Supplementary Online Content

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This supplementary material has been provided by the authors to give readers additional information about their work

eMETHODS

Air Pollution Measurements and Metrics

Air pollution monitoring stations were established in each of the eight communities. For each year of follow-up, measurements were made for ozone (O_3), NO_2, PM_{10}, and $PM_{2.5}$, as described previously.[1, 2] Annual means were computed of the 24-hour PM_{10}, $PM_{2.5}$ and NO_2 concentrations and of the 10:00 a.m. to 6:00 p.m. means of O_3. One-year lagged annual means were used to compute the cohort-specific mean levels (1993-2001 cohort: 9-yr average [exposure period: 1992 - 2000]; 1996-2004 cohort: 9-year mean [exposure period: 1995-2003]; and 2003-2012 cohort: 10-year mean [exposure period: 2002 - 2011]) in each community for each pollutant metric. Exposure assignments for individual participants were based on the central site monitoring data from the community where the participants resided. Each station monitored hourly levels of ozone (O_3), PM_{10}, NO_2 and $PM_{2.5}$. Data were collected using a variety of samplers and instruments over time which were then standardized accordingly to reference methods. These approaches included integrated daily $PM_{2.5}$ Federal Reference Method (FRM) samplers, specially-designed CHS integrated-two-week samplers, and Beta-Attenuation Mass Monitors (BAM, MetOne Model 1020). The 10:00 a.m. to 6:00 p.m. metric was selected because O_3 has a marked diurnal pattern, with highest concentrations occurring during midday and afternoon periods, when children were likely to be outside and, therefore, more exposed. Annual means of $PM_{2.5}$ were computed from hourly, daily, and/or two-week average measurements. A systematic quality assurance program was in place to review all data and correct, adjust, or reject any data of suspect quality. In those cases where data were invalidated due to questions of quality, interpolation methodologies using nearby monitoring sites and historical data were used to provide imputed values. PM_{10} mean pollutant concentrations from 1994 were used for Alpine, Riverside and Upland for 1992 and 1993 due to missing data. Similarly, $PM_{2.5}$ mean pollutant concentrations from 1994 were used for 1992 and 1993, for all eight communities, due to missing data. All data were reviewed by both the regional monitoring agency data review teams and the study research teams prior to acceptance into the study database.

Data Analysis

Descriptive Analysis

We examined the distributions of demographic as well as other personal and housing characteristics within each cohort, at study entry, using descriptive statistics and tests for overall associations. Furthermore, to examine the trend in air pollution levels changing from the earlier cohorts (i.e., the 1993-2001 and 1996-2004 cohorts) to the later 2003-2012 cohort within each community, we described the cohort-specific means in air pollutants within each community.

Modeling Approach

As the main modeling paradigm for analyzing the effect of improvements in air quality on bronchitic symptoms, we followed a multilevel modeling strategy described

previously. [3-6] To summarize, a three-level logistic linear mixed effects model was used in this study, with *t, c, i, j* denoting the community, cohort, subject, and year of visit, respectively. In the first level, we modeled the binary outcome on bronchitic symptoms (denoted by $y = 0\ or\ 1$ for "No" or "Yes" respectively) as a function of time-dependent covariates Z_{tcij}. Here, A_{tci} represent subject-specific adjusted probability of bronchitic symptoms, which were used in the second level models. T_{tcij} represents age (appropriately centered, say at 10 13 or 15 years of age to focus the inference), the time variable used for analysis. Based on extensive exploratory analysis, flexible piecewise cubic spline terms were included in the model with breakpoints at ages 10 and 15 years to account for non-linear age related trends in bronchitic symptoms. [7-9]

$$Logit\big(P[y_{tcij} = 1]\big) = A_{tci} + \delta T_{tcij} + \gamma_1 Z_{tcij} \qquad [1]$$

In the second-level model [Eq 2], subject-specific intercepts (i.e., adjusted probabilities of bronchitic symptoms) were regressed against subject-specific covariates, $Z_{2,tci}$. A_{tc} represents community and cohort-specific prevalences of bronchitic symptoms, which were used in the third-level models.

$$A_{tci} = A_{tc} + \gamma_2 Z_{2,tci} + e_{\,tci} \qquad [2]$$

In the third-level, community and cohort-specific adjusted prevalences of bronchitic symptoms A_{tc} from level 2 were regressed as functions of the cohort-specific multi-year means of air pollution for each community (Eq 3). Community indicators were also included in the third-level model as adjustments to focus health-effect estimates on secular changes in air pollutions within-community rather than across communities.

$$A_{tc} = \alpha \quad + \beta \bar{X}_{tc} + \gamma_3 Community + e_{tc} \quad [3]$$

These three regression models were combined to yield a more efficient mixed-effects model (Eq 4).

$$Logit\big(P[y_{tcij} = 1]\big) = \alpha \quad + \beta \bar{X}_{tc} + \gamma_3 Community + \gamma_2 Z_{2,tci} + \gamma_1 Z_{tcij} \ + \ \delta T_{tcij} + e_{tc} + e_{\,tci} \quad [4]$$

The main parameter of interest in the above logistic mixed effects model is the within-community across-cohorts effect of improvements of air quality on trends in bronchitic symptoms, β. To conduct a sensitivity analysis on the implicit assumption of homogeneity of the within-community effects across communities, we used a modified version of Eq. 3 as follows:

$$A_{tc} = \alpha \quad + b_c \bar{X}_{tc} + \gamma_3 Community + e_{tc} \quad [5]$$

$$b_c = \beta + f_c$$

$$\rightarrow A_{tc} = \alpha_t + \beta \bar{X}_{tc} + \gamma_3 Community + e_{tc} + \ f_c \bar{X}_{tc} \qquad [6]$$

Here, we assume $f_c \sim N(0, V_f)$ and the test for heterogeneity is based on whether V_f is significantly different from zero. We finally note that our modeling paradigm is consistent with previous models fitted to CHS data (e.g., [10]) where the interest was on assessing the effects of the within-community yearly fluctuations of pollution levels from the multi-year community means (i.e., $(X_{tcj} - \bar{X}_c)$), and the between-community differences $\bar{X}_c$. In the present analysis, we are essentially decomposing $(X_{tcj} - \bar{X}_{tc})$ into within-cohort between-years $(X_{tcj} - \bar{X}_{tc})$ and between-cohorts within-community $(\bar{X}_{tc} - \bar{X}_c)$ effects. Our results in the present work are based on β, *i.e.*, the effect associated with $(\bar{X}_{tc} - \bar{X}_c)$. Due to the use of community specific intercepts, we implicitly account for any between-community effects (including air pollution). In sensitivity analysis, inclusion of $(X_{tcj} - \bar{X}_{tc})$ did not show any significant results, indicating that the effects of the substantial improvements in air quality between the 1993-2001, 1996-2004 and 2003-2012 cohorts were dominating the effect of yearly fluctuations in air pollution levels.

