Health effects and noise exposure among flight-line mainteners

Anker Jensen[1]*, Søren Peter Lund[2], Thorsten Lücke[3]

1 Danish Defence, Occupational Health Centre South, Fredericia, Denmark

2 National Research Centre for the Working Environment, Copenhagen, Denmark

3 Danish Armed Forces Health Services, Fighter Wing Skrydstrup, Skrydstrup, Denmark

*corresponding author: e-mail: ankerjensen@mil.dk

INTRODUCTION

It is a common experience that exposure to high level noise in the low frequency band cause discomfort in the abdominal region. It has been discussed if low frequency noise (LFN) at a very high level can cause immediate damage to the internal organs. The possibility of using LFN as a weapon has even been discussed (Jauchem & Cook 2007).

A Portuguese researcher group has reported long term effects on the internal organs through prolonged exposure to LFN, defined as noise < 500 Hz and > 90 dB (Castelo Branco & Alves-Pereira 2004), and have grouped the changes and symptoms in a syndrome called Vibro-Acoustic-Disease (VAD). Their main finding is proliferation of connective tissue, i.e. thickening of the pericardium, but changes of the respiratory and gastric epithelium are also reported. Late onset epilepsia and endocrine or autoimmune disorders have also been described as possible expressions of VAD. However, their research results have been questioned (von Gierke & Mohler, 2002).

Research results from other researchers than the Portuguese on extra aural health effects through high level noise is scarce. It is known, that pressure waves can cause damage to internal organs (Yang et al. 1996), mainly the air-filled organs, but it is not clear, if this effect only is related to single and extreme pressure waves or also can be caused by high level noise, which simplified is repeated pressure waves. In animal studies changes to the myocardium have been reported (Gesi et al. 2002), but this might equally well be caused by a stress reaction to the noise exposure.

One important study group of the Portuguese researchers were airfield ground personnel (Marciniak et al. 1999). A high prevalence of different health effects were reported and related to the noise exposure. The actual noise exposure of this study group is assessed (Bento Coelho et al., 1999), but the cumulative exposure of the airfield personnel is not quite clear. The Danish Air Force also employs ground personnel exposed to aircraft noise. This is especially the case for the crew chiefs (flight line mainteners), who are standing directly beside the jet fighters during running up and shutting down the jet engine. They are carrying double hearing protection to prevent noise induced hearing loss, but they are not protected against noise exposure of other parts of the body like i.e. German crew chiefs are (Flugmedizinisches Institut der Luftwaffe 2002).

It was decided to investigate the health among Danish jet fighter crew chiefs compared to an adequate control group, and we wanted to provide documentation of the noise exposure of crew chiefs during launch and recovery procedures.

METHODS

In a Danish air base about 50 crew chiefs have been working with launch and recovery procedures on F16 jet fighters since 1980, many of these with a considerable seniority. About 300 aircraft mechanics are taking care of the maintenance of the jet fighters, and all crew chiefs have a background as aircraft mechanics. Health requirements of aircraft mechanics and crew chiefs are identical and both groups have participated in identical health checks every second year since 1992. Thus, these 2 groups are widely comparable, apart from their specific job tasks, and comparable health data are present for both groups.

This study has a controlled cross sectional design using the crew chiefs as research group and the aircraft mechanics as control group. Crew chiefs have a specific exposure to high level noise during launch and recovery procedures, but otherwise the noise exposure of both groups is supposed to be at the same level. Measuring of noise level, frequency and duration of the noise exposure during launch and recovery was carried out in the 2 different sorts of aircraft shelters present on the air base and in the open air. Knowing the total number of launches a total specific noise exposure for the crew chiefs could be estimated.

The noise exposure during launch and recovery was recorded using a man borne microphone and a multi-channel front end from Brüel & Kjær. A stationary microphone was used as a control. The recorded frequency spectrum was 0.1 Hz to 20 kHz, and the noise tracks were later analyzed in 1/3 octaves. The total noise exposure and the exposure in the bands 0.1–500 Hz and 0.1–200 Hz was calculated. These 2 low frequency bands are used as a definition of LFN by other researchers. The duration of the noise exposure through the running jet engine during launch and recovery was recorded.

A list of present crew chiefs and aircraft mechanics was obtained in December 2006. For each crew chief an aircraft mechanic of comparable age and seniority was randomly selected. Aircraft mechanics, which had been crew chiefs, were excluded. In order to reveal a possible healthy worker effect, as many health data as possible was obtained from former crew chiefs, which left the job before planned retirement.

