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On the Health Status of Workers Using Vibrating Tools in Anthracite Mines

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By implementing epoch-making policies of industrial promotion, the national economy has made a remarkable development. As a result of such economic growth, industrial accidents and occupational diseases have become a serious problem in Korean society.

In the presidential order for the execution of the Korean labor standard law, neuritis and other diseases stemming from health impairments due to vibration in industrial processes are designated to be dealt with as vibration diseases. In the case of vibration disease, industrial accident compensation is not effectively paid.

In order to investigate vibration hazards of rock-drill operators, the author studied subjective symptoms and did physical function tests on a total of 208 persons (vibration exposed group), who used rock-drills, and 115 persons (control group) who are not using rock-drills at anthracite mines.

The results of physical function test are as follows.

1. There is no difference in smoking habits between the vibration exposure group and the control group.
2. In the use of their ear plugs, both the vibration exposed group and the control group showed a low tendency in using the ear plugs.
3. In the prevalence rate of white finger, the vibration exposed group reached 12.5 percent, but only 0.9 percent in the control group. Thus, both groups showed different rates in the initiation of their illness ($p<0.01$).
4. The prevalence rate of finger numbness for the vibration exposed group was 23.1 percent, but only 9.6 percent in control group ($p<0.05$).
5. In the prevalence rate of insomnia, the vibration exposed group had 22.6 percent and the control group 9.6 percent. Thus, the vibration exposure group showed a higher rate than the control group ($p<0.05$).
6. In the vibration sense threshold, the vibration exposed group showed a statistically higher level than the control group ($p<0.01$).
7. In the mean value of skin temperature, the control group was higher than the vibration exposed group ($p<0.05$).
8. In the amount of perspiration, the exposed group measured higher than the control

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group ($p<0.01$).

Key Words : Vibration syndrome, White finger, Vibratory sense threshold

By implementing epoch-making policies for industrial development the national economy has made remarkable progress. However, at the same time industrial accidents and occupational disease have become a serious problem in Korea.

According to the presidential order for the execution of the Korean labour standard law, industrial vibration hazards are regarded as an occupational disease.

In the meantime, the vibration hazards, that advanced countries have already managed and adequately compensated, are not well recognized in Korea.

Following the report of Raynaud's phenomena in 1862, the vibration hazards with the difference names of white finger, traumatic vaso-spastic disease, vibration induced white finger and waxy whiteness has been actively investigated.

The aim of this study is to investigate the present status of the vibration hazards among rock-drill operators in anthracite mines.

METHODS

In order to investigate vibration hazards of rock-drill operators, the authors have studied subjective symptom by means by questionnaires which consisted of 39 questions and performed several physiological function tests, which will be described later, on 208 rock-drill operators and 115 control subjects. The study began in April 1981.

The average temperature of the working environment was found to be 18.5°C.

The physiological function tests employed are, the audiometric test by audiometer (EKSTEIN BROS INC. Model 390 MB), vibration sense threshold test with the vibration sense meter AU-02, Roin Compl), the pain sense threshold test by the algometer and measurement of skin temperature with the finger thermometer(Nihon, Keisokuku). The pain threshold was measured on the backsie of the distal part of both middle fingers and the finger temperature was measured by attaching an electrode to both middle and ring fingers.

The rate of perspiration was determined on both palms with the method developed by Takamatsu.

The sweating rate is expressed in terms of an electrical current between two electrodes on the palm at a given voltage difference.

The Answer sheets of the questionnaire were edited and filed with an individual code and the vibration syndromes were analyses through t-test, z-test and x^2-test by the computer.

RESULTS

A. Characteristic of workers

Range of age of subjects was from 19 to 59 years.

The average age of the vibration group is 36.9±7.7 years, while the control group indicates 34.6±7.3 years.

The figure is not statistically significant by t-tes.

The average weight of the vibration exposed group was 63.6±7.7 kg, and the control group was 62.0±8.0 kg.