To visualize the findings from the modeling approach, regression models were fitted of the prevalence of bronchitic symptoms (estimated based on the longitudinal model with adjustment for gender, race/ethnicity, and a spline function of age) on the long-term mean of a given air pollutant concentration for each of the eight communities (i.e., leading to eight regression lines). Then, for each community-specific regression line, the predicted prevalence of bronchitic symptoms was computed for a given air pollutant. The plots shown in Figure 2 are obtained by plotting the community-specific changes in air pollution levels (i.e., subtracting the maximum from the minimum AP levels) against the community-specific change in the prevalence of bronchitic symptoms (obtained by subtracting the prevalence at the maximum level of a given air pollutant from that obtained at the minimum level of the pollutant). Hence, the plots shown in Figure 2 are scatter plots based on the change in air pollution level and the corresponding change in predicted prevalence of bronchitic symptoms for each community.

Sensitivity Analysis

To test the robustness of study findings reported in the main manuscript (Tables 2 and 3), extensive sensitivity analyses were conducted (and reported in eTable 5) by limiting the analysis to important subgroups *(i)* to those children without SHS or in-utero tobacco smoke exposure, *(ii)* to those with pets, *(iii)* to those stratified by obesity status (i.e., limiting to Non-obese participants and to normal-weight participants based on age- and sex- specific <95th and <85th cutoffs respectively based on CDC percentiles[11]), *(iv)* to those filling English language questionnaire only, *(v)* to those stratified by ethnicity (limiting to Hispanic whites only or to non-Hispanic whites only), *(vi)* to those with parents completing English language questionnaire only, *(vii)* to those children without any asthma medication use, or *(viii)* to those children with complete data during follow-

up. Additional sensitivity analyses were conducted stratified by cat ownership, or parental level of education.

eTable 1. Distribution of prevalence of bronchitic symptoms at ages 10 and 15 by Asthma status for three CHS cohorts[a]

Characteristic		All (N=4602)	Cohort Follow-Up Period		
			1993 - 2001 (N=1008)	1996 - 2004 (N=1067)	2003 - 2012 (N=2527)
Bronchitic symptom at Age 10					
All	Asthma	39.6 (262/662)	52.8 (76/144)	48.7 (74/152)	30.6 (112/366)
	Non-Asthma	11.2 (319/2838)	13.8 (114/828)	14.6 (123/842)	7.0 (82/1168)
Alpine	Asthma	28.0 (23/82)	27.8 (5/18)	25.0 (6/24)	30.0 (12/40)
	Non-Asthma	7.9 (30/381)	11.8 (12/102)	7.0 (8/115)	6.1 (10/164)
Lake Elsinore	Asthma	47.7 (31/65)	57.1 (8/14)	66.7 (10/15)	36.1 (13/36)
	Non-Asthma	11.1 (37/333)	13.7 (14/102)	14.9 (17/114)	5.1 (6/117)
Long Beach	Asthma	44.3 (31/70)	44.4 (8/18)	50.0 (10/20)	40.6 (13/32)
	Non-Asthma	11.2 (34/303)	14.8 (16/108)	15.0 (15/100)	3.2 (3/95)
Mira Loma	Asthma	42.6 (29/68)	80.0 (12/15)	62.5 (10/16)	18.9 (7/37)
	Non-Asthma	8.8 (34/386)	6.3 (7/111)	16.8 (17/101)	5.7 (10/174)
Riverside	Asthma	40.6 (39/96)	61.5 (16/26)	50.0 (8/16)	27.8 (15/54)
	Non-Asthma	11.9 (42/352)	15.8 (18/114)	12.7 (14/110)	7.8 (10/128)
San Dimas	Asthma	43.4 (46/106)	53.3 (8/15)	56.0 (14/25)	36.4 (24/66)
	Non-Asthma	14.0 (48/343)	15.1 (14/93)	17.5 (18/103)	10.9 (16/147)
Santa Maria	Asthma	35.1 (27/77)	50.0 (10/20)	42.1 (8/19)	23.7 (9/38)
	Non-Asthma	11.6 (42/363)	12.9 (13/101)	18.6 (19/102)	6.3 (10/160)
Upland	Asthma	36.7 (36/98)	50.0 (9/18)	47.1 (8/17)	30.2 (19/63)
	Non-Asthma	13.8 (52/377)	20.6 (20/97)	15.5 (15/97)	9.3 (17/183)
Gender					
Girls	Asthma	38.1 (106/278)	49.1 (28/57)	44.6 (29/65)	31.4 (49/156)
	Non-Asthma	10.9 (161/1472)	13.9 (58/418)	14.8 (63/426)	6.4 (40/628)
Boys	Asthma	40.6 (156/384)	55.2 (48/87)	51.7 (45/87)	30.0 (63/210)
	Non-Asthma	11.6 (158/1366)	13.7 (56/410)	14.4 (60/416)	7.8 (42/540)
Dog Ownership					
No	Asthma	37.3 (139/373)	50.0 (32/64)	52.5 (31/59)	30.4 (76/250)

