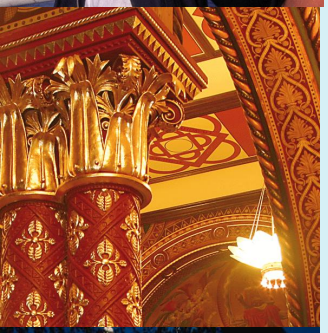
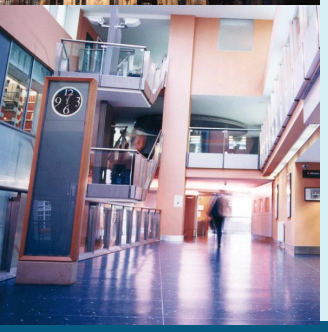




AIR POLLUTION INTERVENTION RESEARCH (AsPIRe) – PREDICTION OF POSSIBLE EFFECTIVENESS AND ASSESSMENT OF INTERVENTION STUDY FEASIBILITY

Dr Heather Walton, Dr Gary Fuller, Timothy Baker

Science Policy Group,

Environmental Research Group

28th June 2012

Main aim of air pollution information services

Provision of information before and during air pollution episodes to allow the public to avoid exposure or ameliorate the effects of air pollution.

Service considered likely to benefit health in some people (rather than proved)

Supporting evidence has been qualitative

Feasibility of intervention study?

Sufficient statistical power?

Can those that would benefit most be identified? (May not be those that sign up)

Distinguishing reasons for any benefits – protecting against air pollution effects or just improving medication compliance?

Unexpected results? Those that sign up may already have good asthma control. May even increase anxiety.

Three stage approach

I Evaluation of airAlert service (qualitative research on public perception)

II Literature evidence, prediction of benefits, scoping feasibility of intervention study (this project)

III Direct study of intervention if feasible

Approach continued

First step to predicting benefits is predicting additional admissions

Baseline is days without alerts (days when all pollutants are low)

i.e. Estimating impacts of episodes not total impacts

Pollutant increments low to high days

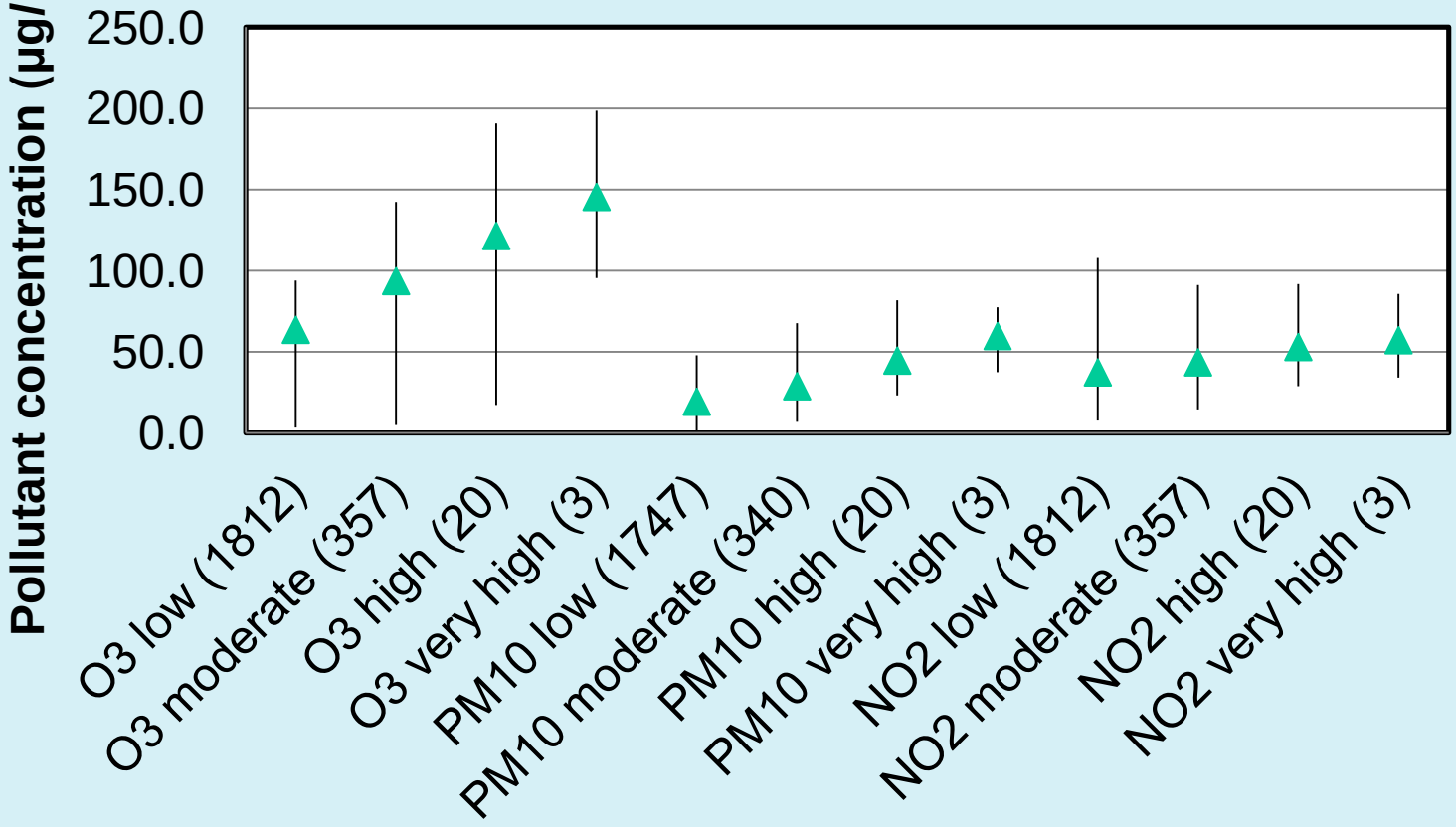
Urban or rural background sites in Sussex

Any site high = high day.

