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The Health of Inhabitants Living in the Immediate Vicinity of the Municipal Dumping-Ground of Cracow

1. Ventilatory Efficiency

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Abstract

For a couple of years a number of inhabitants living in the immediate vicinity of Cracow's municipal dumping ground reported symptoms which could be related to disfunction of the airways. During 2 days of hospitalization thorough medical examinations were given to 50 persons living not further than 300 meters from the edge of the dumping-ground. In frames of the study FVC, FEV_1, $FEV_{25/75}$, RV%TLC and R_{aw} were measured. A significantly higher number of subjects from the vicinity of the dumping ground than from the control group suffered a chronic cough and expectorations. Significantly higher numbers of inhabitants had emphysemal changes and worse patency of central bronchi.

Obtained results confirm that human lungs are not only opened widely to all kinds of toxic substances present in inhaled breath, but also it is a very sensitive and vulnerable organ, easily damaged by asorted toxins present in air in even smaller concentrations than are regarded at present as safe.

It should be postulated that major dumping grounds must have reasonably wide protective zones.

Keywords: dumping-ground, chronic bronchitis, respiratory resistance (R_{aw}), central and small bronchi obturation, clinical index of pulmonary impairment.

Introduction

The municipal dumping-ground for the City of Cracow with its population of approximately 700,000 is located some 14 km south-east from downtown, in a relatively densely populated area (381 people/square kilometer), between the southern edge of the city and the suburban city of Wieliczka, famous for its 700 year-old salt mine. In 1996 the amount of garbage exceeded 244,000 tons. A substantial, yet unknown, part of this was deposited in the largest dumping-ground at Barycz. The inhabitants of Barycz complain of a number of symptoms which could be related to exposure to toxic agents such as ammonia, hydrogen sulphide, carbon monoxide, hydrocarbons and also noxious derivatives of litter combustion: dioxines, nitrogen oxides, sulphur oxides and suspended dust are also abundant there. Furthermore, the persistent fetor is present in this area. Long-term exposure to low concentrations (even below the maximum allowable concentration) of the mentioned irritants produce symptoms of respiratory disorders [2, 3, 16].

The scope of this paper is limited to the evaluation of respiratory efficiency of people living in the immediate vicinity of the municipal dumping-ground. This study was prompted by members of the Barycz community who blamed the vicinity of the dumping-ground for the higher frequency of numerous diseases. Therefore, a complex medical study was undertaken in order to evaluate the health of the inhabitants of Barycz. This paper presents only the first part of the results obtained in the framework of this study.

Materials and Methods

Subjects of the study comprised 100 persons, divided into two groups:

1) The exposed group consisting of 50 persons (26 men and 24 women) aged 36.7 ± 15.1 years; height 167.4 ± 8.6 cm. Exposed group included residents of Barycz living not further than 300 meters from the dumping-ground.

2) The control group (also 50 persons) matched almost ideally as to age, gender, height and smoking habit to the exposed group (26 men and 24 women aged 36.7 ± 16.6

Table 1. The concentration of gaseous irritants and suspended dust in Barycz dumping-ground.

Pullutant	Mean 24 h concentration	Permisible limit for 24 h concentration
SO_2 (μg/m^3)	49	200
NO_x (μg/m^3)	33	150
CO (mg/m^3)	2	1
Susp. dust (μg/m^3)	42	120

years; height 165.4 ± 8.6 cm). The control group included inhabitants of Tokarnia, a village located approx 40 km south-west of Cracow. The village has favorable environmental conditions: high insolation, large green areas and lack of industrial plants in the immediate vicinity. Air pollution in the Tokarnia region is caused only by small house stoves and distant factories. Examined persons had never worked in industry, transportation or trade, and had been residents of Tokarnia for at least 10 years.

In the environment of municipal dumping ground the concentration of suspended dust, SO_2, CO, NO_X and total hydrocarbons were monitored by a mobile monitoring station equipped for computer analysis of collected data. The station was generously donated by the U.S. government. The results of measurements are presented in Table 1.

