Vocal Function and Vocal Discomfort in Sheltered and Non-Sheltered 7- to 10-Year-Old School Children in Aracaju, Brazil

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Summary: Objective. To compare vocal function, school performance, and vocal discomfort between sheltered and nonsheltered school children in Aracaju, Brazil.

Methods. A controlled cross-sectional study was carried out on 7- to 10-year-old children who attended school regularly. Two groups of children were studied: the study group (SG), with children who lived in a shelter, and the control group (CG) containing children who lived with their families. We interviewed 44 children for the SG and 15 (34%) revealed vocal discomfort (SG = 15). Concomitantly, we interviewed 400 regular school children from the same geographical area and 45 (11.25%) were selected for the control group (CG). They were paired by sex and age with the sheltered children using a 3:1 ratio. Both groups were interviewed about school performance and vocal discomfort and were evaluated using perceptual and acoustic measurements for the voice and larynx.

Results. Children from both groups had started public school late. There were more individuals with vocal discomfort in the SG and individuals in this group also had a slower speech rate and inadequate pneumophonic coordination compared with the CG. The Dysphonia Severity Index (DSI) revealed mild-moderate deviation for both groups. Upper harmonics and palatal tonsil hypertrophy were higher in the CG, whereas laryngeal constriction was more common in the SG.

Conclusion. All the SG children revealed mild-moderate deviance on the DSI, a higher level of vocal discomfort, a slow speech rate, inadequate pneumophonic coordination, and laryngeal constriction. The results here presented suggest that social conditions are important for voice behavior in children.

Key Words: Shelter–Children–Student–Dysphonia–Voice–Vocal discomfort.

INTRODUCTION

The voice of a child is influenced by their general health and psychosocial and cultural interaction.[1,2] A poor quality of life and limited care from family, school, and society may result in dysphonia.[3] Family interaction is an important part of child development, especially during early childhood and adolescence, a key period of biological, social, and affective transformation.[4] Thus, the quality of family dynamics promotes vocal well-being and facilitates the process of social and educational inclusion.

Legally, a family's function is to protect and care for the children.[5] Brazil is currently undergoing major changes with regard to economic and societal improvements, and it has been difficult for several Brazilian families to adapt. As a result, families have been disrupted, causing children to suffer from emotional and physical stress. It is quite common for children to be abandoned by their own families and therefore be deprived of a regular family life.

For this reason, many children have to be protected by the state. The institutional shelter has emerged as a provisional protective solution and as a substitution for family custody. The shelter is a refuge for children who have had their rights violated or disrespected and for those who have families that may compromise their protection and development.[6] Children who have been subject to abandonment, neglect, physical violence, psychological, or sexual abuse are referred to the shelter.

Children generally prefer to stay with their parents at home than to live in a shelter, even if their family situation is less than ideal. According to law, these temporary shelters are designed to provide suitable living conditions for the child's education and to give time for the family group to recover. Nevertheless, the children that are the subject of this study have been in shelters for over 3 years, with no prospect in the short-term of returning to their families.

The voice is the main instrument for social interaction, especially in childhood, and during this period, the child establishes both family and social ties. Vocal abuse is common in children; therefore, it is difficult to distinguish between normal development and voice disorders.[2] In addition, adverse socioeconomic conditions and the breakdown of family ties may contribute to voice changes that may continue through to adulthood. Epidemiologic studies, such as the one presented in this article, contribute to prevention and intervention projects that can improve voice care.

A number of epidemiologic studies, using a variety of samples and study designs, reveal prevalence of child dysphonia to be between 0.47% and 37.14%. These studies describe

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individuals suffering from dysphonia as having hoarse, breathy, and tense voices.[2,7–12] However, it is difficult to compare these data due to the difference in methodologies and population characteristics. Furthermore, the children in these studies lived with their families and did not study children living in shelters.

This research was motivated by our previous study, which assessed the vocal behaviors of students who were involved in street labor and was assisted by the Program for the Elimination of Child Labor (PETI).[7] Unlike that study, the children investigated here did not work on the streets, but they did have a similarly reduced, sometimes nonexistent, level of family interaction. The aim of this study was to compare the vocal function, school performance, and vocal discomfort between sheltered and nonsheltered 7- to 10-year-old school children in Aracaju, Brazil.

