Original Article

Nasalance Scores in Normal Thai Adults

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Background: There is limited information exists on normative nasalance scores in normal Thai adults.

Objective: To investigate the normative nasalance scores and how age and gender influence nasalance scores in normal Thai adults.

Materials and Methods: After passing screening tests of communication disorders, 290 normal Thai adults were included as samples. Nasalance scores were obtained using nasometry when subjects read 3 Thai passages comprising Passage 1 which was the oral passage without nasal consonants, Passage 2 that was composed of a series of sentences containing 35% nasal consonants, and Passage 3 which was loaded the oro-nasal passage that included both oral and nasal consonants.

Results: Mean nasalance scores for Passage 1, Passage 2, and Passage 3 were 16.69±5.21%, 51.64±4.98%, and 42.46±5.41%, respectively. Results did not show an explicit relationship between nasalance scores and age for all passages but revealed that females had significantly higher nasalance scores than males for all three reading passages at $p<0.05$.

Conclusion: Present study determined that gender affected nasalance scores for Thai adults whereas age did not. Additional factors should be concerned and might be addressed through further research including dialect, hearing level, etc.

Keywords: Nasalance scores, Adults, Age, Gender

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A nasometer is a non-invasive measuring instrument which is widely used and accepted for speech resonance evaluation[1-7]. The nasometer measures a value called the nasalance score, which is a ratio of nasal acoustic energy to the total of nasal and oral acoustic energies multiplied by 100[1,2,6,8].

Nasalance scores are used as supporting values for speech resonation assessment and also as the reference values that show differences or progression of speech resonation training[2].

Nasalance scores used to consider resonance disorders should be standard scores obtained from normative population data. Previous studies of normal nasalance scores have been conducted in several languages and various countries with results indicating different scores for each language[7,9-11].

Recently, some studies presented normative data of nasalance scores for three Thai standard passages (oral passage, oro-nasal passage, and nasal passage) for normal Thai children aged 6 to 15 years[6,8]. However, normative data of nasalance scores for normal Thai adults has not yet been presented. Manochiopinig et al[12] and Pracharitpukdee et al[13] examined nasalance scores for normal Thai adults when reading three Thai standard passages; however, only a small number of subjects participated in these two studies (Manochiopinig et al[12]; n = 69, Pracharitpukdee et al[13]; n = 32). They noted that those presented scores might not be conclusive as the standard scores. Moreover, Prathanee[6] and Buakanok[8] concluded that gender did not significantly affect nasalance scores for Thai children, while

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Manochiopinig et al[12] who studied nasalance scores in both normal Thai children and adults found that gender and age tended to affect nasalance scores.

Apart from language, several studies focused on multiple factors that might affect adult nasalance scores such as loudness[14], speaking rate[15], dialect[16], age[11,12,17], hearing[18-20], histochemical/hormonal change[21] and gender[4,10-12,16], etc. Some results demonstrated the clear impact of factors affecting nasalance scores. For example, hearing factor: nasalance scores decreased with increased of hearing levels[18-20] and hormonal factor: nasalance scores in pregnant women were lower than in women who are not pregnant[21], while loudness and speaking rate did not affect nasalance scores[14,15]. However, results in many studies on factors that may affect the nasalance scores were controversial or unclear such as the study of dialect[3,16], age[11,12,17] or gender[4,10-12,16], etc. Some studies indicated that these factors affected nasalance scores, while others did not. These difference might arise from disparate research characteristics or other diverse factors.

As mentioned above, normative data for nasalance scores of Thai adults remains limited and still have controversial results regarding the effects of age and gender. Present study of normative nasalance scores among normal Thai adults was conducted to resolve these contentious issues.

Thus, the objective was to find the normative nasalance scores, together with to determine the relationship between age and nasalance scores, and to compare nasalance scores in different gender in normal Thai adults.

Materials and Methods

Study protocol was based on the Helsinki Declaration and reviewed and approved by the Ethics Committee of the Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand (No. ID 07-57-24)

Subjects

Normative data of nasalance scores for Thai adults and effects of age and gender on nasalance scores were examined using nasometric measurements in normal Thai adults aged over 18 years.

