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Effect of living close to a main road on asthma, allergy, lung function and chronic obstructive pulmonary disease

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ABSTRACT

Background: A number of epidemiological studies suggest that the risk of asthma is increased among those living in close proximity to major roads. However, the evidence is inconsistent, and effects on asthma and related respiratory and allergic conditions using objective measures such as lung function and allergic sensitisation have not been widely investigated.

Methods: In 1995, 1996 and 2001 data on respiratory and allergic disease, along with demographic and lifestyle factors, were collected in 59 285 children (aged 2–16 years) and adults as part of the Health Survey for England, a nationally representative annual survey. Using Geographical Information System software, we mapped the location of each participant's home and computed distance to the nearest major road. We estimated the effect of distance on self-reported wheezing in the past year, asthma, eczema and hay fever in 50 994 participants, and on 1-second forced expiratory volume (FEV₁), immunoglobulin E and spirometry-defined chronic obstructive pulmonary disease (COPD) in subgroups of those aged 7+, 11+ and 16+ years, respectively.

Results: Living within 150 m from a major road was not significantly associated with an increased risk of any of the outcome variables in any age group (adjusted odds ratios ranged from 0.85 to 1.05). Furthermore there was little evidence that risk increased with increasing proximity across the 0–150 m range where contrasts in traffic-related pollutant concentrations are greatest.

Conclusion: Our analysis of a large and nationally representative population sample did not provide evidence of an adverse effect of living in close proximity to main roads on the risk of asthma, COPD or allergic disease in England.

The effect of road vehicle traffic pollution exposure on the risk of respiratory and allergic disease is a subject of considerable public concern. However, it is not clear whether people who live in close proximity to major roads have an increased risk of asthma, allergy, or chronic obstructive pulmonary disease (COPD) since the available epidemiological evidence is inconsistent. Studies of asthma have tended to use self-reported outcome measures such as wheeze or diagnosed asthma, with many reporting an increased risk in children^{1–8} and adults^{9–11} living close to busy roads. Others, however, have shown no association among children^{12–13} or adults.^{6–14–15} Investigations of other allergic conditions such as hay fever and eczema have also tended to use self-reported outcomes,^{2–3–5–7–10–12–16} with the majority finding no evidence of an effect.

What this paper adds

- ▶ The effect of living close to a main road on asthma and related respiratory and allergic conditions has yet to be fully established since previous studies have often lacked objective measures of disease.
- ▶ This study found no evidence that close residential proximity to main roads significantly increases the risk of asthma, chronic obstructive pulmonary disease or allergic disease in England.
- ▶ Saturation by background levels of pollution may have resulted in ubiquitous exposure to traffic-related pollutants in this setting, regardless of proximity to roads.
- ▶ In this country and other similar settings, measures that focus on location of housing in relation to roads are unlikely to be effective in improving respiratory or allergic health, and should instead focus on achieving a general reduction in air pollution.

Objective measures of asthma or allergy such as lung function and allergic sensitisation, however, have not been widely used in studies of home proximity to traffic, and little is known about specific effects on COPD. In children, a Dutch study reported reduced lung function in those living close to busy roads,¹⁷ but two other studies found no overall associations.^{5–13} In adults, adverse effects on lung function^{18–19} and spirometry-defined COPD¹⁹ have been seen, but in women only. There is also some suggestion that living close to busy roads may increase the risk of allergic sensitisation to pollen in children^{7–13} and adults,¹⁴ but effects on allergic sensitisation to any allergen have generally not been seen.^{5–13–15}

The present study uses data from 3 years of the Health Survey for England (HSE), an annual, nationally representative, cross-sectional survey of adults and children, to investigate the effect of home proximity to a major road on objectively measured lung function, spirometry-defined COPD and allergen-specific immunoglobulin E (IgE), as well as self-reported measures of asthma, eczema and hay fever. Since concentrations of traffic-related pollutants such as nitrogen dioxide, black smoke and particulate matter have been shown to be highest at the roadside and fall exponentially to background levels within approximately 150 m,^{20–21}

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Table 1 Characteristics of Health Survey for England participants included and excluded from the analyses by age group

