

A study of white finger in the gas industry

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ABSTRACT Men engaged in breaking or reinstating road surfaces are exposed to vibration from mechanical tools. In view of the lack of epidemiological information on vibration white finger in such a population, a survey was carried out to identify the prevalence of symptoms of white finger in a sample of men using these tools in the gas industry and to compare the prevalence with that found in a control group not occupationally exposed to vibration. Altogether 905 men (97%) in the gas industry and 552 men (92%) in the control group were interviewed, using a questionnaire from which the presence or absence of white finger symptoms from all causes was noted. The prevalence of white finger was 9.6% in the group exposed to vibration at work compared with 9.5% in the control group. The prevalence in the former group when adjusted for age differences between the survey and control populations was 12.2%, but this difference did not reach statistical significance. In case the approach of comparing prevalences of white finger from all causes might have obscured any contributory effect of vibration, the prevalence of white finger was examined in relation to the number of years vibrating tools had been used, this being the only measure of exposure to vibration available. No direct association was found between the prevalence of symptoms and number of years vibrating tools had been used. In view of this and the absence of a significant excess of white finger symptoms in the group using vibratory tools, the authors conclude that vibration white finger is not a special problem in the gas industry. Nevertheless, experimental tests carried out on the different types of roadbreakers used in the industry and on different road surfaces indicate that the vibration levels exceed the standards advocated in the draft international standard DIS 5349 (1979) at the lower end of the frequency spectrum. That no particular problem has been found may be due to the relatively short exposures to vibration experienced by the operators or the fact that they are able to grip the tools lightly, or even, possibly, that the standards suggested in DIS 5349 do not accurately reflect the risk of vibration white finger when they are exceeded at the lower end of the frequency spectrum for vibrating tools such as roadbreakers.

Much has been written about white finger since Raynaud described the phenomenon of finger blanching on exposure to cold in his MD thesis in 1862.¹ It is now recognised that there are two categories of the condition, primary Raynaud's disease or constitutional white finger (CWF) as it is commonly referred to and secondary Raynaud's disease, which may be due to various causes, including exposure to vibration at work. This latter condition is commonly referred to as vibration white finger (VWF). It was first described by Loriga in users of pneumatic tools.² Since then, VWF has been described in various occupations such as shoe-making,³ metal cutting and polishing,⁴ grind-

ing,⁵ chainsaw workers in the forestry industry,⁶ fluorspar miners,⁷ and shipyard caulkers.⁸

For many years the Industrial Injuries Advisory Council considered adding VWF to the list of prescribed diseases, but it was not until 1981 that it recommended that the more severe forms of VWF occurring in industries with processes regarded as having a special risk of causing VWF should become prescribed.⁹ The delay in arriving at this decision was mainly because VWF is clinically indistinguishable from primary Raynaud's disease (CWF) and the condition in its early stages causes little, if any, disability. Of the several known aetiological factors in the causation of VWF, the vibration frequency and acceleration of the tool are the most important. In this respect the British Standards Institution has produced

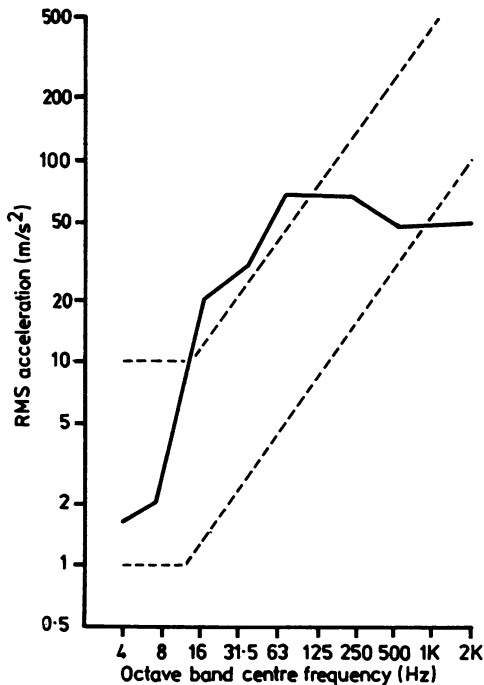


Fig 1 *Vibration spectrum produced by a pneumatic roadbreaker (after Hempstock and O'Connor¹¹).*

a draft for development.¹⁰

The vibration characteristics produced by a pneumatic roadbreaker have been measured and have been shown to exceed the recommended maximum exposure level for regular users over a range of frequencies below 100 Hz (fig 1).

