Mortality in a Cohort of Patients with Vibration Syndrome in Japan

Yoshiharu Fukuda¹ and Makoto Futatsuka²

¹Health Promotion, Department of International Health Development, Division of Public Health, Graduate School of Tokyo Medical and Dental University, ²Department of Public Health, Kumamoto University School of Medicine

Abstract: Mortality in a Cohort of Patients with Vibration Syndrome in Japan: Yoshiharu Fukuda, et al. Health Promotion, Department of International Health Development, Division of Public Health, Graduate School of Tokyo Medical and Dental University—To evaluate the mortality of patients certified to be suffering from vibration syndrome in the Kyushu region of Japan, the cohort consisting of 838 vibration syndrome patients who had worked at local forestry offices was followed up. A total of 15,208 person-yrs of follow-up data from 1966 to 1996 was analyzed. The mortality of the population of Kumamoto Prefecture, a central part of Kyushu region, was used to estimate the expected number. Standardized mortality ratios (SMRs) and 95% confidence intervals (95% CIs) for specific causes were calculated. 208 deaths were observed. The mortality from all causes was similar between in the cohort studied and in the general population. The remarkable differences were seen in leukemia (SMR 370, 95% CI 227-1000) and suffocation (SMR 269, 95% CI 140 to 518). The excess mortality from leukemia in the cohort studied is likely due to exposure to wood dust or gasoline during forestry work and Human T-cell Leukemia Virus type I infection. The increased mortality from suffocation is possibly attributable to suicide. (J Occup Health 2000; 42: 245–250)

Key words: Vibration syndrome, Forestry work, Mortality, Suicide, Leukemia

Various vibration tools such as chainsaws, fettling hammers, power grinders and hammer drills can give rise to several types of physiological damage to the human body. Among them, vascular disturbance, namely, Raynaud’s phenomenon or vibration-induced white fingers (VWF), is the most common consequence. In a historical context, the first case of vascular lesions attributable to the use of pneumatic tools was reported by Loriga in 1911. During the 1930s and 1940s, several outbreaks were detected in groups of workers using pneumatic hammers. In Japan, a number of outbreaks of vibration syndrome among forestry workers have occurred since the 1960s and 1970s, as in other countries. Although the number of certified patients among forestry workers has drastically decreased since the 1980s, a total of about 14,000 forestry workers were diagnosed to be suffering from vibration syndrome by 1990. The compensation system requires certified vibration syndrome patients to be followed up, but there have been few studies in which mortality among vibration syndrome patients in Japan has been investigated. Little is known about long-term prognosis in cases of vibration syndrome. Moreover, many of the certified vibration syndrome patients are aging, and some of them have already died. It is meaningful to investigate mortality in this elderly group and to discuss a prognosis of vibration syndrome, a systemic effect of hand-vibration tools, and social support for the patients.

In order to examine the excess mortality among vibration syndrome patients, various risk factors should be considered. Forestry workers in particular can be exposed to a number of agents that may pose health risks. Past studies revealed that forestry workers had increased mortality from certain types of cancer and external causes, i.e. accidents and suicide. Although the factors responsible for the increased mortality in forestry workers remain unclear, wood dust and some chemicals are considered to be possible risk factors. The International Agency for Research on Cancer (IARC) has evaluated the effects of wood dust and concluded that it is carcinogenic in humans. Many reports have indicated...
that wood dust increases the risk of cancer in several parts of the body such as the nasal cavity, paranasal sinuses, oropharynx, hypopharynx, lungs, lymphatic and hematopoietic systems, stomach and colon\(^{(2)}\). Generally, evidence of increased carcinogenic risk from wood dust was obtained in studies concerning wooden furniture and the plywood industry, whereas little is known about the effect of exposure to wood dust in forestry\(^{(3)}\). It has also been suggested that some chemicals such as gasoline and herbicides are possible risk factors for increased mortality in forestry workers\(^{(4)}\). The purpose of this study is to investigate mortality in a group of certified vibration syndrome patients in Japan and evaluate the effect of vibration syndrome and other working conditions, such as exposure to wood dust and chemicals, on mortality among forestry workers through analysis of long-term follow-up data.