Characteristics	2–6 years		7–15 years		16+ years	
	Included (n = 3500)	Excluded (n = 688)	Included (n = 6015)	Excluded (n = 937)	Included (n = 41 479)	Excluded (n = 6666)
	No (%)	No (%)	No (%)	No (%)	No (%)	No (%)
Sex						
Men	1777 (50.8)	347 (50.4)	3017 (50.2)	483 (51.6)	18778 (45.3)	3009 (45.1)
Women	1723 (49.2)	341 (49.6)	2998 (49.8)	454 (48.5)	22701 (54.7)	3657 (54.9)
Household social class						
I – professional	545 (11.1)	106 (17.0)	972 (17.4)	166 (19.6)	6590 (17.0)	1242 (20.0)
II – managerial/technical	798 (25.0)	153 (24.6)	1477 (26.5)	227 (26.8)	10 009 (25.8)	1580 (25.4)
III NM – skilled non-manual	598 (18.7)	121 (19.5)	921 (16.5)	148 (17.5)	7023 (18.1)	1146 (18.4)
III M – skilled manual	831 (26.0)	159 (25.6)	1542 (27.6)	204 (24.1)	10547 (27.2)	1587 (25.5)
IV and V – semiskilled/unskilled	424 (13.3)	83 (13.3)	666 (11.9)	103 (12.2)	4560 (11.8)	671 (10.8)
Missing	304	66	437	89	2750	440
Townsend quintiles						
1st (least deprived)	579 (16.5)	50 (19.3)	1184 (19.7)	105 (26.7)	8254 (19.9)	743 (25.6)
2nd	648 (18.5)	58 (22.4)	1163 (19.3)	59 (15.0)	8418 (20.3)	615 (21.2)
3rd	715 (20.4)	44 (17.0)	1182 (19.7)	73 (18.5)	8728 (21.0)	605 (20.9)
4th	697 (19.9)	51 (19.7)	1144 (19.0)	80 (20.3)	8008 (19.3)	500 (17.3)
5th (most deprived)	861 (24.6)	56 (21.6)	1342 (22.3)	77 (19.5)	8071 (19.5)	436 (15.0)
Missing	0	429	0	543	0	3767
Smoking status						
Never					13 144 (31.7)	2106 (33.8)
Never regular smoker	na	na	na	na	5789 (14.0)	774 (12.4)
Ex-regular smoker					10286 (24.8)	1496 (24.0)
Current smoker					12260 (29.6)	1859 (29.8)
Missing					0	431
Distance to a main road						
<30 m	188 (5.4)	14 (3.5)	365 (6.1)	13 (2.5)	2816 (6.8)	181 (4.6)
30–60 m	138 (3.9)	13 (3.2)	285 (4.7)	20 (3.9)	2265 (5.5)	188 (4.7)
60–90 m	252 (7.2)	24 (6.0)	405 (6.7)	34 (6.5)	2888 (7.0)	264 (6.6)
90–120 m	260 (7.4)	35 (8.7)	470 (7.8)	37 (7.1)	3172 (7.7)	331 (8.3)
120–150 m	250 (7.1)	36 (9.0)	412 (6.9)	33 (6.4)	2896 (7.0)	306 (7.7)
>150 m	2412 (68.9)	279 (69.6)	4078 (67.8)	383 (73.7)	27442 (66.2)	2706 (68.1)
Missing	0	287	0	417	0	2690

M, manual; na, not applicable; NM, non-manual.

we have investigated dose-response relations across this range of proximity to major roads.

MATERIALS AND METHODS

Study population

The HSE is a series of annual, independent cross-sectional surveys in which participants are selected through two-stage stratified random sampling. In 1995, 1996 and 2001 the HSE focused on respiratory and allergic disease and we therefore used combined data from these years for our analysis, comprising 48 145 adults (aged 16+ years) and 11 140 children (aged 2–15 years). Full details of the survey methods have been reported elsewhere.^{22–24} However, in brief, a random sample of addresses in England was selected and all persons aged ≥ 2 years in the household were eligible for inclusion, although if there were more than two children, only two were randomly selected. Participants were visited at home where the interviewer asked questions on respiratory and allergic disease symptoms and diagnosis, demographics and lifestyle factors including personal and parental smoking history, and then measured the subject's height and weight. The questions on respiratory and allergic disease symptoms and diagnosis were based on the 1984 International Union Against Tuberculosis and Lung Disease questionnaire.^{25–26} For children aged <13 years, questions were answered by a parent or guardian with the child present. In a

