

Supplementary

A Review of Airborne Particulate Matter Effects on Young Children's Respiratory Symptoms and Diseases

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Figure S1. The number of search results for each selected database using the search query ‘Air pollution – Particulate matter – Children’s health – Respiratory’ for five time intervals between 1950 and 2016.

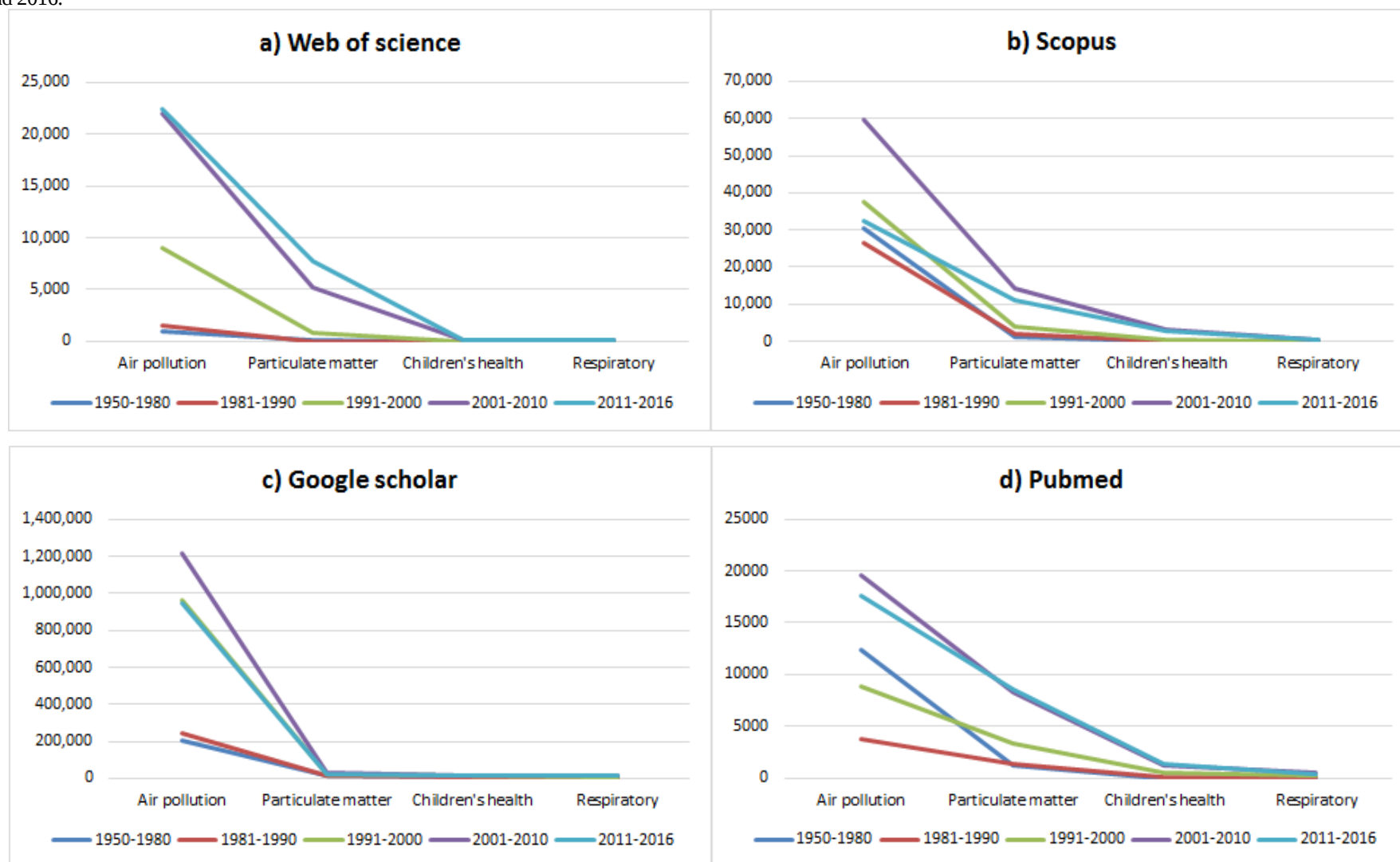


Table S1. Results of databases consultation (number of hits) using “AND” operator with subsequent keywords, grouped by various time intervals.