Computation of the number of samples used sample-size estimation when testing for the mean of a normal distribution (one-sided alternative)[22]. Mean and standard deviation of the mean average nasalance scores for the oro-nasal passage in accordance with the result from the study of Pracharitpukdee et al[13] were substituted into formula for this calculation. Level of precision, significance and power were set at 3%, 5% and 80%, respectively.

Subjects included in the study were 290 normal Thai adults as 145 males and 145 females, aged over 18 years who visited Ramathibodi Hospital and were willing to participate in the present study. All participants were native central Thai speakers who were able to read Thai, had normal conversational hearing levels, and no abnormality of vision that might affected their reading abilities. All subjects passed all perceptual screening tests of speech sounds (articulation, voice, and resonance assessments).Volunteers with oto-rhino-laryngological disorders or any abnormality or other medical problems that might affect speech resonation such as a cold, sinusitis, hoarseness or any airway disease at the time of testing were excluded.

Procedures

After the volunteers signed consent forms and informed their demographic and medical history data; they were asked to count from 1 to 30, read the Noo Jaew Passage part I developed in 1986 by Sindermsuk[23] and hold a conversation with the researcher for 1 to 2 minutes to assess basic communication disorders (articulation, voice, and resonation). If the participants had any of these communication disorder issues, they were instructed to improve their speech and were excluded from the study. Observations of the hearing and visual difficulties of the participants were evaluated during the conversation by a researcher. If they presented behavior indicating hearing and/or visual difficulties at the conversational level, they were advised to consult the ENT-doctors and/or the ophthalmologist before exclusion from the study. After completing basic screening of communication disorders, nasalance score measurements were conducted using a Nasometer II Model 6450. All testing procedures were conducted in a quiet environment with appropriate lighting for passage reading. Prior to actual testing, all participants were given an opportunity to practice reading all of three stimulus passages aloud. If the participants could not read or misread some words, the researcher instructed them how to read correctly. During testing, the participants were asked to read three stimulus passages aloud at a comfortable loudness level and at their habitual speaking rate, and then repeat the reading 3 times for each passage. Stimulus reading order was decided randomly for each subjest. When the

participants were ready to begin, the audio recording session was started. If the participant made an error during reading, he/she was asked to repeat that passage from the beginning. If the participant was tired, he/she was allowed to rest for 5 minutes or until ready to resume testing. Each participant completed testing during the course of one day.

Statistical analysis

Nasalance scores were measured using the nasometer's on-board analysis program connected to a computer terminal. Nasalance scores for each passage were expressed as mean, and standard deviation [SD] at 95% confidence interval. Data were collected and analyzed using predictive analysis software [PASW] statistics 18. Descriptive statistics were used to determine the mean and standard deviation of demographic and medical history data including the nasalance scores for each passage reading. Differences between the nasalance scores of males and females were computed by t-test and linear regression was utilized to analyze the relationship between age and nasalance scores. In addition, a post-hoc Scheffe test was used to analyze pairwise differences of nasalance scores among age groups for support the results of relationship between age and nasalance scores from linear regression analysis.

Results

Study subjects were volunteers who visited Ramathibodi Hospital including students and staff studying or working at the hospital, patients' relatives or caregivers who visited the hospital and other volunteers who agreed to participate in the present study. A total of the 976 people were invited to participate within six months of the data collection period, 681 people (69.77%) declined the invitation. There were just 295 people (30.23%) who voluntarily submitted to participate in the study. Five of the volunteers were excluded from the study because they failed the communication disorder screening test. Two had voice disorders, one had mild hyponasality because of a cold and two had articulation disorders. All five were advised to visit the ENT-doctors for medical evaluation and treatment. They were also given instruction regarding vocal hygiene and basic voice education and a speech therapy course was suggested appropriately. This summary process is represented as a chart in Figure 1.

Nasalance scores and all data analyses were obtained from 290 subjects who were normal Thai adults aged 18 to 74 (mean age 37.49 years). There were 145 males aged 18 to 74 (mean age 35.93 years) and 145 females aged 18 to 73 (mean age 39.59 years).