METHODS

Study design

This comparative, cross-sectional, controlled study was performed in 2005. All shelters that housed children were studied. The protocol (11/2004) was approved by the Ethics Committee of The Federal University of Sergipe. Before a child was included in the study, written consent was obtained from either the manager of the shelter (study group [SG]) or a parent of the child (control group [CG]).

Settings and subjects

The shelters were registered at the Municipal Council for the Rights of the Child and Adolescent—CMDCA-SEMASC in Aracaju, the capital city of Sergipe state, in the Northeast of Brazil. Aracaju has a population of 571 149,[13] and it has the best social indicator profile of all the capital cities in the Northeast of Brazil. Both groups of children received their schooling from the official public education system.

In all shelters and regular schools, children participated in a play-based workshop for socialization. All eligible 7- to 10-year-old students from both genders were evaluated. When selecting subjects, priority was given to individuals who were in the early phase of school and prepuberty to avoid interference from any physiological changes.[14] To ascertain the delay between the age of the child and their school grade, we compared the child's chronological age and their school grade.

Children were individually interviewed on the same day. In addition, each child was given a vocal screening test, which was performed by a speech-language pathologist. Each child was asked to describe his/her negative feelings when using their voice in recent months. Common clinical complaints relating to voice were presented orally to the child and they were instructed to answer yes for each symptom that they had experienced. The symptoms selected for this study were hoarseness, cough, vocal abuse, vocal fatigue, neck ache, and phonatory pain. The responses obtained were used to establish whether the child had experienced vocal discomfort.

Individuals that comprised the CG were chosen from a group of regular school children and paired by sex and age with the sheltered children using a 3:1 ratio. Children were selected randomly and proportionately from the public schools of Aracaju. Therefore, 400 students were interviewed and all were from regular schools in the same region. Of these children, we selected 45 (11.25%) individuals with vocal discomfort. The CG was therefore comprised of 45 children and the SG of 15; both groups were subjected to the same procedures.

Voice and videolaryngostroboscopic evaluation

All evaluations were performed by two speech-language pathologists and two otorhinolaryngologists, who were experts in this type of assessment. During the tests, children from both groups were accompanied by a school representative or a member of staff from a shelter. The parents were not present during the evaluation of the child.

The perceptual-auditory analysis for each subject was performed with the aid of a GRBAS scale, in which the voice properties such as the grade of severity of dysphonia (G), roughness (R), breathiness (B), asthenia (A), and strain (S) are scored on a four-point scale: 0, normal; 1, mild deviance; 2, moderate deviance; and 3, severe deviance.[15,16]

During spontaneous conversation, we evaluated vocal behavior using perceptual-auditory analysis and visual inspection. We selected parameters that assessed the articulation of words (precise, adequate mobility of the lips and jaw; imprecise, reduction in mobility of the lips and jaw); vocal attack (abrupt, hypertonic emission of voice; breathy, air expiration with hypotonic characteristic or adequate); pitch (predominantly low or high); speech rate (predominantly normal, slow, or fast); and pneumophonic coordination (inadequate, requires increased breathing movements to conclude communication; adequate, requires fewer breathing movements to conclude communication). In addition, the maximum phonation time (MPT) task was measured with a chronometer when the subject issued the sounds /a/, /i/, /u/, /s/, and /z/.[17] Each subject was asked to make a certain sound in a single exhalation at a level that was comfortable for them. The subjects were asked to emit vowels in a sustained fashion (/a/, /i/, and /u/) and fricative sounds (/s/ and /z/).

Computational acoustic analysis was performed in room with a noise level below 40 dB using a *Multi-Speech Program*, model 3700 from KayPENTAX (Whippany, NJ). A Shure SM 48 (Shure Americas) dynamic microphone was used, and it was kept at a fixed distance of 15 cm in front of the child's mouth. We recorded the MPT for the vowel /ε/ and number counting (1–10). For each child, we considered a 3-second sustained /ε/ vowel emission. We analyzed the fundamental frequency (F_0, Hz), jitter (J%), shimmer (S%), and harmonics-to-noise ratio (dB). The upper harmonic (Hz) was measured manually. We also analyzed the quality of the harmonics with respect to instability and intensity (degree of browning) using the following scale: 1, optimal; 2, good; 3, regular; 4, bad; and 5, very bad. The noise amount between harmonics was determined using the scale 1, absent; 2, slight; 3, moderate; and 4, intense.[18–20]

