi G, Signori E. The influence of maternal passive and light active smoking on intrauterine growth and body composition of the newborn. *Eur J Clin Nutr* 1998;**52**:760-3.

57. Nafstad P, Fugelseth D, Qvigstad E, Zahlsen K, Magnus P, Lindemann R. Nicotine concentration in the hair of nonsmoking mothers and size of offspring. *Am J Public Health* 1998;**88**:120-4.

58. Peacock JL, Cook DG, Carey IM, Jarvis MJ, Bryant AE, Anderson HR. Maternal cotinine level during pregnancy and birthweight for gestational age. *Int J Epidemiol* 1998;**27**:647-56.

59. Hanke W, Kalinka J, Florek E, Sobala W. Passive smoking and pregnancy outcome in central Poland. *Hum Toxicol* 1999;**18**:265-71.

60. Sadler L, Belanger K, Saftlas A, Leaderer B, Hellenbrand K, McSharry J-E, *et al*. Environmental tobacco smoke exposure and small-for-gestational-age birth. *Am J Epidemiol* 1999;**150**:695-705.

61. Windham GC, Eaton A, Hopkins B. Evidence for an association between environmental tobacco smoke exposure and birth weight: a meta-analysis and new data. *Pediatr Perinat Epidemiol* 1999;**13**:35-57.

62. Chen D, Cho S-I, Chen C, Wang X, Damokosh AI, Ryan L, *et al*. Exposure to benzene, occupational stress, and reduced birth weight. *Occup Environ Med* 2000;**57**:661-7.

63. Haug K, Irgens LM, Skjærven R, Markestad T, Baste V, Schreuder P. Maternal smoking and birthweight: effect modification of period, maternal age and paternal smoking. *Acta Obstet Gynecol Scand* 2000;**79**:485-9.

64. Hrubá D, Kachlík P. Influence of maternal active and passive smoking during pregnancy on birthweight in newborns. *Cent Eur J Public Health* 2000;**8**:249-52.

65. Matsubara F, Kida M, Tamakoshi A, Wakai K, Kawamura T, Ohno Y. Maternal active and passive smoking and fetal growth: a prospective study in Nagoya, Japan. *J Epidemiol* 2000;**10**:335-43.

66. Windham GC. Birthweight and gestational age in relation to prenatal environmental tobacco smoke exposure. In: Watson RR, Witten M, editors. *Environmental tobacco smoke*. Boca Raton, Florida: CRC Press LLC, 2000;25-43.

67. Jaakkola JJK, Jaakkola N, Zahlsen K. Fetal growth and length of gestation in relation to prenatal exposure to environmental tobacco smoke assessed by hair nicotine concentration. *Environ Health Perspect* 2001;**109**:557-61.

68. Kukla L, Hrubá D, Tyrlík M. Smoking and damages of reproduction: evidence of ELSPAC. *Cent Eur J Public Health* 2001;**9**:59-63.

69. Dejmek J, Solanský I, Podrazilová K, Šram RJ. The exposure of nonsmoking and smoking mothers to environmental tobacco smoke during different gestational phases and fetal growth. *Environ Health Perspect* 2002;**110**:601-6.

70. Kutlu T, Gelboin HV, Gozukara EM. Cigarette smoking and secondary smoke in Turkey: effect on placental aryl hydrocarbon hydroxylase (AHH), infant birth weight, and size. *Bull Environ Contam Toxicol* 2002;**69**:855-62.

71. Mitchell EA, Thompson JMD, Robinson E, Wild CJ, Becroft DMO, Clark PM, *et al*. Smoking, nicotine and tar and risk of small for gestational age babies. *Acta Paediatr* 2002;**91**:323-8.

72. Dejin-Karlsson E, Östergren P-O. Psychosocial factors, lifestyle, and fetal growth: the added value of both pre- and post-natal assessments. *Eur J Public Health* 2003;**13**:210-7.

