Prevalence and an Analysis of Noise - Induced Hearing Loss in Army Helicopter Pilots and Aircraft Mechanics

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Background and Objective: *Hearing impairment from noise exposure has been reported in fix-wing pilots, especially in civilized countries. However, there are few studies on rotary wing aviators and aircraft mechanics, especially in developing countries whose hearing conservative program is not well established. The present study, therefore, was done to evaluate the prevalence of noise induced hearing loss and the contributing factors that may effect both groups of noise-exposed population.*

Material and Method: *Report questionnaires were reviewed and physical examination combined with audiometric records of 34 pilots and 42 mechanics in the Royal Thai Army Aviation Center, Lobburi, were examined. Hearing loss was studied using four categories of significant threshold shift (STS). Amplitude of noise radiated by aircraft was also measured at different distances.*

Results: *No significant difference was found in prevalence of hearing loss in aviators (32.4%) and aircraft mechanics (47.6%), but in the aircraft mechanics group there were more damage of frequency involvement including speech frequency and high frequency and more decibels loss than aviators. The type of hearing protection and smoking index were strongly correlated with hearing loss. Age, flight time and alcohol habit had no significant effect and ninety percent of the subjects had no self awareness of hearing loss.*

Conclusion: *Aircraft mechanics had more severity on hearing loss than aviators. Types of noise protector and cigarette smoking had significant association with hearing loss.*

Keywords: *Noise induced hearing loss, Helicopter pilots, Aircraft mechanics, Hearing protection, Cigarette smoking*

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The effect of long term exposure to excessive levels of aircraft noise have been considered to be one of the major factors causing permanent hearing loss of the military aircrews[1-3]. The noise levels vary according to aircraft types and stage of flight but always has high intensity and low frequency including vibration that may led to other sequents such as vibroacoustic

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disease[4,5] which have the effect on the central nervous and cardiovascular system. Usually, the noise levels of fighter aircraft remains around 95-105 dB[6] and in rotary-wing aircraft also always exceeds the level of 100 dB which is most intense at the lower frequency (<300 Hz)[7]. In civilized countries, prevalence and contributing factors of hearing loss in fix-wing aviators had been analyzed in a lot of studies[8-11]. However there were little data that focus on helicopter pilots[12,13] and aircraft mechanics especially in developing countries whose hearing conservative program have not been well established as in fighter aviators. Some studies have reported the small percentage and mild degree of hearing loss in helicopter flyers[14]. But with conflicting results in the literatures, the authors decided to evaluate the prevalence of hearing impairment in Thai helicopter pilots and aircraft mechanics and the relationship between age, flying time or working time, types of noise protection, smoking and alcohol consuming habit as the factors that contribute to hearing loss in both groups.

Material and Method

One hundred helicopter pilots and aircraft mechanics from the Army Aviation Center, Lobburi Province, Thailand were randomized sampling as the study SAMPLES during the aviator's annual physical examination from November 2003 to June 2004. All of them had already passed the audiometric tests at the time of their recruitment as the base lines before starting their career. Before being enrolled in the present study, they had to quit from work and loud noise environment for 3 days to eliminate the acute acoustic effect.

Inclusion criteria included age less than 45 years, no history of chronic ear diseases, head trauma and medical problems of hypertension, DM or hyperlipidemia. They all completed the information forms, physical examinations, blood chemistry tests and audiometric tests.

The audiometric tests consisted of air and bone conduction hearing tests in the frequency range of 500-6000 Hz, including speech tests. Audiometric examinations were performed using audiometers (Qualition Model Odyssey or Amplaid Model 460) calibrated to the International Standard Organization (ISO 1964).

The documents recorded then were reviewed for evidence of hearing loss unrelated to noise exposure and evidence of positive blood tests for DM and hyperlipidemia. These resulted in elimination of 11 subjects who had abnormal blood tests and 3 more for hearing loss other than noise exposure. Consequently the final study group was 76 consisting of 34 aviators and 42 mechanics. The average age of the aviators was 37.64 ± 3.50 and the mechanics was 36.95 ± 6.04. Most common helicopter types were UH1 and the following were B212, B206 and U17.

Data obtained from the information forms were type of work (aviators or mechanics), age, total flying time or work time, type of hearing protection used more than 80%, tobacco use, ethanol consumption and self awareness of hearing loss.

The measurement of sound pressure level in several positions relative to the aircraft (UH1) was also done using portable sound level meters (Guest Electronic OB45).