Health data of the 2 matched groups and of the retired crew chiefs were extracted from the existing health records. The health records mainly consisted of a questionnaire with self-reported health data, simple blood tests, a urine test and a lung function test. The self reported health data were “yes” or “no” answers to present or earlier diseases in one of the major disease groups. Remarks from the examining physician were recorded when present.

Data from the present crew chiefs were compared to data from aircraft mechanics and from former crew chiefs. Statistical analysis was carried out comparing and results were regarded as significant, when $p<0.05$.

RESULTS

Our investigation group consisted of 42 crew chiefs with a mean age of 47.8 years, a mean seniority in the Danish Defense of 26.7 years and a mean seniority as crew chief of 19.6 years. The control group consisted of 42 aircraft mechanics with a mean age of 45.8 years and a mean seniority of 24.1 years. Health data were obtained from 38 earlier crew chiefs with a mean age of 41.5 years. It was not possible to get data from all former crew chiefs and data on seniority and lung function tests from the earlier crew chiefs were not obtainable.

The frequency of diseases of the ear, including hearing loss, was higher among crew chiefs than among aircraft mechanics, although not significant (Table 1). Crew chiefs had more often traces of blood in urine, but the traces were weaker among crew chiefs than among aircraft mechanics. For most other organ systems the frequency of reported diseases was slightly higher for aircraft mechanics than among crew chiefs. The numerical results did not show remarkable differences.

Table 1: Health data on crew chiefs compared to aircraft mechanics

	Crew chiefs		**Aircraft mechanics**		p
n=	42		42		
Personal data		Min-max		Min-max	
Age	47.8	(27-58)	45.8	(27-57)	
Seniority as crew chief	19.6	(4-27)			
Seniority	26.7	(6-41)	24.1	(6-40)	
Questionnaire		%		%	
Frequent airways infections	1	2.4 %	2	4.8 %	0.5589
Cough	1	2.4 %	2	4.8 %	0.5589
Hoarseness	1	2.4 %	0	0.0 %	0.3173
Vertigo	1	2.4 %	3	7.1 %	0.3084
Frequent headache	1	2.4 %	4	9.5 %	0.1691
Diseases of the eye	2	4.8 %	4	9.5 %	0.3996
Diseases of the ear, hearing loss	9	21.4 %	3	7.1 %	0.0629
Gastrointestinal diseases	4	9.5 %	5	11.9 %	0.7258
Diseases of kidney/urinary system	0	0.0 %	1	2.4 %	0.3173
Serious infections	1	2.4 %	0	0.0 %	0.3173
Skin diseases	4	9.5 %	5	11.9 %	0.7258
Cardiovascular diseases	0	0.0 %	0	0.0 %	
Serious accidents	2	4.8 %	2	4.8 %	
Hospital treatment	8	19.0 %	10	23.8 %	0.5971
Daily medicine intake	8	19.0 %	11	26.2 %	0.4367
Smokers	13	31.0 %	15	35.7 %	
Urine sample		%		%	
Blood (trace) in urine	6	14.3 %	3	6.7 %	0.2928
Test results		Min-max		Min-max	
Height (cm)	179.3	(166-196)	178.0	(164-193)	
Weight (kg)	84.0	(69-124)	86.1	(66-124)	0.46
Pulse	64.6	(38-125)	64.8	(48-90)	0.95
Systolic blood pressure (mm Hg)	131.8	(107-185)	128.9	(105-169)	0.42
Diastolic blood pressure (mm Hg)	77.4	(54-100)	74.2	(59-91)	0.15
Hemoglobin (mmol/l)	9.5	(8.3-11.8)	9.3	(7.4-11.3)	0.18
Cholesterol (mmol/l)	5.26	(2.72-9.38)	5.08	(2.59-7.39)	0.47
ALAT/GPT (U/l)	27.5	(16-65.6)	29.0	(10.7-70.8)	0.62
Spirometry		Min-max		Min-max	
FVC (l)	5.27		5.14		
FVC in % of normal	110	(70-167)	107	(79-153)	0.41
FEV1 (l)	4.11		3.98		
FEV1 in % of normal	104	(61-155)	101	(72-137)	0.42

Former crew chiefs reported significantly more frequent airways infections than present crew chiefs, but they had a significantly lower frequency of diseases of the ear, including hearing loss (Table 2). Otherwise, the differences were small, taking the relatively small number of former crew chiefs into account.