	Non-Asthma	11.1 (172/1553)	13.7 (54/395)	16.5 (63/381)	7.1 (55/777)
Yes	Asthma	42.9 (120/280)	55.0 (44/80)	46.2 (43/93)	30.8 (33/107)
	Non-Asthma	11.6 (145/1249)	13.9 (60/433)	13.0 (60/461)	7.0 (25/355)
Bronchitic Symptom at Age 15[b]					
All	Asthma	32.4 (150/463)	38.4 (43/112)	32.5 (39/120)	29.4 (68/231)
	Non-Asthma	18.1 (340/1875)	20.3 (116/572)	21.1 (132/627)	13.6 (92/676)
Long Beach	Asthma	32.1 (17/53)	61.5 (8/13)	25.0 (4/16)	20.8 (5/24)
	Non-Asthma	23.4 (54/231)	26.2 (22/84)	25.8 (16/62)	18.8 (16/85)
Mira Loma	Asthma	31.7 (19/60)	54.5 (6/11)	23.1 (3/13)	27.8 (10/36)
	Non-Asthma	14.2 (42/295)	28.2 (20/71)	16.9 (12/71)	6.5 (10/153)
Riverside	Asthma	37.2 (32/86)	45.0 (9/20)	25.0 (2/8)	36.2 (21/58)
	Non-Asthma	13.9 (42/302)	9.3 (7/75)	15.1 (13/86)	15.6 (22/141)
San Dimas	Asthma	32.3 (30/93)	23.1 (3/13)	50.0 (10/20)	28.3 (17/60)
	Non-Asthma	19.9 (55/276)	18.0 (11/61)	28.9 (24/83)	15.2 (20/132)
Upland	Asthma	28.0 (23/82)	37.5 (6/16)	15.4 (2/13)	28.3 (15/53)
	Non-Asthma	20.1 (64/319)	26.0 (19/73)	25.9 (21/81)	14.5 (24/165)
Gender					
Girls	Asthma	33.2 (66/199)	35.7 (15/42)	34.5 (19/55)	31.4 (32/102)
	Non-Asthma	19.2 (189/986)	20.5 (60/292)	22.2 (73/329)	15.3 (56/365)
Boys	Asthma	31.8 (84/264)	40.0 (28/70)	30.8 (20/65)	27.9 (36/129)
	Non-Asthma	17.0 (151/889)	20.0 (56/280)	19.8 (59/298)	11.6 (36/311)
Dog Ownership					
No	Asthma	30.2 (76/252)	42.0 (21/50)	32.6 (15/46)	25.6 (40/156)
	Non-Asthma	16.6 (172/1036)	19.0 (53/279)	19.0 (55/289)	13.7 (64/468)
Yes	Asthma	34.5 (71/206)	35.5 (22/62)	32.4 (24/74)	35.7 (25/70)
	Non-Asthma	20.6 (168/816)	21.5 (63/293)	22.8 (77/338)	15.1 (28/185)

a. Entries are % (Number of Yes / Total). Numbers may not always add up to overall total of 4,602 participants due to missing data

b. In Cohort E, the crude bronchitic symptom prevalence at age 15 in three communities, including Alpine, Lake Elsinore, and Santa Maria, were not reported due to having no observations at age 15

eTable 2. Long-term mean concentrations of air pollutants in eight communities for the three CHS cohorts

Community	Exposure Period	Mean of air pollutants by cohort exposure period			
		NO_2 (ppb)	O_3 (ppb)	PM_{10}[a] (μg/m^3)	$PM_{2.5}$[a, b] (μg/m^3)
All communities	1992-2000	25.2	47.7	38.3	20.5
	1995-2003	24.2 (-4.0%)	44.9 (-5.8%)	37.6 (-1.8%)	19.5 (-4.9%)
	2002-2011	18.5 (-26.5%)	44.8 (-6.0%)	33.9 (-11.4%)	14.4 (-30.0%)
Alpine	1992-2000	13.2	56	23.9	9.8
	1995-2003	12.9 (-2.7%)[c]	53.4 (-4.6%)	25.5 (6.9%)	9.9 (0.2%)
	2002-2011	9.6 (-27.5%)[c]	52.1 (-6.9%)	25.2 (5.5%)	10.2 (3.7%)
Lake Elsinore	1992-2000	18.2	54.8	34.9	15.5
	1995-2003	17.6 (-3.5%)	53.6 (-2.2%)	34.1 (-2.3%)	14.3 (-7.4%)
	2002-2011	13.9 (-23.8%)	51.4 (-6.1%)	35.3 (1.2%)	10.8 (-30.2%)
Long Beach	1992-2000	34.5	29.4	37	20
	1995-2003	32.1 (-6.9%)	28.7 (-2.4%)	36.6 (-1.2%)	20.3 (1.1%)
	2002-2011	23.5 (-31.8%)	30.4 (3.4%)	30.4 (-18%)	14.8 (-26%)
Mira Loma	1992-2000	24.6	53.8	66.2	30.5
	1995-2003	24.4 (-1.1%)	49.8 (-7.5%)	66.6 (0.6%)	28.8 (-5.7%)
	2002-2011	19.2 (-22%)	48.2 (-10.4%)	55.6 (-16.1%)	20.8 (-31.9%)
Riverside	1992-2000	25.8	59.2	42.1	28.5
	1995-2003	25.2 (-2.3%)	55.2 (-6.8%)	42.3 (0.4%)	26.5 (-7.2%)
	2002-2011	22.0 (-14.7%)	54.7 (-7.6%)	37.2 (-11.7%)	16.8 (-41.1%)
San Dimas	1992-2000	35.4	50.8	38.1	23.3
	1995-2003	33.1 (-6.6%)	44.4 (-12.7%)	33.7 (-11.4%)	21.1 (-9.5%)
	2002-2011	23.5 (-33.5%)	45 (-11.6%)	30 (-21.1%)	14.7 (-37.1%)
Santa Maria	1992-2000	11.2	29.6	21.4	9.1
	1995-2003	11.2 (0.3%)	30.5 (2.8%)	22 (2.9%)	9.4 (2.7%)
	2002-2011	9.2 (-17.7%)	31.1 (4.9%)	22.7 (5.9%)	7.9 (-13.1%)
Upland	1992-2000	39.0	47.7	42.9	27.3
	1995-2003	37.3 (-4%)	43.7 (-8%)	40 (-7%)	25.9 (-5%)
	2002-2011	27.5 (-29%)	45.4 (-5%)	35.2 (-18%)	18.8 (-31%)

a. If the measurements of years 1992 and 1993 are missing, they were estimated by the measurements of 1994.
b. If the measurement of year 2005 is missing, it was estimated by the measurements of 2006.
c. Mean pollutant level over the indicated exposure period in each community (values in parentheses are the percent change compared to the 1992–2000 exposure period for the 1993-2001 cohort)

eTable 3. Correlations of changes in community-specific long term mean levels of air pollutants, 1992 - 2011

