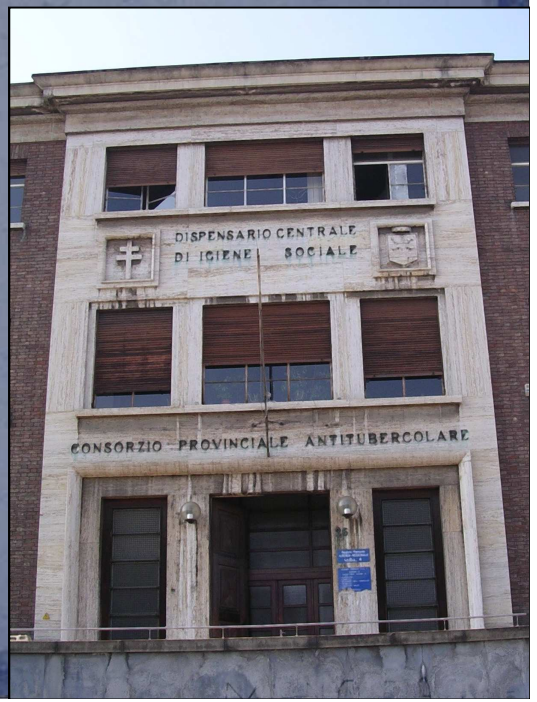
Progetto MAPEC

Local Workshop

14 Ottobre 2014
Torino

Effetti dell' inquinamento atmosferico sulla salute di bambini/giovani (apparato respiratorio)



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IGIENE DELL'AMBIENTE E DEL TERRITORIO

DEMOGRAFIA PREVENZIONE E SANITÀ PUBBLICA

C.G. Edizioni Medico Scientifiche s.r.l.

CAPITOLO 12

L'aria veicolo di inquinanti

Descrizione di un modello sperimentale per il controllo degli effetti sulla salute

W. Arossa - M. Bugiani - C. Bucca

1. PREMESSA

La relazione tra inquinamento atmosferico e danno all'apparato respiratorio può essere studiata con tre metodi:
— esperimenti sull'animale;
— esperimenti sull'uomo;
— studi epidemiologici di popolazioni esposte.

Gli esperimenti su animali permettono di indagare gli effetti tossici ed i meccanismi biologici del danno ma i loro risultati non possono essere estrapolati direttamente all'uomo. Gli stessi esperimenti di esposizione umana a concentrazioni scalari di sostanze tossiche in condizioni controllate non forniscono informazioni sui soggetti «sensibili» (es. asmatici), sulla popolazione generale che è esposta a più inquinanti tra loro mescolati, né sugli effetti delle esposizioni croniche.

Lo studio epidemiologico permette di verificare gli effetti della reale esposizione della popolazione generale ma è molto difficile da organizzare e da controllare in quanto l'inquinamento e la popolazione esposta cambiano continuamente.

Le nostre conoscenze sugli effetti degli inquinanti atmosferici discendono quindi da informazioni ottenute in condizioni sperimentali molto diverse tra di loro dove il ruolo dello studio epidemiologico è verificare gli effetti di esposizioni croniche e/o di modifiche di livelli di esposizione.

Gli studi epidemiologici hanno evidenziato 6 categorie di effetti sulla salute:
— aumento della mortalità;
— aumento della prevalenza di malattie respiratorie croniche;
— aumento della prevalenza di malattie respiratorie acute;
— peggioramento dell'asma bronchiale;
peggioramento della sintomatologia e/o del quadro funzionale respiratorio;
— possibile associazione con il cancro del polmone, le malattie cardiache.

Gli studi di mortalità sono stati importanti nel passato e, classicamente, sono legati ad episodi particolarmente gravi (Valle della Mosa, 1930; Donora, 1948; Londra, 1952-1962; New York, 1953).

Torino ….. Anni 80

Italian Government D.P.R. n. 400 (8/6/82): *Attuazione della direttiva CEE n.* 75/716 (24/11/1975) *relativa al tenore di zolfo in taluni combustibili.* Gazzetta Ufficiale R.L, 4696-4967.

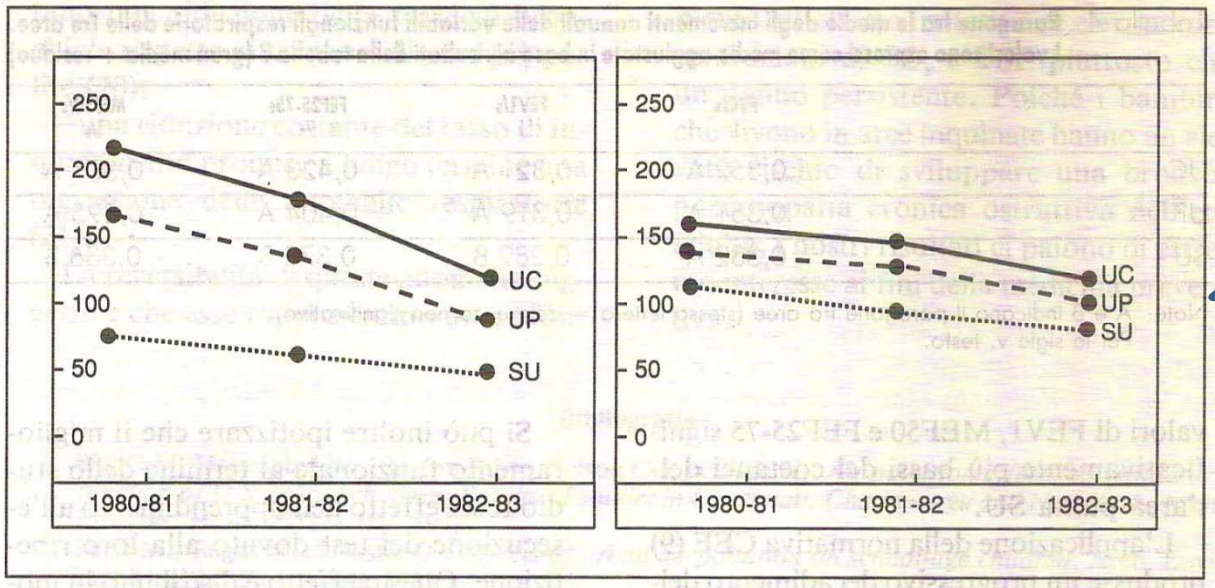


Fig. 2. Misure in mg/m^3 di TSP (parte sinistra) e della anidride solforosa (parte destra) nel periodo 1980-82.

