

Hearing Thresholds of Nigerian Navy Personnel Serving in Lagos Area

Abubakar O Aliyu

Nigerian Navy Medical Services, Abuja

Waheed A Adedeji

University College Hospital Ibadan

Adekunle Daniel

University of Ibadan College of Medicine

Tajudeen Yusuf

University College Hospital Ibadan

Paul A Onakoya

University of Ibadan College of Medicine

Taye J Lasisi

University of Ibadan College of Medicine

Ayotunde J Fasunla

University of Ibadan College of Medicine

Akeem Olawale Lasisi (✉ akeemlasisi@gmail.com)

University of Ibadan College of Medicine

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Abstract

Introduction: Navy personnel are exposed to several risk factors that increase hearing thresholds and impair hearing. The aim of the study was to determine the prevalence of hearing impairment among Nigerian Navy personnel.

Materials and Method: This was a cross sectional study of Nigerian Navy personnel working in various ships. Structured, self-administered questionnaire was used to obtain information on hearing. All the subjects had ear examination and pure tone audiometry of both ears.

Results: The prevalence of hearing impairment was 22(14.7%) in the right and 17(11.3%) in the left ears. The Pure Tone Average for the right and left ear were 19.0 ± 8.6 dB and 17.4 ± 6.7 dB respectively. There was a statistically significant association between noisy work place and total hearing loss ($p < .01$), pure tone average in the left ear ($p < .05$) and frequencies of 3000 Hz ($p < .05$), 2000 Hz ($p < .001$) and 1000Hz ($p < .05$) in the left ear. The association between past history of ear infections and pure tone average in the left ear ($p < .05$) and the frequency 2000 Hz ($p < .005$) in the left ear were significant. The length of service years, occupational group, age, sex report of change in hearing, non-use of hearing protection and presence of tinnitus did not show significant association with pure tone averages nor on the frequencies tested.

Conclusion: The significant unilateral hearing impairment on the right ear suggests the need for more research on hearing impairment in the Nigerian Navy as well as development of a comprehensive hearing conservation programme.

Introduction

Adult-onset hearing loss is regarded by the World Health Organization as the 15th most serious health problem.[1] About 16% of disabling hearing impairment worldwide has been attributable to exposure to loud noise in the work-place.[2] In a population based study that investigated hearing threshold among various occupations in Norway, Engdahl et al reported pure tone average prevalence ratios of 3.8, 3.3 and 5.8 for senior military officers, non-commissioned officers and seamen respectively at high frequencies of 3, 4 and 6kHz. This prevalence ratio placed military officers at the 16th position among the 62 occupation groups studied. [3]

This high prevalence ratio of occupational hearing impairment among the military compared to other occupation populations were also reported in other studies. [4, 5] Barney et al on the other hand had reported a lesser prevalence of hearing impairment among military officers compared to non-commissioned officers. [6] Higher ranking and older officers were found to have a higher prevalence of hearing impairment compared to the younger, lower ranking officers.[7] This was attributed to the influence of age as a risk factor in the development of hearing impairment. Helfer et al also acknowledged the influence of ageing on a higher incidence of occupational hearing loss. [4, 8] Potentially hazardous noise sources in the military are the weapon systems, jet engines and other aircraft, generators of ships and communication systems. Military weapons are characterized by an almost instantaneous rise in the pressure in the ear.[8]

The peak sound pressure level is about 155-160dB for a rifle.[9] Humes et al reported impulse noise levels of 155–160dB peak for small calibre weapons and 178–190dB for large calibre weapons. [8] The small calibre weapons mostly affect the 1000Hz frequency range while the large calibre weapons such as the mortars, howitzers and explosions affect the lower frequencies.[10] In sea-going ships, sound levels as high as 106dB have been measured.[8]Radio operators and sonar technicians are found to be exposed to high sound levels. [8]Navy personnel serving on-board ships at sea are also exposed to continuous noise level for a long duration of time making recovery of the auditory system for acoustic injury difficult.[8]