73. Hong Y-C, Lee K-H, Son B-K, Ha E-H, Moon H-S, Ha M. Effects of the GSTM1 and GSTT1 polymorphisms on the relationship between maternal exposure to environmental tobacco smoke and neonatal birth weight. *J Occup Environ Med* 2003;**45**:492-8.

74. Rashid M, Rashid HM. Passive maternal smoking and pregnancy outcome in a Saudi population. *Saudi Med J* 2003;**24**:248-53.

75. Adamek R, Florek E, Piekoszowski W, Bręborowicz GH. Status socjo-ekonomiczny kobiet palących papierosy w czasie ciąży a urodzeniowa masa noworodkow (The socio-economic status of women smoking during pregnancy and birth weight of their newborns). *Przegl Lek* 2004;**61**:1006-11.

76. Goel P, Radotra A, Singh I, Aggarwal A, Dua D. Effects of passive smoking on outcome in pregnancy. *J Postgrad Med* 2004;**50**:12-6.

77. Hanke W, Sobala W, Kalinka J. Environmental tobacco smoke exposure among pregnant women: impact on fetal biometry at 20-24 weeks of gestation and newborn child's birth weight. *Int Arch Occup Environ Health* 2004;**77**:47-52.

78. Jedrychowski W, Bendkowska I, Flak E, Penar A, Jacek R, Kaim I, *et al*. Estimated risk for altered fetal growth resulting from exposure to fine particles during pregnancy: an epidemiologic prospective cohort study in Poland. *Environ Health Perspect* 2004;**112**:1398-402.

79. Kharrazi M, Delorenze GN, Kaufman FL, Eskenazi B, Bernert JT, Jr., Graham S, *et al*. Environmental tobacco smoke and pregnancy outcome. *Epidemiology* 2004;**15**:660-70.

80. Nakamura MU, Alexandre SM, Kuhn dos Santos JFK, de Souza E, Sass N, Auritscher Beck AP, *et al*. Obstetric and perinatal effects of active and/or passive smoking during pregnancy. *Sao Paulo Med J* 2004;**122**:94-8.

81. Ojima T, Uehara R, Watanabe M, Tajimi M, Oki I, Nakamura Y. Population attributable fraction of smoking to low birth weight in Japan. *Pediatr Int* 2004;**46**:264-7.

82. Perera FP, Rauh V, Whyatt RM, Tsai W-Y, Bernert JT, Tu Y-H, *et al*. Molecular evidence of an interaction between prenatal environmental exposures and birth outcomes in a multiethnic population. *Environ Health Perspect* 2004;**112**:626-30.

83. Alonso Ojembarrena A, Cano Fernández J, Girón Velasco A, Yep Chullen G, Sánchez Bayle M. Peso al nacimiento y tabaquismo familiar (Birth weight and familial smoking). *An Pediatr (Barc)* 2005;**63**:116-9.

84. Gomez C, Berlin I, Marquis P, Delcroix M. Expired air carbon monoxide concentration in mothers and their spouses above 5 ppm is associated with decreased fetal growth. *Prev Med* 2005;**40**:10-5.

85. Ramesh KN, Vidyadaran MK, Goh YM, Nasaruddin AA, Jammal AB, Zainab S. Maternal passive smoking and its effect on maternal, neonatal and placental parameters. *Med J Malaysia* 2005;**60**:305-10.

86. Gomółka E, Piekoszewski W, Florek E, Morawska A, Breborowicz GH, Kramer L. Wpływ palenia tytoniu przez kobiety ciężarne na stężenie ołowiu i kadmu w moczu oraz na stan zdrowotny noworodka (The influence of tobacco smoking on the lead and cadmium concentration in the urine of pregnant women and the health state of newborn). *Przegl Lek* 2006;**63**:985-92.

87. Hegaard HK, Kjærgaard H, Møller LF, Wachmann H, Ottesen B. The effect of environmental tobacco smoke during pregnancy on birth weight. *Acta Obstet Gynecol Scand* 2006;**85**:675-81.