Level in air of SO_2 and NO_X was within normal limits. The concentration of suspended dust was normal if compared to the value for the daily mean, equal to 42 μg/m^3, but several times reached peaks as high as 650 μg/m^3. Mean daily concentration of CO was 0.5-2 μg/m^3 (treshold value -1 μg/m^3), exceeding this level in appx. 40% of measuring period of time.

To secure equal conditions for execution of pulmonological tests and learn more about their state of health two days of hospitalization were warranted for all subjects of the study. All subjects were interviewed at admission using a standardized Questionnaire of the Medical Research Council (MRC) extended for smoking, health and environmental histories. On the basis of the questionnaire frequency of chronic cough, chronic expectoration and chronic bronchitis was calculated. On the second day of hospitalization a physical examination, electrocardiography, x-ray chest examination and spirometric test were performed.

The ventilatory parameters of forced vital capacity (FVC), forced expiratory volume in Is (FEV_1) and forced expiratory flow between 25% and 75% of FVC ($FEF_{25/75}$) were measured from the flow-volume loop recorded by a computer-aided spirometer ("Screenmate" manufactured by Jaeger, FRG). The measurements of respiratory resistance (R_{aw}) were obtained from whole body plethysmography using a body plethysmograph "Pulmostar SMB" manufactured by Godart (Holland). The residual volume (RV) was estimated by the helium method using a "Spiro-Junior" spirometer manufactured by Jaeger. All examinations were performed in the morning (9:00-11:00) by the same technician. The obtained results were compared with predicted values (N) regarding gender, age and anthropometric indices. Values higher than 70% of the predicted ones were adopted as those within normal limits and values lower than 70%N as a pathologic ones. R_{aw} values higher than 0.25 hPa/dcm^3/s were pathological.

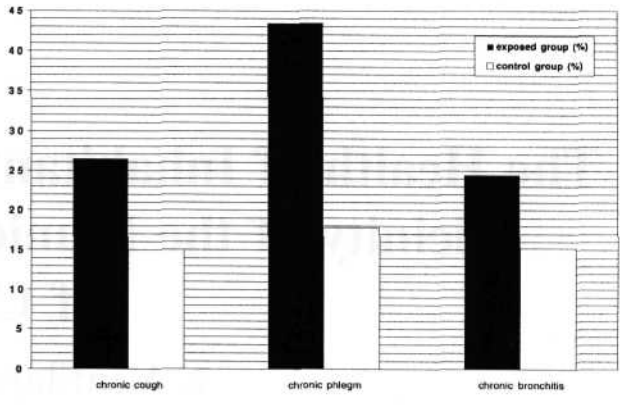

Fig. 1. Relative frequency of chronic cough, chronic expectoration and chronic bronchitis in the exposed and control groups.

The following criteria for ventilatory disorders were definied:

1. Obturative disorders:

a) central bronchi (an inside diameter larger than 2 mm) obturation

FEV_1 < 70%N, FEV_1%VC < 70%,

R_{aw} > 0.25 hPa/dcm'/s

b) small bronchi (an inside diameter smaller than 2 mm) obturation $FEF_{25/75}$ < 70%N

c) central and small bronchi obturation

the (a) and (b) parameters below 70%N

2. Restrictive disorders:

VC < 70%N, RV%TLC > 40%

3. Mixed disorders:

VC < 70%N, RV%TLC > 40%, $FEF_{25/75}$ < 70%N,

FEV_1 < 70%N, FEV_1%VC < 70%,

R_{aw} > 0.25 hPa/dcm^3/s

In the analysis of quantitative variables average, median, minimum, maximum, and standard deviation were calculated. The distance between compared distributions were measured by the Kolmogorow-Smirnoff test. The smaller distance between compared subpopulations, the smaller DN value obtained in this test (in the range of 0 to 1) and visualisation of the span between subpopulations were shown by plots of cumulative degrees of freedom (CDF), where abscissa was a numeric value for a given parameter [20].