Videolaryngostroboscopic (VLS) examination was performed with a 3.2-mm flexible nasofibrolaryngoscope (Machida), using a xenon light source of 350 W (Stroboview, Rotterdam,

TABLE 1.
Voice Assessment Using GRBAS Scale

Variables	SG (n = 15), %	CG (n = 45), %	Total (n = 60), %	χ^2	*P* Value	OR (95% CI)
(G) Grade of severity of dysphonia						
Normal	0.0	33.0	25.0	6.67	0.01*,†	
Mild-moderate	100	67.0	75.0			
(R) Roughness						
Absent	20.0	31.0	28.0	0.68	0.408ns	0.55 (0.14–2.28)
Mild-moderate	80.0	69.0	72.0			
(B) Breathiness						
Absent	20.0	44.4	38.3	2.84	0.09ns	0.31 (0.07–1.26)
Mild-moderate	80.0	55.6	61.7			
(S) Strain						
Absent	20.0	35.6	32.0	1.25	0.262ns	0.45 (0.11–1.84)
Mild-moderate	80.0	64.4	68.0			

Note: Some data were discarded if imprecise.
Abbreviations: CI, confidence interval; OR, odds ratio; ns, not significant.
* Significant at the 0.05 level.
† Fisher test.

The Netherlands), a micro-camera (Toshiba CCD IK-M30AK; Japan), and a DVD recorder (Samsung). The examinations were carried out under topical anesthesia using 2% lidocaine spray. We instructed the children to breathe deeply to ensure the comfortable production of sustained vowels /e/ and /i/ and inspiratory phonation.[21]

Not all the patients agreed to participate in the procedures and some were absent. Some patients did not respond to any questions because they did not attend school on the agreed day and other patients did not respond to certain sections of the tests. This did not affect the results and these patients were omitted from the sample. In addition, the quality of some recordings was poor so they had to be discarded.

Statistics

The chi-square and Fisher tests were used to verify possible differences between categorical variables, and the Student *t* test was used to verify possible differences between continuous variables. In addition, when possible, we compared with the odds ratio (OR) and 95% confidence intervals (CIs). It is not possible to use OR when there are blank categories. The CG was

TABLE 2.
Vocal Behavior Parameters

Variables	SG (n = 15), %	CG (n = 45), %	Total (n = 60), %	χ^2	*P* Value	OR (95% CI)
Articulation						
Precise	6.7	0.0	2.0	2.85	0.091†, ns	
Imprecise	93.3	100.0	98.0			
Vocal attack						
Abrupt	0.0	2.0	2.0	4.34	0.227†, ns	
Aspirate	6.7	0.0	2.0			
Adequate	93.3	98.0	96.0			
Pitch						
Predominantly low	93.0	73.2	78.2	2.37	0.124ns	0.21 (0.02–1.79)
Predominantly high	7.0	26.8	21.8			
Speech rate						
Fast	40.0	80.0	70.0			
Slow	33.0	5.0	12.0	12.50	0.006*	
Normal	27.0	15.0	18.0			
Pneumophonic coordination						
Inadequate	53.0	19.0	72.0	6.44	0.01*	0.20 (0.06–0.74)
Adequate	47.0	81.0	28.0			

Note: Some data were discarded if imprecise.
Abbreviations: CI, confidence interval; OR, odds ratio; ns, not significant.
* Significant at the 0.05 level.
† Fisher test.

considered to be standard or low risk, compared with SG. ORs can range from 0 to infinity. An OR less than 1 indicates a negative association, an OR equal to 1 indicates no association, and an OR greater than 1 indicates a positive association between the two variables. If both the lower and upper limits of the CIs are less than 1, there is a significant negative association, whereas if both the lower and upper limits are greater than 1, there is a significant positive association. The level of significance was 5% ($P < 0.05$).[22]

RESULTS

In the final sample, 60 children had vocal discomfort (15 individuals in the SG, 34%, and 45 individuals in the CG, 11.25%). All children from both groups had started public school late. There were 32 girls (53.3%) and 28 boys (46.7%) and there was no difference in age or gender between groups.

