Age Related Changes in Hearing Level among Thai People

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The present study was conducted to develop a normal aging curve in hearing of Thai people. The subjects were 805 males and 1110 females ranging in age from 7 to 89 years. Audiometric hearing threshold testing was performed at the frequencies of 1, 2, 4 and 8 kHz. Subjects with no evidence of hearing impairment were selected for hearing level analysis. The accepted subjects comprised of 1298 ears in males and 1818 ears in females with normal hearing. A normal aging curve of hearing level at each frequency was established by calculating the 25th, 50th, and 75th percentiles for each age group. The hearing threshold level gradually increased with age and rapidly over 50 years in both sexes, in particular at 8 kHz and 4 kHz. The results showed significant correlations between the hearing level and age. There were sex differences in hearing level at the 4 kHz from the age of 40. This normal curve established from subjects with no evidence of hearing problems may be useful for monitoring hearing levels of Thai people.

Keywords: *Hearing level, Age-related, Thai people*

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Physiological functions of various organs have been studied with some parameters showing age-related changes. The rate of change with age varies among individuals depending on their lifestyle, occupation and living environment. Among physiological functions, hearing acuity has been found to deteriorate with age, in particular in the high frequency range[1].

Hearing loss remains a significant occupational health issue in Thailand. Several studies have reported that exposure to noise and chemicals in work environment caused hearing impairment at high frequencies[2-5]. Age-related change in hearing level should be taken into account when assessing hearing impairment among workers exposed to noise or chemical. However, there is no reference value of hearing to assess hearing impairment of workers in different age groups.

The present study was designed to clarify the age variation in hearing level and to set standard aging curves for evaluating age-related changes in hearing.

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Material and Method

Subjects

Research design used in the present study was a cross sectional study. The examination was conducted from June to August 2003 in 5 provinces of Thailand; Prachuapkhirikhan, Chaiyapum, Chachoengsao, Lopburi and Pichit, where the population were not much exposed to industrial or environmental noise. The subjects were recruited by a research assistant at the local level. Researchers were not involved in any step of selection. Therefore, no selection bias was found in the present study. Total subjects were 805 males and 1110 females ranging in age from 7 to 89 years.

Measures

A preliminarily check of each subjects' history was made and an audiometric test was done. Before audiometric testing, the researcher explained to the subjects the meaning of the test and how to respond. The hearing test was then done in a quiet room where

the background noise level was below 50 dB (A).

Audiometric hearing threshold testing with air conduction was carried out using three audiometers (RION, AA-68N) to test air conduction threshold. Regular electronic calibrations were conducted on each audiometer to JIS-T1210 standards[6]. Ascending threshold technique was used to determine hearing level. Hearing level was defined as where the tone was heard 100% of the time and below which the tone was never heard. The hearing levels were determined at the audiometric frequencies of 1, 2, 4, and 8 kHz.

Analysis

During audiometric hearing threshold testing, abnormality was found among the subjects. Thus, the subjects were classified according to the results of audiometry. Table 1 shows the standard of hearing level that was used to select normal ears in the present study[7]. The ears of subjects with no evidence of hearing impairment were selected to analyze the hearing level at various ages and frequencies. If subjects had been exposed to drugs, to noise level harmful to hearing, or if their audiogram showed deafness of unknown origin, they were excluded. One ear of a subject was excluded if it showed evidence of otitis media, low frequency impairment or apparent diseases of the tympanic membrane. Persons who reported illness history of diabetic mellitus or hypertension were also excluded. The subjects finally accepted comprised of 3116 otologically normal ears (1298 ears in males, 1818 ears in females). Table 2 presents the age and sex distribution of the subjects and normal ears.

Table 1. Standard of hearing level, in decibels, in each age group for normal ears selection

Age group (years)	Frequencies (kHz)			
	1	2	4	8
7-34	≤ 35	≤ 35	≤ 35	≤ 35
35-44	≤ 35	≤ 35	≤ 35	≤ 40
45-49	≤ 35	≤ 35	≤ 40	≤ 45
50-54	≤ 35	≤ 40	≤ 45	N-R
55-59	≤ 40	≤ 45	N-R	N-R
60-89	N-R	N-R	N-R	N-R

N-R: no relation

Statistical analysis

The data were analyzed using the statistical package for the social sciences (SPSS) program. The significance of differences between the variables was assessed by the T-test. Pearson's correlation was used to assess the correlation between hearing level and age of the subjects using a p-value of less than 0.05 as significant.