**Materials and Methods**

**Study population and follow-up**

The study cohort consisted of certified vibration syndrome patients who were employed at local forestry offices in the Kyushu region and who had been engaged in national forestry management. The Kyushu region is located in the western part of Japan and consists of eight prefectures. Its population is about 14.7 million, approximately 12% of the total population of Japan. There were 40 local forestry offices in Kyushu in the 1960s. The central forestry office of the Kyushu region is located in Kumamoto prefecture.

Certification for vibration syndrome is obtained according to the results of a health checkup established by the Labor Standard Law or the National Personnel Authority. The preliminary screening includes an interview regarding work history and working conditions, vibration tools used, and worker’s subjective complaints. A physical examination is also performed by a physician. For workers suspected to be suffering from vibration syndrome, specialists perform a secondary health examination. The secondary examination consists of a peripheral circulation test, a cold water immersion test, a neurosensory test, and others. All workers handling hand-arm vibration tools must take a health examination twice a year. About 4,000 workers who had been employed in national forestry were certified as vibration syndrome patients by 1990. The subjects of this study cohort were those who were certified as vibration syndrome patients during the period between 1966 and 1996 and followed-up by the Kumamoto central forestry office.

If the worker is certified to be suffering from vibration syndrome, he or she is compensated for the health damage. Follow-up will be done by his or her own doctor. Each certified patient must visit a specified institution and receive an established health examination twice a year. When a vibration syndrome patient dies, his or her doctor must report the information, including the cause and the date of the death. These data are managed by the forestry offices.

Causes of death are then coded according to the Japanese simple classification code, which is based on the international classification of disease (ICD). The causes of death are classified into approximately 120 categories. Although the ICD was modified three times during the period between 1966 and 1996, the simple classification code used in this study was hardly affected by such ICD modifications.

**Statistical methods**

Person-yrs at risk were counted from the date of onset of vibration syndrome until either the date of the final health checkup in 1996 or the date of death before then. The person-yr calculation is based on five-yr age categories and ten-yr calendar periods: 1966–74, 1975–84, and 1985–96. The number of expected deaths for each cause was calculated based on the person-yr at risk according to the corresponding standard mortality rates. The standard rates used here were the age specific mortality rates for Kumamoto prefecture. As Kumamoto prefecture is the central part of Kyushu and its population is about two million, geographic differences between the study subjects and the standard population are negligible. This analysis was restricted to the period 1975–1996, as the data on mortality in Kumamoto prefecture before 1975 were not available.

The standardized mortality ratios (SMRs) were obtained by calculating the ratio of the observed number of deaths to the expected number of deaths for each specific cause of death. Two-tailed 95% confidence intervals (95% CIs) and statistical significance for each SMR were calculated based on a Poisson distribution of the deaths observed\(^{(4)}\).

**Results**

The total number of certified vibration syndrome patients as study subjects was 838. These workers belonged to 31 local forestry offices in seven prefectures. Table 1 shows the number of subjects categorized according to the year of onset. In most of these cases, the onset occurred before 1980, particularly during the period from 1970 to 1974. The mean (\(\pm\) S.D.) duration of employment on chainsaws until the vibration syndrome onset was 6.7 (\(\pm\) 3.8) yr. And the proportions of VWF stages in the population studied was 31.1% (\(n=251\)) at stage 1, 48.6% (\(n=407\)) at stage 2, and 20.3% (\(n=170\)) at stage 3, respectively, on the Stockholm Workshop scale.

Table 2 shows the age distribution of the study subjects at the time of onset, the calculated person-years, and the number of deaths. The person-years and number of deaths are limited to the period from 1975 to 1996. The estimated total person-yrs were 15,208. Most of the
subjects were in the group 40 to 60 yr of age at the time of onset, and most of the deaths were observed in the group 50 yr of age and over.