Studies recently carried out by Tasker and Robinson at the British Gas Engineering Research Station, Newcastle, have confirmed these findings in respect of both pneumatic and hydraulic roadbreakers as used in the gas industry (appendix 1).

Whereas there have been isolated reports of VWF in users of roadbreakers (W Taylor, personal communication 1980), there is no epidemiological information about the prevalence of VWF in such a population. That no survey seems to have been carried out to date is mainly due to the difficulty of examining such a group of workers, who tend to be constantly moving location or changing jobs. Although isolated cases of white finger have occurred in users of vibratory tools in the gas industry, there was no indication that the number exceeded those likely to be due to CWF. Nevertheless, it was considered important to investigate the matter in view of the known association between the use of vibrating tools and VWF.

The distribution function in the gas industry is responsible for providing and maintaining a gas sup-

ply and is, therefore, involved in laying pipes and replacing them when necessary. Pneumatic drills and hammers have been used to break and reinstate road surfaces for many years, although in more recent years they are being progressively replaced by hydraulic versions. Road breaking is carried out by a member of the distribution team of two or three men, depending on the nature of the job in hand and the experience of the individuals in the team.

The task of road breaking generally rotates within the team and accurate assessment of the frequency and duration of this task is difficult, since numerous factors determine the necessity to use roadbreakers. It is estimated, however, that a distribution worker generally operates such tools for up to two hours a day.

The present paper describes a survey to examine the prevalence of symptoms of white finger among a group of distribution workers in the gas industry and to compare the level with that found in a control group who were not exposed to vibrating tools. Any significant excess of symptoms found in the gas industry group would be considered to be possibly induced by vibration and would indicate a need to carry out a wider and more detailed survey.

Materials and methods

The survey was carried out in the Scottish and North West regions of the British Gas Corporation, using a questionnaire from which data relating to the circulation to the hands were obtained. In addition, questions on back, chest, and hearing troubles were included to minimise the possibility of bias by focusing attention on the questions on circulation to the hands. The analyses of these additional questions are not included in this report. Two nurses from each region who had attended a communal training session aimed at reducing observer error administered the questionnaire. Clinical examination and tests to identify the aetiology of white finger symptoms were not included.

The survey population comprised distribution workers in the Glasgow, Edinburgh, Manchester, and Liverpool conurbations. All distribution workers (craftsmen, distribution fitters, assistant distribution fitters, and adult trainees) from these areas were included in the survey. Of the 937 men available, 905 (97%) were interviewed. It was difficult to choose a control population as it was not possible to include sufficient distribution workers who had never used vibrating tools. It was, therefore, decided to include a group of meter reader/collectors as the control group as they were not exposed to vibration and, as in the distribution group, they worked predominantly out of doors. In view of the relatively small numbers in the main conurbations, meter reader/collectors from the

Table 1 Age distribution (No/%) of sample and control populations

	< 20	20-29	30-39	40-49	50-59	≥60	Mean age	Age not recorded	Total
Meter readers	0	29 (5.3%)	123 (22.5%)	169 (31.0%)	171 (31.3%)	54 (9.7%)	46.3	7	546
Distribution	44 (4.9%)	292 (32.6%)	239 (26.7%)	138 (15.4%)	136 (15.2%)	46 (5.1%)	36.3	10	895

Table 2 Prevalence of white finger in distribution workers and meter readers

	Crude prevalence (%)	Age standardised prevalence (%)	No
Distribution workers*	9.6	12.4	82/851
Meter readers	9.5	9.5	52/546
Statistical significance		Chi-square (Mantel-Haenszel test = 2.39; p > 0.05)	

*Excluded are 44 distribution workers aged under 20.