	O_3 (ppb)	PM_{10} (μg/m^3)	$PM_{2.5}$ (μg/m^3)
NO_2	0.38	0.80	0.84
O_3		0.47	0.54
PM_{10}			0.88

Note: All correlations significant at $p<0.001$

eTable 4. Relative changes in bronchitic symptoms at age 10 (1993-2012) associated with reductions in air pollution by asthma status – Two pollutant models

Air Pollutants		Asthma		Non-asthma	
2-Pollutant Model	Pollutant	OR[a] (95% CI)	p-value	OR[a] (95% CI)	p-value
$NO_2 + O_3$[b]	NO_2	0.79 (0.66, 0.94)	0.007	0.76 (0.69, 0.85)	<0.001
	O_3	0.74 (0.55, 0.99)	0.04	0.95 (0.83, 1.10)	0.52
$PM_{10} + O_3$[c]	PM_{10}	0.66 (0.51, 0.87)	0.003	0.78 (0.68, 0.91)	0.001
	O_3	0.81 (0.60, 1.09)	0.16	0.95 (0.82, 1.10)	0.50
$PM_{2.5} + O_3$[c]	$PM_{2.5}$	0.65 (0.49, 0.87)	0.004	0.69 (0.58, 0.81)	<0.001
	O_3	0.81 (0.59, 1.11)	0.18	1.00 (0.85, 1.17)	0.98

a. Odds Ratios (ORs) are per median decreases in pollution levels based on the eight community-level average changes during the period between the 1993-2001 and the 2003-2012 cohorts (4.9, and 3.6 ppb for NO2, O3, and 5.8 and 6.8 $\mu g/m^3$ for PM10, and PM2.5, respectively). 95% CI entries refer to 95% Confidence Intervals.

b. Odds Ratio (OR), by asthma status, adjusted for age, gender, race, longitudinal exposure to second hand tobacco smoke, and roaches at baseline.

c. Odds Ratio (OR), by asthma status, adjusted for age, gender, race and longitudinal exposure to second hand tobacco smoke.

eTable 5. Relative changes in bronchitic symptoms at age 10 (1993-2012) associated with reductions in air pollution by asthma status – sensitivity analysis

Air Pollutants	Sensitivity Analysis Group	Number of Participants	Asthma		Non-asthma	
			OR[a] (95% CI)	p-value	OR[a] (95% CI)	p-value
NO_2[b]	All participants	4602	0.79 (0.67, 0.94)	0.007	0.84 (0.76, 0.92)	<0.001
	Participants without second hand or in-utero smoke exposure	2519	0.87 (0.69, 1.09)	0.22	0.82 (0.71, 0.94)	0.004
	Participants with pets	2892	0.88 (0.72, 1.07)	0.19	0.81 (0.72, 0.91)	<0.001
	Non-obese participants[d]	3465	0.81 (0.67, 0.99)	0.04	0.84 (0.75, 0.94)	0.002
	Normal-weight participants[e]	2529	0.79 (0.62, 0.99)	0.04	0.87 (0.76, 0.99)	0.04
	English questionnaire users only	3870	0.81 (0.69, 0.96)	0.02	0.88 (0.79, 0.97)	0.01
	Hispanic Whites	2081	0.92 (0.68, 1.26)	0.61	0.74 (0.63, 0.89)	<0.001
	Non-Hispanic Whites	1883	0.79 (0.62, 1.00)	0.05	0.79 (0.69, 0.91)	<0.001
	Participants without any asthma medication use	3671	0.85 (0.59, 1.23)	0.38	0.79 (0.71, 0.88)	<0.001
	Participants with complete data	1207	0.71 (0.54, 0.91)	0.008	0.79 (0.68, 0.92)	0.002
O_3[c]	All participants	4602	0.66 (0.50, 0.86)	0.002	0.85 (0.74, 0.97)	0.02
	Participants without second hand or in-utero smoke exposure	2519	0.74 (0.49, 1.13)	0.17	0.82 (0.67, 1.02)	0.07

	Participants with pets	2892	0.69 (0.5, 0.95)	0.02	0.81 (0.69, 0.95)	0.009
	Non-obese participants[d]	3465	0.60 (0.44, 0.82)	0.001	0.81 (0.70, 0.95)	0.009
	Normal-weight participants[e]	2529	0.58 (0.41, 0.82)	0.002	0.90 (0.75, 1.07)	0.24
	English questionnaire users only	3870	0.70 (0.53, 0.91)	0.008	0.87 (0.76, 1.01)	0.06
	Hispanic Whites	2081	0.64 (0.37, 1.08)	0.09	0.81 (0.63, 1.05)	0.11
	Non-Hispanic Whites	1883	0.64 (0.44, 0.93)	0.02	0.88 (0.73, 1.06)	0.17
	Participants without any asthma medication use	3671	0.65 (0.36, 1.17)	0.15	0.82 (0.71, 0.95)	0.007
	Participants with complete data	1207	0.61 (0.39, 0.94)	0.03	0.91 (0.71, 1.16)	0.42
PM_{10}[c]	All participants	4602	0.61 (0.48, 0.78)	<0.001	0.80 (0.70, 0.92)	0.001
	Participants without second hand or in-utero smoke exposure	2519	0.71 (0.49, 1.03)	0.07	0.73 (0.60, 0.89)	0.002
	Participants with pets	2892	0.74 (0.55, 0.99)	0.04	0.74 (0.63, 0.88)	<0.001
	Non-obese participants[d]	3465	0.60 (0.45, 0.80)	<0.001	0.81 (0.69, 0.95)	0.008
	Normal-weight participants[e]	2529	0.60 (0.43, 0.85)	0.004	0.85 (0.71, 1.02)	0.09
	English questionnaire users only	3870	0.61 (0.48, 0.79)	<0.001	0.85 (0.73, 0.98)	0.02