Results

The percentage of subjects suffering from chronic cough, expectoration and chronic bronchitis is presented in Fig. 1.

The significantly higher number of people suffering from chronic cough and chronic expectoration was noted in the group from Barycz. Also, chronic bronchitis was more frequent in this group when compared to the control group, but the difference was not significant. The results of spirometric examinations are given in Table 2.

Inhabitants of Barycz showed statisticaly lower values of FVC and FEV_1 compared to values obtained in the control group. The values of R_{aw} and RV%TLC were higher in the Barycz group. Only between $FEF_{25/27}$ values characterizing the patency of small bronchi were significant differences not found.

Table 2. Ventilatory parameters in the two populations studied.

Ventilatory parameters	Examined group				Control group				p ≤
	x	SD	Median	Range	x	SD	Median	Range	
FVC (1)	3.65	0.89	3.79	1.45-5.87	4.18	0.95	4.23	2.26-5.97	0.05
FEV_1 (1)	2.89	1.11	2.93	0.81-4.81	3.45	0.97	3.37	1.64-5.23	0.05
R_{aw} (hPa/dcm^3/s)	0.30	0.07	0.29	0.16-0.52	0.25	0.06	0.24	0.15-0.41	0.001
$FEF_{25/75}$ (1/s)	3.84	1.39	3.68	1.36-6.65	4.18	2.06	4.00	0.89-9.99	ns
RV%T1C	35.5	7.70	35.7	17.1-55.0	30.9	4.4	30.0	22.3-42.7	0.001

x – arithmetic mean, SD – standard deviation, ns – not significant.

Plots of cumulative degrees of freedom (CDF) for parameters characterizing the patency of central bronchi (FEV_1 and R_{aw}) are shown in Fig. 2. The clinical index of pulmonary emphysema (RV%TLC) and values of $FEF_{25/75}$ are presented in Fig. 3.

Closer inspection of data from Figs. 2 and 3 revealed substantial differences of spirometric parameters between two compared groups. All differences were statisticaly significant. The most striking difference was noted for R_{aw}. The results for both groups were different in the whole span of R_{aw} values; from 0.15 up to 0.50 hPa/dcmVs. Values for FEV_1 had similar shape, though distance of compared sets of data was smaller than in the case of R_{aw}. It is of interest that the exposed group showed higher values of RV%TLC than the control group (35.5 versus 30.9% - Table 2) but, as may be inferred from Fig. 4 distance between compared groups was greater mostly for higher values of RV%TLC. This finding may be indicative of a higher incidence of pulmonary emphysema in the Barycz group. The patency of small bronchi was almost identical in both compared groups. Constant widening span between two groups starts at appx. 3.5 1/s where plots intersects. The difference is clearly seen for the higher values of FEF25/75. This may be the result of the presence in the control group of far more subjects with high patency, greather than 6 1/s.

The frequency of different respiratory disorders is presented in Fig.4

Normal ventilatory efficiency was found for 27 subjects (54%) of the exposed group, while in the remaining group of 23 persons a variety of respiratory disorders were noted. The normal values of ventilatory parameters were evidenced in 38 persons (76%), while respiratory disorders were found in 12 persons (24%) of the control group. The most common was obturation of central and small bronchi followed by mixed disorders. The purely restrictive disorders, not complicated by the spastic component of the respiratory tract, were not noted.