Each high day $\longrightarrow$ average relevant pollutant across all sites (high or not), also average other pollutants even if not high.

Subtract ave for all low days from site average each high day.

Figure 1a Regional average pollutant concentrations (max, ave, min) in Sussex on low, moderate, high and very high days for any pollutant (background sites)

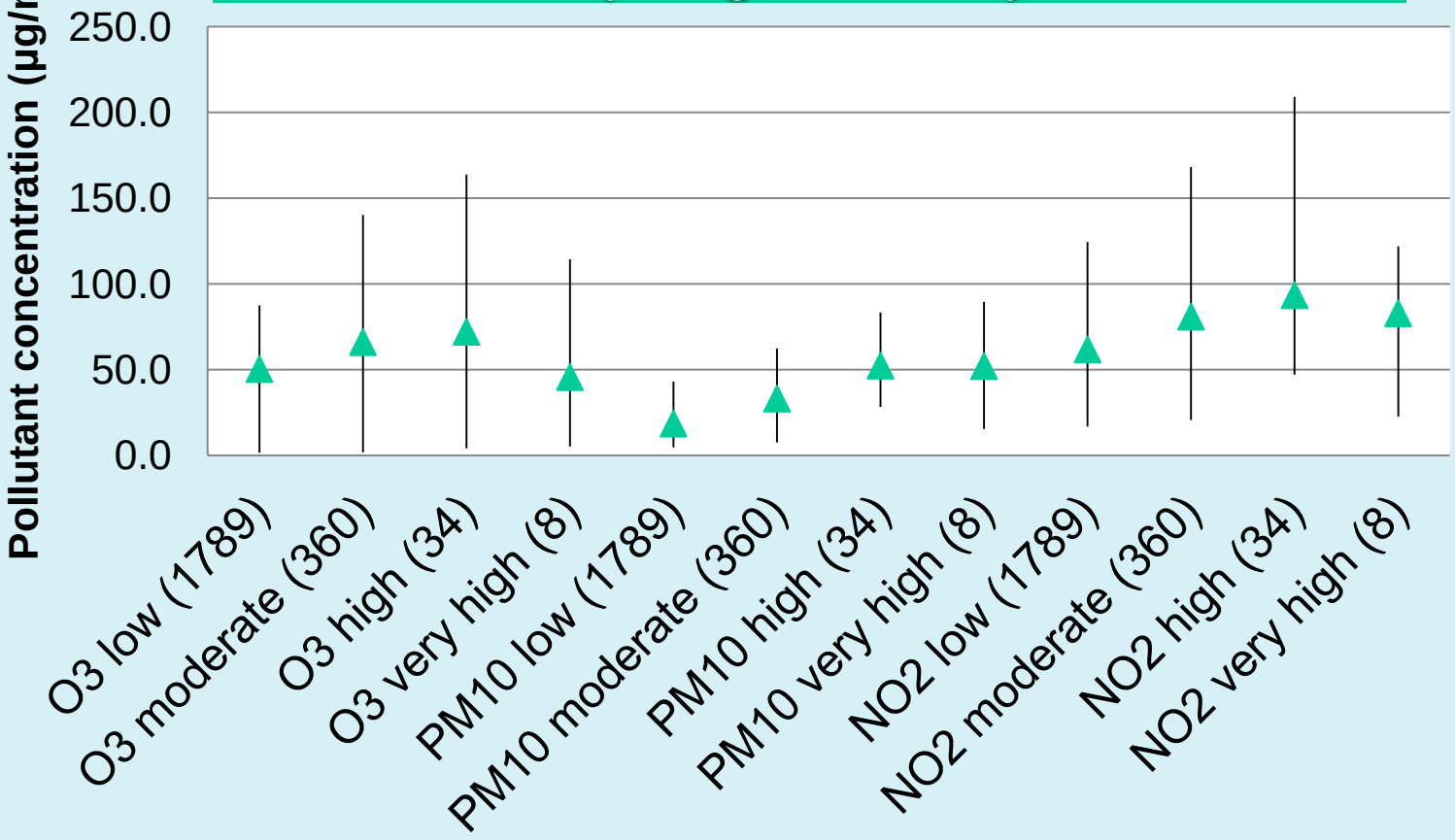


(PM_{10} is given as reference-equivalent values)

Table 1a Increments in pollutant concentrations (μg/m^3) for moderate to low, high to low and very high to low days in Sussex

Pollutant	Ave. (range) difference moderate to low	Ave. (range) difference high to low	Ave. (range) difference very high to low
O_3	30.0 (-58.6 to 78.7)	57.8 (-46.3 to 127.3)	81.8 (31.8 to 135)
PM_{10}	9.6 (-12.4 to 48.5)	25.3 (3.9 to 62.5)	40.5 (18.3 to 58.3)
NO_2	6.2 (-22.7 to 53.9)	15.6 (-8.5 to 54.4)	19.8 (-3.2 to 48.4)