	Hispanic Whites	2081	0.63 (0.42, 0.96)	0.03	0.71 (0.58, 0.88)	0.002
	Non-Hispanic Whites	1883	0.66 (0.46, 0.96)	0.03	0.79 (0.64, 0.98)	0.03
	Participants without any asthma medication use	3671	0.67 (0.39, 1.14)	0.14	0.76 (0.66, 0.88)	<0.001
	Participants with complete data	1207	0.56 (0.39, 0.81)[d]	0.002	0.72 (0.58, 0.89)	0.003
$PM_{2.5}$[c]	All participants	4602	0.68 (0.53, 0.86)	0.002	0.79 (0.69, 0.91)	<0.001
	Participants without second hand or in-utero smoke exposure	2519	0.79 (0.56, 1.11)	0.18	0.72 (0.59, 0.88)	0.001
	Participants with pets	2892	0.81 (0.61, 1.08)	0.15	0.73 (0.61, 0.87)	<0.001
	Non-obese participants[d]	3465	0.70 (0.53, 0.94)	0.02	0.76 (0.64, 0.89)	0.001
	Normal-weight participants[e]	2529	0.66 (0.47, 0.92)	0.01	0.81 (0.67, 0.98)	0.03
	English questionnaire users only	3870	0.69 (0.54, 0.89)	0.004	0.86 (0.75, 1.00)	0.06
	Hispanic Whites	2081	0.72 (0.47, 1.10)	0.13	0.66 (0.52, 0.83)	<0.001
	Non-Hispanic Whites	1883	0.74 (0.51, 1.06)	0.10	0.81 (0.65, 1.00)	0.05
	Participants without any asthma medication use	3671	0.77 (0.43, 1.38)	0.38	0.72 (0.62, 0.83)	<0.001
	Participants with complete data	1207	0.56 (0.39, 0.80)	0.001	0.74 (0.59, 0.92)	0.007

a. Odds Rations (ORs) are per median decreases in pollution levels based on the eight community-level average changes during the period between the 1993-2001 and the 2003-2012 cohorts (4.9, and 3.6 ppb for NO_2, O_3, and 5.8 and 6.8 μg/m^3 for PM_{10}, $PM_{2.5}$, respectively). 95% CI entries refer to 95% Confidence Intervals.
b. OR adjusted for age, gender, race, longitudinal second hand smoke, and roaches at baseline.
c. OR adjusted for age, gender, race and longitudinal second hand smoke.
d. Non-obese participants are identified based on age- and sex- specific CDC cutoffs of <95th BMI percentile.
e. Normal-weight participants are identified based on age- and sex- specific CDC cutoffs of <85th BMI percentile

eTable 6. Relative changes in bronchitic symptoms at age 13 (1993-2012) associated with reductions in air pollution by asthma status

Air Pollutants	At Age 13			
	Asthma		Non-asthma	
	OR[a] (95% CI)	p-value	OR[a] (95% CI)	p-value
NO_2[b]	0.78 (0.66, 0.92)	0.003	0.82 (0.74, 0.90)	<0.001
O_3[c]	0.67 (0.51, 0.88)	0.003	0.85 (0.74, 0.98)	0.03
PM_{10}[c]	0.61 (0.48, 0.78)	<0.001	0.81 (0.71, 0.92)	<0.001
$PM_{2.5}$[c]	0.67 (0.52, 0.85)	<0.001	0.78 (0.68, 0.90)	<0.001

a. Odds Ratios (ORs) are per median decreases in pollution levels based on the eight community-level average changes during the period between the 1993-2001 and the 2003-2012 cohorts (4.9, and 3.6 ppb for NO2 and O3 respectively; 5.8 and 6.8 $\mu g/m^3$ for PM10, and PM2.5, respectively). 95% CI entries refer to 95% Confidence Intervals.

b. Odds Ratio (OR), by asthma status, adjusted for age, gender, race, longitudinal exposure to second hand tobacco smoke, and roaches at baseline.

c. Odds Ratio (OR), by asthma status, adjusted for age, gender, race and longitudinal exposure to second hand tobacco smoke.

eTable 7. Relative changes in bronchitic symptoms (1993-2012) associated with reductions in air pollution by asthma status, based only on data for ages common to all cohorts (i.e., between ages 10 and 15)