The prognosis in cases of certified patients in 1996 is shown in Table 3. While follow-up was continued on 582 subjects as patients, 209 died, and 42 were admitted to medical institutions for some reason. In addition, the prognosis was unknown in five other cases because the patients did not have an annual health examination in 1996. These subjects were therefore excluded from the subsequent analysis. The average follow-up period was 22.4 yr for persons who were continually followed up, and 15.7 yr for persons who died.

Table 4 shows the observed and expected numbers of deaths, SMRs and 95% CIs for selected causes during the period between 1975 and 1996. For all causes, the observed number of deaths was 198, the expected number was 199.7 and the SMR was 99. No significant difference was observed. For most of the specific causes such as stomach cancer and cancer at other sites, cerebrovascular disease and heart disease, mortality in the study subjects was similar to that in the general population. The most remarkable differences were observed in suffocation (9 observed deaths; 1.7 expected deaths; SMR 269; and 95% CI 140 to 518) and leukemia (7 observed deaths; 1.7 expected deaths; SMR 370; and 95% CI 227 to 1000). Even though differences were not as remarkable, mortality due to esophageal cancer and pneumonia was also found to be high with SMRs of 206 and 169, respectively.

Discussion

Exposure to hand-arm vibration leads to several types of physiological damage such as peripheral neuropathies of the hands, injury to the soft tissue of the hands, osteoarthritis of joints of arms, and VWF1). Little is known about the mortality rate among vibration syndrome patients. Our hypothesis is that hand-arm vibration does not affect general mortality rates such as the incidence of death due to circulatory diseases and many types of cancer. The present results indicate that vibration syndrome patients did not show increased mortality for most causes of death such as cancer at all sites and cardiovascular disease, which support the above hypothesis.

Significant excess mortality was found in a few specific causes in this study: leukemia, pneumonia and suffocation. Among them, the excess in pneumonia mortality was small, and prior studies did not report a significant increase in mortality due to diseases of the

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966–69</td>
<td>112</td>
</tr>
<tr>
<td>1970–74</td>
<td>553</td>
</tr>
<tr>
<td>1975–79</td>
<td>164</td>
</tr>
<tr>
<td>1980–</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>838</td>
</tr>
</tbody>
</table>

Table 2. Number of vibration syndrome patients, person-years and number of deaths by age in study subjects

<table>
<thead>
<tr>
<th>Age</th>
<th>–39</th>
<th>40–49</th>
<th>50–59</th>
<th>60–69</th>
<th>70–79</th>
<th>80–</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>137</td>
<td>414</td>
<td>234</td>
<td>51</td>
<td>2</td>
<td>0</td>
<td>838</td>
</tr>
<tr>
<td>Person-years</td>
<td>341</td>
<td>2,977</td>
<td>5,742</td>
<td>4,516</td>
<td>1,496</td>
<td>136</td>
<td>15,208</td>
</tr>
<tr>
<td>Deaths</td>
<td>1</td>
<td>10</td>
<td>36</td>
<td>74</td>
<td>61</td>
<td>16</td>
<td>198</td>
</tr>
</tbody>
</table>

a: Number of certified VWF patients at onset. b: 1975–1996.

<table>
<thead>
<tr>
<th>Status</th>
<th>N</th>
<th>Follow-up period (yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continue to be followed up</td>
<td>582</td>
<td>22.4</td>
</tr>
<tr>
<td>Cured from disease</td>
<td>42</td>
<td>14.0</td>
</tr>
<tr>
<td>Dead</td>
<td>209</td>
<td>15.7</td>
</tr>
<tr>
<td>Prognosis unknown</td>
<td>5</td>
<td>–</td>
</tr>
<tr>
<td>Total</td>
<td>838</td>
<td>20.3</td>
</tr>
</tbody>
</table>

respiratory system). A remarkable difference between the studied population and the standard population was seen in mortality due to leukemia and suffocation. This cannot be explained only by exposure to hand-arm vibration. For leukemia, three possible causes were considered: exposure to wood dust, exposure to gasoline, and infection by Human T-cell Leukemia Virus type I (HTLV-I).