The Nigerian Navy personnel, like other military personnel, are also exposed to impact noise from military weapons, continuous noise from the machines and communication equipment onboard the ships. The Naval helicopter pilots and air-crew are also vulnerable. Noise levels in the cockpits of civil and military aircrafts range from 95 to 105dB[11]with noise levels at the entrance of the ear canal of the pilots documented to be between 90dB and 100dB.[12]In the literature, there is a paucity of accurate population based data on the prevalence of acoustic or noise induced hearing loss among military personnel.[13, 14]The diversity of the various areas and duties within the Navy makes it imperative to study the risk of hearing loss among the personnel of the Nigerian Navy.

It would be appropriate to look for studies in Africa, possibly West Africa, then Nigeria.

Materials And Method

Study Design

This was a cross sectional study of Nigerian Navy personnel serving onboard various ships at the Naval Base Apapa, Lagos

Study Setting

The study was performed on Nigerian Navy personnel serving in Lagos area. The study was carried out at the Sick Bay of the Nigerian Navy Ship BEECROFT, Apapa. Ethical approval was obtained from the University of Ibadan and University College Hospital Ethical Review Board for the conduct of the study. Written permission was obtained from the Nigerian Navy for the conduct of the study and informed consent was obtained from the participants with the assurance that any information obtained in the course of the study will be kept confidential.

Study Population and Recruitment

Participants included 150 Nigerian Navy personnel serving in Lagos Areas between 22 and 59 years across all occupational groups. The Inclusion Criteria included consented Nigerian Navy personnel serving in Lagos who had no history of ear pathology while subjects with perforated tympanic membrane or discharging ear, subjects on ototoxic drugs such as aminoglycosides, quinine, vincristine etc and those with congenital ear abnormality were excluded.

The participants had a structured, self-administered questionnaire which elicited data on biologic and demographic characteristics, length of service years, job description, length of time in the present job description, history relating to hearing loss, past medical, drug and exposure to noise in work place, ear symptoms like ear pain, ear discharge tinnitus, hearing loss and vertigo. This was followed by an examination of the ears and otoscopy and Pure Tone Audiometry. The pinnae were examined for deformities. Otoscopy was performed to assess the external auditory canal for stenosis, presence of wax, inflammation or ear discharge. The tympanic membrane was visualized for the presence of perforation.

Pure tone audiometry was carried out on all the participants using a standard, calibrated clinical audiometer (Amplivox model 260, Amplivox Ltd, Oxford, United Kingdom) with TDH 39 headphones fitted to audio-cups to further attenuate ambient environmental sound to determine their hearing thresholds. Calibration of the audiometer was done according to the system adopted by International Standard Organisation 389 of 1991. [15] The tests were performed in a quiet room with maximum permissible ambient sound pressure level according to the recommendations of the International Standard Organisation 8253-1 (2010). [16] The sound level before each audiometry was determined using a pulsar model 14 sound level meter. Each ear was screened separately from the level of 0dB HL at frequencies 0.25, 0.5, 1, 2, 3, 4, 6, 8 KHz. Air conduction was tested using well-fitting TDH 39 headphones fitted to audiocups to further attenuated ambient environmental sounds. Bone conduction was tested using a bone vibrator applied to the mastoid bone.[17, 18] The participants were informed to raise their hands to indicate the perception of the sound clicks.

The hearing thresholds were determined using the modified Hughson Westlake procedure. This entailed initially presenting the first tone at 30dB at 1kHz. If the subject responds, the signal was reduced in 10dB steps until the subject no longer responded. The test tone was then increased in 5dB steps until a response was obtained. Where the subject did not respond to the initial first tone, the signal was increased in 5dB steps until the subject responded. Thereafter the signal was decreased at 10dB steps until there was no response. The steps were repeated at least 3 times. The signal level at which a subject responded 2 out of 3 times was recorded as the threshold at that particular test frequency. The steps were thereafter repeated for all the frequencies tested.

