THE STUDY ON THE RELATIONSHIP BETWEEN BREATH DUST VALUE (BDV) AND PNEUMOCONIOSIS

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INTRODUCTION

How to determine the exposed-dust volume is the key index in the study on the relationship between dust and pneumoconiosis. Hatch once used the product of dust concentration (mg/m^3) by labour age as exposed-dust volume. Authors, after long kinematic observation, discovered that the incidence rate of pneumoconiosis had significant difference in labour strength, under the same mg. Yes, its cause was related to breath volume. It is verified that the difference in breath volume is greater and it is extremely reached 1:2:3 in the labour strength medium and heavy.

Therefore, the author proposed the breath dust value obtained by multiplying dust concentration exposed time by labour breath value as the index of exposed-dust volume. The following is the studied results on the relationship between BDV and pneumoconiosis.

METHOD OF STUDY

Two plants were chosen as observation targets where the conditions of dust prevention and production were stable and the workers were exposed to silica dust and had little mobility.

1. Established strict regulations of environment supervision (to measure dust concentration once a month), and health guardianships (to make health examinations once a year). The occupational history and examination results were recorded on "health cards," while the results of measured dust were recorded on "labour hygiene cards."

2. Measured exposed time labour breath volume, oxide exhausted and energy exhausted in a shift in different types of work, and determined the breath volume and labour strength in different types of work according to the measured results.

3. Computed the BDV for all exposed workers and pneumoconiosis cases, and then analyzed the relationships between BDV and pneumoconiosis.

RESULTS

According to the studied results, specified a table of breath volume under various labour strengths as shown in Table I, and then determined breath volume in light, medium, and heavy. According to formula (1), calculate BDV.

$$X = \sum_{i=1}^{n} (K(CHT))i \qquad (1)$$

where:

X—BDV accumulate value;
C—average dust concentration (mg/m^3);
H—labour breath volume (l/min);
T—exposed years of standing (year × shift × min);
K—adjusted index of time unit (0.144).

When dealing with the data of retrospective study, use the average dust concentration of year and month as the basis for calculating BDV. But in prospective study, it is best to use the average dust concentration in a shift as a basis of calculating BDV. Labour time (min), labour breath volume (l/min) and personal exposed concentration (mg/m^3) must be practically measured data.

First, calculate BDV in a shift, then, according to number of worker's shifts determine accumulated value of BDV.

Figure 1 shows the statistical results of the relationship between BDV and accumulated incidence rate of pneumoconiosis from 706 exposed workers in plants A, B.

Table II shows the statistical results of BDV in 42 pneumoconiosis cases in different phases in plant A. The BDV from pneumoconiosis in different phases has significant difference by T test. The greater the difference of BDV is, the more serious the phase of pneumoconiosis.

Figure 2 shows the results of relationship between BDV and fatality rate through 20 years of observation. The greater the BDV is, the higher the fatality rate. When analyzing the relationship between "exposure standing up to diagnosis" and BDV in average years, it was found that there is a straight correlation of BDV in average years with "exposure standing up to diagnosis" as shown in Figure 3. The smaller the BDV average is, the longer "exposure standing up to diagnosis" of pneumoconiosis is.

The BDV of average years in 1 phase pneumoconiosis was obtained by accumulated BDV in 1 phase pneumoconiosis divided by "exposure standing up to diagnosis," which provided the proof for searching the limit value of BDV in pneumoconiosis

Table I
Strength versus Breath Volume

Strength	Energy exhausted (l/min)	Breath volume (l/min)
light		10 - 20
medium		21 - 35
heavy		36 - 50