Variazioni delle concentrazioni di anidride solforosa e di particelle sospese totali (TSP) nelle zone centrali (UC), periferiche (UP) della città di Torino ed in un' area suburbana (SU) della cintura torinese

IGIENE DELL'AMBIENTE E DEL TERRITORIO, C.G. Ed. Med. Scient., Torino, 1989.

Torino ….. Anni 80 2

Spinaci S e all. **The effects of air pollution on the respiratory health of children: a cross-sectional study**.

Pediatr Pulmonol. 1985 Sep-Oct;1(5):262-6

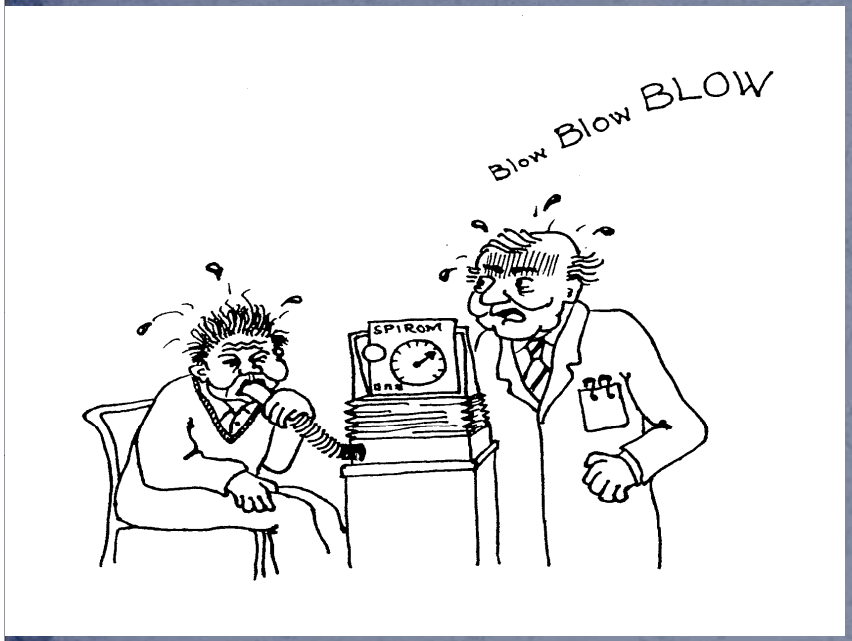
……. To investigate the effects of air pollution on the respiratory health of children, a subject of some controversy, a comparative study was undertaken of **2,385 school children** who lived in central urban, peripheral urban, and suburban areas

Arossa W e all. **Changes in lung function of children after an air pollution decrease**.

Arch Environ Health.1987 May-Jun;42(3):170-4.

….. Forced vital capacity (FVC), forced expiratory volume in 1 sec (FEV1.0), forced expiratory flow between 25 and 75% of FVC (FEF25-75), and maximal expiratory flow at 50% of FVC (MEF50) were measured in **1,880 school children** who lived in urban areas before and after a decrease of air pollution. A group of **162 children** from a suburban area served as controls ……..

spirometria



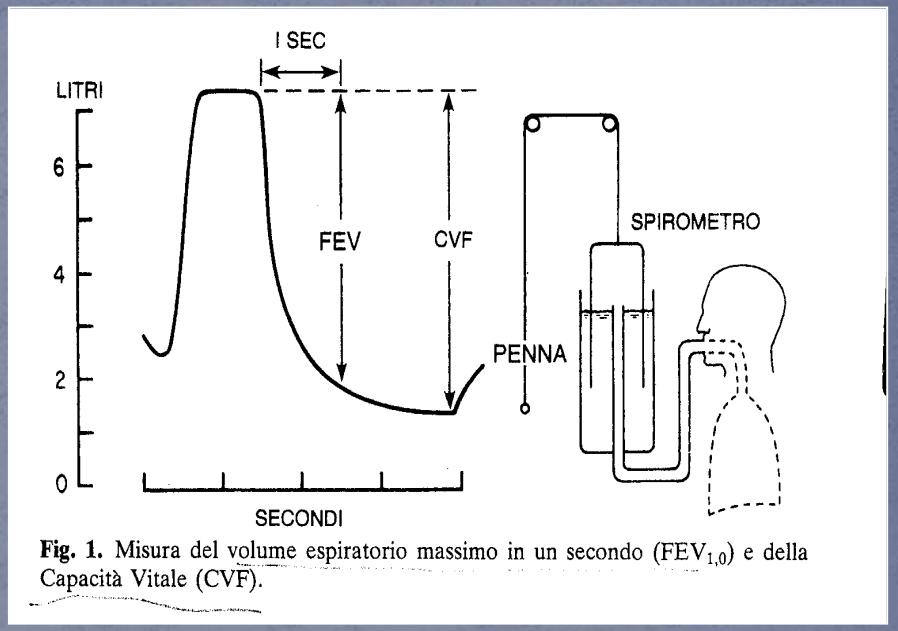
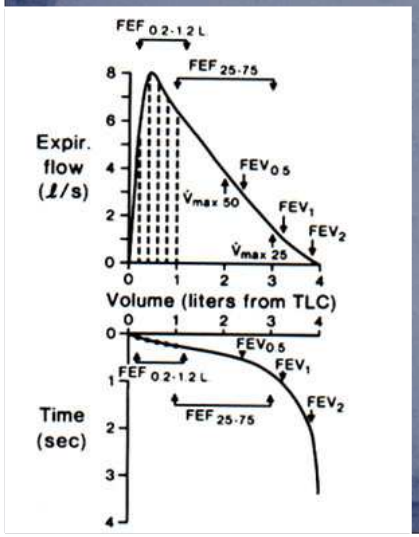
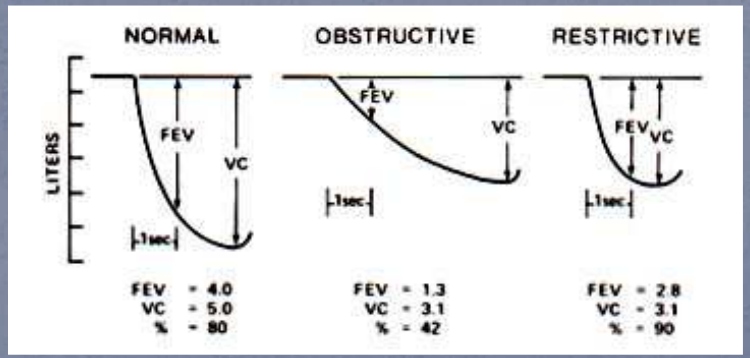
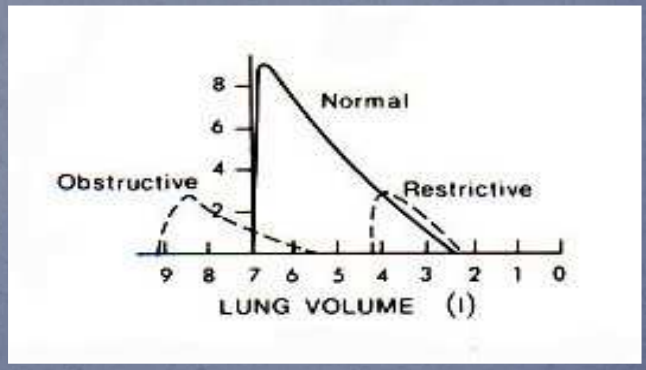