Pure Tone Averages was calculated for frequencies 500Hz, 1kHz, 2 kHz and 4 kHz, and values above 25dB HL in 1 or both ears are reported as impaired hearing. Hearing impairment above 25dB HL affecting frequency range of 3 – 6 KHz are reported as high frequency hearing loss while that affecting frequency range 0.5 – 2 KHz are reported as low or mid frequency hearing loss.

Variables

The independent variables included sex, age, occupational group, work place noise level and years of service while the dependent variables were the hearing threshold level at various frequencies with pure tone average.

Statistics

Data were analysed with the Statistical Package for Social Sciences version 16 (SPSS window Version 16 Inc, Chicago, Illinois, USA) software. The categorical variables including sex, length of period in service stratified into a range of 10 years (0-10, 11-20, 21-30, >30), work place noise level graded (no, mild, moderate

and severe noise level) and occupation groups were summarized in frequency and proportions. The age and hearing thresholds were summarized with mean (standard deviation). Association of gender, period in service(categorized) and occupational groups with the prevalence of hearing loss were evaluated with Chi-square while independent t-test was used to assess the mean hearing thresholds level differences at various frequencies between the left and right ear. A p -value of 0.05 or less was taken as statistically significant.

Results

Demographic Characteristics

The study included 150 respondents, made up of 135 males and 15 females (M: F = 9:1) The mean \pm SD of the participants was 32 ± 9.1 years.

Among the five main occupational groups encountered, seaman branch was the predominant accounting for 92 (61.3%). However, the engineers were the oldest among the occupation groups while the information were the youngest (Table 1). More than half of all the participants 87(58%) reported working in a noisy environment with 8(5.3%) of the total saying the noise is constantly present in their work environment. Presence of noise in the work environment was particularly prominent among the participants in the engineering group (Figure 1). A previous history of ear infection was reported by 14 (9.3%) participants, of which 12(8%) had been in the Navy for less than 10 years.

Audiometric Findings

The Pure Tone Average for the right and left ear were 19.0 ± 8.6 dB and 17.4 ± 6.7 dB (Table 2). All the frequencies in the right ear showed higher threshold values compared to the left ear except for the 1000 Hz frequency, of note the 500 Hz had the most elevated threshold levels across both ears. Paired sample T-test analysis correlating the mean values of the right and left ears showed significant differences at the frequencies 250, 500, 2000 and 4000 Hz.

Twenty- two (14.7%) participants had pure tone average >25 dB HL in their right ears while 17 participants (11.3%) had averages >25 dB HL in their left ears. For the right ear, 1(0.7%) participant each had severe hearing impairment (80 dB HL) and moderate hearing impairment (57.5dB HL) while the remaining 20 had mild hearing impairment. For the left ear, 1(0.7%) participant had moderate hearing impairments and the remaining 16 had mild hearing impairments. Unilateral, asymmetric hearing impairment was noticed in 10 (6.7%) of the participants. Two (1.3%) of the participants had significant air – bone gap (>10 dBHL) suggestive of conductive hearing loss.

Mean Threshold Values and Occupational Groups

The mean threshold levels among the various occupational groups were seamen 19.8 ± 9.6 , Engineering 19.2 ± 7.3 dB, logistic 15.8 ± 6.5 dB, medical 18.0 ± 5.9 dB and information 18.0 ± 4.9 dB. The differences in the mean threshold values across all the frequencies as well as the pure tone averages were however not statistically significant (state the p value or confidence interval).

Mean Threshold Values and Duration in Service

The mean threshold values across all frequencies in both ears were mainly elevated in personnel who had spent 21-30 years in service, however, the difference was statistically significant for the left ear (Tables 3).