separate home visit, lung function tests were administered by a trained nurse in those aged ≥ 7 years using a calibrated, portable spirometer (Vitalograph Escort, Buckingham, UK). Following a demonstration by the nurse, subjects performed repeated tests in a standing position and out of five technically satisfactory tests, the highest measurement of 1-second forced expiratory volume (FEV₁) and forced vital capacity (FVC) was recorded. A test was considered as technically satisfactory as long as none of the following occurred: (1) an unsatisfactory start of expiration; (2) laughing or coughing; (3) holding the breath in; (4) a leak in the system; or (5) an obstructed mouthpiece. Blood was also taken at this visit in those aged ≥ 11 years and used for estimation of total and housedust mite (HDM)-specific IgE using enzyme immunoassay methods.²⁴ Ethical approval for the surveys was obtained from the Local Research Ethics Committees in England.

Computation of postcode-derived variables

The HSE data were provided by the National Centre for Social Research (London, UK) which initially only supplied us with each participant's residential postcode without any other identifiers in order to maintain subject anonymity. We used the postcodes to compute the distance between each residence and the nearest main road as a measure of exposure to traffic pollution. Each postcode was first converted to national

Table 2 Associations between respiratory outcomes and home proximity to a main road by age group

	2–6 years			7–15 years			16+ years		
	No (%)	Adjusted OR* (95% CI)	p Value†	No (%)	Adjusted OR* (95% CI)	p Value†	No (%)	Adjusted OR* (95% CI)	p Value†
Wheeze in last year									
≤150 m	220 (20.2)	0.98 (0.82 to 1.17)	0.80	298 (15.4)	0.85 (0.74 to 0.99)	0.04	2813 (20.0)	0.93 (0.88 to 0.98)	0.01
>150 m	499 (20.7)	1		714 (17.5)	1		5715 (20.8)	1	
Bands of distance									
<30 m	33 (17.6)	0.92 (0.55 to 1.53)	0.60	64 (17.6)	1.62 (1.06 to 2.49)	0.04	522 (18.5)	0.92 (0.08 to 1.06)	0.22
30–60 m	30 (21.7)	1.18 (0.70 to 2.01)		48 (16.9)	1.52 (0.98 to 2.36)		450 (19.9)	0.97 (0.84 to 1.13)	
60–90 m	48 (19.1)	0.99 (0.64 to 1.54)		62 (15.3)	1.38 (0.91 to 2.10)		617 (21.4)	1.06 (0.93 to 1.21)	
90–120 m	61 (23.5)	1.32 (0.86 to 2.04)		76 (16.2)	1.46 (0.99 to 2.17)		646 (20.4)	1.01 (0.88 to 1.15)	
120–150 m	48 (19.2)	1		48 (11.7)	1		578 (20.0)	1	
Diagnosed asthma									
≤150 m	205 (18.9)	0.94 (0.78 to 1.13)	0.53	411 (21.2)	0.92 (0.80 to 1.05)	0.20	1798 (12.8)	1.01 (0.95 to 1.07)	0.76
>150 m	471 (19.6)	1		923 (22.7)	1		3452 (12.6)	1	
Bands of distance									
<30 m	37 (19.7)	1.17 (0.71 to 1.93)	0.65	88 (24.2)	1.35 (0.95 to 1.91)	0.29	349 (12.4)	0.99 (0.84 to 1.17)	0.81
30–60 m	25 (18.1)	1.05 (0.59 to 1.86)		57 (20.0)	1.03 (0.69 to 1.54)		283 (12.5)	1.00 (0.84 to 1.18)	
60–90 m	47 (18.7)	1.04 (0.66 to 1.64)		80 (19.8)	1.04 (0.72 to 1.51)		420 (14.6)	1.17 (1.01 to 1.36)	
90–120 m	51 (19.6)	1.12 (0.70 to 1.79)		107 (22.8)	1.24 (0.88 to 1.73)		381 (12.0)	0.95 (0.82 to 1.11)	
120–150 m	45 (18.0)	1		79 (19.2)	1		365 (12.6)	1	
COPD									
≤150 m	na	na	na	na	na	na	1418 (12.7)	0.96 (0.89 to 1.03)	0.21
>150 m							2825 (13.0)	1	
Bands of distance									
<30 m	na	na	na	na	na	na	270 (12.0)	0.94 (0.77 to 1.13)	0.54
30–60 m							242 (13.5)	0.97 (0.80 to 1.18)	
60–90 m							290 (12.7)	0.94 (0.78 to 1.14)	
90–120 m							321 (12.8)	0.97 (0.81 to 1.17)	
120–150 m							295 (12.7)	1	

*OR, odds ratios adjusted for sex and Townsend quintiles and, in adults, also for groups of age and smoking status.

