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CHRONIC AND ACUTE EFFECTS OF AIR POLLUTION ON THE HUMAN AIRWAYS *
(Results of epidemiological studies in Holland)

R. van der Lende, C. Huygen, E.J. Jansen-Koster, S. Knijpstra, R. Peset, Ph.H. Quanjer, E.H.E. Wolfs and N.G.M. Orie
Groningen, Netherlands

Epidemiologie va CARA

Since 1965, we have conducted longitudinal epidemiological studies on chronic non specific lung disease (CNSLD) in randomly selected populations from a rural area, namely the area of Vlagtwedde, and from one of the most polluted areas of the Netherlands, the city of Vlaardingen. In these studies, we applied the standard questionnaire of the Medical Research Council, collected sputum and carried out several types of lung function tests, including vital capacity (VC) and a forced expiratory volume in one second (FEV_1).

First, I present some results of the first studies which we carried out in each area of residence. These data should be considered as prevalence data, since they were obtained during the first survey, which must be regarded as the cross-sectional part of the longitudinal investigation as a whole. First we studied the production of phlegm in both areas. Both the prevalence of persistent phlegm (based on the questionnaire) and the number of men and women who brought bottles with sputum was greater in Vlaardingen than in Vlagtwedde. This is in accordance with the findings of Takahashi.

Figure 1 shows the mean value for the FEV_1 in various "age groups" of men and women, standardized for a height of 1.70 m. In each age group, the mean FEV_1 in Vlagtwedde and Vlaardingen for various smoking habits is given separately. The Figure shows that the FEV_1 is much lower at older ages than at younger ages. Compared with this effect of age, there are only very slight differences between smokers and nonsmokers and between the polluted area and the non-polluted one. A consistent trend cannot be distinguished : in some age categories, the values for the FEV_1 in the polluted area are higher; in other categories, the values in the rural area are. Our conclusion is that our data did not show an effect of living in a polluted area on FEV_1 (and VC).

This conclusion from the lung function measurements was in accordance with our observation that in <u>older</u> men aged 40-64, there was no difference in the prevalence of dyspnoea between the polluted area and the non-polluted area. However, in the <u>younger</u> men aged 15-39, and in the <u>women</u>, we found a higher prevalence of dyspnoea

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* From the Research Unit for Epidemiology of CNSLD of the Organization for Health Research TNO; the Department for Pulmonary Diseases of the University Hospital in Groningen; the institute for Social Medicine and Community Health Care, State University Groningen; the Research Unit for Environmental Hygiene TNO, Delft; the Public Service of the City of Vlaardingen; and the University Computer Center, Groningen.

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in Vlaardingen, especially in those who smoked cigarettes. Thus, there was a discrepancy between the conclusions on the basis of the questionnaire and the conclusions on the basis of the lung function investigation. One of the explanations for this discrepancy could be that, in a cross-sectional study, a self-selection influences the outcome of the studies.