Grading of Hearing Impairment

There was a statistically casual relationships between noisy work place with total hearing loss ($p < .01$), pure tone average in the left ear ($p < .05$) as well as frequencies of 3000 Hz ($p < .05$), 2000 Hz ($p < .001$) and 1000 Hz ($p < .05$) in the left ear. There was also a statistically significant association between past history of ear infections and pure tone average in the left ear ($p < .05$) and the frequency 2000 Hz ($p < .005$) in the left ear. The other independent variables such as length of service years, occupational group, age, sex report of change in hearing, non-use of hearing protection and presence of tinnitus did not have any statistically significant relationship with pure tone averages nor on the frequencies tested.

Discussion

The main findings in this study were that hearing thresholds were worse in the right ear compared to the left ears. Increasing age, duration of years spent in service, working in a noisy environment and past history of ear infections affected hearing thresholds in this study. There was no statistical difference in the hearing thresholds across the occupational groups studied.

This study revealed higher threshold values of frequencies in the right ears compared to the left ears of the participants. Our finding is similar findings of Ologe et al [18] in a study on Nigerian workers who reported the right ear being worse than the left ears. They suggested it might be due to environmental factors. However, Abel [9] in Canada reported worse hearing in the left ear. Another explanation for the interaural difference could be that louder noise may have been reaching the right ear more than the left ear in a majority of the participants as explained by the Stenger effect.[20] The relevance of this interaural difference might be important during auditory rehabilitation purposes where the decision of monaural or binaural hearing aids or cochlear implantation and hearing aids may be required to be fitted.

The prevalence of hearing impairment (Pure Tone Average > 25 dB HL) was 14.7% in the right ear and 11.3% in the left ear. The criteria for making a diagnosis of unilateral, asymmetrical hearing impairment [20, 21] was met in the audiograms of 10 (6.7%) of the participants. The significance of unilateral asymmetrical hearing impairment is that these participants might need to be further screened for other causes of asymmetrical hearing impairment apart from noise [21] and more importantly for medicolegal reasons.[20]

Our finding leads to an inference that age was a major determinant of hearing thresholds and in agreement with other studies. [19, 22] Previous studies had reported the effect of past ear infections on impaired threshold levels. [23, 24] The impact of ear infections on hearing impairment was significant in this study unlike the findings in a study carried out in Canada. [19] This finding of elevated hearing thresholds among relatively young personnel may make it pertinent to enforce ear screening processes during the recruitment of young adults into the Nigerian Navy. The finding of an association of noisy work place and impaired hearing thresholds was also reported by Abel.[19] It may thus be deduced that working in a noisy environment has a

bearing with hearing impairment. An attempt at determining whether the hearing impairment seen in the participants were noise induced was difficult as none of the audiograms was classical as in published works. [25, 26]

A limitation of this study was that the audiometric measurements were done only once, hence it might be difficult to determine if the measurements were not as a result of temporary threshold shifts. Attempts were made at overcoming this limitation by performing the measurements on the first working day of the week after a likely 48 hours free from work. The response by participants of working in a noisy environment may require a further comprehensive survey of the Nigerian Navy work environment. It can also form a basis for the development of a hearing conservative programme.

Conclusion

The right ear showed worse hearing thresholds across all the frequencies. The prevalence of hearing impairment in the right ear was 14.7% and 11.3% in the left ear. The hearing threshold of Nigerian Navy personnel is significantly affected by their age, noisy work environment as well as past ear infections.

Declarations

Ethical Approval and Consent to participate – Approved by the Ethical approval was obtained from the joint University of Ibadan/ University College Hospital, Ibadan Ethical Review Board, no:UI/EC/12/0144

- **Consent for publication** – taken from the subjects and included in the Ethical Approval

- **Availability of data and materials** - Yes

- **Competing interests** – No competing interest

- **Funding**–Self funded by Dr Aliyu

- **Authors' contributions**

Aliyu – Conceptualised the study, proposal writing, subject recruitment and writing of manuscript

