The Impact of a Teaching or Singing Career on the Female Vocal Quality at the Mean Age of 67 Years: A Pilot Study

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Summary: Objectives. The purpose of this study was to measure the objective and subjective vocal quality in women aged between 60 and 75 years. Secondly, the impact of a teaching or singing career on the vocal quality was investigated by comparing the vocal quality of retired women with different careers.

Study design. This is a case-control study.

Methods. Seventy-three retired women between 60 and 75 years (mean age: 67 years, standard deviation: 4.49) participated in the study and were divided into three groups: women with a teaching career (n = 21), choir singers with a singing career (n = 12), and women with a non-vocal career (n = 40). All subjects underwent the same assessment protocol consisting of objective (aerodynamic, maximum performance, vocal range, acoustic measurements, and the Dysphonia Severity Index) and subjective (the Voice Handicap Index, auditory-perceptual evaluations by three listeners) voice measurements.

Results. In all three groups, objective and perceptual voice analysis showed a mild dysphonia. No differences in the Dysphonia Severity Index were found between the three groups. The voices of choir singers with a singing career were perceived significantly less rough than voices of the women with a non-vocal career. Additionally, the lowest frequency of the frequency range was significantly lower in the retired teachers and choir singers than in the controls.

Conclusion. The results of this study prudently suggest that a singing or a teaching career compared with a non-vocal career has a positive impact on the vocal frequency range, and that singing has a positive impact on the perceptual vocal quality of the older female voice.

Key Words: Teaching–Singing–Careers–Aging–Voice.

INTRODUCTION

Vocal aging in women has been widely investigated in the literature. The aging voice is characterized by anatomical and physiological changes, perceptual changes, decrease of vocal range, and acoustic changes. Changes in the cartilages, muscles, connective tissues, glands, and vascular tissues within the larynx contribute to these changes.[1] Perceptually, the female aging voice is associated with increased roughness and lower pitch.[2] Additionally, the frequency and intensity range of the female voice decreases with advancing age.[3–6] Finally, a number of age-related acoustic changes have been reported in the literature. The most striking acoustic characteristic of the female aging voice is a decreased fundamental frequency (F_0).[3,7–10] Other reported acoustic characteristics are substantial differences in standard deviation (SD) of the F_0[11] and harmonic-to-noise ratio.[9] Studies investigating changes in jitter and shimmer have yielded inconclusive results.[1] Studies of the movement patterns of the vocal folds in women using videolaryngoscopy indicated that elderly women show greater aperiodicity, reduced and asymmetric mucosal wave, and reduced amplitude of vibration, compared with younger women.[12,13] During the aging process, persistent or larger glottis opening with voicing and prominence of the vocal processes of the arytenoid cartilages are found.[13,14]

It is clear that aging influences the female voice and decreases the vocal capacities. Hence, age-related vocal changes may also impact the quality of life.[15] An important question is whether different careers of voice users lead to differences in the aging voice. More specifically, do vocal characteristics differ between retired nonprofessional voice users, professional voice users (like teachers), and elite vocal professionals (like singers)?

During their professional career, teachers are vulnerable for developing voice disorders.[16,17] This is shown by an increased prevalence of voice disorders and associated absenteeism in teachers.[17,18] Hence, an increased number of teachers, compared with non-teachers (17%), consider changing their occupation.[18] Currently, it is not clear whether a teaching career can have a permanent impact on the vocal quality. Hypothetically, the vocal quality of retired women with a teaching career may be worse than the vocal quality of women with a "non-vocal career."

A number of studies have investigated the impact of singing on the vocal quality and the vocal capacities. Singing is associated with an increased maximal phonation time (MPT)[19] and vocal range[19–22] and a more stable vocal quality.[21] Studies investigating the effect of aging on singers' voices reveal a positive, conserving effect of singing on the aging voice. Prakup[23] found that older singers (aged between 65 and 80 years) are perceived and rated significantly younger than non-singers by blinded listeners. A study by Lortie et al[24] revealed a moderating effect

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of singing on most acoustic parameters of the aging voice. In singers (singing frequently), there was no decrease of vocal stability with aging.[24] Furthermore, a study by Brown et al[25] showed that the mean speaking F_0 of older female professional singers (between 65 and 85 years) is significantly higher than that of non-singers. The results of these studies prudently suggest that singing could, to a certain extent, preserve the voice from age-related vocal changes.

The purpose of this study was to measure the objective and subjective vocal quality in women aged between 60 and 70 years (mean age of 67 years). Secondly, the impact of a teaching or singing career on the vocal quality was investigated. The authors hypothesize that, compared with a non-vocal career, a teaching career can result in a decreased vocal quality and a singing career can result in an increased vocal quality at the age of 67.

METHODS

This study was approved by the Ethics Committee of the Ghent University Hospital (registration number: 2014/0996). Informed, written consent has been obtained from each participant.