Fig. 1. Misura del volume espiratorio massimo in un secondo ($FEV_{1,0}$) e della Capacità Vitale (CVF).







Torino ….. Anni 80 3

Spinaci S e all. The effects of air pollution on the respiratory health of children: a cross-sectional study. Pediatr Pulmonol. 1985 Sep-Oct;1(5):262-6

…… **children from both urban areas had lessened pulmonary function and a higher prevalence of bronchial secretion with common colds than did those from the suburban area**. These differences persisted after corrections for exposure to indoor pollutants, active or passive smoking, socioeconomic status, and sex. **Parental cigarette smoking was related to a fall in forced expiratory volume in 1 second and an increased incidence of acute respiratory illnesses and chronic cough in children** ….

……. **It was concluded that air pollution has a significant effect on the respiratory health of children**

Arossa W e all. Changes in lung function of children after an air pollution decrease. Arch Environ Health.1987 May-Jun;42(3):170-4.

…… In the first survey, **FEV1.0, FEF25-75, and MEF50** of children from urban areas were significantly lower, while **in the second survey they were not significantly different from those of controls**. **The slopes over time of FEV1.0, FEF25-75, and MEF50, adjusted for sex and anthropometric variables, were closely related to the decrease of pollutants concentration.** Our results suggest that **a decrease of air pollution may produce an improvement of lung function.**

Torino ..... Anni 80 4

Tabella 2. **Paragone fra le medie aggiustate delle variabili funzionali respiratorie registrate nelle tre aree nello studio iniziale e finale**

		UC	UP	SU	p<
Studio iniziale					
FVC	l	2,67 A	2,67 A	2,69 A	N.S.
FEV1	l	2,32 A	2,34 A	2,38 B	0,001
FEF25-75	l/s	2,94 A	3,02 A	3,11 B	0,001
MEF50	l/s	3,39 A	3,40 A	3,53 B	0,001
Studio finale					
FVC	l	3,39 A	3,36 A	3,35 A	N.S.
FEV1	l	2,97 A	2,97 A	2,96 A	N.S.
FEF25-75	l/s	3,74 A	3,78 A	3,78 A	N.S.
MEF50	l/s	4,17 A	4,23 A	4,20 A	N.S.

Note: Le medie sono aggiustate per sesso, età, altezza, peso, fumo attivo e passivo. classe socioeconomica, tipo di riscaldamento.
A e B indicano le differenze tra le aree (stessa lettera = differenza non significativa)
Per le sigle v. testo.

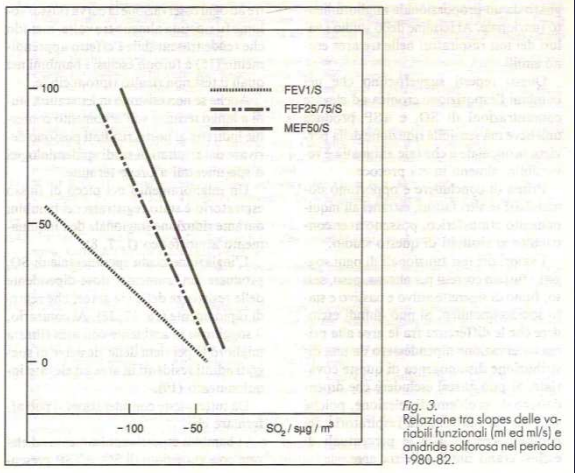


Fig. 3. Relazione tra slopes delle variabili funzionali (ml ed ml/s) e anidride solforosa nel periodo 1980-82.

IGIENE DELL'AMBIENTE E DEL TERRITORIO, C.G. Ed. Med. Scient., Torino, 1989.