Adedeji – proposal writing, statistics analysis, manuscript writing

Daniel – subject recruitment, statistics analysis and manuscript writing

Yusuf - subject recruitment, statistics analysis and manuscript writing

Onakoya - subject recruitment, statistics analysis and manuscript writing

Lasisi TJ - subject recruitment, statistics analysis and manuscript writing

Fasunla – proposal writing, statistics analysis and manuscript writing

Lasisi OA – Leader of the team, study concept, coordination, proposal and manuscript writing
- Acknowledgements – This work was an excerpt from the dissertation submitted by Dr Aliyu for the Fellowship of the West African College of Surgeons
- Authors' information – As in title page

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Tables

Table 1: Sociodemographic factors of the selected Navy personnel serving in the Lagos Area, Nigeria

Variables	Frequency	Proportion
Sex		
Male	135	90.0
Female	15	10.0
Occupational groups		
Seaman	92	61.3
Engineering	21	14.0
Logistics	19	12.7
Information	10	6.7
Medical	8	5.3
Duration in the services(years)		
0-10	80	53.3
11-20	52	34.7
21-30	18	12.0
Grading of work place noise level		
No noise		
Mild	63	42.0
Moderate	34	22.7
Severe	46	30.6
	7	4.7
Mean (SD) age (years) of occupational groups		
Seaman		
Engineering	32.8(9.4)	
Logistics	36.4(9.6)	
Information	29.8(8.0)	
Medical	30.5(6.4)	
	26.1(5.4)	

Table 2: Mean Hearing Threshold values of the participants across the hearing frequencies

Mean (standard deviation) in dB HL				
Frequency (Hz)	Right Ear	Left Ear	t	p-value
250	17.5(11.7)	15.4(10.9)	2.41	0.017
500	22.7(10.1)	20.9(9.4)	2.16	0.032
1000	21.1(10.6)	21.4(8.9)	-0.28	0.781
2000	15.2(8.6)	12.8(7.3)	3.53	0.001
3000	13.7(10.4)	12.8(8.8)	1.08	0.280
4000	16.7(12.0)	14.6(10.6)	2.35	0.020
6000	16.4(13.1)	15.6(10.6)	0.76	0.439
8000	16.4(13.8)	14.3(11.7)	1.82	0.071
PTA	19.0(8.6)	17.4(6.7)	2.41	0.017

PTA – Pure Tone Average

Table 3: Association of the Mean Hearing Threshold values across the hearing frequencies and the duration of services of the participants

Freq. (Hz)	RIGHT EAR				LEFT EAR			
	Mean (standard deviation) in dB HL				Mean (standard deviation) in dB HL			
	0-10 yrs	11-20yrs	21-30 yrs	p-value	0-10 yrs	11-20yrs	21-30 yrs	p-value
250	17.3(11.5)	17.1(12.5)	17.5(11.7)	0.15	16.3(11.5)	13.9(9.5)	15.3(12.1)	0.20
500	22.8(11.8)	22.6(7.9)	22.5(8.3)	0.08	21.8(10.6)	19.2(7.2)	21.4(8.9)	0.16
1000	21.2(11.1)	19.9(10.7)	24.4(7.5)	0.10	21.9(9.2)	19.8(8.3)	23.6(8.5)	0.08
2000	15.2(9.5)	14.3(7.7)	17.5(6.5)	0.10	13.5(7.4)	10.3(6.2)	15.0(8.6)	0.01
3000	13.4(10.0)	13.9(11.6)	14.7(9.0)	0.20	13.0(8.8)	11.7(7.8)	15.3(10.9)	0.40
4000	16.2(12.3)	16.6(11.0)	19.4(13.5)	0.40	15.1(10.6)	12.7(9.2)	18.1(13.7)	0.07
6000	16.7(14.1)	16.5(12.4)	15.0(11.0)	0.20	14.5(10.9)	16.3(9.2)	18.3(12.6)	0.09
8000	17.2(14.4)	15.7(13.8)	15.0(11.0)	0.09	14.4(12.4)	14.2(11.6)	14.2(9.7)	0.20
PTA	19.0(9.3)	18.5(8.0)	21.0(6.4)	0.15	18.1(7.2)	15.6(5.3)	19.5(7.2)	0.02