Results of mean nasalance scores and standard deviations for the three reading passages are shown in Table 1.

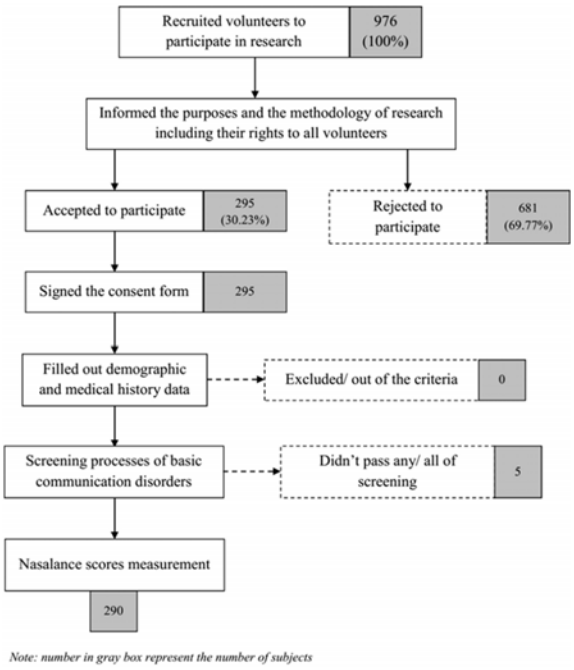

Figure 1. Summary chart representing subjects included in the study.

Table 1. Means and standard deviations of nasalance scores for the three passages

	Nasalance score (%)	
	Mean	SD
Oral passage		
Total (n = 290)	16.69	5.21
Male (n = 145)	16.05	5.12
Female (n = 145)	17.33	5.25
Nasal passage		
Total (n = 290)	51.64	4.98
Male (n = 145)	51.06	5.10
Female (n = 145)	52.23	4.81
Oro-nasal passage		
Total (n = 145)	42.46	5.41
Male (n = 145)	41.32	5.55
Female (n = 145)	43.60	5.03

Linear regressions were calculated to analyze the relationship between age and nasalance scores for the three passages. Results showed no explicit relationship between age and nasalance scores for all three passages. A scattergram of nasalance scores and age for the oral passage is shown in Figure 2A; for the nasal passage is shown in Figure 2B; and for the oro-nasal passage is shown in Figure 2C.

These results were confirmed by further statistical analysis. Five age groups were identified as Group 1 (18 to 30 years), Group 2 (31 to 40 years), Group 3 (41 to 50 years), Group 4 (51 to 60 years) and Group 5 (61 to 74 years). A post-hoc Scheffe test significant at the 0.05 level was used to analyze pairwise difference among the age groups. Results revealed no significant differences between mean nasalance scores for all three passages. However, for passage 1, mean nasalance scores tended to increase with age.

Differences of mean nasalance scores for the three passages between males and females were computed using t-test statistics. Comparative results of two independent sample t-tests are shown in Table 2. These revealed that females had significantly higher nasalance scores than males for all reading passages.

Discussion

In the present study, mean values of nasalance scores for all three passages were reported. Results revealed that mean nasalance score from reading the nasal passage stimuli was higher than the oro-nasal passage and the oral passage, respectively. These normative nasalance scores concurred with previous findings[3,4,9-13].

Resonance structures consist of various muscles and tissues[1,24]. With increasing age, human skeletal muscles slowly decrease in volume due to