Epidemiologic Studies on Short-Term Effects of Low Levels of Major Ambient Air Pollution Components

- For ambient **ozone**, effects on **lung function** of subjects exercising outdoors have now been documented at 1-hr maximum levels not exceeding 120 pg/m3, i.e. (half the current U.S. EPA standard). One study even suggests that **such effects occur at levels below 100 pg/m3**.
- Several studies are now available documenting effects of particulate air pollution on health in the virtual absence of SO2.
- Effects on **mortality and hospital admissions for asthma** have been documented at levels not exceeding 100 pg/m3, expressed as 24-hr average inhalable particles **PM10 concentration**.
- Effects on **lung function**, acute respiratory symptoms, and medication use have been found at **24-hr average PM10 levels not exceeding 115 µg/m3**.

Brunekreef B et all. Environ Health Perspect. 1995 Mar;103 Suppl 2:3-13.

Epidemiologic Studies on Short-Term Effects of Low Levels of Major Ambient Air Pollution Components

Ozone

Table 1. Summary of studies relating hourly ozone concentrations of less than 240 µg/m^3 with specific effects on human health.

	Category of health effects			
Concentration	Hospital admissions	Symptom exacerbations	Lung function changes	Reference
<100	+			Pönkä (*6*)
<240	?			Thurston et al. (*7*)
<240	+			Thurston et al.(*8*)
<240			+	Avol et al. (*9*)
<240		–	+	Spektor et al. (*11*)
<240		+		Berry et al. (*12*)
<240		–	+	Hoek (*16*); Hoek et al. (*17*)
<240		–	+	Hoek et al. (*18*)
<200			+	Krzyzanowski et al. (*15*)
<200			+	Korrick et al. (*20*)
<160			+	Spektor et al. (*19*)
<160			+	Kinney et al. (*14*)
<160			–	Thurston et al. (*13*)
<160			+	Braun-Fahrländer et al. (*22*)
<120		–	+	Spektor et al. (*10*)
<120		+	+	Brunekreef et al. (*21*)

Studi condotti su bambini:
9,10,11,12,16,17,18,22

Brunekreef B et all. Environ Health Perspect. 1995 Mar;103 Suppl 2:3-13.

Epidemiologic Studies on Short-Term Effects of Low Levels of Major Ambient Air Pollution Components

TSP

Table 2. Summary of studies relating 24-hr average particle concentrations of less than 200 μg/m^3 (TSP or black smoke) or 150 μg/m^3 (PM10) with specific effects on human health.

	Category of health effect				
Concentration	Mortality	Hospital admissions	Symptom exacerbations	Lung function changes	Reference
? (BS)	+				Schwartz and Marcus (*24*)
<137, TSP	+				Schwartz (*25*)
<100 (PM10)	+				Pope et al. (*26*)
<100 (TSP)	+				Schwartz and Dockery (*27,28*)
<100 (PM10)	+				Dockery et al. (*29*)
<100 (TSP)		+			Schwartz et al. (*30*)
? (BS)		+			Diaz-Caneja et al. (*31*)
<150 (BS)		+			Sunyer et al. (*32,33*)
<105 (PM10)		+			Schwartz et al. (*34*)
<60 (BS, weekly)		+			Walter et al. (*35*)
<115 (PM10)			+	+	Pope et al. (*39*)
<75 (PM2.5)			+		Ostro et al. (*36*)
<100 (TSP)			+		Braun-Fahrländer et al. (*38*)
<150 (PM10)			+	+	Pope and Dockery (*40*)
<150 (PM10)			+		Ransom and Pope (*41*)
<120 (BS), <175 (PM10)			+	+	Roemer et al. (*42*)
					Brunekreef and Hoek (*43*)
					Hoek and Brunekreef (*44*)
<25 (BS)			+		Forsberg et al. (*37*)
<130 (PM10)			–	+	Hoek and Brunekreef (*45*)

Studi condotti su bambini: 38,39,40,41,42,43,44 ,45

Brunekreef B et all. Environ Health Perspect. 1995 Mar;103 Suppl 2:3-13.

Epidemiologic Studies on Short-Term Effects of Low Levels of Major Ambient Air Pollution Components

SO_2

Table 3. Summary of studies relating 24-hr average SO_2 concentrations of less than 200 μg/m^3 or 24-hr average NO_2 concentrations of less than 150 μg/m^3 with specific effects on human health.

	Category of health effect				
Concentration	Mortality	Hospital admissions	Symptom exacerbations	Lung function changes	Reference
<200 (SO_2, >99% of days)	–				Mackenbach et al. (*47*)
<200 ? (SO_2)		+			Saez et al. (*48*)
<72 (SO_2)		+			Sunyer et al. (*32,33*)
<176 (SO_2) <79 (NO_2)			–		Lipfert et al. (*50*)
<130 (SO_2)			+		Vedal et al. (*51*)
<81 (SO_2) <95 (NO_2)			+	+	Pönkä (*52*)
<100 (SO_2)					Moseholm et al. (*53*)

Studi condotti su bambini:
51,52

Brunekreef B et all. Environ Health Perspect. 1995 Mar;103 Suppl 2:3-13.

Particulate air pollution and panel studies in children: a systematic review (Ward 2004)

- The majority of identified studies indicate an adverse effect of particulate air pollution that is greater for PM2.5 than PM10.
- However, results show considerable heterogeneity and there is evidence consistent with publication bias, so limited confidence may be placed on summary estimates of effect.
- The possibility of interaction between particle and ozone effects merits further investigation .....

Ward DJ. Occup Environ Med.2004 Apr;61(4):e13.