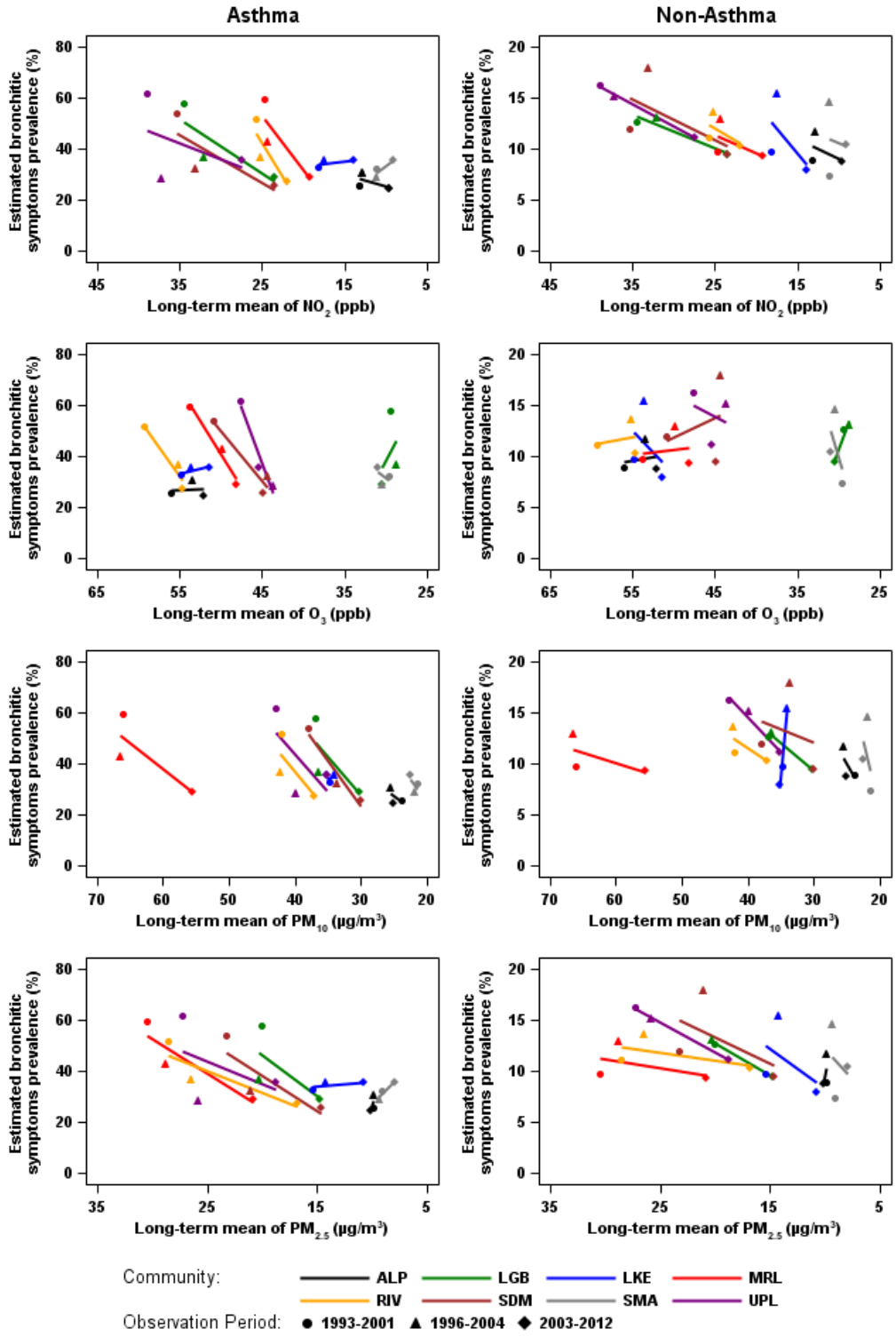
Air Pollutants	Asthma		Non-asthma	
	OR[a] (95% CI)	p-value	OR[a] (95% CI)	p-value
NO_2[b]	0.90 (0.80, 1.02)	0.10	0.84 (0.78, 0.91)	<0.001
O_3[c]	0.78 (0.65, 0.92)	0.006	0.94 (0.86, 1.02)	0.22
PM_{10}[c]	0.74 (0.61, 0.88)	<0.001	0.81 (0.73, 0.90)	<0.001
$PM_{2.5}$[c]	0.80 (0.67, 0.95)	0.01	0.81 (0.73, 0.90)	<0.001

a. The averaging periods for exposure in this analysis for the three successive cohorts were as follows: 1992-1997, 1995-2000, and 2006-2011 respectively. Odds Ratios (ORs) are per median decreases in pollution levels based on the eight community-level average changes during the period between the 1993-2001 and the 2003-2012 cohorts (4.9 and 3.6 ppb for NO_2, O_3, and 5.8 and 6.8 $\mu g/m^3$ for PM_{10}, and $PM_{2.5}$, respectively), for effects to be comparable to those in other model tables**.** 95% CI entries refer to 95% Confidence Intervals.

b. Odds Ratio (OR), by asthma status, adjusted for age, gender, race, longitudinal exposure to second hand tobacco smoke, and roaches at baseline.

c. Odds Ratio (OR), by asthma status, adjusted for age, gender, race and longitudinal exposure to second hand tobacco smoke.

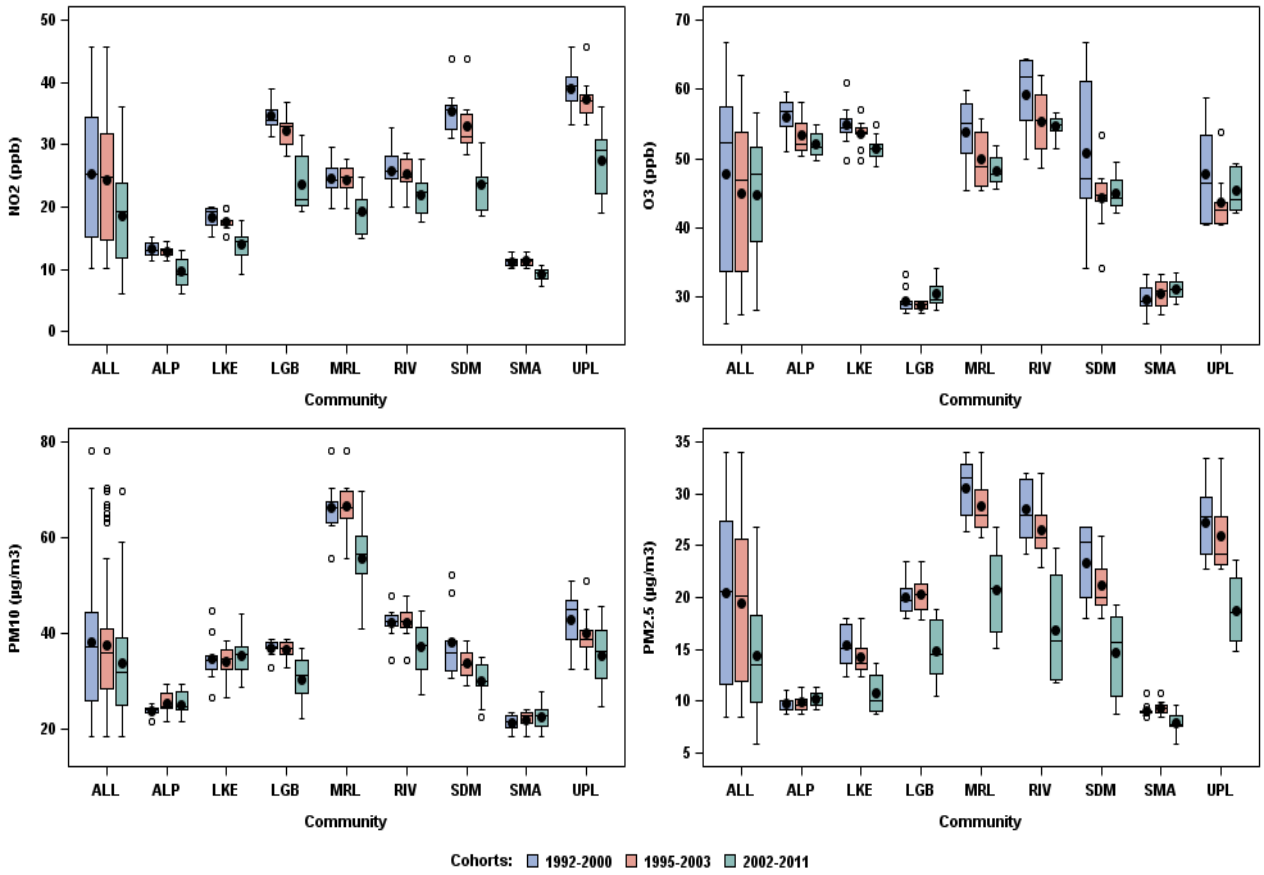
eFigure 1. Estimated bronchitic symptom prevalences at age 10 vs. mean air pollutant concentrations among CHS participants by asthma status.[a,b]