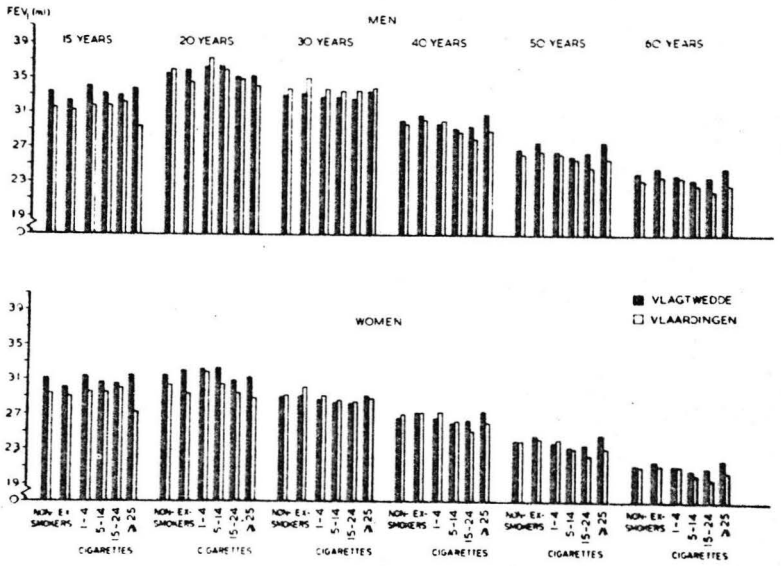

Fig. 1

For example, if we look at the values for the FEV_1 in those who smoked 25 or more cigarettes as compared with those who smoked less, then we see that those who smoked 25 or more cigarettes a day had a higher FEV_1 than those who smoked less. This could be explained by assuming that the heavy smokers are inclined to stop smoking if their FEV_1 decreases substantially or to smoke a smaller amount of tobacco, leaving smokers with an unimpaired FEV_1 in the categories in which a large amount of tobacco is smoked. The same thing may have happened with the inhabitants of the town of Vlaardingen, namely that the men and women with lung function impairments move away from Vlaardingen, leaving in the town those who have no decreased FEV_1, or only a slightly decreased one.

This is one of the reasons why we carried out follow-up studies of the cohorts who took part in our first studies. These studies are carried out once every three years, always within 5 days. The data which I am going to present now all concern the younger men (15-39), since we have not yet sufficiently analyzed all of the data for the women and the older men.

First, I present some data on absenteeism from work in both areas of residence. I must explain first that in the second surveys in Vlagtwedde and Vlaardingen, we asked the people whether in the past three years, i.e. between the two studies, they had stayed home from work because of respiratory diseases. The proportion of men with one or more periods of absence from work in Vlagtwedde, the rural area, and in Vlaardingen, the polluted area, were compared. For this presentation, we have divided the men into 2 age groups - namely 15-29 and 30-39 during the first investigations. There was more absenteeism in the polluted area, especially in the older groups. In the polluted area, 6.9 % of men aged 15-29 had one or more absences from work compared with 4.9 % in the rural area; the corresponding figures for the 30-39 age group were 12.2 % and 4.6 %. Of course, it is possible that people in a town are more inclined to stay home from work than are people in rural areas; at least, that is generally believed. However, in our opinion, such a difference in behaviour cannot account for the great difference in absenteeism between Vlagtwedde and Vlaardingen in the men aged 30-39, because the difference is much smaller in the men aged 15-29.

Table 1 shows the frequency of absenteeism from work in both areas of residence. Here again, in the three years between the two investigations, it is evident that there was a higher proportion of people with 2 or more periods of absenteeism in the polluted area.

Table 1
FREQUENCY OF ABSENTEEISM IN MEN IN THE PAST 3 YEARS

	Vlagtwedde		Vlaardingen	
	Age (years)		Age (years)	
	15 - 29 (No. = 345) %	30 - 39 (No. = 328) %	15 - 29 (No. = 333) %	30 - 39 (No. = 230) %
No absenteeism	95.1	95.4	93.1	87.8
Once	3.5	3.4	2.7	5.7
2 times or more	1.5	1.2	4.2	6.5

Table 2 shows the duration of the absenteeism. In Vlaardingen, the duration of absence from work due to respiratory diseases was longer than in Vlagtwedde.

In Table 3, the incidence of one or more periods of absenteeism for people without respiratory symptoms and for people with respiratory symptoms is presented. I would like to make it clear that the prevalence of respiratory symptoms is based on the data of the first investigation and that, in the second study, we asked about the incidence of one or more periods of absenteeism in the past three years; that is, since the first investigation started. I think

it is very impressive to see how large the difference in absenteeism is between people with respiratory symptoms and people without respiratory symptoms. One might say that the presence of respiratory symptoms is a distinct risk for absenteeism from work in the future.

Table 2
DURATION OF ABSENCE IN MEN

	Vlagtwedde		Vlaardingen	
	Age (years)		Age (years)	
	15 - 29 (No. = 345) %	30 - 39 (No. = 328) %	15 - 29 (No. = 332) %	30 - 39 (No. = 230) %
1 - 4 days	1.2	0	0.9	0.9
5 - 9 days	0.6	0.6	1.2	1.3
> 10 days	2.9	3.9	4.5	10.0

Table 3
ABSENTEEISM FROM WORK IN THE NEXT 3 YEARS
IN MEN AGED 15-39 WITHOUT AND WITH RESPIRATORY SYMPTOMS

	Vlagtwedde		Vlaardingen	
	No.	Abs. in %	No.	Abs. in %
No resp. symptoms	434	3.0	291	5.2
Persistent cough	59	10.2	65	20.0
Persistent phlegm	47	14.9	69	26.1
Dyspnoea grade 3	27	11.1	29	24.1
Wheeze grade 3	22	9.1	34	29.4
Asthmatic attacks	19	15.8	24	12.5
Bronchitis periods	45	15.6	84	20.2

The conclusion of this section of my report is that long term exposure to air pollution seems to have little or no effect on VC and FEV_1, but induces a higher prevalence of respiratory symptoms as well as more absenteeism from work due to (acute) respiratory diseases.