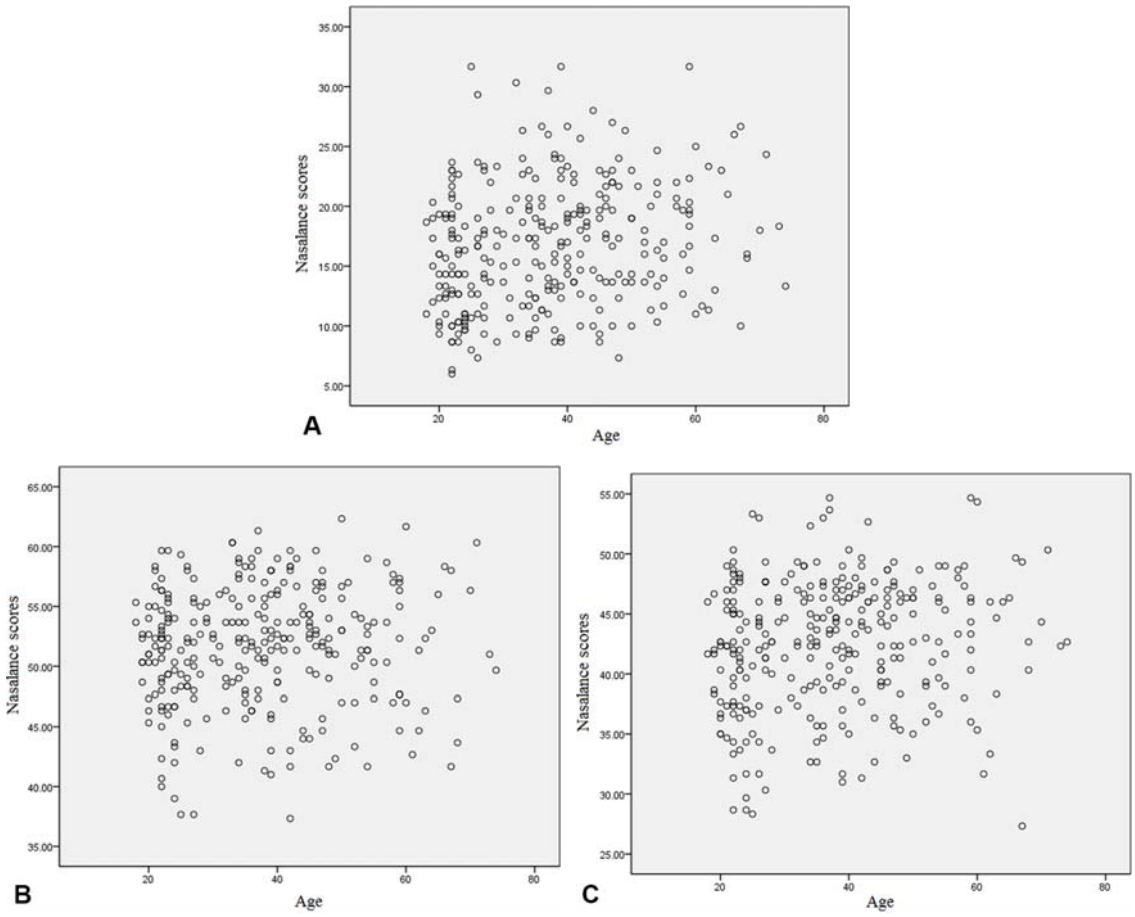

Figure 2. A) Scattergram of nasalance scores and age for the oral passage, B) Scattergram of nasalance scores and age for the nasal passage, C) Scattergram of nasalance scores and age for the oro-nasal passage.

Table 2. Comparative results of 2-independent sample t-test of nasalance scores between male and female subjects

Passage	Mean nasalance scores (%)		t	df	*p*-value	95% CI
	Male (n = 145)	Female (n = 145)				
1) Oral	16.05	17.33	2.11*	288	0.035	0.09 to 2.48
2) Nasal	51.06	52.23	2.01*	288	0.045	3.17 to 10.51
3) Oro-nasal	41.32	43.60	3.67*	288	<0.001	0.02 to 2.32