Figure 1b Regional average pollutant concentrations (max, ave, min) in London on low, moderate, high and very high days for any pollutant (background sites)



(PM_{10} is given as reference-equivalent values)

Table 1b Increments in pollutant concentrations (μg/m^3) for moderate to low, high to low and very high to low days in London

Pollutant	Ave. (range) difference moderate to low	Ave. (range) difference high to low	Ave. (range) difference very high to low
O_3	15.7 (-58.5 to 89.9)	21.7 (-46.1 to 113.5)	-4.7 (-45 to 64)
PM_{10}	14.6 (-11 to 43.7)	33.8 (2 to 64.8)	33.5 (-3.2 to 70.9)
NO_2	19.1 (-41.1 to 106.3)	31.7 (-14.8 to 147.3)	21.1 (-39.1 to 60.2)

APED (2007) Report Single city meta-analytical estimates respiratory hospital admissions (% increase per 10 μg/m^3 or 10 ppm)

(random effects, not adjusted for publication bias for this table)

Pollutant	Ave. time	Studies for meta-analysis	Pooled estimate	lcl	ucl
Ozone	8 hour	7	0.63	0.09	1.18
NO_2	1 hour	4	0.15	-0.08	0.38
PM_{10}	24 hour	19	1.71	1.19	2.23

Calculation

(% increase per 10 μg/m^3)/10 x ΔC = % increase per increment (simple version)

% increase per increment x number of events per 100,000 population per year = increase in number of events per 100,000 population per year

Number of events x 1/100,000 x 1/365 x pop of Sussex x number of days = number of events from high days for each pollutant

Inputs

Baseline rate emergency respiratory hospital admissions = 1196.7/100,000 (England 2010/11)

Population of Sussex = 1563000 (2010)

Baseline emergency respiratory hospital admissions in Sussex per day ~ 51

Rescaling coefficients

Ozone 0.63% increase per 10 $\mu g/m^3$

Relative risk = 1.0063

$E(Y|x) = e^{\beta x}$ RR = exp(βx)

$\beta = (\ln RR)/x = (\ln 1.0063)/10 = 0.000628$

New β = 0.000628 x new concentration change

Reverse process to get new % increase

Table 3a Range of daily values for additional emergency respiratory hospital admissions in Sussex for moderate, high and very high days vs. low days

Pollutant	Moderate	High	Very high
O_3	-2 to 3	-1 to 4	1 to 5
PM_{10}	-1 to 4	<1 to 6	2 to 5
NO_2	<0 to <1	<0 to <1	<0 to <1
Total without NO_2	<0 to 6	2 to 6	6 to 7
Total with NO_2	<0 to 6	2 to 6	6 to 7

Table 3b Range of daily values for additional emergency respiratory hospital admissions in London for moderate, high and very high days vs. low days

Pollutant	Moderate	High	Very high
O_3	-8 to 15	-7 to 19	-7 to 11
PM_{10}	-5 to 20	1 to 30	-1 to 33
NO_2	-2 to 4	-1 to 6	-2 to 2
Total without NO_2	-4 to 30	-2 to 31	-5 to 39
Total with NO_2	-4 to 29	-1 to 34	-6 to 41

Table 4a Total additional emergency respiratory hospital admissions in Sussex for each and all pollutants on moderate, high and very high days vs. low days for period 2006-2011

Pollutant	Moderate	High	Very high
O_3	350	38	8
PM_{10}	289	45	11
NO_2	17	2	0
Total without NO_2	639	84	19
Total with NO_2	656	86	20

Table 4b Total additional emergency respiratory hospital admissions in London for each and all pollutants on moderate, high and very high days vs. low days for period 2006-2011

Pollutant	Moderate	High	Very high
O_3	939	124	-6
PM_{10}	2329	518	123
NO_2	266	42	7
Total without NO_2	3268	643	118
Total with NO_2	3534	684	124

Total additional respiratory hospital admissions at background sites in Sussex 2006-2011 for moderate, high and very high days compared with low days

