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Comparative overview of indoor air quality in Antwerp, Belgium

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Abstract

This comprehensive study, a first in Belgium, aimed at characterizing the residential and school indoor air quality of subgroups that took part in the European Community Respiratory Health Survey and the International Study of Asthma and Allergy in Childhood [Masoli M, Fabian D, Holt S, Beasley R. Global Burden of Asthma, Medical Research Institute of New Zealand, University of Southampton; 2004.] questionnaire-based asthma and related illnesses studies. The principal aim was to perform a base-line study to assess the indoor air quality in Antwerp in terms of various gaseous and particulate pollutants. Secondly, it aimed to establish correlations between these pollutants investigated, the pollutant levels in the indoor and outdoor micro-environments, findings of the previous questionnaire-based studies and an epidemiological study which ran in conjunction with this study. Lastly, these results were compared and evaluated with current indoor and ambient guidelines in various countries This paper presents selected results on PM1, PM2.5 and PM10 mass concentrations and elemental C estimates as black smoke, as well as gaseous NO_2, SO_2, O_3 and BTEX concentrations of 18 residences and 27 schools. These are related to current guidelines of Flanders, Germany, Norway, China and Canada and evaluated with reference to selected similar studies. It was found that indoor sources such as tobacco smoking and carpets, the latter causing re-suspension of dust, are responsible for elevated indoor respirable particulate matter and place school children and residents at risk. Both PM2.5 and PM10 equalled or exceeded the current guidelines adopted by Flanders, noting that 12-h and 24-h PM2.5 were compared with an annual limit value. Indoor and ambient NO_2 concentrations in the school campaign were higher than the annual EU ambient norm. The other studied pollutant levels were below the current guidelines.

Keywords: Indoor air quality; PM1; PM2.5; PM10; Gaseous pollutants

1. Introduction

In recent years, multiple studies have reported worldwide increases in asthma and allergy prevalence (Masoli et al., 2004; Wickman and Lilja, 2003; Asher et al., 1998). The assessment of the geographical distribution of asthma and allergy occurrence is of considerable interest since it could contribute to the identification of asthma triggers. In the framework of the 'Global Burden of Asthma' (Masoli et al., 2004) report, the world map of asthma deaths per 100 000 asthmatics has been elaborated based on a collection of recent international respiratory health surveys and showed the highest fatality rate in the Middle East (> 0.01%) with Belgium in the 2nd highest category (0.005–0.01%). Several questionnaire-based studies were conducted to date in Europe, including Belgium, on the prevalence of asthma and asthma-related illness in different environmental settings (Masoli et al., 2004; Wieringa et al., 1997, 1998, 2001).

During the last decade various international epidemiological research programs, probed the relationship between ambient air pollution and morbidity, mortality and respiratory related diseases. Although evidence of causal relationships were reported (e.g. Farhat et al., 2005; Burnett et al., 2001; Goldberg et al., 2001; Schwartz et al., 2001; Pope et al., 2002; Hoek et al., 1998), some studies did not indicate a meaningful correlation, such as those of Roemer et al. (1998), Ramadour et al. (2000) and Peacock et al., 2003. Toxicological evidence, however, supports a connection between adverse health effects and air pollutants (Godish, 1990). Exposure to ambient air pollutants measured at a few fixed monitors was related to personal health

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(Pikhart et al., 2001; Roemer et al., 2000; Boezen et al., 1999; Hilterman et al., 1998; Peters et al., 1996), but provided results of high uncertainty due to the subjectivity of the completed questionnaires. More objective lung function measurements or allergy tests were only performed in a few longitudinal or time-series studies, which focussed on the evolution of the health situation of a limited number of participants, due to the fact that these measurements are more time consuming and require more

Table 1
Overview of the published indoor air quality guideline values as reported by Carrer et al. (2002)

Germany (1999)	GVII [a]	GVI [b]	Averaging period
Toluene	3 mg m^{-3}	0.3 mg m^{-3}	1–2 weeks
Styrene	0.3 mg m^{-3}	0.03 mg m^{-3}	30 min
CH_2Cl_2	2 mg m^{-3}	0.2 mg m^{-3}	24 h
CO	15 mg m^{-3}	1.5 mg m^{-3}	8 h
	60 mg m^{-3}	6 mg m^{-3}	30 min
NO_2	60 μg m^{-3}	6 μg m^{-3}	1 week
	350 μg m^{-3}	36 μg m^{-3}	30 min
Norway (1999)		**Guideline conc.**	
ETS	1 μg m^{-3}		
	10 μg m^{-3}		
CH_2O	100 μg m^{-3}		30 min
PM2.5	20 μg m^{-3}		24 h
CO_2	1800 μg m^{-3}		
CO	10 mg m^{-3}		8 h
	25 mg m^{-3}		1 h
NO_2	100 μg m^{-3}		1 h
Flanders (2004)		**Guideline value**	**Threshold value**
CH_2O	10 μg m^{-3}	100 μg m^{-3}	0.5 h
C_2H_4O	46 μg m^{-3}		
Other aldehydes	20 μg m^{-3}		
Benzene	2 μg m^{-3}		
Toluene	260 μg m^{-3}		
VOC tot	200 μg m^{-3}		
O_3	110 μg m^{-3}		8 h
NO_2	135 μg m^{-3}	200 μg m^{-3}	1 h
PM2.5	15 μg m^{-3}		y
PM10	40 μg m^{-3}		24 h
CO	5.7 mg m^{-3}	30 μg m^{-3}	24 h–1 h
CO_2	900 mg m^{-3}		
C_2HCl_3	200 μg m^{-3}		
C_2Cl_4	100 μg m^{-3}		
China (2001)		**Guideline conc.**	
SO_2	0.15 mg m^{-3}		
NO_2	0.10 mg m^{-3}		
CO	5.0 mg m^{-3}		
CO_2	0.10%		
NH_3	0.2 mg m^{-3}		
O_3	0.1 mg m^{-3}		1 h
CH_2O	0.12 mg m^{-3}		1 h
Benzene	90 μg m^{-3}		1 h
Inhalable PM	150 μg m^{-3}		
Canada		**ALTER°**	**ASTER°°**
NO_2	$<$100 mg m^{-3}	$<$480 mg m^{-3}	1 h
O_3		$<$240 mg m^{-3}	1 h
PM2.5	$<$40 mg m^{-3}	$<$100 mg m^{-3}	1 h
SO_2	$<$50 mg m^{-3}	$<$1000 mg m^{-3}	5 min

°ALTER: Acceptable Long-Term Exposure Range; that concentration range to which is believed from existing information that a person may be exposed to over a lifetime without undue risk to health.

°°ASTER: Acceptable Short-term Exposure Range; that concentration to which is believed from existing information that a person may be exposed to over the specified time period without undue risk to health.

[a] GVII: Guideline value II; health related values based on current toxicological and epidemiological knowledge.

[b] GCI: Guideline value I; the concentration at which a substance (individually) does not give rise to adverse health effects even at a life-long exposure.