Supplemental Table S5-3 Supplementary Epidemiologic Studies of Short-term Exposure to Oxides of Nitrogen and Respiratory Hospital Admissions and Emergency Department Visits

Study	Location (Years)	Type of Visit (ICD9/10)	Metric	Mean NO_2 Concentration (ppb)	Upper Percentile Concentrations of NO_2 (ppb)	Exposure Assessment	Selected Effect Estimates (95% CI)[a]
Hospital Admissions							
Alencar and Santos (2014)	São Paulo, Brazil (2006-2011)	Hospital Admissions: All Respiratory (J)	24-h avg	NO_2: 30.6 NO (µg/m3): 58.7 NO_x (µg/m3): 77.9	NO_2: 90th: 16.4 Max: 85.4 NO: 90th: 121.3 Max: 325.7 NO_x: 90th: 141.8 Max: 349.5	Average of 4 monitors	**% Change mean, median, 90% quantile of hospitalization rate for 10-90th percentile change In daily mean of each pollutant, lag 1** NO: Mean: 4.4 (1.3, 7.6) Median: 3.9 (-0.9, 8.8) 90%: 6.3 (1.8, 10.9) NO_2: Mean: 4.2 (0.5, 8.1) Median: 4.1 (-1.2, 9.7) 90%: 7.8 (1.5, 14.4) NO_x: Mean: 4.8 (1.5, 8.3) Median: 4.5 (-0.7, 10.0) 90%: 7.3 (3.1, 11.7)
Alves et al. (2010)	Lisbon, Portugal (1999-2004)	Hospital Admissions: All Respiratory (460-519) Asthma (493) COPD (490-492, 494-496)	1-h max	40.1	75th: 49.3 Max: 153.7	Average of 3 monitors	No respiratory results presented. Author's state no significant results found for NO_2 and any respiratory outcome.
Bener et al. (2009a)	Qatar (2002-2005)	Hospital Admissions: All Respiratory (460-466, 480-486, 490-496)	24-h avg	33	75th: 39 Max: 111	Average of all monitors	Quantitative results not presented
Bener et al. (2009b)	Qatar (2002-2005)	Hospital Admissions: All Respiratory (460-466, 480-486, 490-496)	24-h avg	33	75th: 39 Max: 111	Average of all monitors	Quantitative results not presented
Cai et al. (2014)	Shanghai, China (2005-2011)	Hospital Admissions: Asthma (J45)	24-h avg	31.9	75th: 38.3 Max: 88.8	Average of 6 monitors	% Increase, lag 0-1 ≥18 10.9 (5.9, 15.9)
Chen et al. (2010)	Shanghai, China (2005-2007)	Hospital Admissions: All Respiratory (J00-J98)	24-h avg	30.3	75th: 37.2 Max: 77.7	Average of 6 monitors	Lag 0-6: 1.4 (-3.1, 6.0)

Study	Location (Years)	Type of Visit (ICD9/10)	Metric	Mean NO_2 Concentration (ppb)	Upper Percentile Concentrations of NO_2 (ppb)	Exposure Assessment	Selected Effect Estimates (95% CI)[a]
Cheng et al. (2009)	Kaohsiung, Taiwan (1996-2006)	Hospital Admissions: Pneumonia (480-486)	24-h avg	26.1	75th: 34.5 Max: 65.4	Average of 6 monitors	**ORs; lag 0-2** **Warm Days:** Comorbid Conditions: Hypertension With:1.4 (1.2, 1.7) Without: 1.4 (1.3, 1.5) Diabetes: With: 1.4 (1.2, 1.6) Without: 1.4 (1.3, 1.5) URI: With:1.5 (1.3, 1.8) Without: 1.4 (1.3, 1.5) Asthma: With: 1.4 (1.1, 1.7) Without: 1.4 (1.3, 1.5) **Cool Days:** Comorbid Conditions: Hypertension With: 2.1 (1.8, 2.5) Without: 2.3 (2.2, 2.5) Diabetes: With: 2.2 (1.9, 2.6) Without: 2.3 (2.2, 2.4) URI: With: 2.4 (2.0, 2.8) Without: 2.3 (2.2, 2.4) Asthma: With: 2.2 (1.8, 2.8) Without: 2.3 (2.2, 2.4)
Chiu et al. (2009)	Taipei, Taiwan (1996-2004)	Hospital Admissions: Pneumonia (480-486)	24-h avg	30.6	75th: 35.4 Max: 78.0	Average of 6 monitors	**OR; Lag 0-2** **≥ 23° C** 1.49 (1.41, 1.53) **< 23° C** 1.14 (1.08, 1.19)
Giovannini et al. (2010)	Southwest Milan, Italy (2007-2008)	Hospital Admissions: Asthma (493) Upper Respiratory Disease (381, 382, 461-465) Lower Respiratory Disease (466, 480-486, 490)	24-h avg	14.6-46.1	NR	Central-site monitor	All Respiratory: 144% (11, 440) Asthma: 22.1% (0, 49.1) URD: 34.9% (0, 81.9) LRD: 64.7% (10.5, 170.5)
Hsieh and Liao (2013)	Taiwan (1998-2010)	Hospital admissions: Asthma (493)	24-h avg	14.8	25.2	Average of monitoring stations in each city/county.	**RR not presented.**