Now I discuss another subject, which has been published this year in the Bulletin de Physio-Pathologie Respiratoire (Van der Lende *et al.*, 1975). A cross-sectional study has certain limitations and it is impossible to exclude effects of "self-selection". Now, if we assume that atmospheric pollution does indeed cause lung function impairments, then we should expect that, in the course of a couple of years, the age-related decrease in the vital capacity (VC) and the forced expiratory volume in one second (FEV_1) would be greater in the polluted area of Vlaardingen than in the rural area of Vlagtwedde, at least in the age groups above 25.

After completing our second survey in these areas, that is, 3 years after the first survey, we calculated the difference between the VC measured during the second survey and the VC measured during the first survey for each individual who took part in both investigations. The same was done with the values for the FEV_1. We refer to these differences as "the individual differences in VC (or FEV_1)" between the two investigations.

Figure 2 (top panel) shows the means of these individual differences in the VC in five-years categories of men and women between the two investigations in the rural area Vlagtwedde. In this area of residence, the results were as would be expected : in the youngest age group (those who were 15-20 years old at the first study), there had been an increase in VC and FEV_1 after a period of three years, but in the men and women older than 25, there was a slight "decrease" in VC and FEV_1 (i.e. the means of the individual differences between the second and the first investigation were smaller than zero).

In the polluted area of Vlaardingen, however, the results were completely contrary to our expectations. In this city, in the second investigation (which was carried out in 1972), the values for VC and FEV_1 in the majority of the men and women were higher than the values in the first investigation, carried out three years previously. Figure 2 (bottom panel) shows that in Vlaardingen the means of the individual differences between the studies in 1972 and 1969 were larger than zero in each 5-year age group.

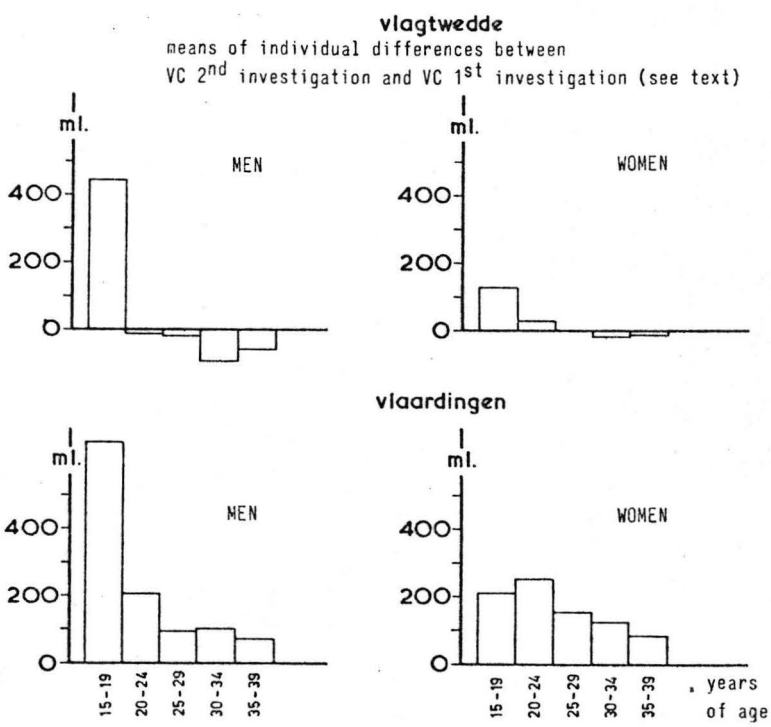

Fig. 2

As already stated, we always carry out our studies within 5 days. Figure 3 shows that, on each of the 5 days of the second investigation, the individual values for the VC and FEV_1 were higher, on the average, than on each of the 5 days of the first investigation. There is, however, a daily fluctuation in the mean height of the individual differences in VC (and FEV_1); for instance, the mean difference is highest on the third day of the investigation.