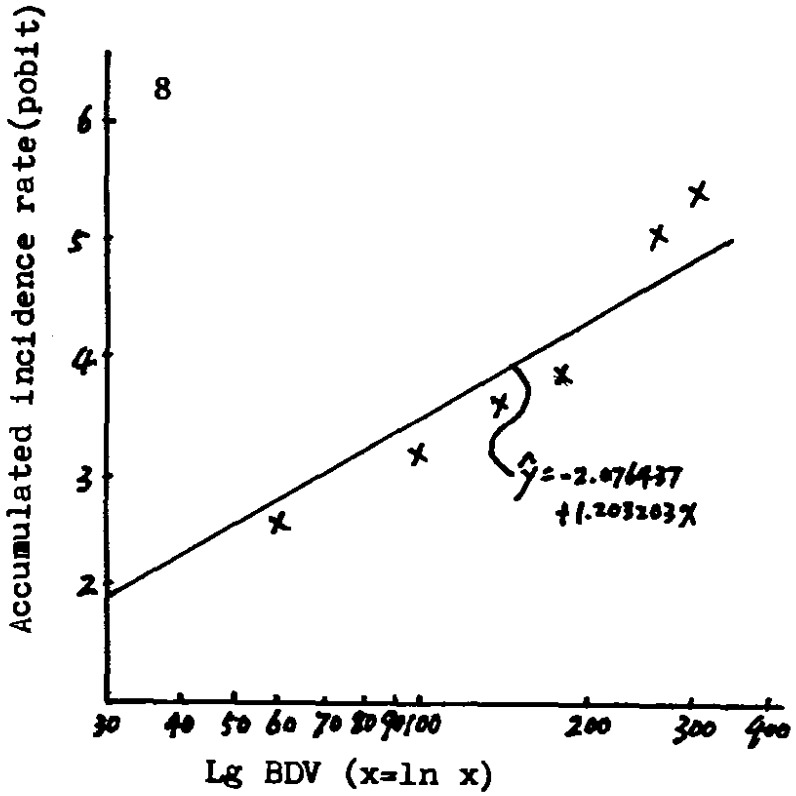

Figure 1. The relationship between BDV and the incidence rate of pneumoconiosis.

According to the closed relationship between the occurrence and development of pneumoconiosis and BDV, from the correlation of BDV in average years with "exposure standing up to diagnosis," the author provided the formula of calculating dust allowable concentration.

$$D = \frac{g - t_{0.05}(n') \cdot Sg}{T \cdot K} \quad (2)$$

where:

D — dust allowable concentration;
g — logarithmically geometric mean of BDV in I pneumoconiosis;
Sg — logarithmically standard error of geometric mean of BDV in 1 phase of pneumoconiosis;
$t_{0.05}(n')$ — one-sided value obtained by the statistical number of cases N and degrees of freedom N-1 in table.
T — the specified breath volume under the certain labour strength;
T — the longest labour age of exposed workers;
K — factor 0.144 adjusted by time unit.

Table II
BDV in 42 Pneumoconiosis Cases

Phases of pneumoconiosis	Statistical cases	Average of BDV
0 - 1	7	846.09
1	12	1890.39
2	10	8185.50
3	13	15636.48

See the following example from the original data of BDV of 27 cases in 1 phase pneumoconiosis in plant B as shown in Table III.

where:

1. logarithmically geometric mean g=2.4119;
2. logarithmically standard deviation Sg=0.3488;
3. $t_{.05}(26) = 1.706$;
4. labour breath volume, 20 l/min;
5. the longest exposed labour ages, 30 Yrs.
6. K = 0.144
   D = lg^{-1} ((2/411.9-1.706 0.3488-lg(30 × 0.144 × 20))
   = 0.76 (mg/m^3)

DISCUSSION

The key problem in the survey is how to determine the relationship of dose-response between dust and pneumoconiosis. Dutoid, Risner, Bedlle, etc. have studied the above problem and proposed various indexes after Hatch. Among these indexes are dust concentration and the most basic parameters. But they all do not involve the labour strength.

The author considered that labour strength shouldn't be ignored according to studied results. Because of various labour strength effects on labour breath, which effects the dust deposit rate in the respiratory tract, it is related to inhaled dust volume. Therefore, the important factor of labour breath volume should be induced into the calculation of three factors of dust concentration (c), exposed time (T) and breath value (H). But, because it has a difference from practically inhaled dust volume, it should be called exposed volume named as BDV. The parameters of BDV are strong according to the different data. In the data treatment of retrospective study, although no method to recollect historic date, it is possible to calculate the BDV's factors according to the table of dust concentration in different years obtained by collected monitored data. But in introspective study, it is based on personal exposed concentration while labour breath volume and labour time should be measured practically. Still, a lot of problems about how to obtain the exact data of dust concentration need to be researched.

The Relationship Between BDV and Pneumoconiosis

Studied results, proved further that there is a dose-response relationship between dust and pneumoconiosis

Objective of investigation is these workers who were exposed to silica dust and their pneumoconiosis is the typical silicosis. In the long statiistical survey of 20 years, dust monitoring and workers' health examinations were carried out by study groups, themselves under the unified planning. Most data about measured dust is measured by themselves, and diagnosed by a special diagnosis group which is composed of experts of X-ray, lungs, tuberculosis, and hygiene. So, the first-hand data is reliable, and based on that, we have confidence to search the limit value of BDV in pneumoconiosis by the relation of both of them and proposed assessment formula of dust allowable concentration. The formula's property is that data treatment is based on BDV of 1 phase pneumoconiosis. It is not easy to set data on an exposed population in an investigation of pneumoconiosis for a long time, therefore, treating the data on dynamic incidence rate is difficult. But for each record of pneumoconiosis, such as occupational dust concentration, diagnosis is actual. Most cases of pneumoconiosis occurred in major, exposed types of work. There were detailed records of occupational history, and data of dust concentration in the workplace. Other workers who were not affected by pneumoconiosis worked in unimportant, exposed type of work, where there was little detailed data of measured dust. And hence, it was very difficult to calculate exposed-dust volume. Sometimes to resolve the above mentioned problem, the method must be adopted of assession or multiplication of the data of major exposed type of work by a certain factor. Hence, the calculation of exposed-dust volume in health population is not certain. From the practical conditions, there is an actual significance to search a method with reliable data of cases of pneumoconiosis. Of course, its science and reality must be tested and proved in practice