Hearing classification was classified by frequency groups using significant threshold shift (STS) criteria. American Academy of Otolaryngology head and Neck Surgery has used an average absolute hearing level of 25 dB at 500, 1000 and 2000 Hz as the threshold for impairment[15], so a threshold shift of 25 dB was selected as a fulcrum[12]. Threshold shift was calculated by substracting the preflight hearing threshold level from the level on a current audiogram at each frequency. Four class levels were categorized;

Table 1. Distribution of hearing loss (%) by STS criteria

Criteria	Class 1 (No loss)	Class 2 (0.5 k - 2 k)	Class 3 (3 k - 6 k)	Class 4 (4 k - 6 k)	Hearing Loss (%)
1) Type of Work					
Aviators	67.2	-	18.2	14.2	32.4
Mechanics	52.4	9.4	19.1	19.1	47.6
2) Age (year)					
≤ 30	62.5			37.5	37.5
31-35	66.7		13.3	20.0	33.3
36-40	54.8	6.5	12.9	25.8	45.2
41-45	59.1	9.1	18.2	13.6	40.9
3) Flight Hours (or Work Hours)					
≤ 500	75.0	-	12.5	12.5	25.0
500-750	45.4	18.2	18.2	18.2	54.6
751-1000	46.2	-	30.7	23.1	53.8
1001-1500	64.3	-	14.3	21.4	35.7
1501-2000	71.5	14.2	-	14.3	28.5
≥ 2001	56.3	-	6.2	37.5	43.7
4) Noise Protection					
Helmet	69.1	-	9.5	21.4	30.9
Headset	63.1	5.3	5.3	26.3	36.9
Ear plugs	33.3	8.3	33.3	25.1	66.7
Not use	-	66.7	33.3	-	100.0
Total	**45**	**4**	**10**	**17**	

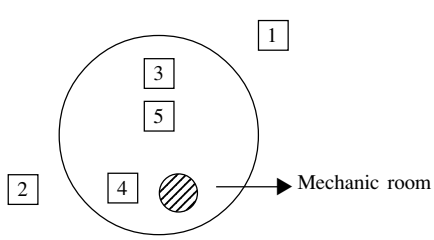
Table 2. Smoking index of the two audiometrically dichotomous groups

	Smoking Index* X ± SD			
	Normal hearing	Hearing loss	N	p-value**
All subjects	3.50±2.02	5.95±4.1	110	0.047
Aviators	3.28±2.27	7±4.17	34	0.119
Machine authors	3.71±1.9	5.48±4.23	76	0.248

* = Number of Packs per day x Year Smoked

** Unpaired to test

Table 3. Noise levels at various positions of UH1 aircraft



Measurement site	Positions	dBa
1	15 m. in front of A/C	99
2	5 m. from one site of A/C	110
3	Aviation position in cockpit	91-96.3
4	Mechanics position in cockpit	97-102
5	Passenger position in cockpit	91-96.3

Site 1 and 2 = location where the mechanics working on tasks for long periods (e.g. run up procedures) Site 3, 4, 5 = positions of aviators, mechanics and passengers in cockpit during flying

Class 1: decibel shift of less than 25 dB for all frequencies

Class 2: decibel shift of 25 dB or more for any frequency in the 500-2000 Hz range (speech frequency)

Class 3: decibel shift of 25 dB or more in the 3000-6000 Hz range (both speech and high frequency)

Class 4: decibel shift of 25 dB or more at the 4000 or 6000 Hz range (high frequency)

Computation and statistical analyzes were performed. Using Univariate analysis, hearing levels and the significant shifts were analyzed in relation to types of work, age, types of noise protector and flight hours or work hours. The SPSS/PC software package was used to conduct the data analysis. A p-value of less than 0.05 was considered significant.

Results

Table 1 demonstrates the various degrees of hearing loss among variable parameters. Prevalence of hearing loss in the aviators was 32.4% and in the aircraft mechanics was 47.6%. No significance was found in the prevalence of both groups but higher damage was found in the aircraft mechanics. In mechanics, they had more range of frequency loss that included speech and high frequency (Class 2 and Class 3) than the aviators.

There appeared to be no association between hearing loss and age groups and no significant dependency to flight hours or working hours was found. There was a clear dependency of hearing loss to types of hearing protection used.