Table 3 Prevalence of white finger by age group

	20-29 (%/No)	30-39 (%/No)	40-49 (%/No)	50-59 (%/No)	≥60 (%/No)	Chi square test (Linear trend)
Distribution workers	5.8 (17/292)	7.9 (19/239)	7.9 (11/138)	17.6 (24/136)	23.9 (11/46)	22.2 p = < 0.01
Meter readers	6.8 (2/29)	4.8 (6/123)	8.3 (14/169)	13.5 (23/171)	13.0 (7/54)	5.5 p = < 0.05

Excluded are 44 distribution workers aged under 20.

Table 4 Prevalence of white finger in 509 distribution workers* using vibrating tools within the gas industry

	Use of vibrating tools (years)				
	1-5	6-10	11-15	16-20	≥21
Prevalence	9.3%	9.1%	12.9%	14.6%	17.8%
Observed cases	17.0	13.0	9.0	6.0	13.0
Expected cases	15.0	13.5	8.8	5.6	15.0
Number at risk	182	143	70	41	73

(Differences between observed and expected cases are not significant).

*Excluded are workers who have used vibrating tools in other industries, those with less than one year's use within the gas industry, workers aged under 20.

entire Scottish and North West regions were included in the survey. Of the 602 available, 553 (92%) were interviewed.

The survey took place in March and April 1982. This time of year was selected to avoid possible over-reporting of symptoms by administering the questionnaire in mid-winter and underreporting in the summer. The questionnaire was completed either at the place of work or in depots according to local requirements. Each nurse interviewed a proportion of workers from each of the two groups examined.

In the present paper white finger status is broadly classified by the answers to the questions "Have you ever suffered from occasional whitening of the fingers?" and "Do you still suffer from this?" No attempt is made to proceed to a more detailed classification according to seasonal variations or work or social interference as in the commonly used classification of VWF.¹² This was because the purpose of the survey was to compare the prevalences of

white finger symptoms in the sample and control populations rather than to quantify the severity of any symptoms found. In any event it was not thought to be appropriate to use a VWF classification for white finger of different aetiologies.

Results

In view of incomplete data in respect of ten distribution workers and seven meter readers the following analyses are based on a total of 895 distribution workers and 546 meter readers.

Table 1 shows the age distribution of the sample and control groups examined. The mean age of the 895 distribution workers was considerably lower than that of the 546 meter reader/collectors in the control population. Therefore, in comparing prevalence rates between the distribution workers and the control group both crude and age standardised rates were calculated, the latter by using the meter readers' group

as the standard population. The significance of any difference between the groups was evaluated by using the Mantel-Haenszel test.

Table 2 shows the difference in the prevalence of white finger in the two groups. In calculating the age standardised rates for the distribution group 44 men aged under 20 were excluded as there were no meter readers in this age group. The differences in both the crude and age standardised prevalences in the two groups were small and did not reach statistical significance.

The prevalence of white finger was compared within various age groups and the results are shown in table 3. The prevalence clearly increased with age in the case of the distribution workers. A similar, though less pronounced association was evident for the meter readers.

The chi square test for linear trend confirmed that this relation was significant for both the distribution workers and the meter readers ($p < 0.01$ and $p < 0.05$ respectively). The differences in the prevalences of white finger between the distribution workers and meter readers did not reach statistical significance in any of the age groups.

The prevalence of white finger in the distribution group was examined in relation to years of using vibratory tools (table 4). In the 509 current users with no previous experience of using such tools in other industries the prevalence of white finger showed a significant association with increasing number of years that vibratory tools had been used. That this effect is due to age rather than exposure to vibration is seen when the observed cases in each exposure group are compared with the number of cases expected (calculated by using age specific prevalences). The small differences between the observed and expected cases are not statistically significant. Thus there does not appear to be a relation between prevalence of white finger symptoms and use of vibratory tools in distribution workers in the gas industry.

Discussion

The sample of distribution workers examined was relatively young. This might be considered to affect the overall prevalence of white finger symptoms in that group and, therefore, to obscure any relation that might exist between their use of vibratory tools and symptoms of VWF. Nevertheless, significantly high prevalences of VWF have been found in miners using pneumatic drills in four fluorspar mines where the mean age ranged from 33.8 to 37.3 years.⁷

It is also possible that low exposure to vibration might obscure any contribution by VWF to the prevalence of white finger. Table 4, however, shows that

most of the group have had over five years' experience of such tools and a considerable number have had over ten years. In the group of miners previously referred to high prevalences of VWF were found in miners where use of pneumatic drills was estimated at 12 hours a week on average⁷ (similar to the use of roadbreakers by the distribution group in this survey). The mean latent interval in those who developed VWF was five to six years.