The average height of the vibration exposed group was 166.7±6.8 cm, as compared with 166.2±7.6 cm of the control group, as shown

Table 1. Distribution of subjects by age

Age	Vibration group	Control group
less than 20	3 (1.4)	1 (0.9)
20 to 29	25 (12.0)	29 (25.2)
30 to 39	112 (53.9)	60 (52.1)
40 to 49	65 (31.3)	24 (20.9)
50 or Above	3 (1.4)	1 (0.9)
Total	108 (100.0)	115 (100.0)

Table 2. Physical characteristics of subjects

Item	Vibration group (208)	Control group (115)
Age (year)	36.9± 7.2	34.6±7.3
Height (cm)	166.7±6.8	166.2±7.6
Weight (kg)	63.6±7.7	62.0±8.0

Figure indicated mean±S.D.

Table 3. Average consumption of cigarettes and alcoholic beverage

Item	Vibration exposed group (208)	Control group (115)
Smoking (cigarettes)	19.8±8.0	17.9±9.4
Drinking (ml of 25% proof)	165.4±136.3	151.7±136.3

Fig. represents mean±S.D.
The figures is not statistically significant.

Table 4. Use of personal protective devices

	Vibration exposal group (persons/percent)	Control group (persons/percent)
Ear plug	26 (22.5)	2 (1.7)
Golves	201 (96.7)	113 (98.2)

* The figures showes a significant difference ($P<0.01$) by z-test.

in table 2.

Smokers in the vibration exposed group was found to be 92.1 percent and this group consumed an average of 19.8±8.0 cigarettes a day, as compared with 90.4 percent of smokers and 17.9±9.4 cigarettes consumed by the control group, as indicated in table 3.

As for alcoholic consumption, workers of the vibration exposed group replied that they consumed 165.4±136.3 ml of 25% proof alcoholic beverage a day, as compared with 152.7±131.7 ml of the control.

Therefore, it may be concluded that there was no significant difference in the consumption of cigarettes or alcoholic beverage between the vibration exposed and control group.

The figure is not statistically significant.

As for protective devices, 26 workers of the vibration exposed group used ear plugs.

The figure accounts for 12.5 percent while in the control group only two persons used a protective device, accounting for 1.7 percent as indicated in table 4. Most of the subjects in coal mining areas used rubber gloves with cotton insulation; 96.7 percent of the vibration exposed group, and 98.2 percent of the control group wore the protective gloves. (Table 4).

Table 5 shows the frequency of taking a hot shower in the subjects. As can be seen 61.5 percent of the vibration exposed group take a hot shower ever day, 24.0 percent every third day, and 14.4 percent once a week.

In the meantime, 98.2 percent of the control group take a hot shower every work day, 0.9 percent every third day and 0.9 percent once a week.

Table 6 shows hours of rock-drill operation in vibration exposed group. Eighteen point three percent of the workers used a rock-drill for less than two hours a day, 46.2 percent used a drill two to four hours, 24.0 percent used a drill four to six hours and 11.5 percent

Table 5. Frequency of shower between groups

Frequency	Vibration group (208)	Control group (115)
Daily	128 (61.5)	113 (98.2)
Every third day Per three days	50 (24.0)	1 (0.9)
Weekly	30 (14.4)	1 (0.9)

Table 6. Hours of rock drill operation in vibration group

Hours (per day)	Workers	Percentage
loss 2	38	18.3
2 to 4	96	46.2
4 to 6	50	24.0
6 and above	24	11.5
Total	208	100.0

Table 7. Number of years of rock-drill operation

Years	Workers	Percentage
less 4	88	42.3
4 to 8	61	29.3
8 to 12	42	20.2
12 to 16	11	5.3
16 and above	6	2.9
Total	208	100.0

of the workers operated a drill or more than six hours a day.

Forty-two point three percent of the workers have used a rock-drill for less than four years, 29.3 percent workers four to eight years, 20.2 percent 12 to 16 years, and only 2.9 percent of the workers have used a rock-drill for more than 16 years as indicated in table 7.

B. The prevalence rate of vibration syndrome:

According tot he classification of vibration syndrome by Taylor, 26 workers of the vibration exposed group(208) have suffered from white finger, representing 12.5 percent of the total vibration group as indicated in table 8.