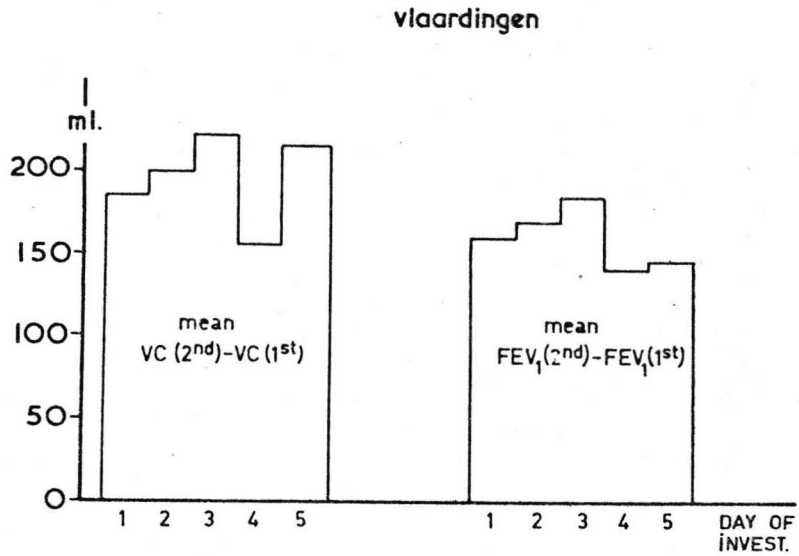

Fig. 3

These results in Vlaardingen can possibly be explained by the observation that there was a difference in the amount of air pollution between the first investigation (1969) and the second investigation (1972). Figure 4 (top panel) shows - as indicators of the pollution on the days of investigation - the daily means of SO_2, dust particles and NO_2 at one measuring post in the centre of Vlaardingen. The measurements at this station were representative for the air pollution in Vlaardingen during these days.

The Figure shows the daily concentrations of these air pollutants on each of the 5 days of investigation. The total height of the bars represents the daily concentration measured during the first investigations (1969); the open part of the bars represents the concentration measured during the second investigation (1972). The hatched

part of the bars in this Figure thus represents the differences between the concentrations of SO_2, suspended dust, and NO_2 on the days of the investigation in 1969 and in 1972. These differences (the surplus in air pollution during the first investigation) are presented in the graph in the bottom panel of the Figure, also according to the day of investigation.