The carcinogenicity of wood dust has recently been recognized. There are many reports indicating that exposure to wood dust increases the risk of cancer at several sites. Among the most common sites of cancer for which the risk is increased by exposure to wood dust are the nasal and the paranasal cavity. In addition, it has been reported that the incidence of cancer at other sites such as the oropharynx, hypopharynx, lung, stomach, lymphatic system and hematopoietic system is increased by exposure to wood dust. The reports concerning the carcinogenic risk from wood dust are mainly associated with the wooden furniture industry. In this connection, no deaths from sino-nasal cancers and only two deaths from malignant lymphoma were found in this study cohort.

Some chemicals used in the wood products industry such as formaldehyde are suspected to be associated with the risk of cancer from wood dust. Especially exposure to gasoline can possibly increase the risk of leukemia, as there are several reports indicating that occupational exposure to gasoline among petroleum workers, professional drivers, vehicle mechanics, service station attendants, and others, increases the risk of occurrence of leukemia.

Enterline et al. and Hunting et al. have pointed out that benzene, which is a component of gasoline, is responsible for hematological cancers. As well as the abovementioned types of work, exposure to volatile gasoline fuel vapor or exhaust from a chainsaw in the course of forestry work might increase the risk of leukemia.

Another possible cause of the increased mortality due to leukemia is HTLV-I infection. The western part of Kyushu is one of the regions where HTLV-I is endemic. Three of seven leukemia cases in the present study were diagnosed as Adult T-cell Leukemia, which is related to HTLV-I infection. Stuver et al. showed that forestry workers had a high HTLV-I seropositive rate in Miyazaki prefecture which is also in the Kyushu region.

Suffocation is the other cause of death that was shown to contribute to remarkably higher mortality among vibration syndrome patients. Most cases of suffocation are thought to be suicide; hanging. Earlier reports indicated that forestry workers in other countries had increased mortality due to suicide. Green speculated that phenoxy acid herbicide is a cause of increased suicide. While, Notkola et al., investigating the impact of socioeconomic factors in mortality in forestry workers, demonstrated that these factors did not explain the high rate of suicide. Although no clear explanation exists, we presume that incidence of suicide may be affected mainly by social factors. Certified patients receive social support to a certain degree, including financial support. But their quality of life may be diminished as a result of their vibration symptoms. Their social network may also be poor. Moreover, their ability to perform tasks in daily living may be decreased as a result of aging, in addition
to the symptoms. This may add anxiety in daily life and thereby affect the prognosis of their health problems.

Although our study does not provide enough evidence to reach a conclusion, there are a few reports that are consistent with our results. Ohara et al. investigated the mortality among certified patients who had been forestry workers in Japan. They demonstrated a high rate of mortality due to lymphatic and hematopoietic tissue diseases. They suggested that the increased mortality might be due not to vibration syndrome but to forestry work.

Before concluding, it should be mentioned that this study was subject to a few limitations in the investigation of excess mortality. First of all, the study subjects were vibration syndrome patients, and the control population is the general population. Therefore, this study might not reveal the specific health risks among vibration syndrome patients but general health risks among forestry workers. Alternatively, studies which compare vibration syndrome patients with forestry workers without vibration syndrome could reveal the specific health risks of vibration syndrome. The second limitation is related to the reporting and coding of death causes. The methods for reporting and coding causes of death for the study population did not coincide exactly with those for the control population; the cause of death of the study subjects was reported from hospitals, and the coding was performed by ourselves. The last limitation is the suitability of the population of Kumamoto prefecture as a control population. Although it would have been ideal to use the total population of the entire Kyushu region as a control population, the data were not available.

In summary, exposure to hand-arm vibration is suspected not to increase general mortality, but the exposure to wood dust or gasoline in forestry work may be closely related to an increased risk of leukemia. Increased suicide can probably be attributed to poor support provided for the patients or social and mental problems arising from vibration syndrome. Therefore, careful follow-up and sufficient social support are needed for vibration syndrome patients.

References

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