Study	Location (Years)	Type of Visit (ICD9/10)	Metric	Mean NO_2 Concentration (ppb)	Upper Percentile Concentrations of NO_2 (ppb)	Exposure Assessment	Selected Effect Estimates (95% CI)[a]
Jayaraman and Nidhi (2008)	New Delhi, India (2004-2005)	Hospital Admissions: NR	24-h avg	45.8	Max: 79.3	City-wide average of 7 monitors.	**Results not presented, CIs in the paper are incorrect**.
Krmpotic et al. (2011)	Zagreb, Croatia (2004-2006)	Hospital Admissions: Asthma	24-h avg	16.1	75^{th}: 19.1 90^{th}: 24.7 Max: 59.8	Average of 4 monitoring stations	**Regression Coefficient (SE)** **Raw:** 0.0126 (0.0042); lag 5 **Natural Log:** 0.3511 (0.1497); lag 5
Leitte et al. (2009)	Drobeta-Turnu Severin, Romania (2004-2006)	Hospital Admissions: Asthma (345) Chronic bronchitis (341-342) COPD (344)	24-h avg	6.2	95^{th}: 9.9 Max: 17.8	Central-site monitor	**No quantitative results provided.**
Makra et al. (In Press)	Szeged, Hungary (1999-2007)	Hospital Admissions: Allergic Rhinitis (J3010, 3020, 3030, 3040) Asthma (J4500, 4510, 4580)	24-h avg	1/14-7/14: 15.1 7/15-10/16: 14.1 10/17-1/13: 14.5	NR	Central-site monitor	**RR not presented.**
Namdeo et al. (2011)	Leeds, West Yorkshire, UK (2002-2005)	Hospital Admissions: All Respiratory (J00-J99)	24-h avg	NR	NR	Central-site monitor	0-59: 3.1% (0.8, 5.0); lag 0 60-69: 3.4% (-2.6, 9.4); lag 0 70-74: 3.4% (-3.7, 11.1) 75-79: 3.8% (-6.2, 14.5) > 80: 2.7% (-1.9, 7.0)
Negrisoli and Nascimento (2013)	São Paulo, Brazil (2007-2008)	Hospital Admissions: Pneumonia (J12-J18)	24-h avg	NO: 6.6 NO_2: 25.6	Max: NO: 61.3 NO_2: 80.3	Central-site monitor	**Children 0-10; RR** **NO; lag 3** 1.02 (1.00, 1.04) **NO_2; lag 0** 1.06 (1.03, 1.10)
Park et al. (2013)	7 South Korean cities (1999-2003)	Hospital Admissions: Asthma (J45, J46)	24-h avg	20-36	47-75	Average of all monitors in each city ranging from 3-27 monitors, after calculating 5% trimmed daily average at each monitoring station.	**RR (per 10,000 hospital admissions); lag not reported** < 15: 3.0 (-3.2, 9.6) 15-64: 1.2 (-2.8, 5.3) 65+: 11.8 (3.9, 20.3)
Sauerzapf et al. (2009)	Norfolk, UK (1/2006-2/2007)	Hospital Admissions: COPD	24-h avg	Case days: NO: 4.3 NO_2: 12..2 NO_X: 18.7	Max: Case days: NO: 15.2 NO_2: 22.9 NO_X: 44.4	Central-site monitor	**≥18** **OR, Lag 0-7** **NO:** 1.3 (1.0, 1.7) **NO_2:** 2.0 (1.3, 3.0)