†p Value of Wald test for association in ≤150 m versus 150 m effects and for trend in bands of distance effects.

na, not applicable.

northing and easting grid references of 1 m resolution using the Code-Point database (Ordnance Survey, Southampton, UK). We linked this grid reference to a digitised road map of Great Britain (Meridian database; Ordnance Survey), a geometrically structured 1:50 000 scale vector database with a coordinate resolution of 1 m, and calculated the shortest distance between each postcode location and the nearest major road using ArcMap-ArcInfo 9.0 (ESRI, Redlands, USA) software. A main road was defined as a motorway (freeway), or an A-road or B-road (principal road) according to the UK road classification system.

We also used the postcodes to obtain a number of potential confounding variables, namely Townsend score (an area level measure of socioeconomic deprivation),²⁷ degree of urbanisation (urban, town/fringe, village or hamlet/isolated dwelling) and annual mean background concentrations of nitrogen dioxide and particulate matter (PM₁₀) (see online supplement). Our postcode-derived variables were then linked to the full HSE datasets by the National Centre for Social Research, who removed all postcodes prior to supplying the full datasets.

Statistical analyses

Analyses were carried out in Stata 8 (Stata Corporation, College Station, Texas, USA) using complex survey analytical methods, and performed separately for adults (aged ≥16 years), children aged 7–15 years (for whom lung function data were available) and children aged 2–6 years. Where numbers were small, the complex survey methods could not be applied and instead regression models with robust estimates of variance were fitted

to allow for the clustered sampling (inclusion of multiple members of the same household); this was necessary in the analyses of lung function in children, COPD disease in adults and all dose-response associations.

We used multiple logistic regression to estimate the effect of distance on the binary outcomes wheeze in the past year, doctor-diagnosed asthma, hay fever and eczema, high HDM IgE (defined as >0.35 kU/l), and in adults only, COPD. COPD was defined as having an FEV₁/FVC less than 70% based on the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria to define stage I disease or above²⁸ (but using lung function measurements taken without prior administration of bronchodilators). Distance was initially analysed as a binary variable, ≤150 m versus >150 m, and then to investigate dose-response effects, as 30 m bands in the subgroup of subjects living within 150 m of the roadside. Odds ratios (ORs) were adjusted for sex and Townsend deprivation quintiles, and in adults, additionally for age and smoking status. To estimate effects of distance on FEV₁, we used multiple linear regression controlling for height, age, age squared, sex, smoking status, pack-years of cigarettes, Townsend quintiles and age–height interaction in adults, and height, height squared, age, sex, weight, Townsend quintiles and age–height interaction in children. In all models, the additional effects of exposure to passive smoking, pet ownership, cooking and heating appliances, number of children in the household, body mass index, degree of urbanisation, ethnic group, year of survey and background pollution concentrations were investigated, and if any induced a ≥10% change in the estimates, they were

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Table 3 Associations between atopic outcomes and home proximity to a main road by age group