Table 1 shows the results obtained using the GRBAS scale. All the SG demonstrated mild deviance on the Dysphonia Severity Index (DSI) ($P = 0.01$). Both groups showed a similar distribution of rough, breathy, and tense voices.

The vocal behavior parameters for each group are detailed in Table 2. The SG revealed a slower speech rate ($P = 0.006$) and a higher incidence of inadequate pneumophonic coordination ($P = 0.01$) than the CG.

The results of the MPT and acoustic parameters are shown in Table 3. The upper harmonic was higher in the CG ($P = 0.04$), but there was no difference in the MPT or any other acoustic parameters between groups.

The data from the VLS evaluation is shown in Table 4. According to the adjusted ORs, the CG was significantly more likely ($P = 0.033$) than the SG to have palatal tonsil hypertrophy (OR = 6.33, 95% CI = 1.06–37.8). Laryngeal constriction was higher in the SG than the CG ($P = 0.017$). There was no

TABLE 3.
Measures of MPT and Acoustic Parameters

MPT	N	Mean ± Standard Error	SD	CV (%)	CI	*t*	*P* Value
/a/							
SG	15	7.33 ± 0.96	3.73	50.88	0.0192 to 14.64	−1.28	0.21^{ns}
CG	42	5.97 ± 0.43	2.79	46.73	0.5016 to 11.43		
/i/							
SG	15	7.26 ± 0.88	3.41	46.96	0.5764 to 13.94	−1.58	0.1^{ns}
CG	42	5.95 ± 0.38	2.49	41.84	0.5196 to 10.83		
/u/							
SG	15	7.0 ± 0.99	3.83	47.14	−0.5068 to 14.50	−1.60	0.11^{ns}
CG	42	5.54 ± 0.41	2.67	48.19	0.3068 to 10.77		
/s/							
SG	15	6.53 ± 1.13	4.38	79.06	−2.0548 to 15.11	−1.34	0.19^{ns}
CG	42	4.95 ± 0.32	2.10	42.42	0.8340 to 9.06		
/z/							
SG	15	5.0 ± 0.62	2.42	48.4	0.2568 to 9.74	−0.52	0.59^{ns}
CG	42	4.64 ± 0.33	2.18	46.98	0.3672 to 8.91		
Ratio s/z							
SG	15	1.33 ± 0.16	0.62	46.61	0.1148 to 2.54	−1.08	0.28^{ns}
CG	42	1.16 ± 0.069	0.44	37.93	0.6496 to 1.67		
Acoustic F_0 (Hz)							
SG	13	224.27 ± 7.97	28.75	12.81	167.92 to 280.62	−1.51	0.13^{ns}
CG	29	206.79 ± 6.83	36.78	17.78	134.7012 to 278.87		
Jitter (%)							
SG	13	2.43 ± 0.54	1.96	80.65	−1.4116 to 6.27	0.67	0.51^{ns}
CG	29	3.19 ± 0.70	3.81	119.43	−4.2776 to 10.65		
Shimmer (dB)							
SG	13	0.55 ± 0.59	0.21	38.18	0.1384 to 0.9616	0.33	0.73^{ns}
CG	28	0.59 ± 0.73	0.38	64.4	−0.1548 to 1.33		
HNR (Hz)							
SG	12	6.31 ± 1.13	3.93	62.28	−1.3928 to 14.0128	−0.70	0.49^{ns}
CG	29	5.19 ± 0.91	4.94	95.18	−4.4924 to 14.87		
Upper harmonic (Hz)							
SG	15	3.60 ± 0.46	1.80	50	0.072 to 7.12	2.05	0.04*
CG	45	4.55 ± 0.21	1.47	32.3	1.6688 to 7.43		

Note: t Independent samples test. Some data were discarded if imprecise.
Abbreviations: CI, confidence interval; CV, coefficient of variation; HNR, harmonics-to-noise ratio; MPT, maximum phonation time; ns, not significant; SD, standard deviation.
*Significant at the 0.05 level.