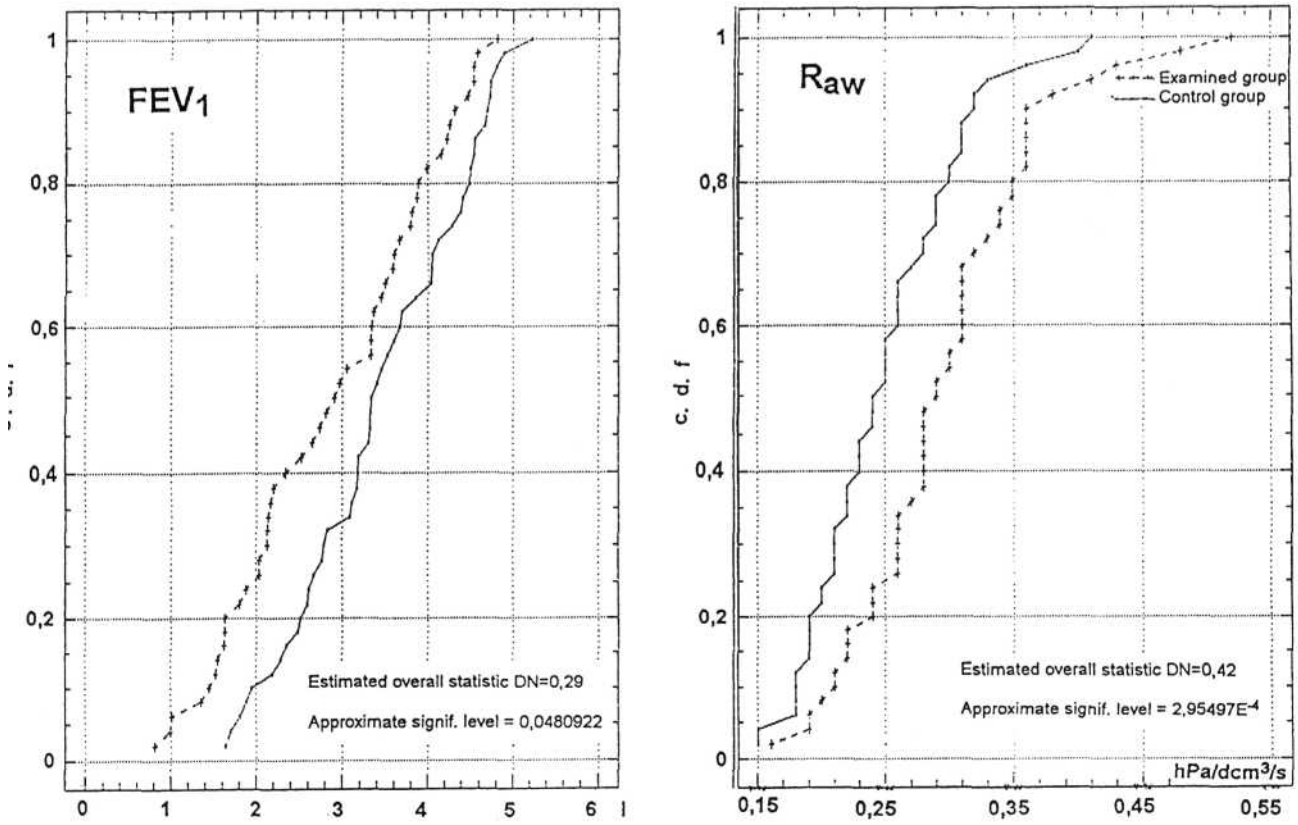

Fig. 2. Parameters characterizing the patency of central bronchi in two populations studied.

