Nasalance Scores for Normal Persian-Speaking Girls

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Abstract

Background: Obtaining normative nasalance scores is essential in the process of assessing and treating resonance disorders. The purpose of this study was to obtain nasalance scores in Persian-speaking girls aged 4-6 years and investigate the age-related differences.

Materials and Methods: All participants (n=40) were screened to identify any overt problems relating to resonance, hearing, voice quality, or speech and language skills. The mean nasalance scores were obtained from normal-speaking girls during the repetition of the Persian version of the Simplified Nasometric Assessment Procedures (SNAP) test subtests. The Nasometer II (model 6450) was used to obtain the nasalance scores.

Results: The mean nasalance score for the SNAP test subtests was obtained. Group mean and standard deviation (SD) nasalance scores of girls for oral and nasal sentences were 12.59 ± 3.74 and 50.52 ± 6.39 , respectively. There was no significant difference between age groups (4, 5 and 6 years old) ($P < 0.05$).

Conclusion: Our results provided normative nasalance scores based on the SNAP test that can be used for the evaluation and treatment of resonance problems in Persian-speaking girls.

Keywords: SNAP test, Nasometer, Nasometry, Persian-speaking

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Introduction

One of the most important features of human speech is resonance (1). In the past, in order to assess the type of resonance, speech-language pathologists solely relied on perceptual assessment. However, aerodynamic and acoustical techniques were gradually developed to assess velopharyngeal function indirectly. The Nasometer (Kay Elemetrics, Lincoln Park, NJ) is one of these instruments introduced in 1986. The nasometry is a noninvasive method for assessing resonance and audible nasal emission in both the research and clinical setting (2).

When nasometry was first introduced, several research articles demonstrated its advantages in the assessment of velopharyngeal insufficiency and reported the correlation between perceptual assessment and the nasalance scores (3-9). Hirschberg et al listed a set of advantages for the Nasometer: it is an objective procedure that provides quantitative results; it is noninvasive and safe; the results are precise and real time; the Nasometer can be used for children; and the data can be easily saved or documented. In their study, they also found a high correlation between nasometry and perceptual assessments (1).

In a study by Sweeney and Sell, 50 children with cleft palate, with and without velopharyngeal insufficiency, there was a high correlation between the results of

nasometry and perceptual assessments. This study showed that both nasometry and perceptual assessment are valid for assessing nasality (10). In different studies conducted between 2004 and 2018, the correlation was different and ranged from 0.3 to 0.7 (10-15). This variability in results can be due to differences in methodologies in different research studies (i.e. using different speech samples and different numbers of raters) (3). In spite of the differences in the results of these studies, there is a general agreement that there is a general agreement that nasometry is a valuable method in addition with the perceptual assessment in clinical diagnosis of resonance and velopharyngeal function (1).

Many studies have been conducted to measure normative nasalance scores in different languages. Van Doorn and Purcell (16) obtained nasalance score for 122 boys and 123 girls for Australian English. In another research, Haapanen (17) obtained nasalance score for 3-54 years old Finnish participants. In Swedish language, Brunngrd and van Doorn (18) studied 92 boys and 128 girls. The participants were 4-11 years old and the results for oral and nasal speech materials were 12.7-15.7 and 56.5, respectively. In Korea, Park et al (19) studied 108 participants with an age range of 7-11 years and reported the nasalance score for oral and nasal speech materials as

11.69 and 63.72, respectively.

Regarding Persian language, Musapour et al obtained normative nasalance scores for low-pressure syllables and rainbow text among individuals aged 7-20 years in Isfahan, Iran (20). In another research, Sadeghi et al. obtained the normative nasalance scores for 4-6 year-old Persian-speaking boys by using the Persian version of the Simplified Nasometric Assessment Procedures (SNAP) test (21). Nasalance score has also been obtained by Ghaemi et al in 7-11-year-old boys in Mashhad in continuous speech, though they did not obtain the score for girls (22).