Fig. 1 presents average hearing threshold levels in each group of aviators

and mechanics (left ear). In the mechanics, there was more substantial decibel loss in both high frequency (4000-6000 Hz) and speech frequency (at 3000 Hz) than aviators.

Fig. 2 exhibits the average hearing threshold level of all subjects in relation to various types of hearing protection used (left ear). The graph point to the significant effect of hearing protection types on hearing threshold level found. The subjects who used a helmet as the dominant noise protection had less degree of hearing loss than those who used a headset or earplug respectively. In the "not use" group, all of whom were mechanics personnel, had the most serious hearing level loss. These same results were also observed in the right ear.

In the written survey, 44.1% of aviators and 65.2% of mechanics reported smoking cigarettes. Table 2 presents the mean of smoking index of the two audiometrically dichotomous groups. Those in the impaired hearing group had a higher smoking index than those in the normal hearing group ($p<0.05$). In alcohol consumption parameter, the subjects reported consuming a mean of one-two alcoholic beverage per week which failed to appear differentially in the two hearing groups. During the survey, all subjects were asked for self detection of any hearing impairment, 93.5% with a significant threshold shift were unaware of their hearing loss.

The measuring of noise level radiated by UH1 helicopters was also done at different positions around the aircraft and in the cockpit room. Table 3 presents the noise levels of these locations. The mechanics, even though in the cockpit area, expressed a higher noise level than the aviators.

Discussion

There was diversity of prevalence of noise induced hearing loss in aviators in the literature, ranging from 8% to 30% at different degrees[1,3,8,12,16]. The relevant factors also varied such as total flight hours, types of hearing protection[12], normal aging process[16] to no clear dependency on aircraft noise[6,9,17,18]. These different findings may be due

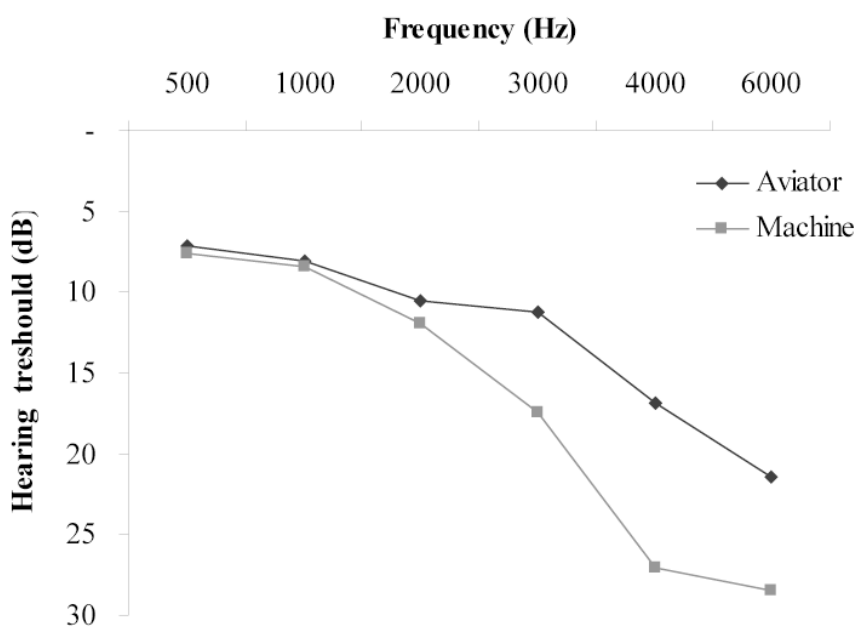


Fig. 1 Average hearing (left ear) threshold of aviators group and mechanics group base on last audiogram