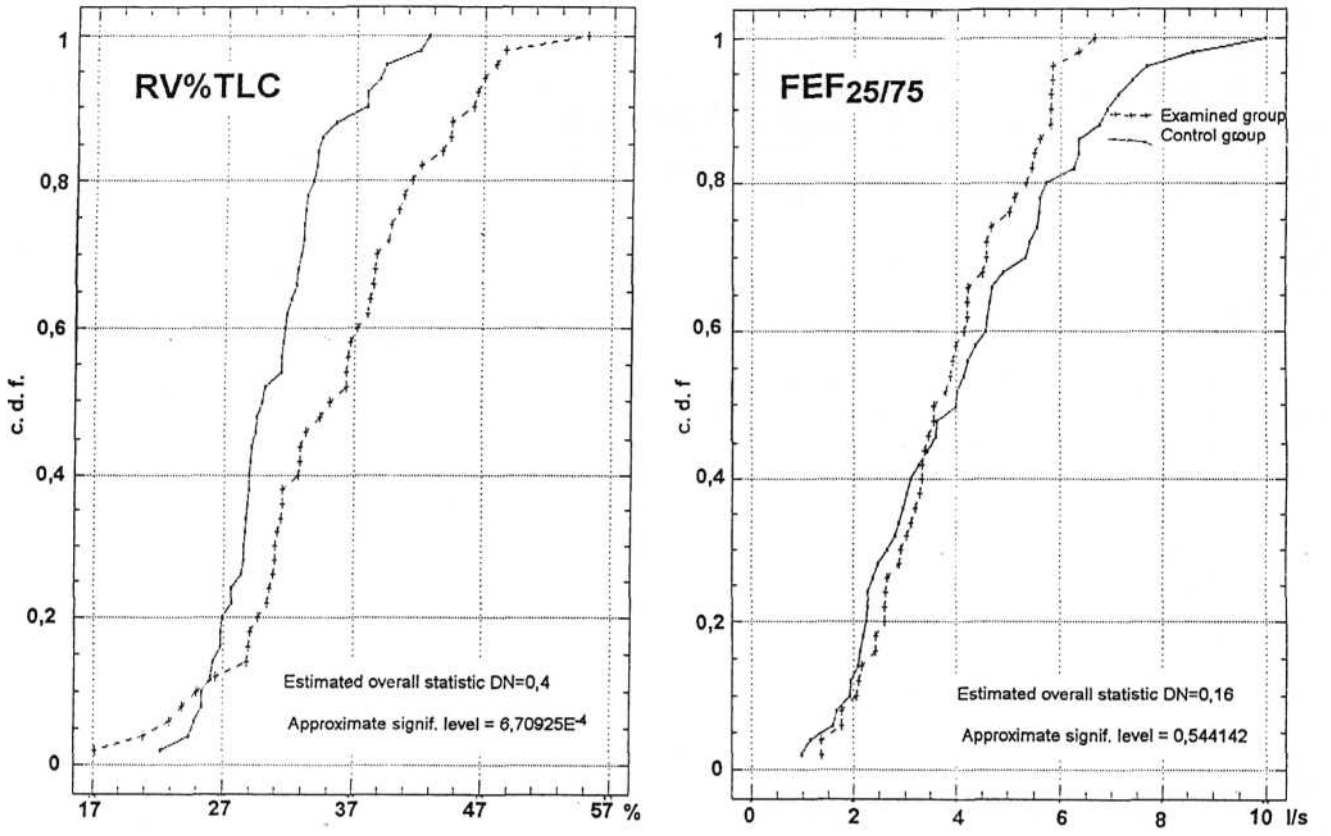

Fig. 3. The values of RV%TLC (clinical index of pulmonary emphysema) and the values of $FEF_{25}/_{27}$ characterizing the patency of small bronchi.

Discussion

Chronic bronchitis and pulmonary emphysema are considered to be diseases of civilisation. Some authors [6, 12, 18] even believe that the frequency of chronic bronchitis may be taken as a marker of air contamination. Chronic irritation of bronchial mucosa by air pollutants (especially by inhaling oxidizing chemicals) are blamed for impairment of mucosa and inhibition of ciliary clearance. As a result, viral and bacterial infestation often takes place. Infections diseases are more frequent due to a diminishing of natural immunological defense mechanisms of the bronchial tree and lung tissue [6, 11, 12, 18]. Ventilatory disorders were noted in 46% of subjects from the exposed group. The results obtained from the spirometric examination of people exposed to all noxious factors related to the vicinity of the dumping-ground are similar to those obtained from examination of people exposed to industrial pollutants. Inhabitants of villages situated in the vicinity of a steel-mill had higher frequency of chronic bronchitis and pulmonary emphysema in comparision to people living in favourable environmental conditions [4, 7]. They also showed significantly worse values of all parameters characterizing ventilatory efficiency: forced expiratory volume for Is, airway resistance and residual volume [5, 7]