Various studies showed that the language and regional dialect (23-28), gender (23, 25, 27-31), age (1, 17, 18, 21, 22, 25-27, 32), and the model of Nasometer (33-34) can affect the nasalance scores; however, some other studies did not report any significant difference related to the age (21, 32-35), sex (1, 3, 16, 18, 26, 35-38), or dialect (18, 31, 37). In general, different authors believe that regional dialect and language can affect nasalance scores; thus, it is essential to develop normative data for each language and dialect.

As different languages and Persian dialects are spoken in different cities of Iran, and since there is no research on 4-6 year old girls in Iran, we attempted to obtain the normative nasalance scores in this age group with Nasometer through using the Persian version of SNAP test (39). The SNAP test was designed in 1994 by MacKay and Kummer and then revised by Kummer in 2005 (40). This test is applicable in assessing children and adults and includes sentences that are semantically, lexically, and pragmatically simple. It also includes repetition of single phonemes that increase diagnostic ability of the examiner (41).

Accordingly, this study aimed to obtain the nasalance scores for normal-speaking Persian girls aged 4-6 years old. The reason for choosing this age group is that it is the appropriate age for secondary surgery in cleft palate (41). In addition, we compared the nasalance scores of different age groups (4, 5 and 6 years old).

Materials and Methods

Subjects

In this study, 50 girls with an age range of 4-6 years were chosen from different kindergartens of Isfahan, Iran in 2017 (December 2017- January 2019). Cluster sampling method was used for choosing kindergartens and simple sampling method was used to choose the children. The selection of schools and kindergartens was as follows: nine schools and kindergartens were selected from girls' schools and kindergartens in each district. Students of these schools participated in the study by simple sampling method. Informed consent forms were completed by the parents of all subjects.

All children underwent an examination before inclusion in the study by the speech and language pathologist

(SLP). Only children with normal articulation, resonance, and voice characteristics were included. Children were excluded from the study if they had a history of orofacial abnormalities, nasal or oral trauma, hearing problems, or nasal obstruction.

Children who had a cold on the day of assessment and those who were not able to repeat the wanted statements were excluded from the study. A total of 10 children were excluded due to the cognitive problems ($n=2$), voice disorders ($n=5$), and not being able to repeat the requested phrases ($n=3$). Finally, 40 girls (13 [4 years old]; 15 [5 years old]; 12 [6 years old]) were included in the study and we assessed these three different age groups.

Speech Material

The Persian version of the SNAP test was used to obtain speech samples, whose reliability (8.6) and validity (0.96) were confirmed in 2014 by Ashtab et al (39); the tool included syllable repetition/prolonged sound subtest and picture-cued subtest (see Supplementary file 1). In the syllable repetition/prolonged sound subtest, the participants were requested to repeat 14 consonant-vowel (CV) syllables of pressure-sensitive consonants combined with either a low vowel (/a/) or a high vowel (/i/). Furthermore, they were requested to utter two prolonged vowels (/a/, /i/) and two prolonged consonants (/s/, /m/) in the subtest. In the picture-cued subtest, which contains passages that are essentially phonetically homogeneous, participants were requested to repeat each sentence twice. In this subtest, there were sentences that contained each of the following: bilabial plosives, lingual-alveolar plosives, velar plosives, sibilant fricatives, and nasals.

Instrumentation and Data Collection

The Kay Pentax Nasometer II model 6450 (PENTAX) was used to obtain nasalance scores. The Nasometer measures the acoustic correlation of nasality. A headset containing a sound separator with microphones on either side, which detects oral and nasal components of the patient's speech, is one of the most important parts of a nasometer. The nasometer processor filters and digitizes the sound. The resultant signal is the ratio of nasal to total (nasal plus oral) acoustic energy and is expressed as a nasalance score in percentage. Nasometer software was installed on a laptop and calibration was done in the data collection room at the beginning of the day. Data were collected in a silent room by one examiner. The instruction of the test was explained orally for the participants after which the nasometer headgear was put on their heads as advised by the manual. The mentioned speech samples were uttered by the examiner with slow and steady speed, and the participants were asked to repeat the speech sample after the examiner with normal speech. If there was a technical problem, such as low quality recording due to low voice, that sentence was repeated. The speech sample of each participant was recorded by the Nasometer software.