It is considered, therefore, that the sample of distribution workers was suitable for the purposes of this survey.

The crude prevalence of white finger was almost identical in the two groups (distribution group 9.6% compared with 9.5% in meter readers' group) and is of the same order as that reported due to all causes of white finger in control group populations of other surveys.¹³

Even when the prevalence in the distribution group was standardised for age, the difference between that group and the control group did not reach statistical significance and the prevalence was still much lower than that for VWF found in other surveys of users of vibratory tools; 44% and 47% in forestry workers^{14 15} and 50% in fluorspar miners.⁷ The lack of statistically significant excess of white finger symptoms among the distribution group and the absence of an association between white finger symptoms and number of years vibratory tools had been used provides evidence to suggest that the use of such tools has not materially contributed to the number of cases of white finger found in that group.

Detailed tests carried out on both pneumatic and hydraulic roadbreakers used in the industry (appendix 1) show that when they are used on concrete and tarmacadam surfaces the vibration levels exceed the standards suggested in the draft international standard DIS 5349 (1979) at the lower end of the frequency spectrum.

That this has not resulted in large numbers of cases of vibration white finger may be due to the intermittent use of these tools in the industry and the fact that the weight of the tool is supported by the ground thus enabling the operator to grip it loosely. Tightness of grip is known to be a factor in causing vibration white finger in users of vibrating tools.

Another possible explanation is that the limits suggested in the draft standard DIS 5349 do not accurately reflect the risks of developing vibration white finger in users of roadbreaking tools and may indicate a need to develop different standards for different types of vibrating tools.

A statistically significant association was found between prevalence of white finger symptoms and age. This was so for both groups and indicates that white finger symptoms, whether they be due to primary or

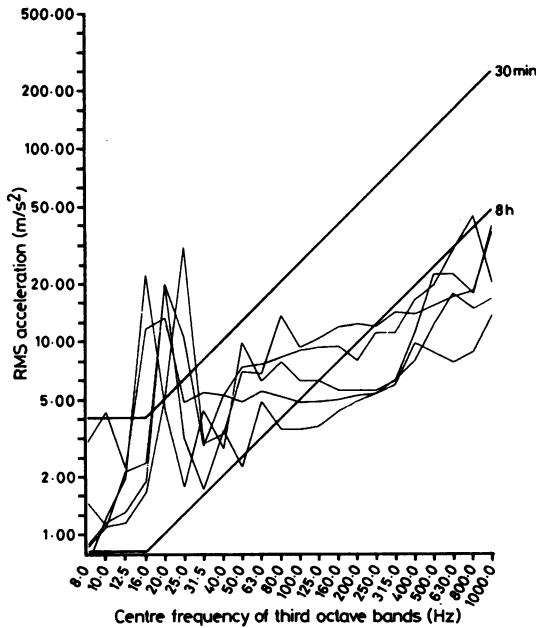


Fig 2 Vibration envelope: five pneumatic roadbreakers on concrete accelerometer mounted on standard handle/grip (August 1983).

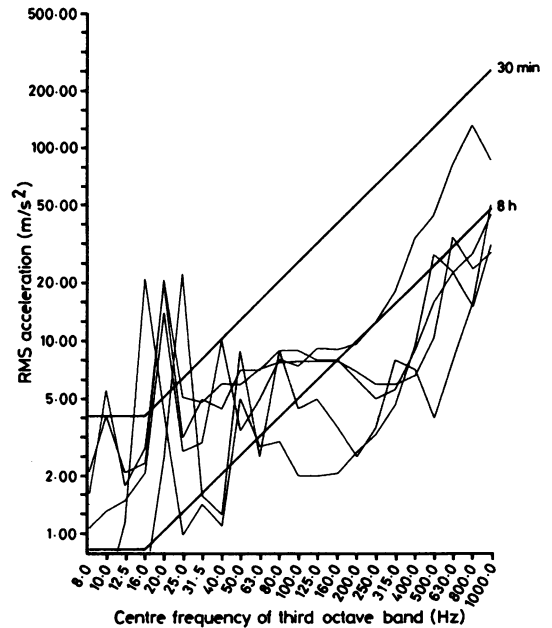


Fig 4 Vibration envelope: five pneumatic roadbreakers on asphalt accelerometer mounted on standard handle/grip (August 1983).