Results

The variation with age of the hearing levels of each frequency is shown in Fig. 1. Levels began to clearly increase after the mid-forties. In particular, the hearing threshold levels at 4 kHz and 8 kHz increased progressively. Fig. 2 shows hearing level in each age group in males and females. The hearing level at 1, 2, and 8 kHz in all age groups showed no difference between males and females. However, over age 50 years, the hearing threshold level of males at 4 kHz was significantly greater than that of females ($p < 0.05$). The

Table 2. Age and sex distribution of subjects

Age (years)	Males		Females	
	Subjects (n)	Ears (n)	Subjects (n)	Ears (n)
7-9	74	112	80	125
10-19	294	500	315	610
20-29	96	168	153	264
30-39	75	104	139	217
40-49	94	116	156	207
50-59	70	96	118	177
60-69	56	112	60	120
70-89	45	90	49	98
Total	805	1298	1110	1818

correlation between hearing level at each frequency and age is shown in Table 3. The hearing level at each frequency had a close relationship to age.

The 25th, 50th and 75th percentiles were calculated for each group at intervals of 5 years. The variability of percentiles was computed as the inter-quartile range (R_Q) and the coefficient of quartile variation (V_Q)[8]. Inter-quartile range contains one half of the total frequency and provides a simple measure of dispersion that is useful in descriptive statistics. The authors compute:

$$R_{Q=} Q1\text{-}Q3$$

$$V_{Q=} 100\,(Q1\text{-}Q3)\,/\,(Q1+Q3)$$

where Q1 indicates the upper quartile (the value which is the top quarter of the samples), namely the 25th percentile, and Q3 indicates the lower quartile (that below which a quarter of the ordered samples fall), namely the 75th percentile. The variability became slightly wider with increasing age at all frequencies in both sexes. The inter-quartile range showed no difference between males and females at 1 and 2 kHz. At 4 and 8 kHz, the inter-quartile range of males was wider than that of females from the age of 40 and 55, respectively.

The normal aging curves of hearing level in each frequency were then drawn by calculating the 25th, 50th and 75th percentiles for groups at intervals of 10 years as shown in Fig. 3. Smoothing the percentiles was done by eye but very little was necessary at the 50th percentiles. The hearing level in both males and females at 8 kHz gradually increased with age. With