Statistical Analysis

Data were analyzed by SPSS statistical software program version 16 (SPSS Inc., Chicago, IL, USA). Results were presented as mean (SD) for quantitative variables. Analysis of variance (ANOVA) was used for comparing the nasalance score among age groups. $P < 0.05$ was considered as a statistically significant level.

Results

The mean nasalance score and standard deviation was calculated up to the sentence level according to the SNAP test. Nasalance scores in nasal consonant, syllables, and sentences were higher than other stimulus. Also, the nasalance scores in /i/ and the syllables containing /i/ were higher than /a/ and the syllables containing /a/ vowel (see Table 1).

Also, the mean of nasalance score in different ages was compared with ANOVA test. Considering $P < 0.05$, there was not a significant difference in the nasalance scores between different age groups (see Table 2).

Discussion

The purpose of this study was to determine the normative nasalance scores in Persian-speaking girls aged 4-6 years old. Furthermore, the mean nasalance scores of girls in

Table 1. Mean Nasalance Scores (%) and Standard Deviation for Persian-Speaking Girls Aged 4-6 Years

Speech Material	Mean	SD
/a/	7.35	1.74
/i/	18.72	5.40
/m/	94.55	2.22
/s/	0	0
/papapa/	8.62	1.83
/tatata/	10.62	2.60
/kakaka/	11.00	2.37
/sasasa/	10.62	2.59
/jaʃaʃa/	10.60	2.34
/pipipi/	17.52	5.18
/tititi/	20.82	5.39
/kikiki/	20.70	5.32
/sisisi/	19.57	5.68
/ʃiʃiʃi/	19.12	5.60
/mamama/	67.95	6.65
/nanana/	66.22	7.08
/mimimi/	83.80	4.69
/ninini/	81.37	4.77
Bilabials	13.37	3.73
Alveolars	10.65	3.45
Velars	12.65	3.98
Sibilants	13.70	3.81
Nasals	50.52	6.39

Table 2. Comparing the Significance of Mean Nasalance Scores (%) in Different Age Groups (4, 5 and 6 years old) in Persian-Speaking Girls

Speech Material	P value
/a/	0.170
/i/	0.991
/m/	0.079
/s/	0.000
/papapa/	0.106
/tatata/	0.707
/kakaka/	0.872
/sasasa/	0.579
/jaʃaʃa/	0.371
/pipipi/	0.738
/tititi/	0.498
/kikiki/	0.929
/sisisi/	0.561
/ʃiʃiʃi/	0.878
/mamama/	0.967
/nanana/	0.830
/mimimi/	0.399
/ninini/	0.225
Bilabials	0.901
Alveolars	0.491
Velars	0.992
Sibilants	0.998
Nasals	0.897

different age groups were compared and the SNAP test was used for obtaining the normative nasalance data. According to our results, the nasalance scores for oral and nasal sentences were 12.59 (3.74%) and 50.52 (6.39%), respectively.

Nasalance scores in /i/ vowel and in syllables containing /i/ were higher than /a/ and syllables containing /a/ vowel. It should be noted that /i/ is a high central unrounded vowel and its vowel height is close (known as high), which means that the tongue is positioned as close as possible to the roof of the mouth without creating a constriction that would be classified as a consonant. Hypernasality is more noted on high vowels than low vowels. This is due to the high tongue position, which reduces oral resonance space and causes partial impedance of sound coming through the oral cavity. This increases the sound pressure, which can consequently result in increasing the transmission of sound through the velum (41).

Although it is generally believed that different languages will result in different nasometry scores, it should be noted that passages in the same language will result in different scores, depending on the vowel content of the passage. Therefore, the nasalance score is totally based on the vowel content of the individual passage. If there are mostly high vowels in the passage, the score will be

higher than a passage with mostly low vowels. Therefore, understanding the true impact of language and dialect on nasalance scores requires matching of vowel content in the passage. Vowel nasalization forms the similarities and differences between nasalance scores of different languages and dialects (19). The use of nasal consonants in a passage is another factor that can affect the obtained scores (22).

