

**EPIDEMIOLOGICAL STUDY ON POPULATION
EXPOSED TO AIR POLLUTION BY CHLORINE
AND ITS COMPOUNDS**

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The present study was designed to assess health effects in residents of a Bulgarian city polluted by a transboundary chlorine emitter. The study was undertaken on account of the local population's complaints of pervasive specific odour and irritation of respiratory ways and the eyes. The study aimed at assessment of both acute and long-term effects of exposure to air pollution.

MATERIALS AND METHODS

A longitudinal epidemiological study was carried out on the total population of the city, including vulnerable groups (children and people suffering from chronic pulmonary diseases). Concentrations of chlorine and other irritative gases (sulphur dioxide, nitrogen dioxide, hydrogen sulphide) were continually monitored by the local Hygienic and Epidemiological Inspectorate and the District Inspectorate for Environmental Protection.

In order to assess acute health effects, daily morbidity rates of respiratory diseases, eye inflammations, and cases of exacerbation of chronic pulmonary pathology were registered during high pollution episodes and compared to those during periods of lower pollution. The data were collected from the local polyclinics and pneumo-phtysiatric outpatient clinic. In order to assess long-term health effects, annual morbidity of the population (children and adults) was studied for a period of five years and compared to the background morbidity for an equivalent period before the start of the source of chlorine, as well as the average national urban population morbidity for corresponding time periods. All causes of morbidity and diseases of specific organs and systems were studied.

The local and national morbidity registers were used as sources of information. All data were statistically evaluated by Student's T Test and Chi Square Method.

RESULTS

Table 1 lists the mean annual and maximal short-term levels of the air pollutants measured at the time of the study.

Table 1: Concentrations of chlorine and other irritative gases in the air of residential area (mg/m³)

	1985	1986	1987	National Standard
<u>Chlorine</u>				
Mean annual	0.360	0.266	0.146	0.030
Maximal short-term	1.6	0.624	0.858	0.100
<u>Sulphur dioxide</u>				
Mean annual	0.030	0.023	0.026	0.050
Maximal short-term	0.286	0.384	0.096	0.500
<u>Hydrogen sulphide</u>				
Mean annual	0.006	0.006	0.005	0.008
Maximal short-term	0.042	0.031	0.032	0.008
<u>Nitrogen dioxide</u>				
Mean annual	0.022	0.026	0.032	0.040
Maximal short-term	0.102	0.119	0.101	0.085

It is evident that chlorine was the dominating component of pollution. Its short-term concentrations during episodes of high pollution reached 1.6 mg/m³ (16 times the national standard), and its mean annual levels varied from 0.14 to 0.36 mg/m³. The mean annual concentrations of SO₂, H₂S, and NO₂ were lower than their respective national standards of 0.05 mg/m³, 0.008 mg/m³, and 0.04 mg/m³. Occasionally, short-term concentrations of H₂S over MAC were measured, but they did not exceed 0.04 mg/m³.

Table 2 summarizes the daily morbidity of respiratory diseases and eye inflammations during episodes of high chlorine pollution in comparison to chlorine-free periods.

Table 2: Cases of respiratory diseases and eye inflammations registered during episodes of high chlorine pollution in comparison to pollution-free periods of equivalent duration in 1986 and 1987

	Number of patients registered in periods free from chlorine pollution	Number of patients registered in periods of high chlorine pollution	Increased percent(%)
Asthma	373	774	207.5%*
Acute bronchitis	1735	2405	138.6%*
Pneumonia	1110	1525	137.4%*
Acute respiratory infections	9200	11611	126.2%*
Grippe	234	389	166.2%*
Rhinopharyngitis	1536	2008	130.7%*
Tonsillitis	900	1264	140.4%*
Eye inflammation	902	1304	144.6%*

* Statistically significant, p < 0.01

Both acute respiratory diseases and eye inflammations were significantly increased during episodes of high chlorine pollution. The elevation was particularly high for asthma (over 200%), followed by acute bronchitis. A marked increase of diseases due to respiratory infections was found, e.g. rhinopharyngitis, tonsillitis, acute respiratory infections, grippe, and pneumonia. In parallel, a pronounced increase in the rate of exacerbation of chronic pulmonary diseases was observed among the patients of the local pneumo-phthisiatric outpatient clinic (Table 3). It is noteworthy that an elevated exacerbation rate was traced up to three days after each high-pollution episode.