Particulate air pollution and panel studies in children: a systematic review (Ward 2004) 2

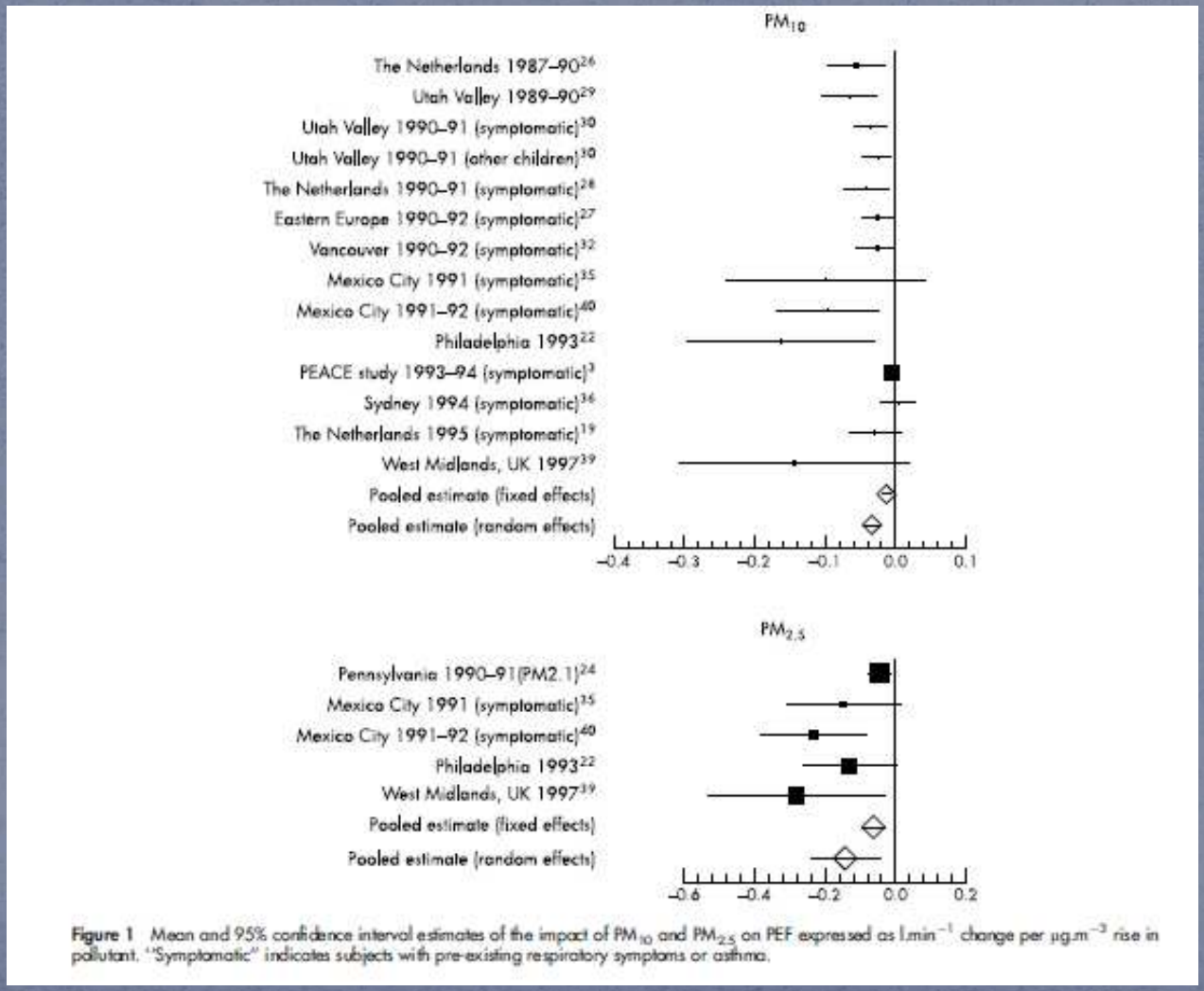


Figure 1 Mean and 95% confidence interval estimates of the impact of PM_{10} and $PM_{2.5}$ on PEF expressed as $l.min^{-1}$ change per $\mu g.m^{-3}$ rise in pollutant. "Symptomatic" indicates subjects with pre-existing respiratory symptoms or asthma.

Ward DJ. Occup Environ Med.2004 Apr;61(4):e13.

Particulate air pollution and panel studies in children: a systematic review (Ward 2004) 3