In another research conducted in 2017, we also obtained nasalance normative data according to the SNAP test for 4-6-year-old boys, which were 11.57 ± 3.16 and 48.51 ± 7.03 for oral and nasal sentences, respectively (21). A comparison between the recent study and our previous study shows that there is not any significant difference between the scores obtained by girls and boys. T-test was used for comparing the nasalance score in girls and boys because Kolmogorov-Smirnov test showed normal distribution of this variable. Our findings about sex differences are in agreement with the study by Bettens et al conducted on 74 Flemish children (37 boys and 37 girls) (42). Hamdan et al also did not find a significant difference in Lebanese English-speaking adults between males and females, though scores for the zoo passage were slightly higher among males than females (43). Hirschberg et al (1), Sweeney et al (3), Tachimura et al (38), and Litzaw and Dalston (35) also reported that speech nasality did not have any relation to the gender, and nasalance scores were not significantly different between males and females. Sarac et al in their research in Turkish language did not report a significant difference corresponding to sex, however in some syllables (tat- li- lil-aya), girls obtained higher nasalance scores than boys (44). On the other hand, Nichols (25), Seaver et al (23), Park et al (19), Van Lierde et al (27), Hutchinson et al (29), and Kim et al (45) reported that nasalance scores in female participants were significantly higher than male ones; this might be due to the incomplete obstruction of VP in females due to gender based on anatomical and physiological differences.

Comparison of nasalance scores between different age groups of 4, 5, and 6 year olds in girls also did not reveal any significant difference. Our results confirm the findings of Seaver et al (23), Van de Weijer and Slis (26), Van Doorn and Purcell (16), Ghaemi et al (22), and Musapour et al (20), who did not report significant differences in the age groups. In Sarac and colleagues' study, there was not a significant difference between the age groups; however, these syllables (iki, şe, eşe, işi, aç, eç, çi, içi, iç, al, yi, iy, iyi, yiy, ana, ne) had a positive relation with age (44). Our results regarding age differences in nasalance scores do not correspond with some of the published international data (1, 24, 28, 32). It should also be noted that they compared the children group with adult groups in their research, or the age range included in the studies were wider than the range in this study. In addition, the difference may be due to the changes

attained in maxillofacial structures (19, 44, 46).

also nasometry test and nasalance scores have improved objective information for determining the severity of resonance disorders and the efficiency of clinical interventions (1), we believe that the nasalance test provides helpful complementary information to direct methods of assessing the function of VP closure, such as nasopharyngoscopy and videofluoroscopy.

Conclusion

In this study, the mean nasalance scores of 4-6-year-old girls were obtained according to SNAP test in Isfahan, Iran. Comparing the scores in different ages did not show a significant difference; hence, the scores can be used in children with an age range of 4-6 years old. Even though the Nasometer is an appropriate assessment tool for nasality, it is noteworthy to consider that some of the children cannot complete the entire test procedure because they get tired of the prolonged test. Clinically, the normative data reported in the present study may help identify children with suspected velopharyngeal dysfunction. When participants have audible nasal emission, nasal obstruction, palatal fistula, or compensatory articulation errors, the data should be interpreted with caution. Additionally, caution should be practiced in using hard cut-off points for patient diagnosis due to variability of scores between individuals (16,47).

Conflict of Interest Disclosures

The authors declare that they have no conflict of interests.

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Ethical Statement

The Ethics Committee of Isfahan University of Medical Sciences, Iran approved the study (code: IR.MUI.MED.REC.1394.492).

Authors' Contributions

Study concept and design: SS, PR; Analysis and interpretation of data: SS, FD; Manuscript drafting: SS, FD, PR; Critical revision of the manuscript for important intellectual content: HA; Statistical analysis: SS.

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Informed Consent

Informed consent forms were completed by the parents of all subjects.

Supplementary files

Supplementary file 1. The MacKay-Kummer SNAP Test- R.

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