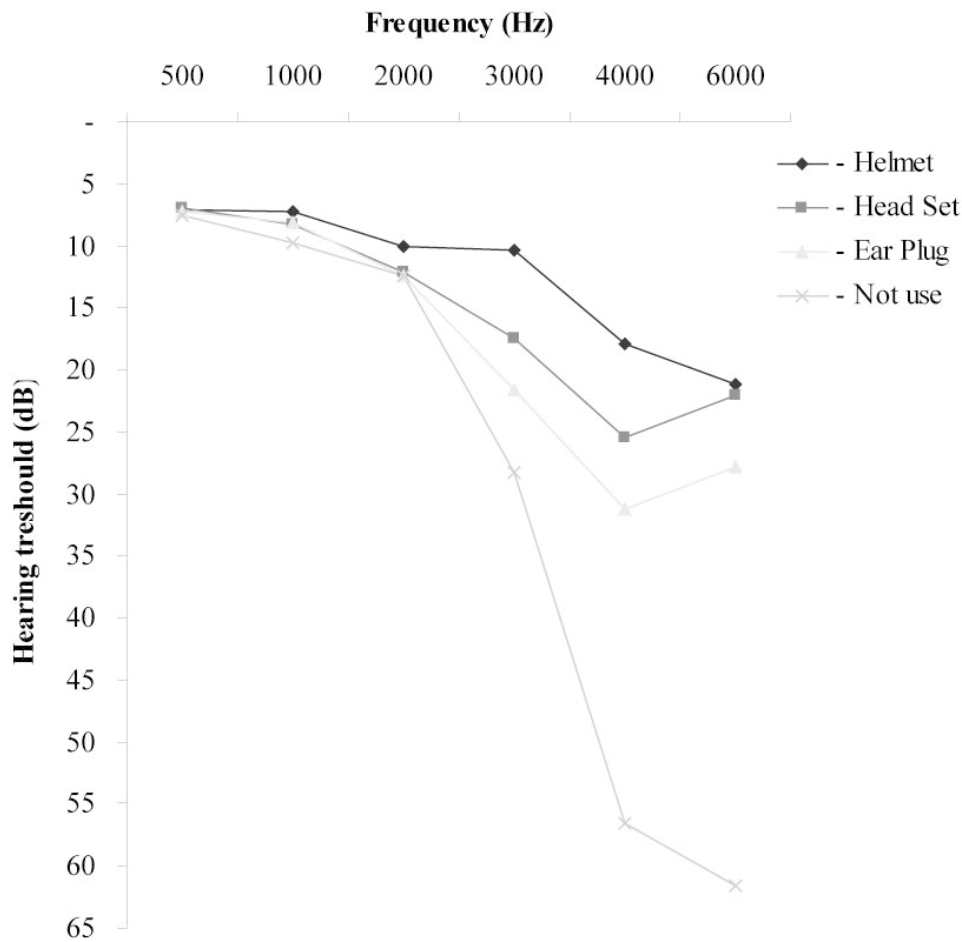


Fig. 2 Average hearing (Left ear) threshold of all subjects, presented for various types of noise protection used

to criteria of hearing loss in each standard, types of aircraft, size and types of study samples.

While most of the studies were interested in evaluation of hearing loss in fighter of fix-wing aviators, the authors decided to evaluate the effects of helicopter noise and contributing factors in Royal Thai Army aviators and aircraft mechanics. The authors selected the significant threshold shift criteria as the criteria for hearing loss because it is more sensitive than absolute data collected from the last audiogram only.

Using the same criteria, prevalence of hearing loss in aviators was 32.4% which did not differ from Fitgzpatrick's study in U.S. Army helicopter pilots[12].

In aircraft mechanics, whose data have not been mentioned much in the literature, had the prevalence of hearing loss of 46.7% and had more severity of the damage as will be discussed later.

To eliminate the effect of normal aging process, the authors studied the population under age 45. In the present study, unlike previous findings, age and total flight hours or work hours had no significant relationship on noise induced hearing loss, but the types of hearing protection had a strong association with hearing impairment. In Thai

aviators, all of them used helmets for noise protection and for communication. Unlike U.S. Army Pilots, very few of them used both helmets and earplugs. In the aircraft mechanics, there were various types of protection. These included helmets 22.9%, headsets 34.3%, earplugs 34.3% and "not use" 8.6%. In the "not use" group, all of them had more severity of hearing loss than earplugs, headset and helmet use group respectively. Also, mechanics work longer hours and have higher noise levels, thus, these should lead to more hearing damage than aviators. Lack of self awareness of hearing loss in most of the subjects was another factor that led to a greater degree of damage without protecting themselves.

The other interesting factor was the smoking habit. It is known that cigarette smoking lowers oxygen levels[19] and raises blood carbon monoxide[20,21] which have been shown to result in hearing loss[22,23]. Furthermore, Shapiro[24] postulated that nicotine can cause vasospasm of the inner ear blood vessels that can cause damage in some individuals. In the present study, the impaired hearing group had smoked more cigarettes for a greater period of time than did the normal hearing group. Further research and more population are required to make the definite conclusion regarding smoking cigarettes as a risk factor of hearing loss.