Table 2: Health data on present crew chiefs compared to former crew chiefs

	Crew chiefs		**Earlier crew chiefs**		p
n=	42		17		
Personal data		Min-max		Min-max	
Age	47.8	(27-58)	41.5	(31-50)	
Seniority as crew chief	19.6	(4-27)			
Seniority	26.7	(6-41)			
Questionnaire		%		%	
Frequent airways infections	1	2.4 %	3	17.6 %	**0.0362**
Cough	1	2.4 %	2	11.8 %	0.1407
Hoarseness	1	2.4 %	1	5.9 %	0.5045
Vertigo	1	2.4 %	1	5.9 %	0.5045
Frequent headache	1	2.4 %	0	0.0 %	0.5246
Diseases of the eye	2	4.8 %	1	5.9 %	0.8604
Diseases of the ear, hearing loss	9	21.4 %	0	0.0 %	**0.0398**
Gastrointestinal diseases	4	9.5 %	0	0.0 %	0.1913
Diseases of kidney/urinary system	0	0.0 %	0	0.0 %	
Serious infections	1	2.4 %	0	0.0 %	0.5246
Skin diseases	4	9.5 %	1	5.9 %	0.6520
Cardiovascular diseases	0	0.0 %	0	0.0 %	
Serious accidents	2	4.8 %	0	0.0 %	
Hospital treatment	8	19.0 %	3	17.6 %	0.9013
Daily medicine intake	8	19.0 %	0	.0 %	0.0550
Smokers	13	31.0 %	6	35.3 %	
Urine sample					
Blood (trace) in urine	6	14.3 %	2	12 %	0.7995
Test results		Min-max		Min-max	
Height (cm)	179.3	(166-196)	180.5	(164-191)	
Weight (kg)	84.0	(69-124)	81.6	(60-99)	0.46
Pulse	64.6	(38-125)	63.2	(37-81)	0.72
Systolic blood pressure (mm Hg)	131.8	(107-185)	131.3	(119-145)	0.92
Diastolic blood pressure (mm Hg)	77.4	(54-100)	75.7	(62-97)	0.59
Hemoglobin (mmol/l)	9.5	(8.3-11.8)	9.6	(7.9-11)	0.83
Cholesterol (mmol/l)	5.26	(2.72-9.38)	4.71	(3.2-6.24)	0.13
ALAT/GPT (U/l)	27.5	(16-65.6)	26.5	(9.8-53)	0.77

On the background of the recorded duration of noise exposure, the total number of launches each year and the number of crew chiefs, the mean duration of exposure during launch and recovery procedures for each crew chief could be calculated to be between 19 and 29 hours yearly, depending on the time period. The average cumulated duration of this noise exposure during their entire duty could be calculated to be 470 hours during the 19.6 years of mean seniority.

The noise level during three launches and 2 recoveries were recorded in one type of shelter and 2 launches and 2 recoveries in the other type of shelter. Only 1 launch and no recovery could be recorded in open air due to the actual procedures at the air base (Table 3). There was a failure of the stationary microphone in some of the tests in one of the shelters.

Table 3: Duration and noise levels during launch and recovery procedures. All values in dB(lin)

	Time (min)	0.1–20 k Hz (dB)				0.1–500 Hz (dB)		0.1–200 Hz (dB)	
		Man-Borne		Stationary		Man-borne	Stationary	Man-borne	Stationary
		Leq	Peak	Leq	Peak	Leq	Leq	Leq	Leq
Launch									
Shelter 1	13 10 10	124 122 122	144 143 144	123 - -	146 - -	121 120 119	121 - -	120 119 118	121 - -
Shelter 2	11 9	117 119	141 140	115 115	143 142	112 112	110 111	108 109	108 110
Open air	11	117	137	114	146	110	110	106	110
Recovery									
Shelter 1	6 5	118 117	140 139	- -	- -	114 115	- -	114 114	- -
Shelter 2	6 6	115 118	140 142	114 -	140 142	111 108	113 -	109 107	112 -

The distribution according to frequency bands of aircraft noise during launch and recovery procedures shows an overweight of high frequencies (Figure 1), apart from a peak around 1.6 Hz representing the resonance frequency of the shelters and thus, not present in open air.