PTA-Pure Tone Average, Yrs-years, Freq-frequency

Figures

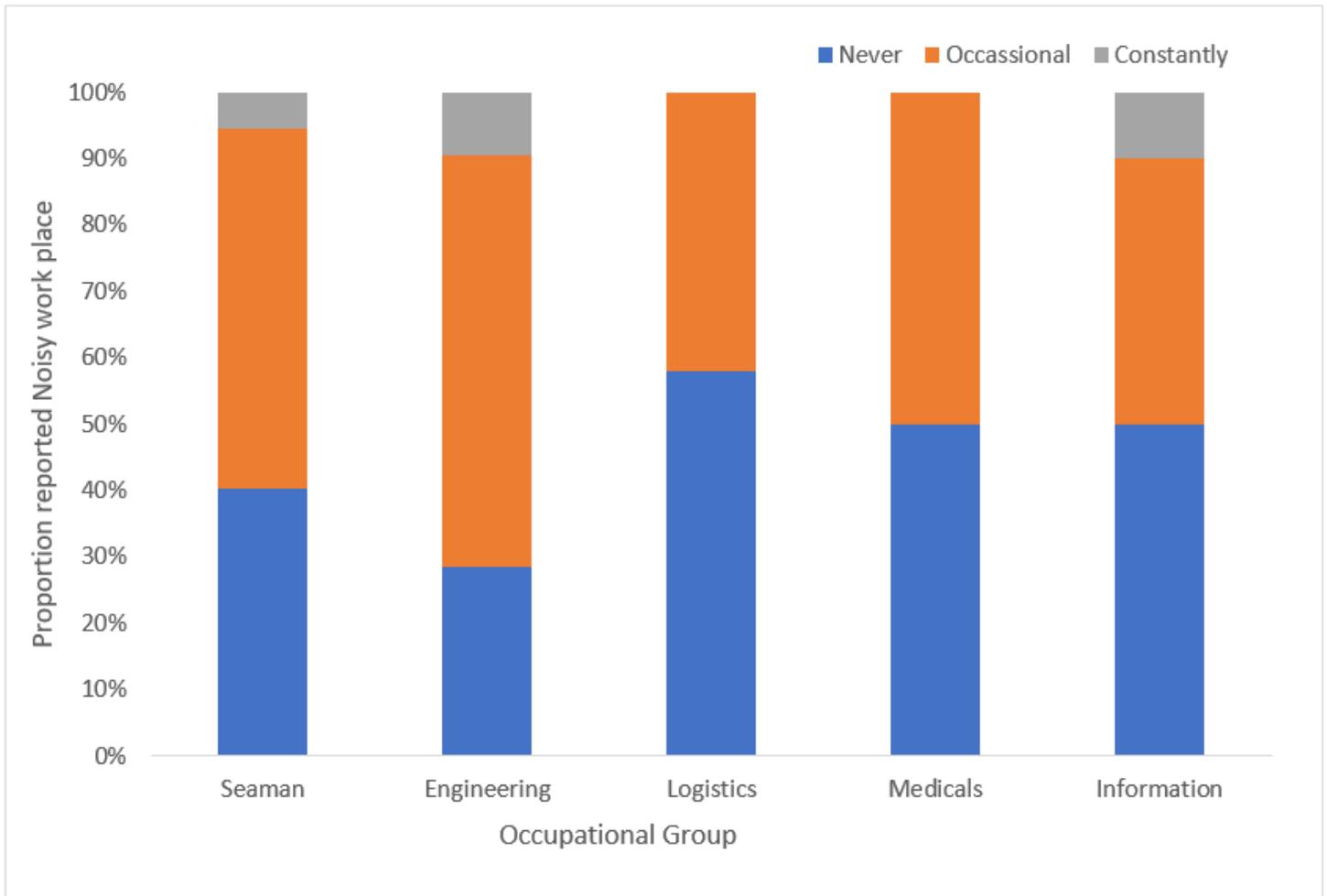


Figure 1

Distribution of noisy work place among the various occupational groups