88. Steyn K, de Wet T, Saloojee Y, Nel H, Yach D. The influence of maternal cigarette smoking, snuff use and passive smoking on pregnancy outcomes: the Birth To Ten Study. *Paediatr Perinat Epidemiol* 2006;**20**:90-9.

89. Lee NL, Samet JM, Yang G, Zhou M, Yang J. Parental secondhand smoke exposure and infant birth weight in China [Abstract]. *Ann Epidemiol* 2007;**17**:748 (P74)-749.

90. Sanyal MK, Mercan D, Belanger K, Santella RM. DNA adducts in human placenta exposed to ambient environment and passive cigarette smoke during pregnancy. *Birth Defects Res A Clin Mol Teratol* 2007;**79**:289-94.

91. Ward C, Lewis S, Coleman T. Prevalence of maternal smoking and environmental tobacco smoke exposure during pregnancy and impact on birth weight: retrospective study using Millennium Cohort. *BMC Public Health* 2007;**7**:81.

92. Wu FY, Wu HD, Yang HL, Kuo HW, Ying JC, Lin CJ, *et al*. Associations among genetic susceptibility, DNA damage, and pregnancy outcomes of expectant mothers exposed to environmental tobacco smoke. *Sci Total Environ* 2007;**386**:124-33.

93. Wu T, Hu Y, Chen C, Yang F, Li Z, Fang Z, *et al*. Passive smoking, metabolic gene polymorphisms, and infant birth weight in a prospective cohort study of Chinese women. *Am J Epidemiol* 2007;**166**:313-22.

94. Kramer MS. Determinants of low birthweight: methodological assessment and meta-analysis. *Bull World Health Organ* 1987;**65**:663-737.

95. US Surgeon General. *Reducing the health consequences of smoking. 25 years of progress. A report of the Surgeon General*. Rockville, Maryland: US Department of Health and Human Services; Public Health Services; 1989. DHHS Publication No. (CDC) 89-8411. http://www.cdc.gov/tobacco/sgr/index.htm

96. Lee PN. *Environmental tobacco smoke and mortality. A detailed review of epidemiological evidence relating environmental tobacco smoke to the risk of cancer, heart disease and other causes of death in adults who have never smoked*. Basel: Karger; 1992.

97. US Surgeon General. *Smoking and health. A report of the Surgeon General*. Rockville, Maryland: US Department of Health, Education, and Welfare; Public Health Service; 1979. DHEW Publication No. (PHS) 79-50066. http://www.cdc.gov/tobacco/sgr/index.htm

98. Berkowitz GS, Papiernik E. Epidemiology of preterm birth. *Epidemiol Rev* 1993;**15**:414-43.

99. Haste FM, Brooke OG, Anderson HR, Bland JM. The effect of nutritional intake on outcome of pregnancy in smokers and non-smokers. *Br J Nutr* 1991;**65**:347-54.

100. Lindbohm M-L, Sallmén M, Taskinen H. Effects of exposure to environmental tobacco smoke on reproductive health. *Scand J Work Environ Health* 2002;**28 (Suppl 2)**:84-96.

101. Jensen GM, Moore LG. The effect of high altitude and other risk factors on birthweight: independent or interactive effects? *Am J Public Health* 1997;**87**:1003-7.

102. Independent Scientific Committee. *Fourth report on smoking and health*. London: HMSO; 1988.

103. Witorsch RJ, Witorsch P. Environmental tobacco smoke and birthweight of offspring: a critical review and analysis of the epidemiological literature. *Indoor Built Environ* 1996;**5**:219-31.

104. Windham GC, Hopkins B, Fenster L, Swan SH. Passive smoking and low birthweight in a prospective study [Abstract]. *Epidemiology* 1996;**7**:37S.

105. Hanke W, Sobala W, Kalinka J. Wpływ środowiskowej ekspozycji kobiet ciężarnych da dym tytoniowy na masę urodzeniową noworodka - badanie prospektywne z wykorzystaniem markerów ekspozycji (The effect of environmental tobacco smoke on birthweight: a prospective study employing biomarkers of exposure). *Ginekol Pol* 2000;**71**:833-6.