Search database with keywords	Time interval with search results					
	1950-1980	1981-1990	1991-2000	2001-2010	2011-2016	TOTAL
<i>Web of Science</i>						
Air pollution	968	1583	8,960	22,070	22,470	56,051
Particulate matter	102	7	774	5,170	7,715	13,768
Children’s health	1	6	7	76	153	243
Respiratory	1	1	7	53	95	157
<i>Scopus</i>						
Air pollution	30,419	26,436	37,579	59,768	32,401	186,603
Particulate matter	1,094	1,881	4,104	14,363	11,001	32,443
Children’s health	15	57	588	3,126	2,939	6,725
Respiratory	7	8	90	516	406	1,027
<i>Google Scholar</i>						
Air pollution	208,000	245,000	965,000	1,220,000	948,000	3,586,000
Particulate matter	16,900	16,500	22,300	28,600	23,500	107,800
Children’s health	3,250	3,510	12,900	17,600	17,200	54,460
Respiratory	1,190	1,390	6,110	16,700	17,500	42,890
<i>Pubmed</i>						
Air pollution	12,337	3,726	8,865	19,584	17,574	62,086
Particulate matter	1,220	1,422	3,345	8,289	8,499	22,775
Children’s health	19	130	548	1,282	1,298	3,277
Respiratory	8	75	229	449	356	1,117

Table S2. Summary of selected studies based on eligibility criteria and best judgment of paediatric experts on the effects of particulate matter on children's respiratory disease (non-exhaustive list).

No.	Author (publication year) [Ref]	Description	Country	Location of study	Exposure period	Health effects	Number of Children
1	Watanabe, et al. (2016) [75]	The study investigated the effect of particulate air pollutants on respiratory symptom and the inflammatory response in schoolchildren. The results suggested that the effects of particulate air pollutants on respiratory symptoms in schoolchildren might depend more on the pro-inflammatory response to them than on their mass concentration.	Japan	Indoor & outdoor	Short-term	Respiratory symptom and the inflammatory response	360
2	Lim et al. (2016) [98]	Being the only children-specified review paper about the short-term effect of fine particulate matter on children's hospital admissions and emergency department visits for asthma, the authors retrieved 26 time-series and case-crossover design studies and conducted random effect meta-analyses and mixed-effect meta-regression analysis.	Global	Indoor & outdoor	Short-term	Hospital admissions and emergency department visits for asthma	N/A
3	Paulin & Hansel. (2016) [82]	A review paper on the effects of PM exposure on objective measurements of lung function in both healthy individuals and those with existing lung disease.	Global	Indoor & outdoor	Short-term & long-term	Lung function	N/A
4	Rice et al. (2016) [80]	A study assessed traffic-related pollution exposure and childhood lung function and found that even low levels of air pollution including fine particulate matter (PM _{2.5}) and soot (black carbon) appear to affect children's lung health.	USA	Indoor & outdoor	Long-term	Lung function	614
5	Nunes et al. (2015) [88]	Evaluation of indoor PM concentrations on different microenvironments of three rural nursery schools and one urban nursery school, by comparing urban and rural nursery schools considering the PM ₁ , PM _{2.5} and PM ₁₀ fractions (measured continuously and in terms of mass).	Portugal	Indoor & outdoor	Long-term	Respiratory symptoms	N/A
6	Zhang et al. (2014*) [106]	A two-year prospective study and investigated associations between environmental parameters such as room temperature, relative air humidity (RH), carbon dioxide (CO ₂), nitrogen dioxide (NO ₂), Sulphur dioxide (SO ₂), ozone (O ₃), particulate matter (PM ₁₀), and health outcomes including prevalence, incidence and remission of SBS symptoms in junior high schools in Taiyuan, China.	China	Indoor	Long-term	Onset of skin, mucosal and general symptoms	2134
7	Ferreira & Cardoso. (2014) [102]	Evaluation of the effect of exposure to air pollutants in terms of respiratory function in children in the 1st cycle of primary education (CEB) of Coimbra, Portugal. A number of 1019 children were assessed by spirometry and air quality in 81 classrooms and outdoor air quality were further evaluated.	Portugal	Indoor & outdoor	Long-term	Deterioration of lung function	1019
8	Marchettia et al. (2014) [105]	Evaluate whether proximity to wood factories was associated with the risk of hospital admissions in children living in the Viadana district (Italy), where two big chipboard industries and other smaller wood factories (sawmills, multi-strata layer manufacturing) are located.	Italy	Outdoor	Long-term	Increasing hospitalization diagnoses risk for all	3854
9	Nandasena et al. (2012) [90]	Respiratory health status of 7- to 10-year-old children in two settings (urban and semi-urban) was assessed using standard questionnaires. Information on socio-demographic characteristics and potential determinants of both outdoor and indoor air pollutants exposure levels were also obtained. The respiratory health status of children in the two settings was compared.	Sri Lanka	Indoor/outdoor	Long-term	Wheezing/poor respiratory health status	N/A
10	Pedersen et al. (2013) [91]	A European cohort study on ambient air pollution and low birthweight.	Europe	Outdoor	Long-term	Wheezing/poor respiratory health status	N/A