Conclusion

As the high prevalence of noise-induced hearing loss in Thai helicopter pilots and aircraft mechanics, a hearing conservative program should be strongly established. Using proper noise protectors such as helmets or a mix of helmets and earplugs should be highly motivated and stop smoking should be recommended Audiometric examinations should be administered strictly at yearly intervals to detect the early high frequency hearing loss before the progress to permanent hearing loss.

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ความชุกและปัจจัยที่เกี่ยวข้องในการสูญเสียการได้ยินของนักบินและช่างเครื่องบิน ประจำศูนย์การบินทหารบก

ปริยนันทน์ จารุจินดา, ธนินศักดิ์ ทองดีแท้, สุธี พานิชกุล, พงษ์เทพ หารชุมพล

วัตถุประสงค์: ในประเทศที่พัฒนาแล้วมีการศึกษาถึงภาวะสูญเสียการได้ยินจากเสียงดังในสิ่งแวดล้อมของการบินมากมายโดยเฉพาะในนักบินปีกตรึง อย่างไรก็ดีข้อมูลของนักบินปีกหมุนหรือเฮลิคอปเตอร์ รวมทั้งช่างประจำเครื่องยังมีการศึกษาไม่มากนักโดยเฉพาะในประเทศกำลังพัฒนาซึ่งโครงการติดตามดูแลภาวะสูญเสียการได้ยินยังไม่มีการวางแนวทางที่ชัดเจน ในการศึกษานี้ มีจุดประสงค์เพื่อหาความชุกและวิเคราะห์ปัจจัยที่เกี่ยวข้องในการสูญเสียการได้ยินของนักบินและช่างเครื่องในเครื่องบินปีกหมุนกองทัพไทย เพื่อวางแนวทางในการป้องกันและดูแลภาวะสูญเสียการได้ยินในกลุ่มประชากรทั้งสอง

วัสดุและวิธีการ: ได้ทำการศึกษาแบบสุ่มตัวอย่างจำนวน 76 ราย เป็นนักบิน 34 ราย ช่างเครื่อง 42 ราย จากศูนย์การบินทหารบก จังหวัดลพบุรี ทั้งหมดได้รับการสัมภาษณ์ถึงข้อมูลและปัจจัยที่เกี่ยวข้องต่างๆ ตรวจร่างกาย ตรวจเลือด และตรวจภาวะการได้ยิน ข้อบ่งชี้ของการสูญเสียการได้ยินใช้ข้อบ่งชี้ของ Significant threshold shift (STS) 4 ระดับ เทียบกับภาวะการได้ยินก่อนรับการบรรจุเข้าทำงาน การศึกษานี้ได้ทำการวัดระดับเสียงที่ระยะต่างๆ จากตัวเครื่องบิน UH1 ซึ่งเป็นระดับเสียงของภาวะแวดล้อมในการทำงานด้วย

ผลการศึกษา: ความชุกของการสูญเสียการได้ยินในนักบินเท่ากับ 32.4 % ในช่างเครื่องเท่ากับ 47.6 % ซึ่งไม่มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ แต่ในช่างเครื่องพบว่ามีความรุนแรงของการสูญเสียการได้ยินมากกว่านักบิน ซึ่งย่านความถี่ที่สูญเสียมีช่วงกว้างมากกว่านักบินโดยมีทั้งย่านความถี่เสียงสูงและย่านความถี่เสียงพูด และระดับการได้ยินของช่างเครื่องมีระดับการสูญเสียมากกว่านักบินในทุกย่านความถี่ นอกจากนี้ยังพบว่าชนิดของเครื่องป้องกันเสียงและดรรชนีการสูบบุหรี่มีความสัมพันธ์อย่างชัดเจนกับภาวะสูญเสียการได้ยิน ในขณะที่อายุชั่วโมงบินหรือชั่วโมงการทำงานและภาวะการดื่มแอลกอฮอล์ไม่มีความสัมพันธ์อย่างชัดเจน 90% ของนักบินและช่างเครื่องที่มีการสูญเสียการได้ยิน ไม่ทราบว่าตัวเองสูญเสียการได้ยินแล้ว

สรุป: ช่างเครื่องมีภาวะการสูญเสียการได้ยินในระดับที่รุนแรงกว่านักบิน ชนิดของเครื่องป้องกันเสียงและดรรชนีการสูบบุหรี่มีความสัมพันธ์กับภาวะการสูญเสียการได้ยินอย่างมีนัยสำคัญทางสถิติ