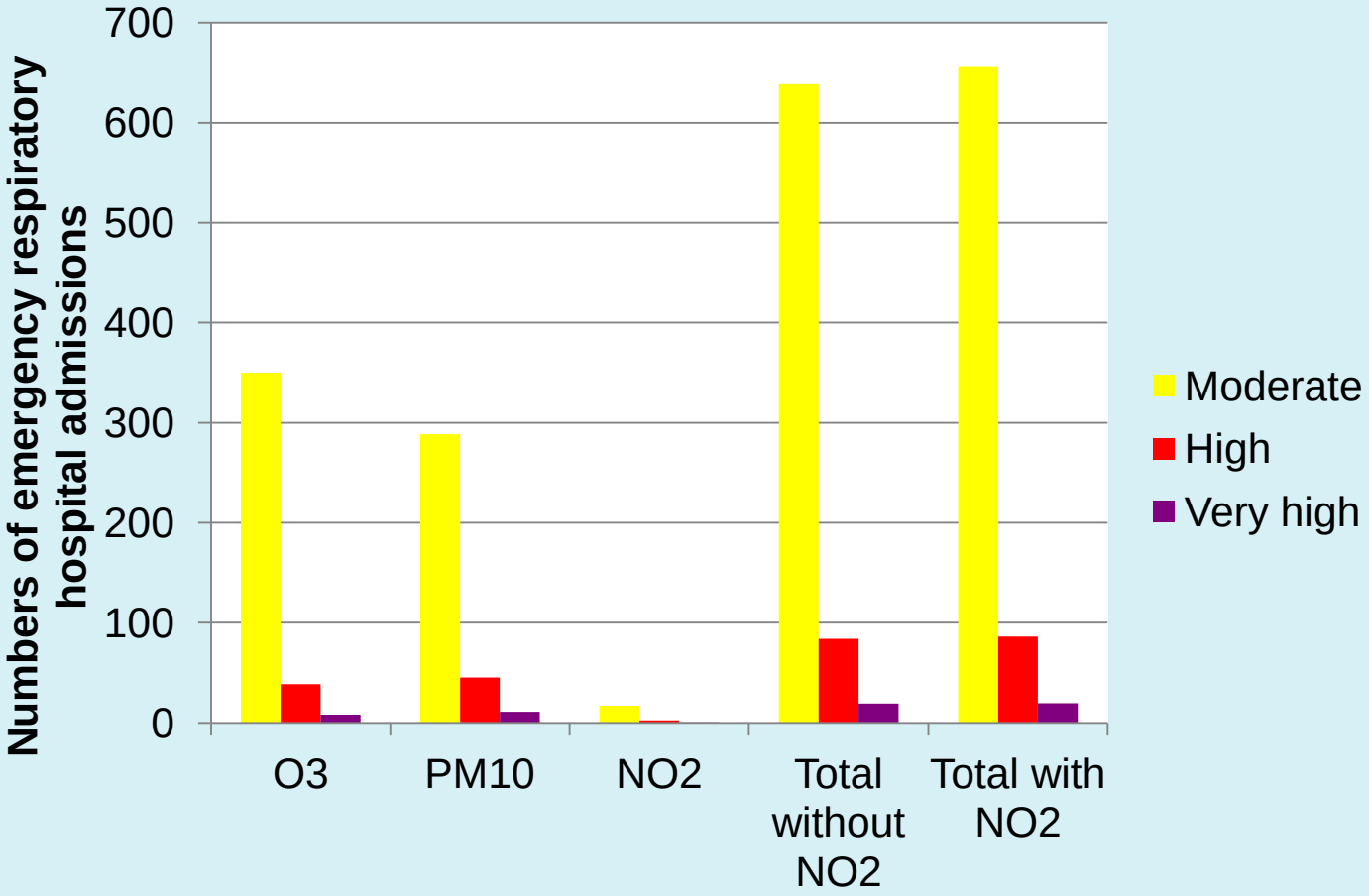
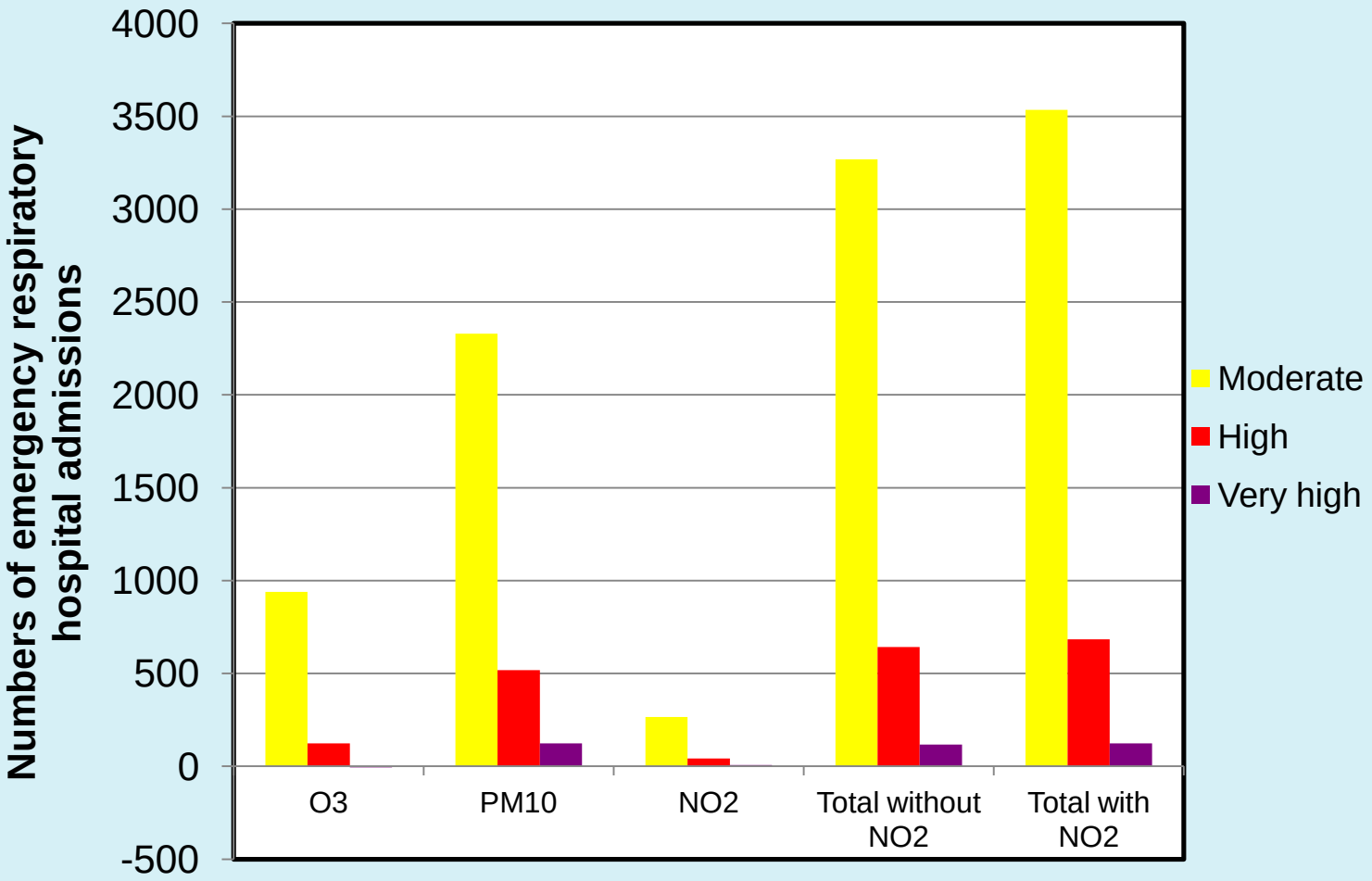
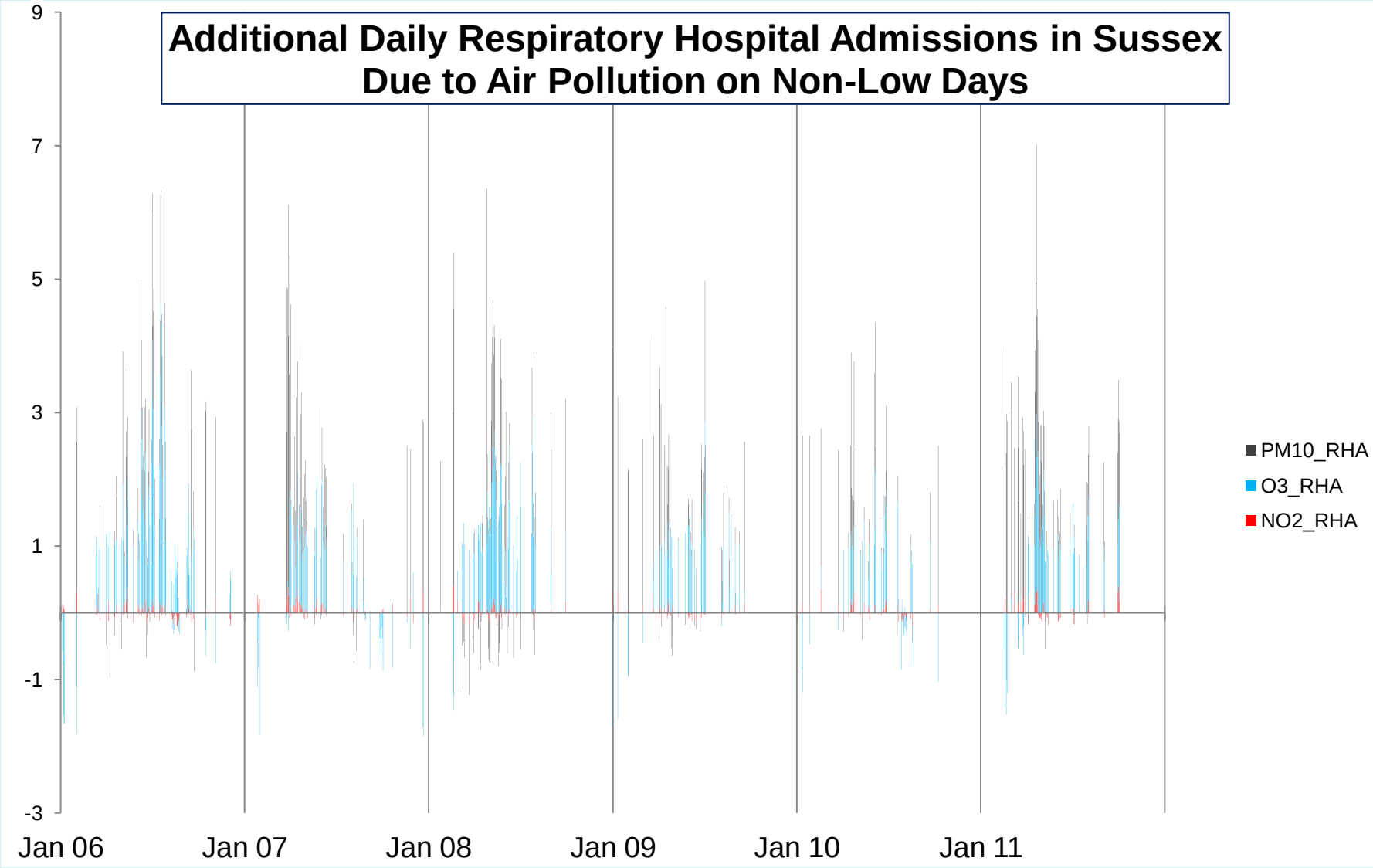