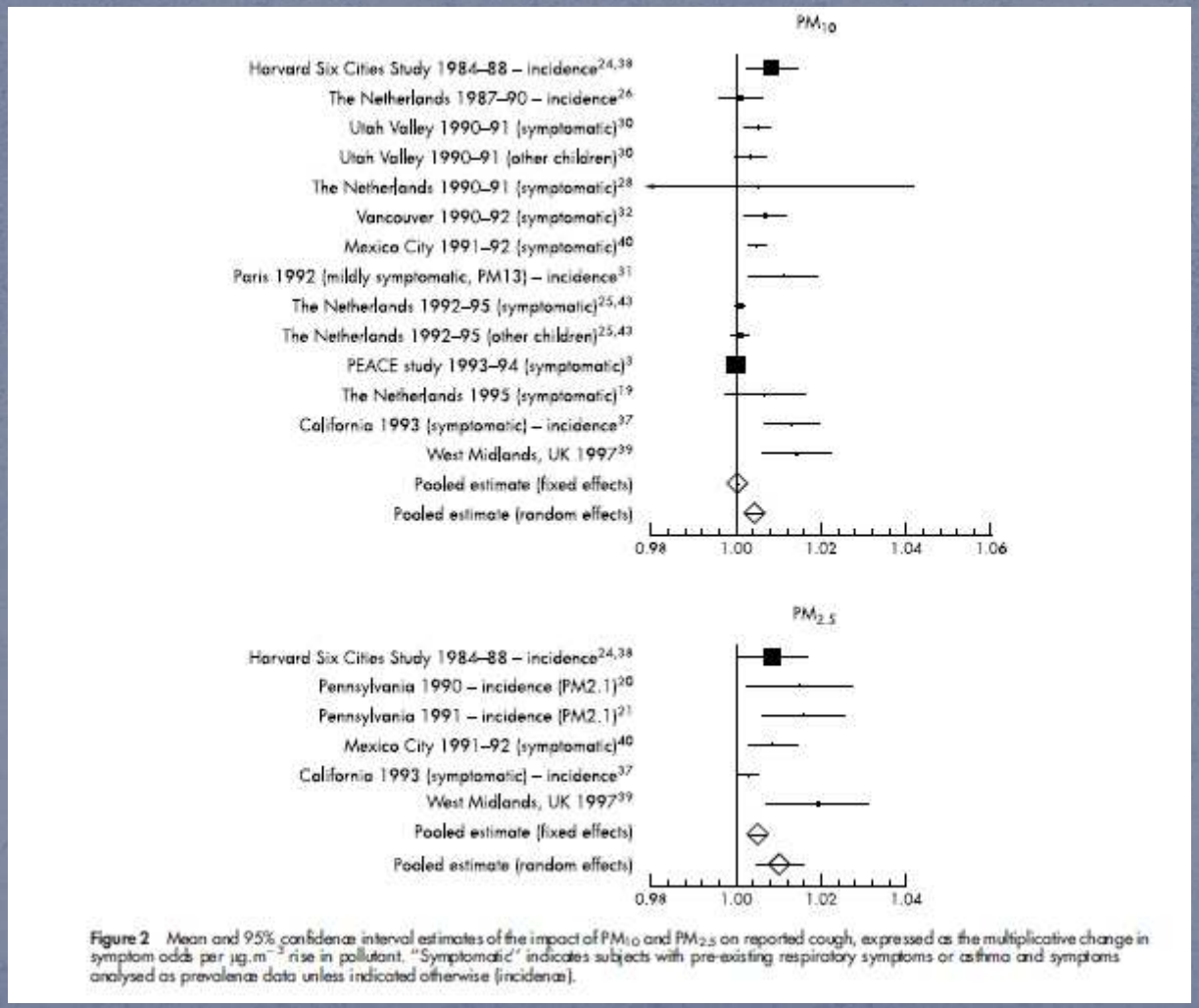


Figure 2 Mean and 95% confidence interval estimates of the impact of PM_{10} and $PM_{2.5}$ on reported cough, expressed as the multiplicative change in symptom odds per $\mu g.m^{-3}$ rise in pollutant. "Symptomatic" indicates subjects with pre-existing respiratory symptoms or asthma and symptoms analysed as prevalence data unless indicated otherwise (incidence).

Ward DJ. Occup Environ Med.2004 Apr;61(4):e13.

Particulate air pollution and panel studies in children: a systematic review (Ward 2004) 4

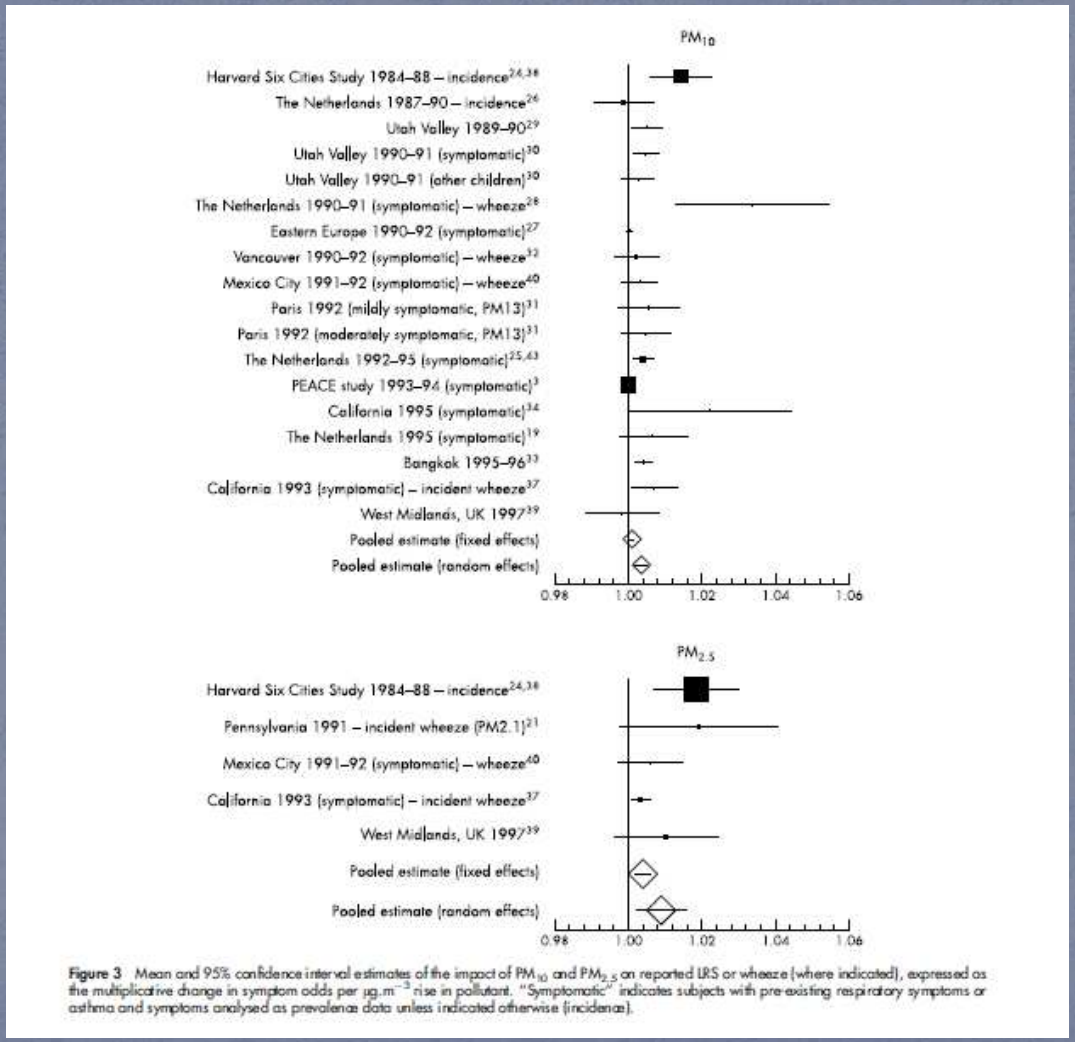


Figure 3 Mean and 95% confidence interval estimates of the impact of PM_{10} and $PM_{2.5}$ on reported LRS or wheeze (where indicated), expressed as the multiplicative change in symptom odds per $\mu g.m^{-3}$ rise in pollutant. "Symptomatic" indicates subjects with pre-existing respiratory symptoms or asthma and symptoms analysed as prevalence data unless indicated otherwise (incidence).