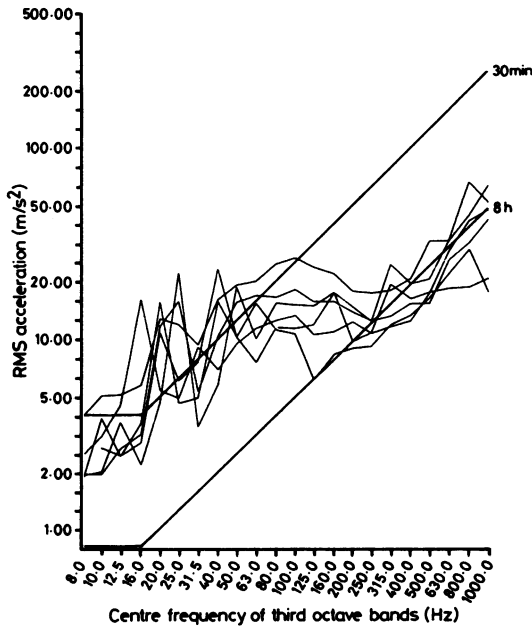


Fig 3 Vibration envelope: six hydraulic roadbreakers on concrete accelerometer mounted on standard handle/grip (August 1983).

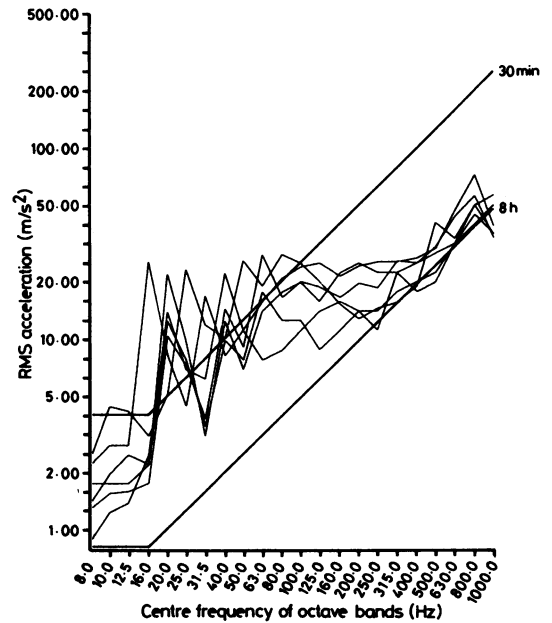


Fig 5 Vibration envelope: six hydraulic roadbreakers on asphalt accelerometer mounted on standard handle/grip (August 1983).

secondary Raynaud's disease, occur more commonly in the older age groups, a not unexpected finding.

Appendix 1

A test programme was set up to measure the vibration levels of six hydraulic and five pneumatic roadbreakers when used on concrete and asphalt surfaces.

The basic criterion for vibration analysis is the measurement of acceleration of the tools in the hand grip position.

An accelerometer with adequate frequency response, particularly at the low frequency end of the spectrum, was chosen and clamped to the roadbreaker in the hand grip position close to the operator's hand. A mechanical filter was used to filter out the high acceleration levels generated above 1 kHz outside the analysis spectrum from 6 Hz to 1 kHz. The roadbreakers were then manually operated for at least 20 seconds to provide a representative sample of data for analysis. A standard moil point tool steel and an asphalt cutter were used respectively on the concrete and asphalt road surfaces.

The test data were then processed using a digital frequency analyser to provide an acceleration output in single and third octave bands through the frequency spectrum.

The results were plotted on a graph on which is superimposed the recommended exposure limits defined in DIS 5349 (1979), which is the current draft international standard for hand-arm vibration, and these results are reproduced in figs 2, 3, 4, and 5. They indicate that all the roadbreakers tested exceeded the standard for an exposure time of 30 minutes, at the lower end of the frequency spectrum, which corresponds to the natural blow frequencies of the roadbreakers.

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