Subjects

Seventy-three retired women between 60 and 75 years with a mean age of 67 years (SD: 4.49) participated in the study. Inclusion criteria were a normal mental and physical state of well-being (as reported by the participants and observed by the experimenter) and no history of vocal surgery. The first group consisted of 21 retired classroom teachers from elementary or secondary school with a career of minimum 30 years. The mean age of the retired teachers was 66 years (SD: 4.60; range: 60–74 years). Two teachers received voice therapy in the past. The second group consisted of 12 women with a professional or semi-professional singing career in a choir of minimum 30 years. All of the women were still active choir singers at the moment of testing and were aged between 60 and 72 years (mean age 66, SD: 4.95). The control group consisted of 40 retired non-singers with a career as a non-vocal professional. In this group, non-vocal professionals[26] (like doctors, nurses, caregivers) and non-vocal nonprofessionals[26] (like cleaning staff, laborers, clerks, employees) were included. The mean age of the control group was 67 years (SD: 4.36, range: 60–70 years). There was no significant difference in age between the three groups (analysis of variance, $P > 0.05$). Snowball sampling was used for the recruitment of the participants.

Methods and materials

All subjects underwent the same voice assessment protocol consisting of objective voice measurements (maximum performance task, aerodynamic parameters, acoustic analysis, voice range profile, and the Dysphonia Severity Index [DSI]) and self-evaluation questionnaires (the Voice Handicap Index [VHI], pain scale). Voice assessments were performed by three master students in speech-language pathology (L.L., A.-S.V.C., N.V.D.).

Objective voice assessment

The MPT (in seconds) for the sustained vowel /a:/ (at habitual pitch and loudness) was measured after a maximal inspiration. Then, the vital capacity (in cc) was determined using a dry spirometer (Riester, Jungingen, Germany). For both measurements, the best value of three attempts was retained. The phonation quotient was determined as the ratio of the vital capacity to the MPT.

An acoustic analysis of the sustained vowel /a:/ was performed using the Multidimensional Voice Program of the *Computerized Speech Lab* (KayPENTAX, Montvale, NJ) using a sampling rate of 50,000 Hz. The subjects were instructed to produce the vowel /a:/ at habitual speaking pitch and loudness. The microphone (SM48 microphone, Shure [KayPENTAX, Montvale, NJ]) was located at a distance of 15 cm from the mouth and angled at 45 degrees. A midvowel segment of 3 seconds was retained for further analysis. The following acoustic parameters were selected: F_0 (in Hz), jitter (%), shimmer (%), noise-to-harmonic ratio, and variation of F_0 (vF_0).

The frequency and intensity range based on the highest and lowest frequency (Hz) and intensity (dB) was measured using the voice range profile of the *Computerized Speech Lab* (KayPENTAX). The procedure described by Heylen et al[27] was used. The patients were instructed to produce the vowel /a/ for at least 2 seconds and with an acceptable vocal quality (as judged by the experimenter) subsequently at habitual pitch and loudness, at the lowest frequency (F_{low}), the lowest intensity (I_{low}), the highest frequency (F_{high}), and the highest intensity (I_{high}).

For each subject, the DSI was determined. The DSI is a multiparameter approach based on the following parameters: MPT (s), jitter (%), I_{low} (dB), and F_{high} (Hz), and is designed to establish an objective and quantitative correlate of the perceived vocal quality.[28] The DSI varies between −5 and +5 for, respectively, severely dysphonic vocal quality and good vocal quality. The cutting point between normal and dysphonic voices is 1.6.[29]

Auditory-perceptual evaluation

All subjects were asked to read aloud a Dutch text (The north wind and the sun) at habitual pitch and loudness. Voice samples were audio recorded using a digital camera with high-quality microphone (Sanyo VPC-HD200 [Panasonic, Japan]). For the auditory-perceptual evaluation, the GRBAS scale of Hirano[30] was used. The GRBAS consists of five well-defined parameters: G (overall grade of hoarseness), R (roughness), B (breathiness), A (asthenic), and S (strained quality) of the voice. A sixth parameter I[31] for instability of the voice was added to the GRBAS scale. A four-point grading scale (0 = normal, 1 = slight, 2 = moderate, 3 = severe) was used for each parameter. The evaluations were performed blinded by listening to the recordings and in consensus (100% consensus) by three master students in speech language pathology (L.L., A.-S.V.C., N.V.D.).

Self-evaluation questionnaires

Participants' history for voice influencing factors was investigated using the questionnaire of the European Laryngological Society protocol[32] (Table 1). To measure the psychosocial impact of vocal complaints, the Dutch version[33] of the VHI[34] was used. The VHI is a self-rating questionnaire consisting of 30 statements. Each statement is evaluated on a four-point grading scale (0 = never, 1 = almost never, 2 = sometimes, 3 = almost always, 4 = always). The total VHI score varies between 0 and 120, and