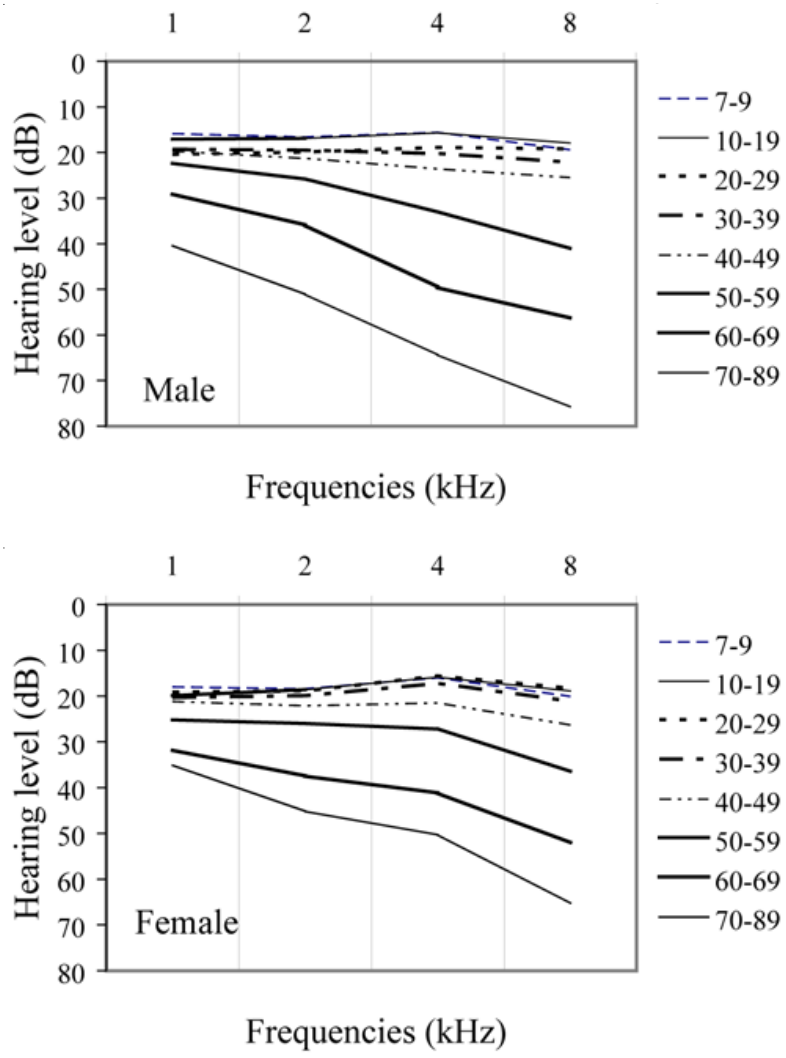

Fig. 1 Hearing level at 1, 2, 4 and 8 kHz in each age group for male and female

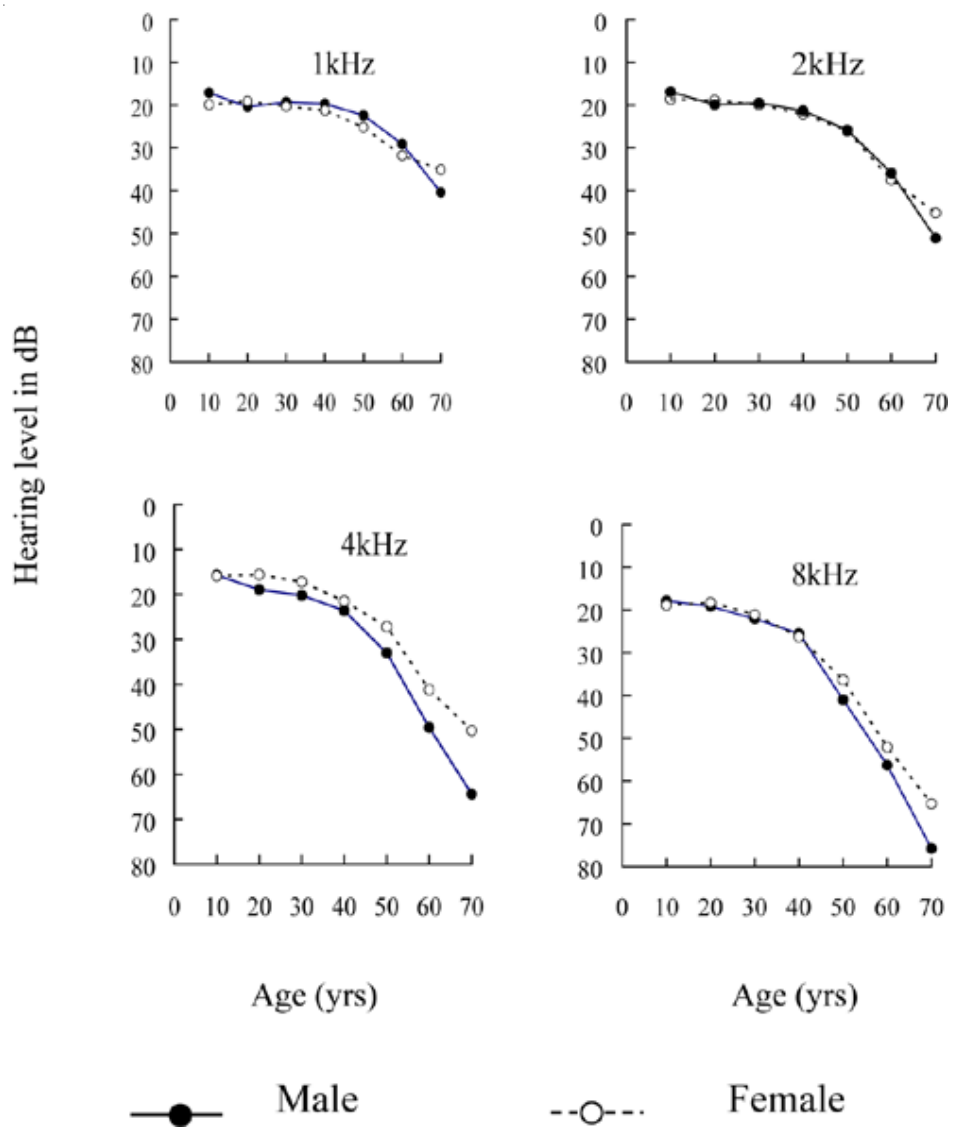

Fig. 2 Effect of age on hearing level in decibels at 1, 2, 4 and 8 kHz

Table 3. Mean, standard deviation and correlation between hearing level and age in male and female