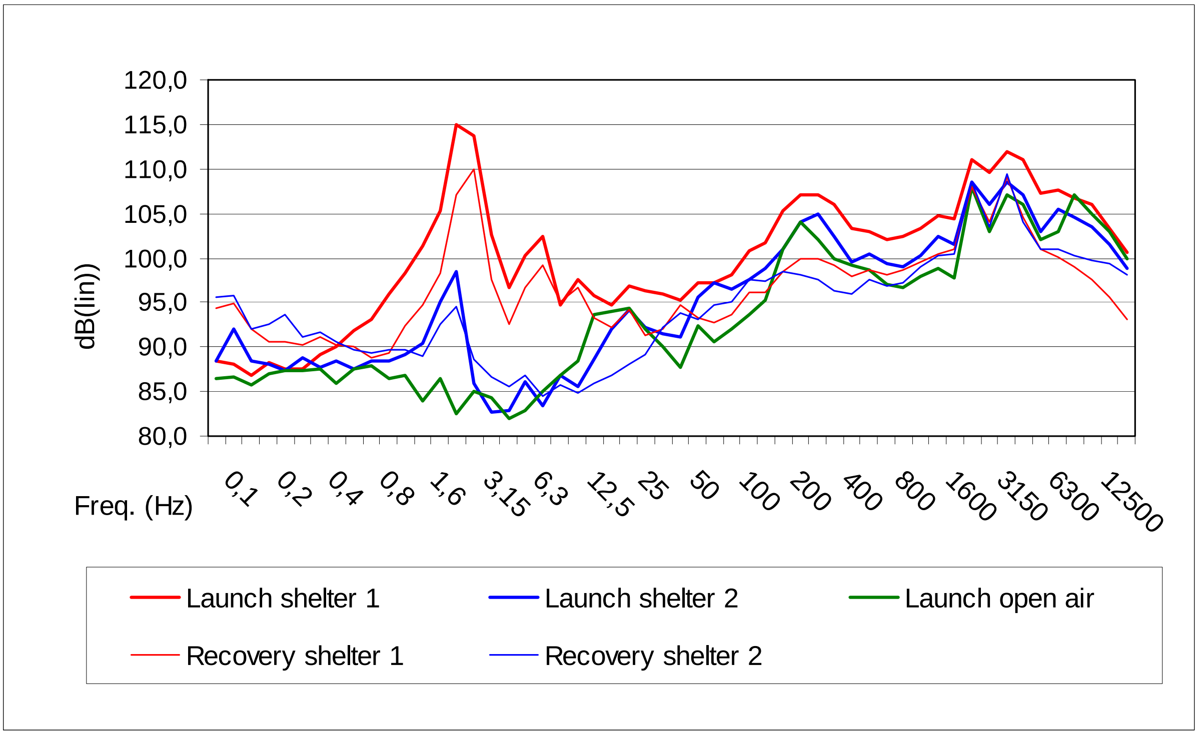

Figure 1: Frequency distribution of aircraft noise during launch and recovery

DISCUSSION

The noise exposure of crew chiefs is considerable, even though the duration is limited. The specific noise exposure in connection with launch and recovery of jet fighters has duration of roughly calculated 1.5 % of the total time on duty. Still, this exposure is specific for crew chiefs, and the exposure level exceeds by far the noise level usual in private and professional settings. Aircraft mechanics are exposed to aircraft noise like all other employees at air bases, but not to noise levels like those measured at run-up and shut-down of jet engines, and there is a clear exposure contrast between crew chiefs and aircraft mechanics. This assumption is supported by the higher frequency of ear diseases among crew chiefs compared to aircraft mechanics. Furthermore, the crew chiefs had a relatively high seniority. Only 4 crew chiefs had a seniority of less than 10 years. If LFN is a major risk factor for diseases other than hearing loss, an elevated relative disease frequency would be expected among crew chiefs.

Using existing health data from regular health checks has advantages and disadvantages. Neither the health examination nor the questionnaire is very specific for the health effects of special interest. There might have been slight differences in the way, the health checks are carried out. Still, the health checks used in this study were following a fixed protocol and enclose all major disease groups. The data from the health checks will not tend to be biased, because neither the examining physician nor the employee knew, that the test results later would be used for this study.

It was not possible to obtain health data for all crew chiefs, who left the job before planned retirement; at the obtained health data were not complete. The significantly elevated rate of frequent airways infections is an interesting difference to the present crew chiefs. Diseases of the airways is among the reported health effects of LFN according to the Portuguese group (De Sousa Pereira et al. 1999). It cannot be ruled out completely that airway disease in connection with LFN exposure has contributed to the decision to leave the job for some crew chiefs. Still, no elevated rate of frequent airways infections were found among present crew chiefs. One former crew chief reported allergy-like symptoms when exposed to fuel vapor. Anecdotal reports among crew chiefs, why some crew chiefs had chosen to leave the job, gave no indications of health factors as a relevant factor.

CONCLUSIONS

This study does not support the findings of the Portuguese researcher group. The present data does not indicate that there is a specific disease risk apart from hearing loss among crew chiefs, although they have a considerable specific exposure to high level noise.

Although the data on former crew chiefs could not completely rule out a healthy worker effect, it still does not seem likely, that a healthy worker effect is of importance.

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