TABLE 4.
Otolaryngology Disorders

Otolaryngology Disorders	SG (n = 15), %	CG (n = 45), %	Total (n = 60), %	χ^2	*P* Value	OR (95% CI)
Rhinitis						
Yes	62.5	71.0	69.0	0.21	0.64ns	1.47 (0.29–7.47)
No	37.5	29.0	31.0			
Palatal tonsil hypertrophy						
Yes	25.0	76.0	58.0	4.70	0.03*	6.33 (1.06–37.8)
No	75.0	24.0	42.0			
Pharyngeal tonsil hypertrophy						
Yes	100.0	78.6	83.0	2.057	0.15†, ns	
No	0.0	21.4	17.0			
Posterior medial glottal closure						
Yes	67.0	76.0	74.0	0.22	0.64ns	1.60 (0.22–1.49)
No	33.0	24.0	26.0			
Laryngeal constriction						
Yes	100.0	44.4	58.0	5.71	0.017*, †	
No	0.0	55.6	42.0			
Laryngeal nodules						
Yes	67.0	84.0	80.0	0.876	0.34ns	2.67 (0.33–21.7)
No	33.0	16.0	20.0			
Vocal fold cyst						
Yes	50.0	25.0	31.0	1.35	0.24ns	0.33 (0.05–2.21)
No	50.0	75.0	69.0			

Note: Some data were discarded if imprecise.
Abbreviations: CI, confidence interval; ns, not significant; OR, odds ratio.
* Significant at the 0.05 level.
† Fisher test.

difference in the number of nodules or vocal cysts between groups nor was there any difference with regard to posterior medial glottal closure, pharyngeal tonsil hypertrophy, and rhinitis.

DISCUSSION

Change of voice has multifactorial etiology and can be due to organic, socioeconomic, and emotional aspects. The vocal hyperfunction can also be associated with stress and emotions such as sadness and melancholy. Thus, emotions do influence vocal health. Likewise, the expression of sadness and melancholy has been associated with slow and uncoordinated speech.[17] The results presented in this study are consistent with this, indicating that social conditions and emotions influence the development of voice behavior in children.

The comparison between chronological age and school grade revealed that all children in this study had delayed starting school. Delaying the start of public education is a common reality among less privileged social groups in Brazil and children need emotional support from their family to develop properly and receive an education.[23]

The SG reported more vocal discomfort than the CG, which may be due to a stressful family situation or as a response to living in a shelter for extended periods. Institutionalized children may experience more stressful family-related events than children who live with their families, despite the separation.[23]

All children in the SG revealed mild-moderate deviance on the DSI. The shelters neither engage in social and educational projects nor do they provide a creative space for meaningful social interactions, which could help with oral expression. This creates insecurity, anxiety, and stress. This stress may have first been experienced when living with their family and is worsened by the loneliness of the shelter. Voice change seems to be a result of total body stress,[24] but it is important to emphasize that these findings relate to the vocal behavior of a specific group of children.

The acoustic measure for the upper harmonic was higher in the CG children than the SG children. The higher upper harmonic indicates better vocal quality and is due to periodic movements of the vocal fold surface.[20] This difference suggests that the voice quality of the SG children was inferior. In addition, the SG had a higher incidence of laryngeal constriction than the CG. Laryngeal constriction is a functional adaptation that is consistent with vocal fold disorders[17] and produces vocal discomfort, indicating that vocal fold disorders may be more common in the SG. However, although several nodules and cysts were observed in the vocal folds of individuals, there was no significant difference between the two groups.

In conclusion, the results from this study suggest that social conditions are important for voice behavior in children. All the SG children revealed mild-moderate deviance on the DSI, a higher level of vocal discomfort, a slow speech rate, inadequate pneumophonic coordination, and laryngeal constriction, indicating that family support and an appropriate standard of care are required for proper vocal function.