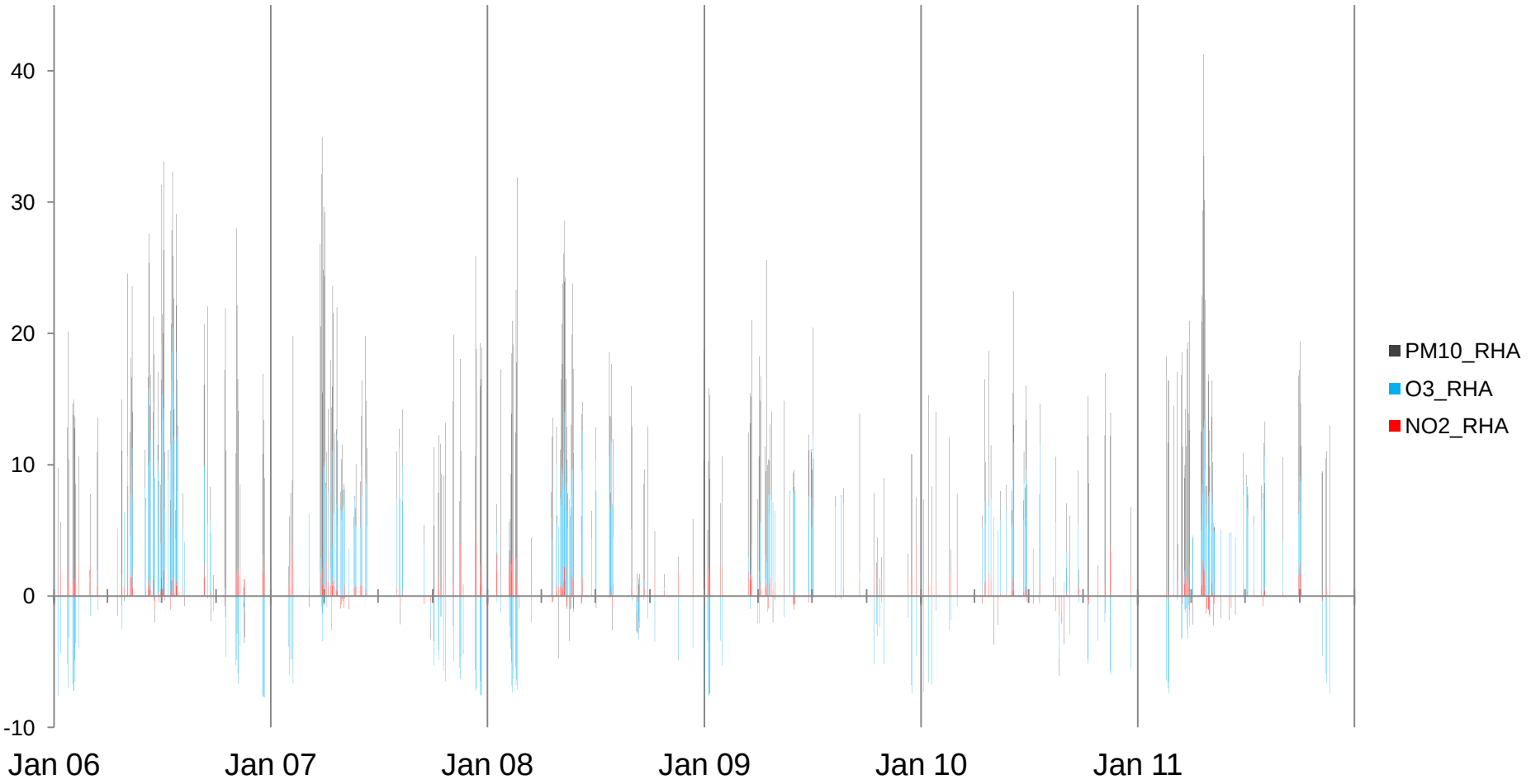
Figure 2b Total additional respiratory hospital admissions at background sites in London 2006-2011 for moderate, high and very high days compared with low days