The prevalence rate of white finger increases as the number of years of drill operation increases.

C. Subjective symptoms:

Table 9 represents the result of an analysis made on the subjective symptoms of both groups. Twenty three point one percent of the vibration exposed group complained of numbness, compared to 9.6 percent of the control group. This is a highly significant difference between the two groups ($p<0.05$).

Six point seven percent of the vibration exposed group and 2.6 percent of the control group suffered from finger pain, and this also

Table 8. Prevalence rate of white finger and number of years of drill operation

Year	Number of patient (white finger)	Number of workers of vibration exposed group	Prevalence rate (percentage)
less 4	5	88	5.7
4 to 8	7	61	11.5
8 to 12	9	42	21.4
12 to 16	3	11	27.3
16 and above	2	6	33.3
Total	26	208	12.5

Table 9. Analysis of subjective symptoms between two groups

Symptoms	Vibration exposed group (person/percentage)	Control group (person/percentage)
Finger hand		
Numbness	48 (23.1) *	11 (9.6)
White finger	26 (12.5)*	1 (0.9)
Pain	14 (6.7)	3 (2.6)
Stiffness	12 (5.8)	6 (5.2)
Sweating	12 (5.8)	3 (2.6)
Insomnia	47 (22.6)*	11 (9.6)
Headache	22 (10.6)	9 (7.8)
Tinnitus	28 (13.5)	9 (7.8)

* Note: The figure is statistically significant ($P<0.05$) by z-test

Table 10. Results of the physiological function tests between groups

Test	Unit		Vibration group (208)	Control group (115)
Audiometer	dB	Left	40.3±14.8	40.6±8.1
		Right	40.6±13.9	40.1±6.9
Vibratory sense	dB	Left had	0.1±4.6**	−3.7±4.1
threshold		Right hand	0.4±4.9**	−3.3±4.2
Pain sense	g	Left hand	2.6±1.8	2.4±1.0
threshold		Right hand	2.6±1.9	2.3±0.9
Skin temperature	eC	Left hand	28.9±3.5*	29.8±3.2
		Right hand	28.1±3.1**	29.6±3.4
Sweating meter	mA	Left hand	2.6±1.1**	1.7±0.8
		Right hand	2.6±1.1**	1.7±0.8

Value represents mean±S.D.

* Statistically significant ($P<0.05$) by t-test

** the same at $p<0.01$

is statistically significant ($p<0.05$).

Five point eight percent in the vibration exposed group and 5.2 percent of the control grop complained of finger stiffness.

As for the other miscellaneous subjective symptoms such as sweating and headache, no differences were noted between the two groups ($p<0.05$).

Twenty-two point sit percent of vibration exposed group was affected by insomina, compared to 9.6 percent of the control group.

Thus, the higher rate of insomnia was seen in the vibration exposed group compared to the control group ($p<0.05$).

The occurrence of tinnitus was 13.5 percent in the vibration exposed group, as compared to 7.8 percent in the control group, but there was no significant difference between the two groups ($p<0.05$).

D. Physiological function tests

(1) Audiometric tests

The results of audiometric tests conducted on both groups did not show any significant difference.

(2) Vibration sense threhold test

In order to prevent transient threshold test changes in the vibration sense threshold test, the test was conducted after a rest for at least 30 minutes after finishing work.

As shown in table 10, the vibration sense threshold measurement averaged 0.1±4.6 dB for the left hand and 0.4±4.9 dB for the right hand respectively, in the vibration exposed group, and -3.7±4.1 dB, and -3.3±4.2 dB in the control group.

The vibration exposed group showed a higher threshold than the control group ($p<0.01$).

(3) Pain sense threshold test

The pain sense threshold averaged 2.6±1.8 g for the left hand and 2.6±1.9 g for the right hand in the vibration exposed group, while the values of the control groups were 2.4±1.0 g and 2.3±0.9 g.