	2–6 years			7–15 years			16+ years		
	No (%)	Adjusted OR* (95% CI)	p Value†	No (%)	Adjusted OR* (95% CI)	p Value†	No (%)	Adjusted OR* (95% CI)	p Value†
High HDM IgE									
≤150 m	na	na	na	136 (26.2)	0.99 (0.77 to 1.26)	0.91	1856 (19.4)	1.02 (0.96 to 1.09)	0.49
>150 m				277 (26.6)	1		3562 (18.9)	1	
Bands of distance									
<30 m	na	na	na	27 (27.6)	1.18 (0.64 to 2.17)	0.54	354 (18.1)	0.88 (0.74 to 1.03)	0.18
30–60 m				22 (32.4)	1.47 (0.75 to 2.85)		285 (18.7)	0.94 (0.79 to 1.12)	
60–90 m				22 (22.0)	0.86 (0.46 to 1.59)		414 (21.2)	1.06 (0.91 to 1.24)	
90–120 m				38 (27.1)	1.18 (0.65 to 2.17)		399 (18.8)	0.93 (0.80 to 1.09)	
120–150 m				27 (23.9)	1		404 (20.2)	1	
Diagnosed hay fever									
≤150 m	40 (3.7)	0.81 (0.56 to 1.17)	0.26	256 (13.2)	1.05 (0.89 to 1.23)	0.66	2022 (14.4)	1.01 (0.95 to 1.07)	0.83
>150 m	106 (4.4)	1		519 (12.7)	1		3946 (14.4)	1	
Bands of distance‡									
<30 m				53 (14.6)	1.14 (0.72 to 1.79)	0.33	378 (13.4)	0.96 (0.82 to 1.11)	0.93
30–60 m				43 (15.1)	1.13 (0.71 to 1.78)		343 (15.2)	1.13 (0.96 to 1.32)	
60–90 m				52 (12.9)	1.01 (0.66 to 1.56)		438 (15.2)	1.10 (0.94 to 1.28)	
90–120 m				55 (11.7)	0.88 (0.57 to 1.35)		453 (14.3)	1.03 (0.89 to 1.20)	
120–150 m				53 (12.9)	1		410 (14.2)	1	
Diagnosed eczema									
≤150 m	294 (27.0)	0.97 (0.83 to 1.14)	0.73	423 (21.9)	0.92 (0.81 to 1.05)	0.20	1828 (13.0)	1.03 (0.97 to 1.09)	0.35
>150 m	677 (28.1)	1		959 (23.5)	1		3517 (12.8)	1	
Bands of distance									
<30 m	60 (31.9)	1.32 (0.84 to 2.08)	0.27	67 (18.4)	0.78 (0.55 to 1.13)	0.53	350 (12.5)	0.90 (0.77 to 1.05)	0.71
30–60 m	35 (25.4)	1.02 (0.63 to 1.64)		64 (22.6)	1.03 (0.71 to 1.51)		311 (13.7)	1.05 (0.90 to 1.23)	
60–90 m	69 (27.7)	1.15 (0.77 to 1.73)		108 (26.7)	1.28 (0.92 to 1.77)		386 (13.4)	0.99 (0.85 to 1.16)	
90–120 m	67 (25.8)	1.05 (0.69 to 1.58)		93 (19.8)	0.87 (0.61 to 1.23)		388 (12.3)	0.90 (0.77 to 1.05)	
120–150 m	63 (25.2)	1		91 (22.1)	1		393 (13.6)	1	

*OR, odds ratios adjusted for sex and Townsend quintiles and, in adults, also for groups of age and smoking status.

†p Value of Wald test for association in ≤150 m versus 150 m effects and for trend in bands of distance effects.

‡Estimates for 30 m bands of distance in 2–6-year age group not included because of small numbers.

HDM IgE, immunoglobulin E against house dustmites; na, not available.

included in the final models. We also assessed the confounding effect of social class based on occupation of the household head as an alternative to Townsend score, and tested for interactions by degree of urbanisation, and by sex since some researchers have found effects on respiratory outcomes only evident or stronger in females.^{1–3 6 17 18}

The sample size of the study allowed an OR for wheeze of 1.10 in adults and of 1.35 in 2–6-year-old children to be detected with 90% power and alpha (probability of type I error) of 5% (Epi Info version 3.2, CDC Atlanta).

RESULTS

After excluding 3394 participants with no valid postcode and a further 4897 without complete confounding data, the analyses of questionnaire outcomes were based on information from 50 994 participants (86.0%). The demographic characteristics of these subjects were generally similar to those excluded, with the exception of socioeconomic status, for which there was a tendency for the most advantaged to be slightly under-represented (table 1). Overall 33.5% (17 062/50 994) were classified as living within 150 m of a main road. For analyses of lung function and IgE, some subjects without outcome or confounding data had to be further excluded. Therefore, of our sample of 41 479 adults, measurements for the FEV₁ analyses were available in 31 771 (76.6%), spirometry-defined COPD analyses in 32 912 (79.3%) and IgE analyses in 28 382 (68.4%). Analysis of FEV₁ in children could be performed on 4654 of our 6015 children aged 7–15 years (77.4%) and IgE in 1562 of our

3288 children aged 11–15 years (47.5%). Subjects with and without lung function and IgE data were also similar in terms of demographic characteristics (data not shown).