No.	Author (publication year) [Ref]	Description	Country	Location of study	Exposure period	Health effects	Number of Children
11	Oluwole et al. (2013) [87]	Investigation of the extent of household air pollution from biomass fuels and the effectiveness of stove intervention to improve indoor air quality, exposure-related health problems, and lung function.	Nigeria	Indoor	Long-term	Respiratory symptoms (dry cough, chest tightness, difficult breathing, and runny nose), moderate airway obstruction on spirometry	59
12	Buonanno et al. (2013) [101]	Continuous exposure monitoring to estimate alveolar and tracheobronchial dose, measured as deposited surface area, for 103 children and to evaluate the long-term effects of exposure to airborne particles through spirometry, skin prick tests and measurement of exhaled nitric oxide (eNO).	Italy	Indoor & outdoor	Short-term	Changes in pulmonary function tests (spirometry, measurement of exhaled nitric oxide)	103
13	Zora et al. (2013) [100]	Repeated measure panel study to examine weekly associations between ACQ scores and traffic- and non-traffic air pollutants among asthmatic schoolchildren in El Paso.	USA	Outdoor	Short-term	Changes in lungs function and asthma symptoms/asthma exacerbation	NA
14	Lewin et al. (2013) [96]	A case-crossover design to assess the risk of hospitalization, February 1999–December 2008, in relation to short-term variation in levels of exposure among children 0–4 years old living less than 7.5 km from the smelter.	Canada	Outdoor	Short-term	Asthma and bronchiolitis	NA
15	Sram et al. (2013) [104]	An analysis of the effects in the polluted district Teplice (North Bohemia) and control district Prachatice (Southern Bohemia) increase in intrauterine growth retardation (IUGR) was associated with PM ₁₀ and c-PAHs exposure (carcinogenic polycyclic aromatic hydrocarbons) in the first month of gestation.	Czech Republic	Outdoor	Long-term	Acute respiratory diseases, lower respiratory tract illness	1492
16	Madureira et al. (2015) [97]	The study includes: a) measurements on priority indoor air quality parameters: specific volatile organic compounds, formaldehyde, carbon dioxide, carbon monoxide, nitrogen dioxide, ozone, particulate matter, radon, temperature, relative humidity, ventilation rate and biological agents; b) a checklist for the physical characterization of buildings and indoor spaces and description of occupants' time daily activities; c) three health questionnaires and d) several clinical tests and biomarkers.	Portugal	Indoor	Long-term	Asthma allergic reactions and respiratory tract infections	1600
17	Ramesh et al. (2012) [103]	A case-control study of risk factors, particularly indoor air pollution, for developing acute lower respiratory tract infections (ALRTI) in children under 5 years of age in Udupi District Hospital.	India	Indoor	Long-term	Acute lower respiratory tract infections	202
18	Barakat-Haddad et al. (2012) [86]	Examine the relationship between childhood exposure to air pollution and long-term respiratory health and to identify significant predictors of respiratory health in adulthood.	Canada	Outdoor	Long-term	Respiratory diseases	395
19	Butz et al. (2011 ^a) [17]	An association between biomarkers and environmental measures of second hand smoke (SHS) with caregiver, i.e. parent or legal guardian, report of household smoking behaviour and morbidity measures among children with asthma. Baseline data were drawn from a longitudinal intervention for 126 inner city children with asthma, residing with a smoker. Household smoking behaviour and asthma morbidity were compared with child urine cotinine and indoor measures of air quality including fine particulate matter PM _{2.5} and air nicotine (AN).	USA	Indoor	Long-term	Asthma	126