(4) Skin temperature

The average skin temperature of the left hand of the workers in the vibration exposed group was found to be 28.0±3.5°C, and this was significantly lower than 29.8±3.2°C that of the control group ($p<0.05$). The skin temperature of the right hand in the vibration exposed group was 28.1±3.1°C and this was also lower than 29.6±3.4°C that of the control. ($p<0.01$).

(5) Sweating rate

The average sweating rate of both hands in the vibration exposed group was 2.6±1.1 mA and that of the control was 1.7±0.8 mA and the difference between the two groups was statistically significant ($p<0.01$).

DISCUSSION

In connection with the causes in the development of white finger, vibration, noise and cold are regarded as the stress factors.

In addition individual sensitivity has to be taken into consideration in the development of the vibration syndrome.

The incidence of vibration syndrome among various workers has been reported by many authors; for example 47 percent of 294 chain saw workers are reported to have been affected with vibration syndrome in Norway (Hellstrm, 1972).

Charterjee and others (1978) reported that 50 percent of 115 workers using vibration tools in coal mining suffered from vibration disease and Pyykko (1974) also reported that 40 percent of 118 workers at a lumbermill suffered from vibration syndrome.

The underlying mechanism of white finger development may be due to vasoconstriction in the finger, induced directly or indirectly. The direct effect may be due to transmission of vibration to the smooth muscle of the blood-vessel of the fingers, and the indirect one may be brought about by an activation of the sympathetic nerve system, when the vibration reaches the cerebral cortex through Pacini's corpuscles in the skin of the finger.

In addition it may be postulated that noise causes an alteration in the activities of the autonomic nervous system when the noise affects the functions of the limibic system and hypothalamus, leading to an inducement of white finger.

In the present study, it was observed that the magnitude of the hearing loss was not different in the two groups, but was found to be about 40 dB.

The relationship between incidence of vibration syndrome and cold exposure has been well documented.

For example, the incidence of white finger

among the workers using chain saws in the tropical zone is almost none (Davies et al, 1957) and the workers using rock-drills in metalliferous mines under the condition of high temperature (28 to 32°C) did not show any of Raynaud's phenomena (Matsumoto et al, 1977).

Workers in cold environments developed the vibration syndrome more frequently (Magos, 1963).

From the above consideration cold is one of the important causative factors in the development of the vibration syndrome.

However, since the environmental temperature was not low (18.5°C) in this study, it seems to be that workers wear gloves not for protection from the cold but for the protection from various accidents.

Some authors reported that the quantity of cigarettes smoked showed a good correlation with the incidence of vibration syndrome becaused nicotine constricts peripheral vessels (Charterjee, 1978 and Pyykk's, 1974).

However, in the present study, more than 90 percent of both groups were cigarettes smokers, therefore it was difficult to find the relationship between the incidence of vibration syndrome and cigarette smoking.

From our study, it was observed that the prevalence rate of vibration disease was lower than the rates reported from other countries.

The reasons for this difference are not known at present, but it may be attributed to the differences in climate, type of vibration tools and the length of time of employment etc.

CONCLUSIONS

In order to investigate vibration hazards for rock-drill operators, the author has studied the subjective symptoms by means of a questionnaire and used several physiological function tests on 208-rock-drill operators and 115 control subjects in a two months study starting in April 1981.

The results of the investigation were as follows:

1. There was no difference in the consumption of cigarettes & alcoholic beverage between the vibration exposed and control group.
2. In the use ear plugs, both the vibration exposed and control groups, showed little tendency to use the plugs.
3. The vibration exposed group suffered from white finger and was present in 12.5 percent of the total vibration group, while in the control group this was only 0.9 percent ($p<0.01$).
4. Twenty-three point one percent of the vibration group complained of numbness, compared with 9.6 percent of the control group ($p<0.05$).
5. Twenty-two point six percent of the vibration exposed group was affected by insomnia, compared with 9.6 percent of the control group ($p<0.05$).
6. In the vibration sense threshold measurements, the vibration exposed group showed a higher threshold than the control group ($p<0.01$).
7. In the average degree of skin temperature, the control group measured higher than the vibration exposed group ($p<0.05$).
8. In the average sweating rate, the difference between the vibration exposed and control groups was statistically significant ($p<0.01$).

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