Frequencies	Male			Female		
	Correlation	Mean	SD	Correlation	Mean	SD
1 kHz	0.422**	31.24	16.04	0.308**	33.14	17.58
2 kHz	0.449**	25.03	16.86	0.418**	26.71	19.34
4 kHz	0.680**	28.02	21.10	0.496**	25.20	20.33
8 kHz	0.567**	31.64	23.76	0.525**	30.23	22.52

** $p < 0.001$

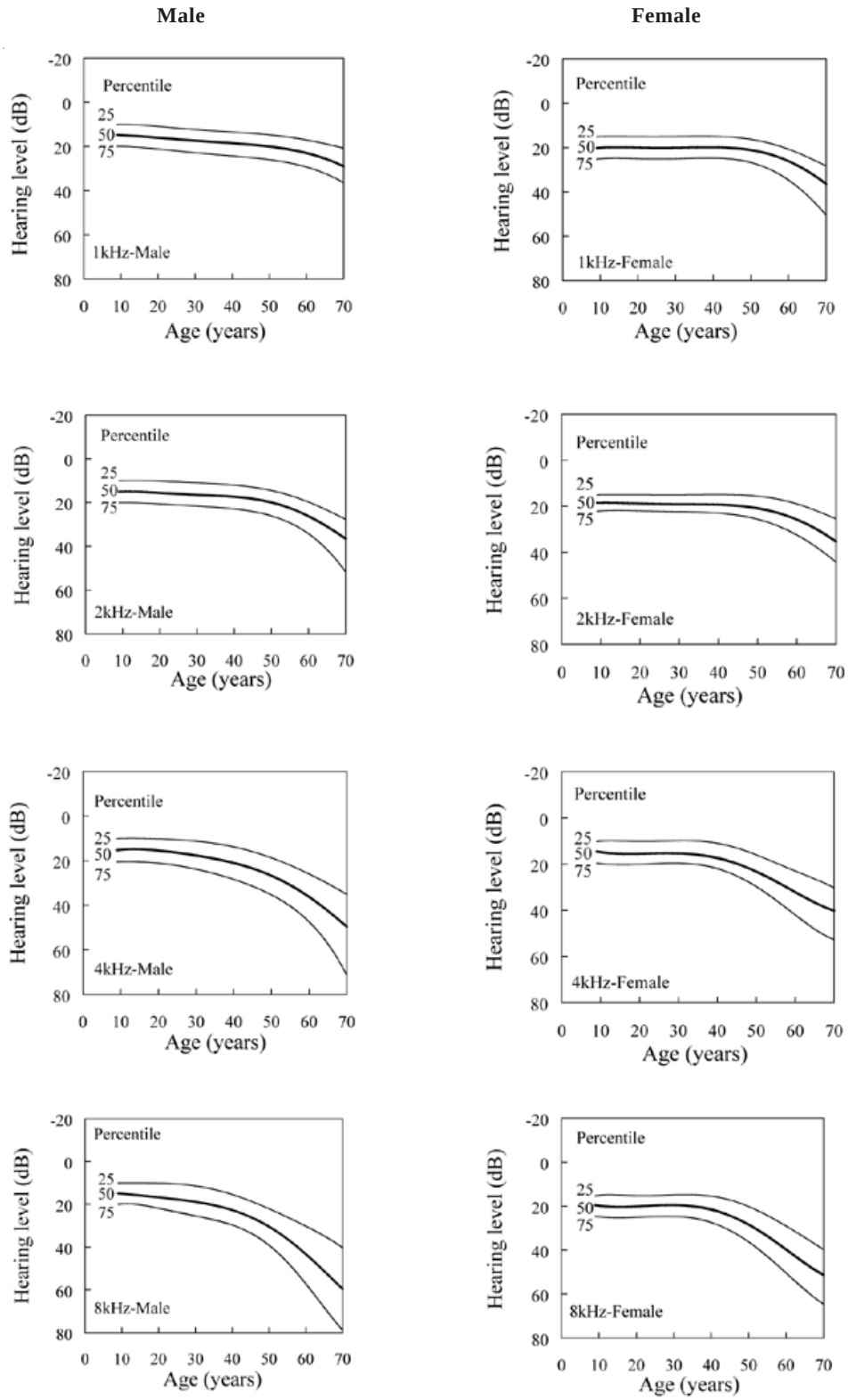

Fig. 3 Normal aging curves of hearing level at 1, 2, 4 and 8 kHz for male and female

subjects over age 50, this tendency was accelerated. At 4 kHz, the hearing level also gradually deteriorated with age with increase at a faster rate in males than in females from the age of 40. At 1 and 2 kHz, the hearing levels of males and females showed the same tendency. There was little increase at younger ages, but the increase accelerated from the age of 50. The distribution of the hearing level became wider with increasing age at all frequencies.