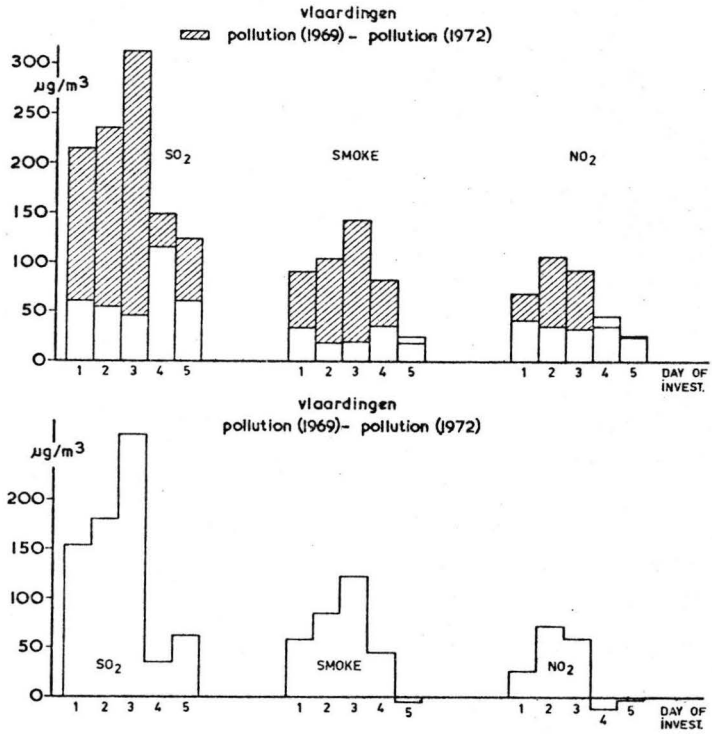

Fig. 4

In Figure 5, this additional pollution is again shown, together with the means of the individual differences between the VC (and FEV_1) of the second investigation and the VC (and FEV_1) of the first investigation, also for each of the 5 days of investigation. The fluctuation in the differences in air pollution over the 5 days and the fluctuation in the means of the individual differences in VC (and FEV_1) are concurrent. On the day that the surplus in air pollution was greatest, the mean difference in VC (and FEV_1) was also greatest.

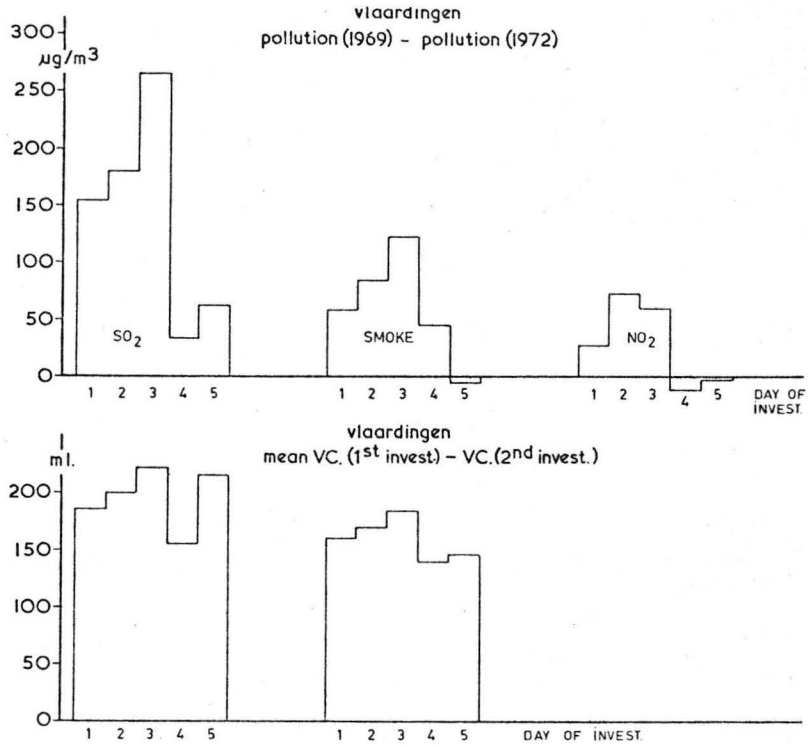

Fig. 5

DISCUSSION

The great difference in air pollution during the time at which we carried out the two studies was due mainly to an unusual high peak in the air pollution in Vlaardingen on the very days of our investigation in 1969, whereas, during the second investigation (in 1972), the pollution data were unusually low. It is tempting to assume that there was a temporary decrease in the VC and FEV_1 in the majority of the population during the period of high pollution. If this were true, then a number of questions would arise.

1) Are there special types of pollution which cause temporary lung function changes ? The association we found with SO_2, smoke, and NO_2 does not mean that these pollutants were indeed the main irritants; they were possibly only indicators of the fact that the pollution in Vlaardingen was higher than usual. A special pollutant (e.g. H_2SO_4) may have been present in the air at that time and might have caused a lung function impairment.

2) What type of lung function impairment is produced during a short period of high pollution ? Is it only a decrease in ventilation (probably due to bronchial obstruction) or are there also impairments in, e.g. mechanics of breathing, diffusion, etc. ? This is an important subject for study, since it might enable us to gain further insight into the pathogenesis of CNSLD.

3) What type of people react ? Although a majority of the people in Vlaardingen showed a lower VC and FEV_1 during the first investigation in 1969, there was also a group in which the reverse was true - namely in which the lowest value was found in 1972. The question arises why some people reacted with a decrease in the ventilatory function under these circumstances, whereas other people did not.

One firm conclusion may be drawn at the end of this report. If one studies whether there are effects of long term exposure to air pollution on the human lung, one must be very careful that the results of the studies are not disturbed by effects of short-term peaks in the air pollution.

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