Overall, living near the roadside was not associated with an increased risk of wheeze, asthma or COPD (table 2). For wheeze, a significantly reduced risk was observed for both the older children and adults, but not the younger children (table 2). When we looked at dose-response relations for those living within 150 m of a road, the trend between increasing proximity and risk of wheeze was positive in the older children (p for trend = 0.04), but no significant dose-response relations were seen with wheeze or with the other outcomes in the adults or younger children (table 2). We found no evidence of associations between home proximity to the roadside and the allergic outcomes HDM-specific IgE, hay fever and eczema (table 3). Results for total IgE (defined as >80 kU/l and 100 kU/l in children and adults, respectively) were similar (data not shown). Additional control for the other potential confounding variables made little difference to the effect estimates and there was no evidence of effect modification by sex.

Mean FEV₁ measurements in children (aged 7–15 years) were seen to be similar for those living within 150 m of a main road and those living further away (2390 ml and 2370 ml, respectively), although following adjustment for a priori confounders, close residential proximity (≤150 m) was associated with a small, but non-significant lower FEV₁ (adjusted mean difference = −5.9 ml, 95% CI −30.4 to 18.5, p = 0.64). In adults, FEV₁ was also similar regardless of proximity to a main road

(mean FEV₁ = 3061 ml if ≤ 150 m and 3068 ml if >150 m), with a mean difference following adjustment for a priori confounders plus social class, body mass index and use of oil fired boilers of -4.9 ml (95% CI -18.5 to 8.8 ml, $p=0.49$). There was no evidence of dose-response relations amongst those living within 150 m of the roadside (p for trend = 0.84 and 0.65 for children and adults, respectively), nor effect modification by sex.

DISCUSSION

In this large nationally representative sample of adults and children we found no detrimental effect of living near a major road on the risk of chronic respiratory or allergic disease, measured either by self-report or with objective measures of lung function and IgE. For wheeze in 7–15-year-old children only, there was some suggestion of an increasing risk with increasing proximity across the first 150 m from the roadside. However, this was an isolated result which may have arisen by chance, particularly since the initial binary analysis of this group revealed that overall, those living within 150 m of a road had a significantly lower risk of wheeze compared with those living further away. A similar unexpected protective effect of living within 150 m of the roadside, on wheeze was seen in adults, which although statistically significant, was of a relatively small magnitude. A possible explanation for this is that respondents with asthmatic symptoms might be more likely to move away from, or choose not to live by major roads, which would have negatively biased our estimates. Alternatively, some exposure that is more prevalent in rural areas may be responsible, for example, ozone which has been previously linked to asthma in children.²⁹

Our exposure variable, distance from the home to a main road, was measured objectively and based on a cut-point of 150 m, along with smaller 30 m bands within this range, to reflect the patterns of pollutant decay that occur for most traffic-related pollutants near roads.^{20–21} By using postcode as our home location identifier, a certain degree of non-differential misclassification is inevitable, since in England a postcode identifies on average a group of 15 delivery points or adjacent houses rather than one exact address.³⁰ Using a different UK dataset, we have previously estimated that using postcode instead of exact address results in approximately 5% of people being misclassified for the binary exposure ≤ 150 m versus >150 m.³¹ Therefore for our main analyses, some dilution of effects may have occurred but this is unlikely to fully explain the lack of associations observed. However, for our secondary analyses using the smaller 30 m bands, misclassification will be greater and a true dose-response effect across the first 150 m from roadside could have been missed because of this. Also, because of the large geographical area covered, we were unable to use actual traffic counts to classify our main roads, instead defining a main road as a motorway or principal road (class A or B) according to the English road classification system. While in general such roads will be the busiest, again some non-differential misclassification of exposure status may have diluted our effect estimates.

A further consideration is whether selection bias may have influenced our findings. Over 75% of eligible households took part in the 3 years of survey,^{22–24} although analyses of lung function and IgE were based on smaller numbers as not all agreed to participate in these tests. However, there is no reason to suspect that response would differ between individuals living near or far from main roads since both respondents and interviewers were unaware of the hypothesis under investigation. Some subjects were further excluded from the current analysis because of missing data, and while there was a slight tendency for

the most socially advantaged to be more likely to be excluded, differences were relatively small and unlikely to have significantly biased our findings.