Study	Location (Years)	Type of Visit (ICD9/10)	Metric	Mean NO_2 Concentration (ppb)	Upper Percentile Concentrations of NO_2 (ppb)	Exposure Assessment	Selected Effect Estimates (95% CI)[a]
				Control days: NO: 3.7 NO_2: 11.7 NO_X: 17.3	Control days: NO: 13.6 NO_2: 21.7 NO_X: 40.6		**NO_X:** 2.4 (2.2, 2.6)
Thach et al. (2010)	Hong Kong (1996-2002)	Hospital Admissions: Acute Respiratory Disease (460-466, 480-487) COPD (490-496)	24-h avg	31.2	NR	Average of 8 monitors	**Lag 0-1** **ARD:** 4.7 (2.8, 6.6) **COPD:** 7.5 (6.0, 9.0)
Tao et al. (2014)	Lanzhou, China (2001-2005)	Hospital Admissions: All Respiratory (J00-J99) Upper Respiratory Tract Infection (J00-J06) Pneumonia (J12-J18) COPD (J40-J44)	24-h avg	42.6	Max: 138.3	Average of all monitors	**All Respiratory; lag 1** 4.1 (0.9, 7.2) **Upper Respiratory Tract Infection; lag 4** 9.0 (3.9, 14.6) **COPD; lag 3** 5.9 (0.4, 11.6) **Pneumonia; lag 2** 14.2 (6.3, 22.6)
Zhen et al. (2013)	Lanzhou, China (2001-2005)	Hospital Admissions: All Respiratory (J00-J99)	24-h avg	24.4	75^{th}: 29.8 Max: 138.3	Average of all monitors	**RR; Lag 0-6** Low Temp: 1.48 (1.35, 1.63) Normal Temp: 1.08 (1.05,1.11) High Temp: 1.00 (0.88, 1.14)
Emergency Department Visits							
Abe et al. (2009)	Tokyo, Japan (1/2005-12/2005)	ED Visits: Asthma visits by ambulance	1-h max	NO_X: 137.4	Max: 542	City-wide average of 23 monitors	**Quantitative results presented are for ARIMA model. Not comparable to other results.**
Chan et al. (2009)	Taipei, Taiwan (2000-2002)	ED Visits: Asthma (493.0-493.2, 493.9)	24-h avg	Range of avg concentrations across counties: 14.3-29.2	Range of 95^{th} across counties: 15.1-30.9	Data from 11 monitoring stations used in ordinary kriging	Estimates are for a 10% Increase in NO_2 concentrations (authors did not provide representative concentration): 0.2 (-0.1, 0.4); lag 1
Chen et al. (2013)	Taipei, Taiwan (2000-2008)	ED Visits: Asthma (493)	24-h avg	24.8	NR	Average of 11 monitors.	**NO_2 results not presented because no associations with asthma ED visits observed.**
Halonen et al. (2008)	Helsinki, Finland (1998-2004)	ED Visits: Asthma (J45, J46) COPD (J41, J44)	24-h avg	15	75^{th}: 18.2 Max: 51.3	Average of central monitoring sites	Asthma (<15) 12.4% (0.5, 25.6); lag 3 31.3% (17.7, 46.1); lag 4 26.6% (13.6, 41.2): lag 5 Adults combined asthma and