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REFERENCES

1. Hersan R, Behlau MS. Behavioral management of pediatric dysphonia. *Otolaryngologic Clinics Of North America, Estados Unidos*. 2000;33(5): 1097–1109.
2. Oliveira RC, Teixeira LC, Gama ACC, de Medeiros AM. Análise perceptivo-auditiva, acústica e autopercepção vocal em crianças. *J Soc Bras Fonoaudiol*. 2011;23:158–163.
3. Noguchi MS, Assis SG, Malaquias JV. Occurrence of child abuse: knowledge and possibility of action of speech-language pathologists. *Pró-Fono Rev Atua Cient*. 2006;18:41–48.
4. Fuchs M, Fröehlich M, Hentschel B, Stuermer IW, Kruse E, Knauft D. Predicting mutation change in the speaking voice of boys. *J Voice*. 2007; 21:169–178.
5. Estatuto da Criança e do Adolescente – ECA: Lei federal N° 8.069, de 13 de julho de 1990. Available at: http://www.planalto.gov.br/ccivil_03/leis/L8069.htm. Acessed October 15, 2012.
6. Prefeitura de Aracaju. Esboço para um rastreamento da institucionalização da infância e adolescência no Brasil. In: Tavares M, ed. *Crianças e adolescentes em situação de abrigo: um retrato em branco e preto*. Aracaju: Editora Infographics; 2005:13–26.
7. Sales NJ, Gurgel RQ, Goncalves MIR, Cunha E, Barreto VMP, Todt Neto JC, D'Avila JS. Characteristics and professional use of voice in street children in Aracaju, Brazil. *J Voice*. 2010;24:435–440.
8. Karbasi SA, Fallah R, Golestan M. The prevalence of speech disorder in primary school students in Yazd-Iran. *Acta Med Iranica*. 2011;49:33–37.
9. Carding PN, Roulstone S, Northstone K, et al. The prevalence of childhood dysphonia: a cross-sectional study. *J Voice*. 2006;20:623–630.
10. Mckinnon DH, Mcleod S, Reilly S. The prevalence of stuttering, voice, and speech-sound disorders in primary school students in Australia. *Lang Speech Hear Serv Sch*. 2007;38:5–15.
11. Tavares ELM, Brasolotto A, Santana MF, Padovan CA, Martins RHG. Epidemiological study of dysphonia in 4-12 year-old children. *Braz J Otorhinolaryngol*. 2011;77:736–746.
12. Simões-Zenari M, Nerm K, Behlau M. Voice disorders in children and its relationship with auditory, acoustic and vocal behavior parameters. *Int J Pediatr Otorhinolaryngol*. 2012;6:896–900.
13. IBGE. Instituto Brasileiro de Geografia e Estatística. *Censo Demográfico 2010*. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística; 2010. Available at: www.ibge.gov.br. Accessed October 15, 2012.
14. Guimarães MF, Behlau MS, Panhoca I. Análise perceptivo-auditiva da estabilidade vocal de adolescentes em diferentes tarefas fonatórias. *Pró-Fono Revista de Atualização Científica*. 2010;22:455–458.
15. Isshiki N, Olamura M, Tanabe M, Morimoto M. Differential diagnosis of hoarseness. *Folia Phoniatr (Basel)*. 1969;21:9–23.
16. Hirano M. *Clinical Examination of Voice*. New York, NY: Springer-Verlag; 1981.
17. Behlau M. *Avaliação da voz. The book of the specialist*, Vol 1. Rio de Janeiro, Brazil: Revinter; 2001.
18. Sundberg J. *The Science of the Singing Voice*. Illinois: Northern Illinois University Press; 1987.
19. Pontes PAL, Vieira VP, Gonçalves MIR, Pontes AAL. Características das vozes roucas, ásperas e normais: análise acústica espectrográfica comparativa. *Rev Bras Otorrinolaringol*. 2002;68:182–188.
20. Valentim AF, Côrtes MG, Gama ACC. Análise espectrográfica da voz: efeito do treinamento visual na confiabilidade da avaliação. *Rev Soc Bras Fonoaudiol*. 2010;15:335–342.
21. D'avila JS, Sennes JU, Tsuji DH. Estudo comparativo da microvascularização das pregas vocais humanas acometidas por cisto e reação nodular contralateral sob endoscopia rígida. *Rev Bras Otorrinolaringol*. 2003;69:166–173.
22. Zar JH. *Biostatistical Analysis*. 3. ed. New Jersey: Prentice Hall; 1996.
23. Poletto M, Koller H, Dell'Aglio DD. Eventos estressores em crianças e adolescentes em situação de vulnerabilidade social de Porto Alegre. *Ciência & Saúde Coletiva*. 2009;14:455–466.
24. Van Lierde K, D'haeseleer E, Wuyts F, De Ley S, Geldof R, De Vuyst J. The objective vocal quality, vocal risk factors, vocal complaints, and corporal pain in Dutch female students training to be speech-language pathologists during the 4 years of study. *J Voice*. 2010;24:592–598.