a. The estimated bronchitis symptoms prevalences were obtained from longitudinal analyses with adjustments for gender, race, age, and second hand smoke exposure, for CHS children with asthma (left panel) and without asthma (right panel). The lines depict linear trends in the relationship between estimated bronchitic symptoms and long term mean air pollution across the three cohorts, for each of the eight communities. The long term mean air pollution levels for the 1993 – 2001, 1996 – 2004 and 2003 – 2012 cohorts were obtained by averaging annual mean levels for 1992 – 2000, 1995 – 2003, and 2002 – 2011, respectively. The corresponding observation periods of bronchitic symptoms for the three cohorts were the years 1993 – 2001, 1996 – 2004, and 2003 – 2012, respectively.

b. ALP: Alpine, LGB: Long Beach , LKE: Lake Elsinore, MRL: Mira Loma, RIV: Riverside, SDM: San Dimas, SMA: Santa Maria, and UPL: Upland

eFigure 2. Box plots of annual mean air pollutant concentrations by cohorts and communities[a,b,c]



a. The annual measurements of air pollutants concentrations were lagged by one year, relative to the measurements of bronchitic symptoms. Thus, the exposure periods for the 1993 – 2001, 1996 – 2004, and 2003 – 2012 cohorts were 1992 – 2000, 1995 – 2003, and 2002 – 2011, respectively.

b. In the boxplots:

●: the mean of the air pollutant concentration levels

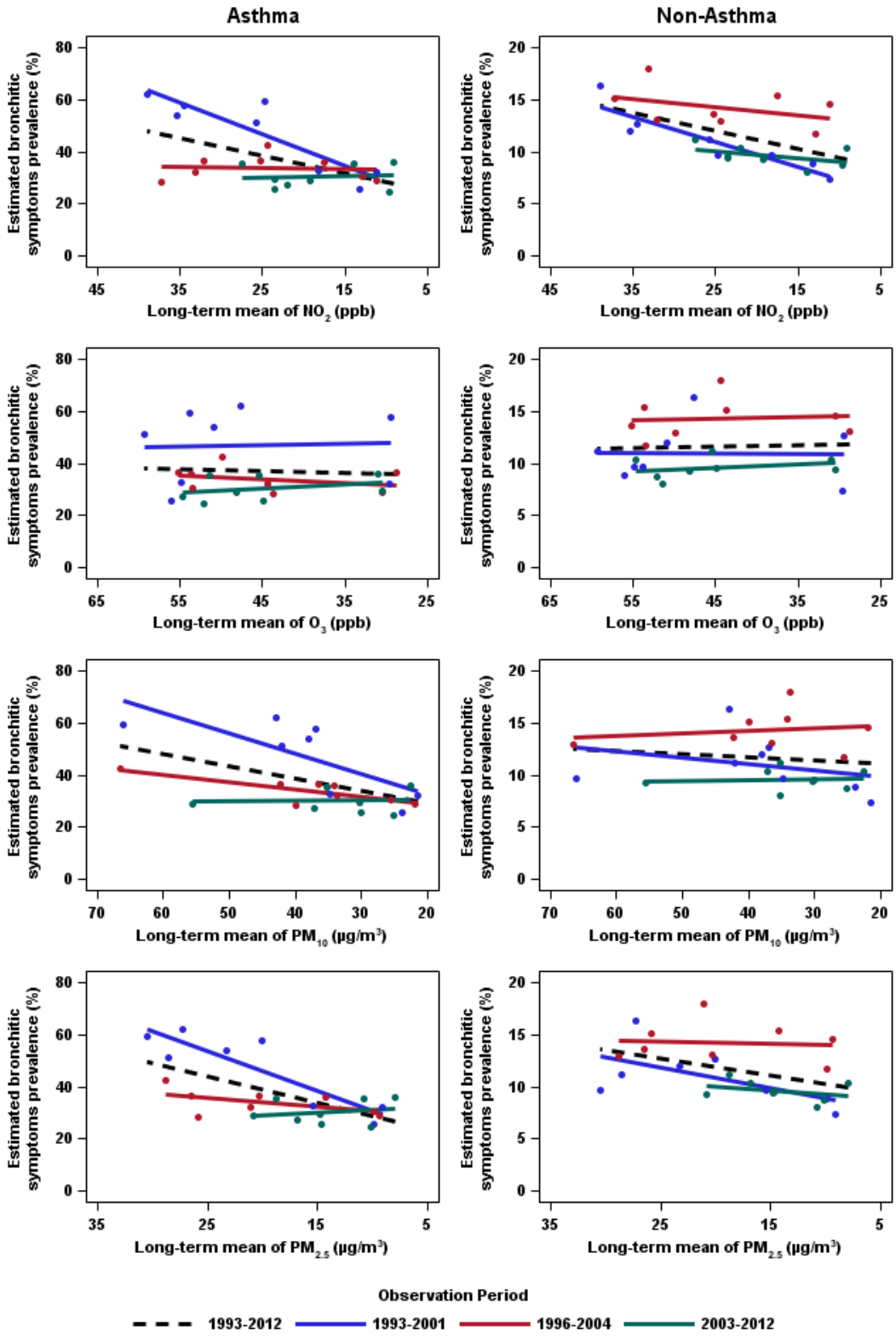
○: the outliers, i.e., the observations above the upper fence (1.5 times of the interquartile range (IQR) above 75th percentile) or below the lower fence (1.5 times of the interquartile range (IQR) below 25th percentile)

-: the upper fence (1.5 times of IQR above 75th percentile), or the lower fence (1.5 times IQR below 25th percentile)

The upper extreme edge, median edge, and lower extreme edge of box represent 75th percentile, median, and 25th percentile, respectively.