Ward DJ. Occup Environ Med.2004 Apr;61(4):e13.

Long-term effects of ambient air pollution on lung function: a review. (Götschi 2008)

Autore	anno	Risultati
Avol	2001	**Lung function growth lowered by moving to high pollution area, up when moved to low air pollution area**
Gauderman	2000/2002/2004	**Reduced lung function growth in children from higher polluted communities**
Gauderman	2007	**Lung function growth independently associated with freeway distance and regional pollution**
Horak	2002	**Reduced lung function growth in summer in children from higher polluted communities**
Ihorst	2004	**O3 decreased lung function growth in summer, opposite pattern in winter**
Kopp	2000	**O3 decreased lung function growth in summer, opposite pattern in winter**
Neuberger	2002	**Faster growth in MMEF in districts with declining NO2**
Rojas-Martinez	2007	**Reduced lung function growth in children from areas with higher PM10, NO2, O3**

Götschi T. Epidemiology. 2008 Sep;19(5):690-701

Respiratory symptoms in children living near busy roads and their relationship to vehicular traffic: results of an Italian multicenter study (SIDRIA 2) (Migliore 2009)

- survey …. conducted in 2002 in 12 centers in Northern, Center and Southern Italy, different in size, climate, latitude and level of urbanization.
- Standardized questionnaires filled in by parents ……
- ….. information on health outcomes and exposure to traffic among 33,632 6-7 and 13-14 years old children and adolescents

Three questions on traffic exposure were asked:

1. the traffic in the zone of residence
2. the frequency of truck and
3. of car traffic in the street of residence

Migliore E. Environ Health. 2009 Jun 18;8:27.

Respiratory symptoms in children living near busy roads and their relationship to vehicular traffic: results of an Italian multicenter study (SIDRIA 2) (Migliore 2009) 2

- **Overall traffic density was weakly associated with asthma symptoms** but there was a **stronger association with cough or phlegm** (high traffic density OR = 1.24; 95% CI: 1.04, 1.49).
- **Car and truck traffic were independently associated with cough or phlegm**.

Table 5: Associations between combined exposure to truck and car transit and cough or phlegm.

			Trucks transit		
			Never	**Sometimes**	**Freq/continuously**
Cars transit	**Never/sometimes**	*n cases (%)*	*426 (5.3)*	*211 (5.9)*	*19 (8.2)*
		OR* (95% CI)	1.00	1.12 (0.95–1.32)	1.50 (0.93–2.43)
	Frequently	*n cases (%)*	*168 (6.3)*	*370 (6.4)*	*140 (7.7)*
		OR* (95% CI)	1.09 (0.90–1.33)	1.12 (0.96–1.30)	1.42 (1.15–1.75)
	Continuously	*n cases (%)*	*56 (7.8)*	*228 (8.4)*	*372 (9.3)*
		OR* (95% CI)	1.30 (0.94–1.81)	1.42 (1.19–1.70)	1.60 (1.36–1.87)

*All ORs were adjusted for presence of current asthma symptoms, study centre, age, sex, parental asthma or allergies, parental education, passive smoke at home, indoor moulds, season, person filling the questionnaire, floor level of the apartment and change of residence.

- ..... **Children living in zones with intense traffic are at higher risk for respiratory effects**. Since population characteristics are specific, the results of validation of studies on self-reported traffic exposure can not be generalized

Migliore E. Environ Health. 2009 Jun 18;8:27.

European Study of Cohorts for Air Pollution Effects (ESCAPE) in children (2013)

.....analyzed data from **five birth cohort studies** situated in Germany, Sweden, the Netherlands, and the United Kingdom that **measured lung function at 6-8 years** of age (**n = 5,921**).....(All studies were designed to study the development of asthma and allergies).

Annual average exposure to air pollution [nitrogen oxides (NO_2, NOx), mass concentrations of particulate matter with diameters < 2.5, < 10, and 2.5-10 µm (**PM2.5, PM10, and PMcoarse**), and **PM2.5 absorbance**] **at the birth address** and **current address** was estimated by land-use regression models.

Associations of lung function with estimated air pollution levels and traffic indicators were estimated for each cohort using linear regression analysis, and then combined by random effects meta-analysis

Gehring U et all. Environ Health Perspect. 2013 Nov-Dec;121(11-12):1357-64

European Study of Cohorts for Air Pollution Effects (ESCAPE) in children 2

..... investigated the following lung function parameters: **FEV1, FVC, and PEF.**

Because 6-year-old children can usually perform reliable spirometry but often have short expiratory times, FEV1 cannot always be determined. For the younger cohorts (GINI and LISA), we therefore used forced expiratory volume in 0.5 sec (**FEV0.5**), which could be determined for all children, instead of FEV1.

... Asthma and allergic sensitization at the time of lung function measurements (as separate variables), sex, and parental allergy were considered as potential effect modifiers.