No.	Author (publication year) [Ref]	Description	Country	Location of study	Exposure period	Health effects	Number of Children
20	Robinson et al. (2011) [91]	Participants filled in questionnaires on asthma and allergy symptoms, environmental exposures and sociodemographic, and underwent spirometry, and exhaled nitric oxide (eNO) and allergy skin testing. Indoor particulate matter (PM) concentrations were measured in 170 households.	Peru	Indoor	Long-term	Asthma, atopy and airways inflammation	1441
21	Butz et al. (2011 ^b) [93]	Test an air cleaner and health coach intervention to reduce second hand smoke exposure compared with air cleaners alone or no air cleaners in reducing particulate matter (PM), air nicotine, and urine cotinine concentrations and increasing symptom-free days in children with asthma residing with a smoker.	USA	Indoor	Long-term	Asthma	41
22	Siddique et al. (2011) [99]	The study was conducted in children. Pulmonary function test was carried out following the guideline of American Thoracic Society using a portable, electronic spirometer. After controlling potential confounders like season, socioeconomic conditions and ETS, PM ₁₀ level in ambient air was found to be associated with restrictive, obstructive, and combined type of lung function deficits	India	Indoor & outdoor	Long-term	Impairing lung function	5671
23	Siddique et al. (2010) [85]	The respiratory health of children was assessed in the capital city of India where the level of air pollution is much above the National Ambient Air Quality Standards. The study was carried out in Delhi, and the findings were compared with those of rural West Bengal and Uttaranchal. The prevalence of respiratory symptoms was determined through a structured respiratory symptomology questionnaire and personal interviews.	India	Outdoor	Long-term	Attacks of shortness of breath, wet and dry cough, wheezing, chest tightness	16164
24	Rodriguez et al. (2010) [89]	Across-sectional study conducted in Bucaramanga, Colombia, comparing respiratory symptoms in 768 children under seven years in two urban zones with different pollution levels of particulate matter and ozone.	Colombia	Indoor & outdoor	Long-term	Wheezing/respiratory symptoms associated with asthma	768
25	Gehring et al. (2010) [92]	Studies the association between traffic-related air pollution and the development of asthma, allergy, and related symptoms in a prospective birth cohort study with a unique 8-year follow-up.	Germany	Outdoor	Long-term	Asthma	3863
26	He et al. (2010) [77]	A number of 983 children from three districts in Guangzhou, China was followed-up for 6 months. The children performed pulmonary function tests twice, and their parents reported the child's respiratory symptoms by self-administered questionnaires in both surveys.	China	Outdoor	Long-term	Adverse effects on lung function growth	983
27	Kumar et al. (2008) [108]	Investigate the effects of indoor air pollution on respiratory function of children.	India	Indoor	Long-term	Cough, shortness of breath, wheezing, common cold, and throat congestion.	441
28	Kumar et al. (2007) [84]	Examine the effects of indoor and outdoor air pollutant levels on respiratory health in 394 children.	India	Indoor & outdoor	Long-term	Cough, shortness of breath, wheezing, common cold, and throat congestion.	394

Table S3. Diagnoses potentially determined or aggravated by the atmospheric pollution classified according to the International Classification of Diseases ICD-10 [71]

Diagnosis code	Diagnosis name	Common etiology/Particularity
J21.9	Acute bronchiolitis, unspecified	Viral infection (most commonly respiratory syncytial virus); severe symptoms are usually evident only in young infants
J44.8	Chronic bronchitis: asthmatic (obstructive) NOS	Acute respiratory infection; one of the top conditions for which patients seek medical care
J45.0	Predominantly allergic asthma	Allergens (or allergy triggers) like pollen, dust mites, or mold; approximately 90% of children with childhood asthma present allergies
J45.9	Asthma, unspecified	Various exogenous triggers, genetics etc.; Environmental exposures and irritants can play a significant role in symptom exacerbations
J46	Status asthmaticus	Unknown; the most severe form of asthma attack that doesn't respond to usual inhaled bronchodilator treatment
J84.9	Interstitial pulmonary disease, unspecified	Interstitial pneumonia: Bacteria, viruses, or fungi may infect the interstitium of the lung; The thickening of the interstitium can be due to inflammation, scarring, or edema
J96.0	Acute respiratory failure	COPD, Pneumonia, Pulmonary edema, Pulmonary fibrosis, Asthma; a syndrome in which the respiratory system fails in one or both of its gas exchange functions
J20.9	Acute bronchitis, unspecified	Viral infections; acute inflammation of the bronchial wall, which causes increased mucus production along with edema of the bronchus
J40	Tracheobronchitis NOS	Viruses, bacteria, cold air, dust, and irritating gas, and anaphylaxis-allergens; occurs most commonly during the winter months
J30.4	Allergic rhinitis, unspecified	Allergens (or allergy triggers); pollen in the air can be problematic in specific months
J31.0	Chronic rhinitis NOS	Indoor allergens; symptoms tend to occur regardless of the time of the year.
R06.2	Wheezing (Abnormalities of breathing)	Infection, an allergic reaction or a physical obstruction; narrowing and bronchospasms in the small airways of lungs.