* Significant at $p<0.05$

reduction of motor units and muscle fibers[11, 17, 25]. As a result, progressive weakening and impairment of movement will occur[11,17,25]. Moreover, some tissues in nasal cavity may swell due to histochemical changes within its layers by increasing age[24], causing airway obstruction in some elderly people. For these reasons, resonance might increase or decrease from muscle or tissue change with increasing age. Nasalance score might increase because of hypernasality due to velopharyngeal dysfunction from muscle weakness and/or it might decrease because of hyponasality due to airway obstruction from nasal cavity change. The study results showed no explicit relationship between age and nasalance scores for all passages. Some previous studies indicated that age might affect nasalance scores in normal adults. Rochet et al[11] and Manochiopinig et al[12] presented data suggesting that adults had higher nasalance scores than youngsters but age limitations of subjects in these two studies differed from the present study. They also included childhood participants in their studies. For adults over 18 years of age, their results could not clearly conclude that age affected nasalance scores. Results in this study were also not strong enough to explain this point; however, age was possibly not related to nasalance scores since all subjects passed the speech screening test, implying that they were all normal speakers, had good health and no speech or resonation disorders. Plus, Porter et al[25] reported that muscle-strength training or proper exercise was beneficial, even in very old people, and could possibly reverse or delay the onset of weaknesses related to age[25]. Individuals who are strong, have good health and no disorders that might affect resonance may find that their age does not affect their resonance score or has only minimal effects. Present results revealed that females had significantly higher nasalance scores than males for all three reading passages at $p<0.05$. These findings concured with previous results of many researchers[3,10-12]. Seaver et al[3] reported that females had significantly higher nasalance scores than males for nasal sentences (p = 0.038), although there were no significant differences between the scores of males and females when reading the other two passages. Van Lierde et al[10] showed that mean nasalance scores of females were significantly higher than males when reading the oro-nasal text (p = 0.001) and the nasal text (p = 0.042). Rochet et al[11] revealed that nasalance scores of the female English speakers were significantly higher than male English speakers for the oro-nasal passage (p = 0.004). Moreover, nasalance scores of the female French speakers were significantly higher than those of male French speakers for the oro-nasal passage (p = 0.007) and the nasal passage (p = 0.008). Manochiopinig et al[12] revealed that females appeared to have higher nasalance scores than males when reading the oro-nasal passage, 'Sai Yok Waterfall' (p = 0.05) and the nasal sentences, 'Manee' (p = 0.01).

Since the results of the present study showed obvious differences in nasalance scores between genders; structural and functional differences in the resonation mechanism between sexes should be a new study focus. However, results in the present study were insufficient to support this fact because the study methods were limited. Moreover, no direct evaluation investigated structural and functional differences of resonation mechanism between males and females. However, Van Lierde et al[10] indicated the possibility that nasalance scores were different between sexes because of the structure and function that related to resonance differences by citing the literature of Kahane in 1997, Goozee et al in 1998, and McKerns and Bozch in the 1970s. In addition, characteristics of male anatomy and physiology in the resonation system were different

from females[10].

The present results indicated that gender affected nasalance scores. When using normative nasalance scores as the database in clinical evaluation and/or for following the progression of treatment in clinical nasalance assessments, assessors should be aware that males and females have different resonation characteristics. It would be advisable to use data for the normative nasalance scores of each gender.

Results of the present study provided information that might offer a standard reference. Thai speech-language pathologists should consider levels of speech resonance disorders or progression of treatment in special clinical settings. These nasalance scores could also be used as a database or guideline for researchers interested in this area.

Conclusion

Results were presented showing normative data. Mean total nasalance scores for oral, nasal, and oro-nasal passages were 16.69±5.21%, 51.64±4.98% and 42.46±5.41%, respectively. The present study did not find an explicit relationship between age and nasalance scores for all three passages. However, results indicated that gender affected nasalance scores and this factor should be addressed in speech resonance evaluation of adults.

Limitations of the study

The present study focused only on the effects of age and gender related to nasalance scores in normal Thai adults. Perhaps, there are additional factors that should be concerned and which might be addressed through further study such as dialect, hearing level, drug using, hormones, etc. An increased number of participants would also be beneficial.

What is already known on this topic?

Normative nasalance scores in Thai children.

Previous studies presented nasalance scores in normal Thai adults when reading three Thai standard passages, however, just a small number participated in these studies. Normative data of nasalance scores for Thai adults have not yet been presented.

What this study adds?

Normative nasalance scores in Thai adults.

Gender factor affects nasalance scores of normal Thai adults. Thai females had higher nasalance scores than males.

Age does not affect normal Thai adults' nasalance scores.

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Potential conflicts of interest

The authors no declare conflicts of interest.

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