Discussion

Among physiological functions, acoustic acuity decreases progressively with age[9]. In the present study, findings were clearly obtained that the hearing level changes with age, particularly at high-frequency (8 kHz and 4 kHz). The hearing level increase was more marked in elderly subjects than in younger ones in both sexes. The present study revealed similar results to many previous studies[7,9,10]. These may be attributed to decline in nerve function as the individual ages. Scholtz et al[11] reported the correlation between declining in patient audiometric and diminished nerve fiber density in the cochlear duct. This correlation could only be found in high- but not in low-tone regions. However, etiology of cochlea defect remains unknown[10].

Miyashita et al[7] reported the age variation in hearing level with 3827 normal ears in Chinese farmers. Their results showed significant correlations between the hearing level and age that were similar to a present study and Bunnag et al[10]. Thus, age variation in hearing level should be highly considered in assessing hearing ability for workers.

As to sex differences, Takeda et al[9] have reported that the hearing of females was, on average, better than that of males, and the differences between sexes were most marked at the higher frequencies. The present study also shows sex differences in hearing at 4 kHz. These results may be explained by, perhaps males received more noise exposure than females and were beginning to experience high frequency losses, or perhaps that females were biologically superior to males in high frequency hearing.

The authors have constructed standard aging curves for hearing level at frequency of 1, 2, 4 and 8 kHz. The normal aging curve for subjects with no evidence of hearing problems may be useful to audiologists to monitor hearing levels in their patients.

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ระดับการได้ยินตามการเปลี่ยนแปลงของอายุของคนไทย

อรวรรณ แก้วบุญชู, สำลี สาลีกุล, สุชาติ ใจภักดี

การศึกษาครั้งนี้ มีวัตถุประสงค์เพื่อพัฒนาโค้งมาตรฐานระดับการได้ยินตามการเปลี่ยนแปลงของอายุของคนไทย กลุ่มตัวอย่างเป็นผู้ที่มีสุขภาพดีเพศชายจำนวน 805 คน เพศหญิงจำนวน 1110 คน มีอายุระหว่าง 7 ถึง 89 ปี กลุ่มตัวอย่างทุกคนได้รับการตรวจวัดระดับการได้ยินที่ความถี่ 1, 2, 4 และ 8 กิโลเฮิร์ต การวิเคราะห์ข้อมูลคัดเลือกเฉพาะหูข้างที่ไม่มีความบกพร่องของระดับการได้ยินจำนวน 1,298 หู ในเพศชาย และจำนวน 1,818 หู ในเพศหญิง โค้งมาตรฐานระดับการได้ยินตามการเปลี่ยนแปลงของอายุ พัฒนาโดยการนำค่าระดับการได้ยินที่ตรวจวัดได้ในแต่ละความถี่ไปคำนวณหาค่าเปอร์เซ็นไทล์ในตำแหน่งที่ 25, 50 และ 75 ของแต่ละช่วงอายุ ผลการศึกษาพบว่า ระดับการได้ยินของคนไทยเพิ่มขึ้นตามอายุ และเพิ่มขึ้นอย่างรวดเร็วเมื่ออายุ 50 ปีขึ้นไป โดยเฉพาะอย่างยิ่งที่ความถี่ 4 และ 8 กิโลเฮิร์ต และพบว่าอายุกับระดับการได้ยินมีความสัมพันธ์กันอย่างมีนัยสำคัญทางสถิติในทุกความถี่ เพศหญิงมีระดับการได้ยินดีกว่าเพศชายที่ความถี่ 4 กิโลเฮิร์ต จะเห็นได้ว่าโค้งมาตรฐานระดับการได้ยินตามการเปลี่ยนแปลงของอายุที่พัฒนาขึ้นในครั้งนี้มีประโยชน์อย่างยิ่งสำหรับใช้ในการเฝ้าระวังความผิดปกติของระดับการได้ยินของคนไทย