SUMMARY

According to long studied results in a field survey, it is considered that breath volume should be introduced to reflect the difference of labour strength while calculating exposed-dust volumes and proposed calculation method of exposed-

Table III
The Example from the Original Data of BDV of 27 Cases in 1 Phase Pneumoconiosis in Plant B

27 cases in 1 phase pneumoconiosis in plant B				
175.19	246.76	261.29	310.68	259.30
92.07	252.66	1019.91	931.54	225.50
271.27	956.45	138.60	935.57	1675.58
262.11	206.66	264.96	113.68	101.11
153.34	159.47	265.20	231.82	148.28
57.11	264.35			

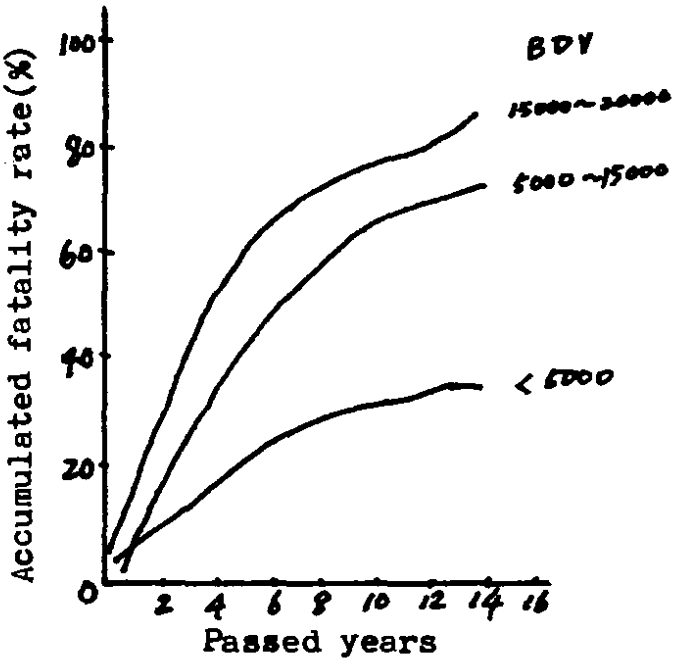

Figure 2. The relationship between BDV and the fatality rate of pneumoconiosis.

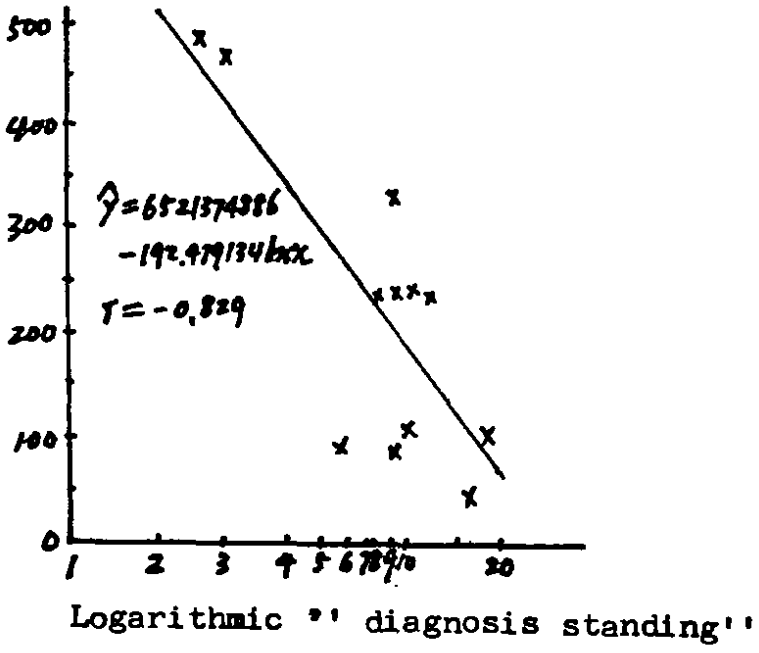

Figure 3. The relationship between BDV average years and "exposure standing upon diagnosis" in 1 phase pneumoconiosis.

dust volumes; i.e., BDV and the studied relationship between BDV and pneumoconiosis. From the closed relationship between pneumoconiosis and BDV, the author has expounded the linear correlation of BDV in average years with "exposure standing upon diagnosis" in 1 phase pneumoconiosis, searched the limit value of BDV in 1 phase pneumoconiosis, and proposed the method of calculating dust allowable concentration, based on BDV in 1 phase pneumoconiosis.

REFERENCES

1. Hatch, *Am. Indust. Hyg. Assoc.* (1), 30, 1955.
2. Liu Zhanyuan, et. al.: *Chinese Journal of Preventive Medicine,* 15 (1), 17, 1981.
3. Liu Zhanyuan, et. al.: Method of Field Investigation Indust. Allowable Concentration, 46.

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