Our findings of no effect of living near busy roads on questionnaire-reported asthma and related symptoms in children fit with others who also found no adverse effects in this age group.^{12–13} Also in accordance with our findings are three case-control studies which used medical records to define cases of asthma and found no effect in children.^{32–34} In contrast, a recent study of Californian schoolchildren reported a significantly increased risk of wheeze and asthma among those living within 75 m of a major road,¹ a similar finding to that previously reported in English schoolchildren by Venn *et al.*² However in both these studies the effect was evident in girls only, a phenomenon also reported in two Dutch studies.^{3–6} In the current study we explored the possibility of gender-specific effects but found ORs close to unity regardless of gender. A number of other studies of children conducted in California and Germany reported overall adverse effects of living close to busy roads on wheeze and/or asthma but did not stratify by gender.^{4–5–7–8} Reasons for the inconsistencies between studies are not clear, although the choice of exposure definition may have contributed, with many of the positive studies using a more extreme definition such as living near heavily trafficked roads.^{3–6–8} Of the few previous studies to examine effects of living close to traffic on FEV₁ in children, all set in Europe, two showed no adverse effect^{5–13} in agreement with our findings, whereas Brunekreef *et al* did report a significant negative effect but only in relation to living near heavy truck traffic and not car traffic.¹⁷ We were unable to investigate the role of type of traffic in the current study as these data were not available. The issue of measurement error must also be considered in such studies of lung function since values of FEV₁ tend to be measured on a single day and may not reflect the subject's usual lung function if factors such as illness, high pollen counts or a pollution episode were operating that day.

In adults, our findings of no significant association with self-reported asthma or associated symptoms are consistent with a number of previous studies,^{6–14–15} but not all. Increased risks of wheeze of borderline statistical significance have been reported in relation to living within 50 m of a major road in US male veterans,⁹ with increasing residential proximity to surfaced roads in an area of Ethiopia with low background pollution,¹⁰ and in those living within 20 m of a main street in Switzerland.¹¹ Using FEV₁ as a more objective marker of asthma, two previous studies have reported an adverse effect of living near to busy roads, a finding not replicated in our investigation. In a large US study both traffic density at the residential location and living within 150 m of a main road were associated with reduced FEV₁, although only the former reached statistical significance, and effects were only evident in women and not men¹⁸; there was no evidence of any gender-specific effects in our analyses of adults. A similar finding was seen in a German study of women only in which those living within 100 m of a major road had significantly reduced FEV₁.¹⁹ This study is also the only other study to our knowledge that has assessed effects on spirometry-defined COPD, and while they used the same disease definition as us, the resulting OR was much larger and statistically significant (OR of 1.79 in relation to living <100 m from major road).¹⁹ As with children, reasons for the lack of agreement between findings in adults are unclear but may relate to the study setting and factors such as the volume of traffic on the roads and background levels of air

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pollution since these will affect the contrasts in exposure between the exposed and unexposed groups.

In addition to affecting respiratory health, it is feasible that exposure to traffic pollution could increase the risk of allergic sensitisation since traffic pollutants have been shown to enhance immunological responses to allergens.³⁵ Our lack of effect of living close to main roads on allergic outcomes including dustmite-specific IgE, fit with others who reported no significant effects on total or allergen-specific IgE,^{5 13} general allergen skin sensitisation^{5 13–15} or self-reported allergic conditions such as hay fever, eczema or doctor-diagnosed allergy.^{2 3 5 6 10 12–15} When specific sensitisation to pollen has been explored, adverse effects of living close to busy roads have been seen in both children^{5 7 13} and adults.¹⁴ Furthermore, in a recent cohort of very young children, sensitisation to common food allergens was more common in those living in an area of high modelled traffic pollution.³⁶ As sensitisation to these particular allergens was not assessed in the HSE, we were unable to explore such relations.

In conclusion, this study did not provide evidence of an adverse effect of living close to a main road on the risk of asthma, COPD or allergic disease in England. This lack of effect may be because in developed countries such as England, increasingly mobile lifestyles and saturation by background levels of pollution has meant that living near busy roads no longer equates to greater exposure to traffic-related pollutants than those living further away. Further studies are needed in the developing world where heterogeneity of exposure is likely to be greater in order to establish the effects of residential proximity to main roads in these populations.

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