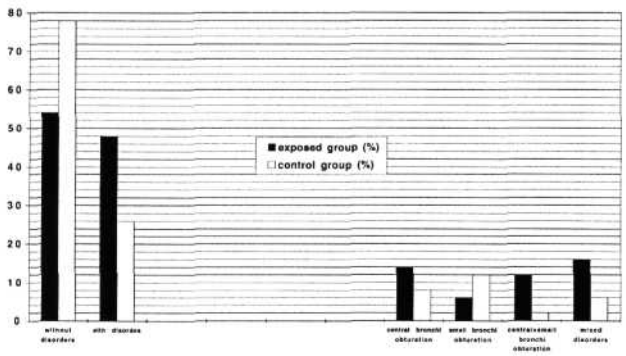

Fig. 4. Relative frequency of types of ventilatory disorders in the exposed and control groups.

People living in the immediate vicinity of municipal dumping-ground are exposed to microbes and mycotic pollutants which are present while the biodegradation of organic garbage takes place and to derivatives of pyrolysis and decay products, i.e. hydrocarbons, carbon monoxide, carbon dioxide, sulfur dioxide, nitrogen oxide, hydrogen chloride, fluoride compounds, dioxines and others [6, 8, 9,15]. Fumes and dust emitted during the combustion of litter have a harmful impact on the state of health. In the exposed group, 40% of subjects (mainly women) suffered headaches, whereas neurovegetative disorders were found in 46% of examined group, predominantly in men.

It also seems that the so called ecological consciousness of people inhabiting the vicinity of stacks of garbage is relatively high, raising the level of permanent anxiety related to air contamination and its impact on their health [1, 15]. These people do not want to accept living conditions which are perceived as dangerous. It should again be pointed out that long-term exposure to low concentrations (even

below the maximum allowable concentration) of the irritants produce symptoms of respiratory disorders [2, 3, 16, 21]. Raaschou - Nielsen [14] found a significantly higher prevalence of chronic bronchitis, asthma, and several other symptoms in 116 Copenhagen street cleaners who were exposed to traffic-related air pollution at levels that were slightly lower than the 1987 World Health Organization - recommended threshold values, compared to 115 Copenhagen cemetery workers. Mustajbegowic et al. [10] found that sanitation workers may develop chronic respiratory symptoms and lung function changes, manifested in the first place by FVC and FEV_1 changes. Sigsgaard et al. [19] noted the significantly higher prevalence of chest tightnees, flu-like symptoms and sore or itching throat among garbage-handling and recycling workers in Denmark, compared to water-supply workers. Also, Shephard and Lavallee in their detailed and well planned study showed that air pollution had a deletorious effect on forced vital capacity of school children, which could not be improved by physical exercises, favorable for children living in better microclimatic conditions [17].

The results of the present study strongly support the suggestion that different, also as yet not investigated or unknown contaminants present in negligible concentrations in air may (alone or acting in concert) have a deleterious effect on lungs.

An exact relation between environmental contamination and frequency of ventilatory disorders is not easy and straightforward. Thus, the present study should be treated as an initial one. Permanent medical care including spirometric examination conducted a minimum of once a year are intended for better insight into the dependence between air contamination and ventilatory efficiency of people inhabiting the immediate vicinity of dumping grounds.

Conclusions

1. In the group of residents of Barycz-village, living in immediate vicinity of the municipal dumping-ground of Cracow, frequency of chronic cough, chronic expectoration and chronic bronchitis was higher than in the control group.
2. Significantly higher values of RV%TLC - clinical index of pulmonary emphysema, and worse patency of central bronchi were noted in the exposed group.

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