Table 3: Exacerbation of chronic pulmonary diseases during episodes of high chlorine pollution in comparison to chlorine-free periods in 1986 and 1987

	Episodes of high chlorine pollution	Next 3 days	Pollution-free periods
Number of chronic pulmonary patients examined	1336	2010	1148
Number of patients with a diagnosed exacerbation of the existing disease	1052	1457	586
Exacerbation rate (percent)	78.7%*	72.5%*	51%

* Statistically significant, p < 0.01

Similar trends were found in the long-term morbidity study. The mean annual morbidity for periods of five years before and after the start of chlorine emitter was analyzed and compared to the average national urban morbidity rates for the same time periods. It was found that while previously no significant differences had existed between the background morbidity of local population and national urban population, a marked rise of some diseases took place after the start of the source (Table 4). This effect was much more pronounced in the younger population (0-14 years of age). While mainly asthma morbidity was elevated in the adults, a broader spectrum of diseases showed an increase among children. In the latter, significantly elevated morbidity rates were found not only for pulmonary diseases and infections (e.g. asthma, pneumonia, grippe), but for some extrapulmonary diseases as well (e.g. nephritis and anaemia).

Table 4: Mean annual morbidity of local residents for a period of five years after the start of chlorine emitter compared to the average morbidity of national urban population for the same time period (rate per 1000)

	Children (0-14 yrs)			Adults (over 15)		
	Local	National	Increase, percent	Local	National	Increase, percent
Asthma	12.8	8.3	154.2%*	5.2	3.9	133.3%*
Grippe	55.3	39.4	140.4%*	18.5	17.5	105.7%**
Pneumonia	87.7	71.6	122.5%*	9.8	11.2	-
Nephritis and nephrosis	2.4	1.7	141.2%*	2.3	2.4	-
Anaemia	1.2	0.8	150.0%*	1.8	1.8	-

* $p < 0.01$; ** $p < 0.05$

DISCUSSION

The results of this study show that air pollution in an urban area dominated by chlorine exerts both immediate and long-term health effects. Acute effects, observed immediately during and after episodes of high chlorine pollution, are manifested by an increase in the rate of diseases related to the irritative effect of pollution (asthma, rhinopharyngitis, acute bronchitis, eye inflammation), as well as of the acute respiratory infections. People suffering from chronic pulmonary diseases are particularly sensitive, as shown by the increased rate of exacerbation of the existing pulmonary pathology during episodes of high chlorine pollution. This effect is detectable in the next three days an episode of high pollution.

Long-term morbidity trends for a period of five years confirm the findings of the acute study with regard to respiratory diseases. Asthma morbidity is more pronounced both in children and adults in comparison to the mean asthma morbidity of urban population in the country. In children, along with a higher asthma morbidity, a long-term increase of other respiratory diseases is found, e.g. pneumonia, tonsillitis, and grippe. This points to an increased susceptibility to infections, most probably enhanced by the air pollution.

The long-term morbidity study revealed an increase of some non-respiratory diseases in children, namely renal diseases (nephritis, nephrosis) and anaemia. The increased nephritis morbidity could be related to a lower resistance to infectious agents as confirmed by the increase of respiratory infections. The increase of anaemia morbidity could be mediated not only directly by the air pollution, but also indirectly, through the increase of renal diseases.

In summary, the present study points out that exposure of urban population to chlorine at levels exceeding 0.100 mg/m^3 leads to acute respiratory effects and a long-term increase of respiratory and non-respiratory morbidity. Particularly vulnerable groups are children and people suffering from chronic pulmonary diseases.

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