Additional Daily Respiratory Hospital Admissions in Sussex Due to Air Pollution on Non-Low Days



Additional Daily Respiratory Hospital Admissions in London Due to Air Pollution on Non-Low Days



APED (2007) Report: Number of studies on admissions for specific respiratory diagnoses

Outcome	Diagnosis	Age group	O3 8hr	NO2 1hr	PM10 24hr
			Number of studies for meta-analysis		
HAD	ASTHMA	AA	7	4	7
HAD	ASTHMA	C	5	7	17
HAD	ASTHMA	YA	5	5	9
HAD	ASTHMA	E	4		
HAD	COPDp	AA			
HAD	COPDp	E			14
HAD	COPDm	AA	4		
HAD	COPDm	E			17
HAD	LRI	AA			3
HAD	LRI	C			
HAD	LRI	YA			
HAD	LRI	E			18

APED (2007) Report Single city meta-analytical estimates asthma hospital admissions (% increase per 10 μg/m^3 or 10 ppm)

(random effects, not adjusted for publication bias for this table)

Pollutant	Ave. time	Studies for meta-analysis	Pooled estimate	lcl	ucl	More studies?
Ozone	8 hour	5	0.75	-1.72	3.28	5?
NO_2	1 hour	7	0.09	-1.05	1.24	2?
PM_{10}	24 hour	17	1.78	1.01	2.55	2-3?