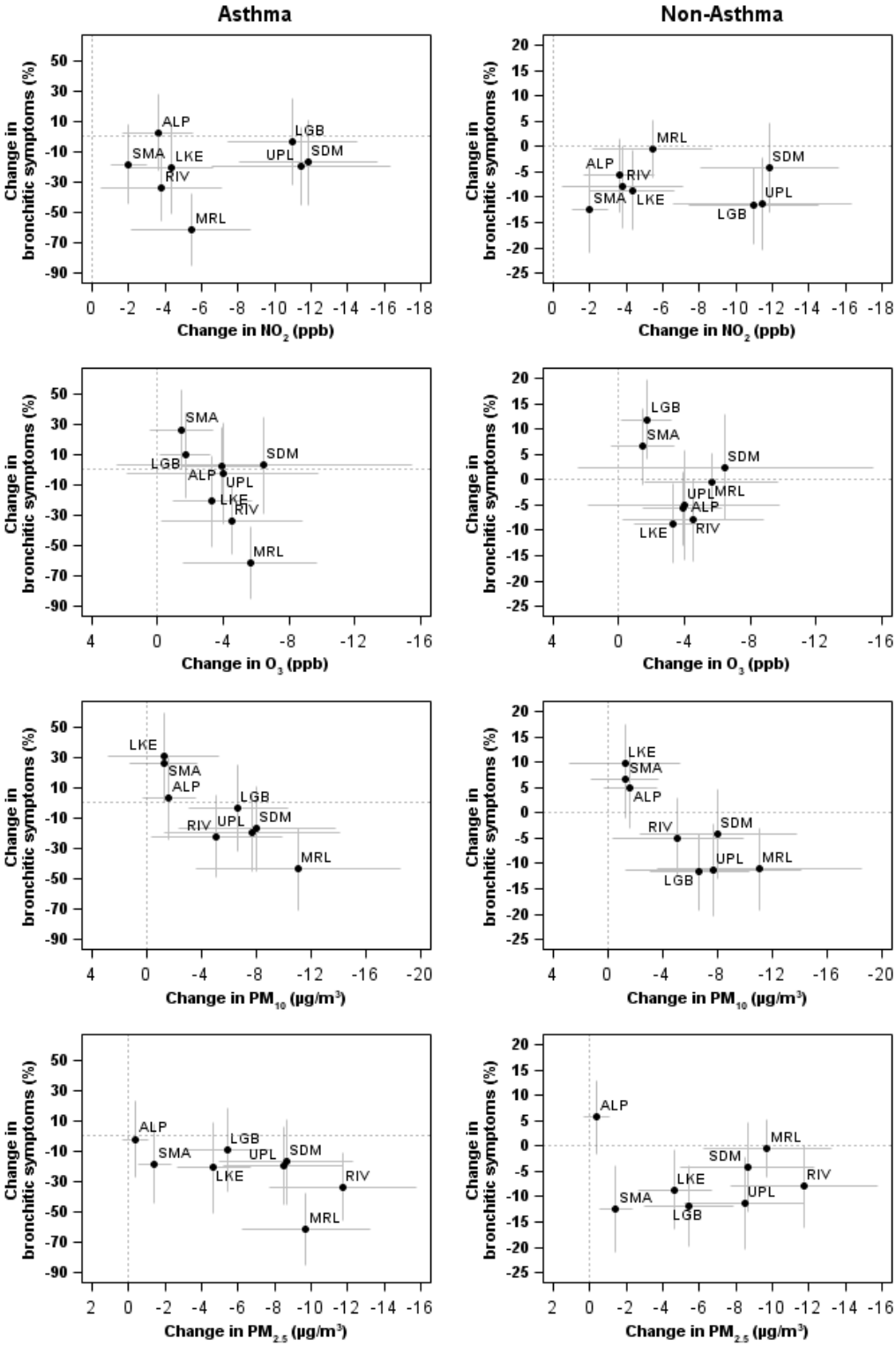
c. ALP: Alpine, LGB: Long Beach , LKE: Lake Elsinore, MRL: Mira Loma, RIV: Riverside, SDM: San Dimas, SMA: Santa Maria, and UPL: Upland

eFigure 3. Estimated bronchitic symptom prevalences at age 10 vs. air pollutant concentrations among CHS participants by asthma status.[a]



a. The estimated bronchitis symptoms prevalences obtained from longitudinal analyses with adjustments for gender, race, age, and second hand smoke exposure, for CHS children with asthma (left panel) and without asthma (right panel). The regression lines depict between-community (within-cohort) comparisons between adjusted prevalence of bronchitic symptoms and long-term mean levels of air pollution for the 1993-2001 (blue), 1996-2004 (red) and 2003 – 2012 (green) cohorts, while the broken line depicts corresponding between-community comparison for all three cohorts combined. Data markers depict entries for each community with color designation by cohort.

eFigure 4. Change in raw bronchitic symptom prevalence at age 10 versus the change in mean air pollutants over the study period by community[a,b]



a. Plots (black dots) depict the observed changes in prevalence of bronchitic symptoms at age 10 during the 1993-2012 observation period for the asthma (left column) and non-asthma (right column) subgroups as functions of the changes in exposure levels in the mean exposure levels during the 1992-2011 exposure averaging periods, comparing the highest and lowest polluted cohorts within each community. In each panel, the gray vertical and horizontal bars depict the 95% confidence intervals for the changes in the respective pollutant and the changes in bronchitic symptom prevalence, respectively.

b. ALP: Alpine, LGB: Long Beach , LKE: Lake Elsinore, MRL: Mira Loma, RIV: Riverside, SDM: San Dimas, SMA: Santa Maria, and UPL:Upland

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