Gehring U et all. Environ Health Perspect. 2013 Nov-Dec;121(11-12):1357-64

European Study of Cohorts for Air Pollution Effects (ESCAPE) in children 3

..... **air pollution monitoring campaigns were performed between October 2008 and February 2010 in each study area**. Three 2-week measurements of NO2 and nitrogen oxides (NOx) were performed within 1 year at 80 sites in the Netherlands and Belgium and 40 sites in the other areas. Simultaneous measurements of "soot" (determined as the reflectance of PM2.5 filters), PM2.5, PM10, and PMcoarse (PM10–PM2.5) were performed at half of the sites (Cyrys et al. 2012; Eeftens et al. 2012b).

Results from the three measurements were averaged to estimate the annual average concentration of each pollutant (Eeftens et al. 2012b). Variables on nearby traffic, population/household density, and land use derived from geographic information systems (GIS) were evaluated as predictors of the spatial

variation in annual average concentrations.

Short-term air pollution exposure assessment. ..... used routine data from regional and urban background sites of air quality monitoring networks in the study areas to estimate for each participant average exposure to PM, NOx, NO2, and black smoke on the days preceding the lung function tests.

Gehring U et all. Environ Health Perspect. 2013 Nov-Dec;121(11-12):1357-64

European Study of Cohorts for Air Pollution Effects (ESCAPE) in children [4]

…. Estimated levels of NO_2, NOx, $PM_{2.5}$ absorbance, and $PM_{2.5}$ at the current address, but not at the birth address, were associated with small decreases in lung function.

For example, changes in forced expiratory volume in 1 sec (FEV1) ranged from:

- **-0.86% (95% CI: -1.48, -0.24%) for a 20-µg/m3 increase in NOx to**
- **-1.77% (95% CI: -3.34, -0.18%) for a 5-µg/m3 increase in $PM_{2.5}$**

Exposure to air pollution may result in reduced lung function in schoolchildren

Gehring U et all. Environ Health Perspect. 2013 Nov-Dec;121(11-12):1357-64

European Study of Cohorts for Air Pollution Effects (ESCAPE) in children [5]

- Overall, there were statistically **significant negative associations between FEV1 and NO_2, NOx, PM2.5 absorbance, and PM2.5 at the current address**.
- Similarly, we estimated **statistically significant negative associations for FVC with NO_2, NOx, and PM2.5 absorbance at the current address, and for PEF with NO_2 and PM2.5 at the current address.**

- Associations of all three lung function parameters and short-term exposure to NO_2 and PM_{10} were negative, but were not statistically significant

- … No association was found between the two traffic indicator variables and lung function in the present study. ……

Gehring U et all. Environ Health Perspect. 2013 Nov-Dec;121(11-12):1357-64

European Study of Cohorts for Air Pol6ution Effects (ESCAPE) in children 6

Oxidative stress and inflammation have been hypothesized as the main mechanisms through which ambient air pollution can affect human health.

With regard to lung function, toxicological evidence on mechanisms is sparse .....

Gehring U et all. Environ Health Perspect. 2013 Nov-Dec;121(11-12):1357-64

Oxidative stress in adolescent passive smokers living in urban and rural environments (Bono 2014)

Purpose of this study was to study the oxidative stress status through the urinary 15-F2t-isoprostane(15-F2t-isoP) among a group of **168 adolescents**, differently exposed to passive tobacco smoke

…… direct relationshipbetween oxidative stress status

and residence of adolescents was found:

- **oxidative stress level was 31%higher for adolescents living in Chivasso (urban site) than for those living in Casalborgone (country-side area).**
- Furthermore, also passive tobacco smoke exposure proved to play another important direct role in the distribution of 15-F2t-isoP levels ($p < 0.0001$).
- Lastly, an inversely proportional relationshipwas found between the age of adolescents and 15-F2t-isoP ($p < 0.0001$).

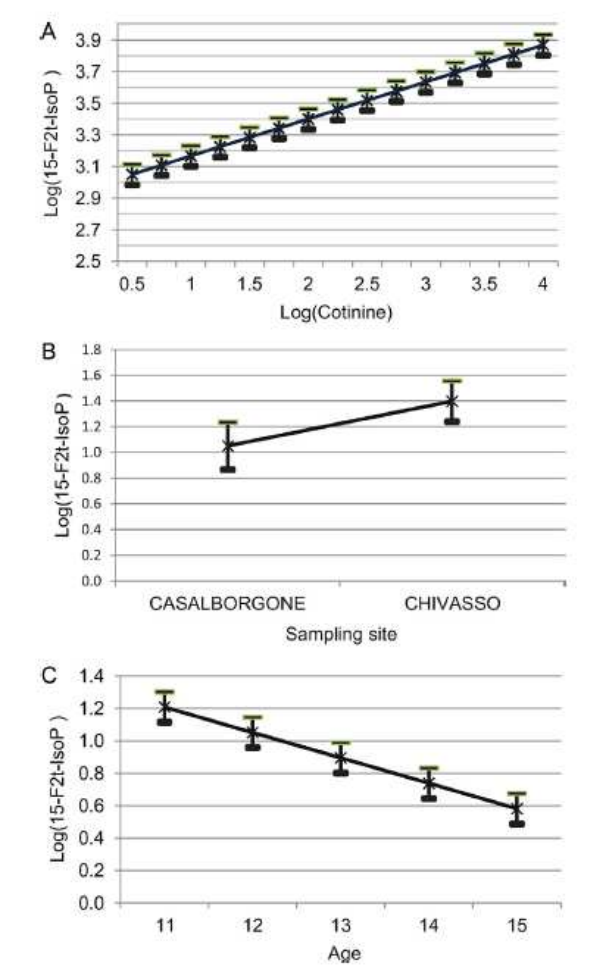


Fig. 2. Marginal means of 15F2t-IsoP adjusted by covariates from multiple regression analysis results: (A) by log (cotinine), adjusted by age and "sampling site". (B) By "sampling site" (Chivasso and Casalborgone) adjusted by age and log(cotinine). (C) By age, adjusted by log (cotinine)a and "sampling site".

Bono R. Int J Hyg Environ Health. 2014 Mar;217(2-3):287-93