APED (2007) Report: Number of studies on emergency room visits

Outcome	Diagnosis	Age group	O3 8hr	NO2 1hr	PM10 24hr
			Number of studies for meta-analysis		
EV	RESP	AA			5
EV	RESP	C			
EV	RESP	YA			
EV	RESP	E			4
EV	ASTHMA	AA			
EV	ASTHMA	C	5	5	
EV	ASTHMA	YA			
EV	ASTHMA	E			

APED (2007) Report: Number of panel studies

Outcome[1]	Pop group[2]	Age group[3]	O3 8hr	NO2 1hr	PM10 24hr
			Number of studies for meta-analysis		
FEV_1	Healthy	C	12		
FVC	Healthy	C	6		
PEFR	Healthy	C	10		
PEFR	Symptomatic	C		only 24 hr	28
PEFR	Unselected	C	4		5
iURS	symptomatic	C		only 24 hr	25
pURS	symptomatic	C		only 24 hr	27
iLRS(O)	symptomatic	C		only 24 hr	25
pLRS(O)	symptomatic	C		only 24 hr	29
iM	symptomatic	C		only 24 hr	18
pM	symptomatic	C		only 24 hr	28

Can these be avoided? (Provisional musings...)

Factors	Numbers avoided 2006-2011 (Sussex)	Comments
All extra admissions	742	Unlikely to avoid all
Take action in response (67%)	497	From focus group work, only if all people had signed up
Proportion of population receiving alerts (650/1,563,000= 0.04%)	0.3	Can't use alert to avoid admission if not signed up! Assumes only one admission avoided per person
Proportion of asthmatics (0.3%)	2	Assumes 15% asthmatic.. Need to add COPD.
Action actually works	?	Need intervention study

$$RHA_{day\ t} = ((EXP(((LN((CR/100)+1)/10) \times \Delta(P_t - P_{low})))-1) \times (((RHA_{base,yeart}/pop\ Eng_{yeart})/365) \times pop\ Ssx_{yeart})$$

((CR/100)+1) is the relative risk per 10 $\mu g/m^3$

$\Delta(P_t - P_{low})$ is the concentration increment between the concentration of the relevant pollutant on that day and the average of the relevant pollutant across all low days

(((LN((CR/100)+1)/10) x $\Delta(P_t - P_{low})$) converts the RR to the slope β and scales it to the new increment

((EXP(((LN((CR/100)+1)/10) x $\Delta(P_t - P_{low})$))-1) converts back to a % increase to multiply by $(((RHA_{base,yeart}/pop\ Eng_{yeart})/365) \times pop\ Ssx_{yeart})$ the baseline rate emergency respiratory hospital admissions per year scaled per day and for Sussex rather than England to give:

$RHA_{day\ t}$ the number of extra emergency respiratory hospital admissions that day due to the increment over the low day average

Quantitative evidence short-term changes in air pollution and respiratory health outcomes

St. George's Air Pollution Epidemiology Database (Anderson, 2007) 700 pp

http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@en/@ps/documents/digitalasset/dh_121202.pdf

Good quality time-series and panel study papers with quantitative results to 2006.

Meta-analyses done for all pollutant/outcome/diagnosis/age groups with 4 or more estimates.

Pollutants: particulate matter (**PM_{10}**, $PM_{2.5}$, $PM_{2.5-10}$, BS, SO_4^{2-} and TSP), **NO_2, O_3**, **SO_2** and **CO**.

Mortality, **respiratory** and cardiovascular hospital admissions, A&E, primary care, **lung function, symptoms**, **medication use**.