Study	Location (Years)	Type of Visit (ICD9/10)	Metric	Mean NO_2 Concentration (ppb)	Upper Percentile Concentrations of NO_2 (ppb)	Exposure Assessment	Selected Effect Estimates (95% CI)[a]
							COPD together, did not present results separately.
Kim et al. (2007)	Seoul, Korea (2002)	ED Visits: Asthma (J45, J46)	1-hr max	36.0	Max: 108.0	Central site monitor in 23 districts, average of 2 in the remaining 2 districts	**Results only presented by socioeconomic position (SEP) referent to another SEP**
Lavigne et al. (2012)	Windsor, Canada (4/2002-3/2009)	ED Visits: Asthma (J45, J46, T486, Y556, Z825)	24-h avg	Cool (October-March): 10.6 Warm (April-September): 7.9	Max: Cool: 29.5 Warm: 23.1	Average of central site monitors	All Year; Lag 1: All: -2.2% (-14.9, 11.5) 2-14: 11.5% (-10.8, 39.1) 15-39: -4.4% (-22.8, 16.2) 40-59: -12.8% (-35.7, 13.8) 60+: -10.8% (-44.1, 41.8)
Makra et al. (2012)	Szeged, Hungary (1999-2007)	ED Visits: Asthma (J4500, 4580, 4590)	24-h avg	1/14-7/14: 15.1 7/15-10/16: 14.1 10/17-1/13: 14.5	NR	Central-site monitor	**RR not presented.**
Mohr et al. (2008)	St. Louis, MO (2001-2003)	ED Visits: Asthma (493)	1-h max	NR	NR	Central-site monitor	**Study did not present single-pollutant results.**
Moura et al. (2009)	Rio de Janeiro, Brazil (2002-2003)	ED Visits: Asthma	24-h avg	33.4	75^{th}: 43.3 Max: 111.6	Central-site monitor	**Children < 12** **Lag 0-2** 3.7% (-3.8, 11.8)
Pereira et al. (2010)	Perth, Australia (2002-2006)	ED Visits: Asthma (J45, J46)	24-h avg	6.3	75^{th}: 10	Modeled daily background concentrations	Results for 1 ppb increase in NO2 concentrations: RR: Ages: 0-4: 1.21 (1.03, 1.43) 5-9: 1.01 (0.83, 1.23) 10-19: 1.05 (0.90, 1.23)
Szyszkowicz (2008)	Edmonton, Canada (4/1992-3/2002)	ED Visits: Asthma (493)	24-h avg	21.9	NR	Average of monitors	Lag 2: 8.4% (3.5, 13.6)
Tramuto et al. (2011)	Palermo, Italy (2004-2007)	ED Visits: Respiratory symptoms	24-h avg	22.1	75^{th}: 26.4 90^{th}: 31.2	Average of 10 monitoring sites	Lag NR 5.8% (1.5, 10.1)
Physician Visits/Outpatient Visits							
Chan et al. (2009)	Taipei, Taiwan (2000-2002)	Outpatient visits: Asthma (493.0-493.2, 493.9)	24-h avg	Range of avg concentrations across counties: 14.3-29.2	Range of 95^{th} across counties: 15.1-30.9	Data from 11 monitoring stations used in ordinary kriging	Estimates are for a 10% Increase in NO_2 concentrations (authors did not provide representative concentration): 0.7 (0.5, 0.8); lag 0

Study	Location (Years)	Type of Visit (ICD9/10)	Metric	Mean NO_2 Concentration (ppb)	Upper Percentile Concentrations of NO_2 (ppb)	Exposure Assessment	Selected Effect Estimates (95% CI)[a]
Larrieu et al. (2009)	Bordeaux, France (2000-2006)	Home Medical Visits: Upper respiratory diseases (R75-77, 83, 97) Lower respiratory diseases (R78-79, 95, 05) Asthma (R96)	24-h avg	11.6	95th: 22.0 Max: 54.4	Average of 4 monitors	Lag 0-3 Upper respiratory disease: 3.0% (-2.6, 8.9) Lower respiratory disease: 10.1% (0.8, 19.7) Asthma: 4.2% (-10.8, 21.0)
Laurent et al. (2008)	Strasbourg, France (2000-2005)	Physician Calls: Asthma Attacks	24-h avg	19.1	NR	Modeled air pollution concentrations using ADMS-Urban software.	RR: Lag 0 1.1 (0.96, 1.3)
Yamazaki et al. (2013)	Himeji City, Japan (2010-2012)	Primary Care Clinic Visits: Physician Diagnosed Asthma and Bronchodilator Prescription	24-h avg	April-June: 12.5 July-August: 8.6 September-November: 10.7 December-March: 12.9	Max: April-June: 27.8 July-August: 16.8 September-November: 23.6 December-March: 40.1	Central-site monitor	ORs; lag 0 April-June: 0.8 (0.4, 1.7) July-August: 1.2 (0.3, 4.9) September-November: 1.3 (0.6, 2.6) December-March: 0.8 (0.4, 1.6)
Zhang et al. (2011)	Beijing, China (3/2009-3/2010)	Outpatient Visits: Allergic rhinitis	24-h avg	28.1	Max: 80.9	Average of 11 monitors	Lag NR 20.6% (19.4, 21.9)
Zhang et al. (2013)	Beijing, China (3/2009-3/2010)	Outpatient Visits: Allergic rhinitis	24-h avg	28.1	75th: 31.5 Max: 84.3	Average of 11 monitors	**Lag 0-3:** Total: 37.8 (34.7, 41.0) Male: -0.6 (-2.3, 1.2) Female: 31.9 (29.1, 34.7) <60: 31.4 (28.5, 34.5) >60: 15.2 (13.6, 16.9)

[a]When possible effect estimates (percent increase unless otherwise specified) were standardized to a 20 ppb increase in 24-h avg NO_2 concentrations, a 40 ppb increase in 24-h avg NO_X, and a 30 ppb increase in 1-h max NO_2 concentrations.