PCTs (operating in six clusters) and Acute/Foundation trusts in London

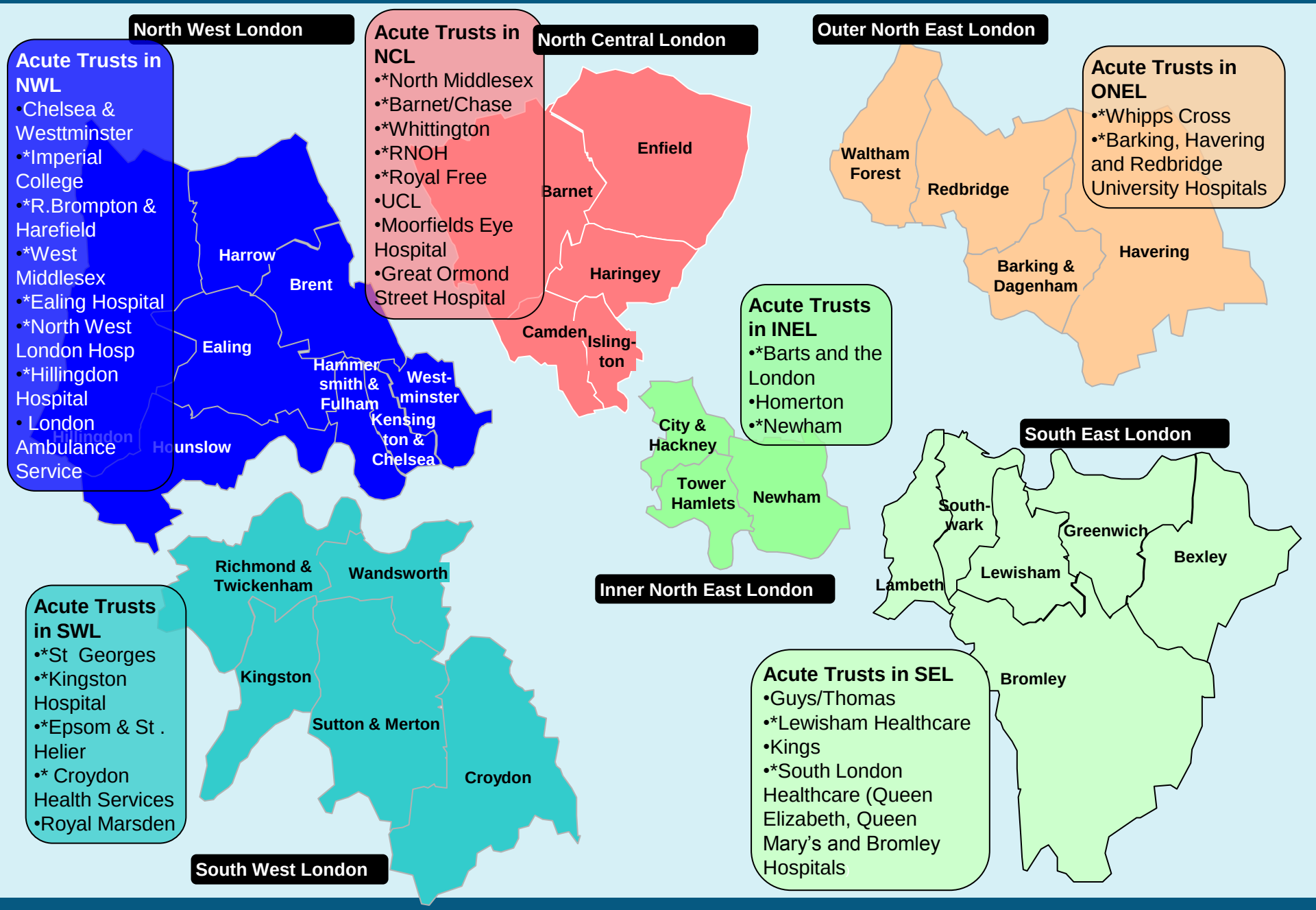
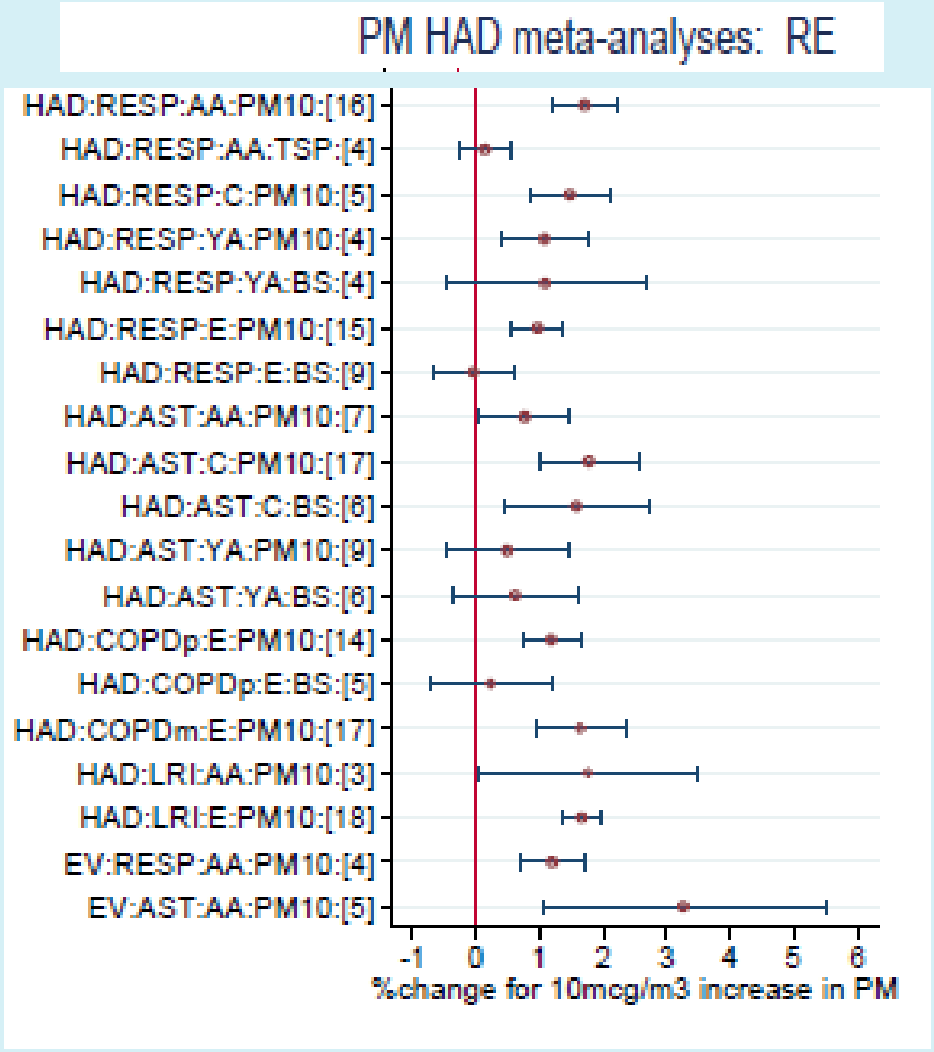


Figure 4.1b: PM. Morbidity. Forest plots of summary estimates from meta-analyses of single city estimates (fixed effects, random effects, trimmed fixed effects, trimmed random effects). (See footnote to Table 4.2b for abbreviations used, [n] = number of cities)



Respiratory hospital admissions +ve sig all age groups

Asthma admissions +ve sig children

COPD admissions +ve sig

Lower resp infections +ve sig

Emergency visits +ve sig

Review updated database to 2009/10 (separate project)

1 year project; funding agreed. Started in full May 2012

Update to 2009 previously done, 2011 almost done

Systematic review ozone, NO_2, particle metrics.

May be meta-analyses of new outcomes