AMBULATORY MONITORING OF TEACHERS' VOICE USE

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INTRODUCTION

For quantifying vocal load over extended periods of time in real-life situations, the best adapted tools are voice dosimeters or voice accumulators. Such devices measure the frequency (F0), the intensity (SPL) and the duration of speech occurrences, generally using an accelerometer attached to the base of the neck. Growing attention has been focused on evaluating patterns of vocal behavior because vocal load is considered to play a major role in the etiology of many common voice disorders; long-term ambulatory monitoring allows for the characterization of these patterns and provides data on what constitutes a normal level of daily voice use [1].

Vocal load has been studied in teachers in particular, because they have one of the most vocally demanding professions. Extended vocal loading is assumed to be one cause of the higher prevalence of voice disorders in teachers than the general population [2-3].

The present study aims to quantify the vocal loading of thirty-two female teachers. The purpose is to provide quantitative data on daily voice use to determine the differences between professional and non-professional vocal load.

METHODS

Subjects

The sample included 32 Belgian French-speaking teachers (12 kindergarten teachers and 20 elementary school teachers), who had no voice problems at the time of the study. None of the subjects had a history of lesion or surgery of the vocal folds. Their mean age was 39 years (range 25 – 58).

Instrumentation and Measurement

We used the Ambulatory Phonation Monitor (APM), Model 3200 (KayPENTAX, Montvale, NJ), a portable voice dosimeter, to measure parameters of vocal load over one workweek (5 full days). Vocal loading parameters analyzed were *F0 average*, *F0 mode*, *SPL average*, *time dose*, *cycle dose* and *distance dose*. *F0 average* is the average F0 over the duration of monitoring and *F0 mode* is the F0 at which the most phonation occurred over the duration of monitoring. *SPL average* refers to the average sound pressure level of voice over the duration of monitoring. The *time dose* accumulates the total time the vocal folds vibrate during the monitoring [4], expressed as a percentage ($D_{t\%}$). The cycle dose (D_c) is an approximation of the total number of glottal cycles over the monitoring. The distance dose (D_d) quantifies the total distance accumulated by the vocal folds during the monitoring. There are no direct methods for measuring D_c and D_d, which are automatically calculated by the software from formulas given by Svec, Popolo, and Titze [5].

Analysis

A total of 160 days of collected data were analyzed. We manually separated the professional and non-professional voice use for each day of recording on the basis of the diary completed by each participant. Professional voice use concerned all time spent at school, including classical teaching periods and all school-related activities (e.g., meetings, before- and after-school daycare). The weekly average duration of non-professional monitoring was 18 hours per participant, while the weekly average duration of professional monitoring was 29 hours per participant. Because the duration of monitoring differed for each day, the F0 mode, F0 average, SPL average, D_c and D_d were normalized to the time dose. To compare professional and non-professional teachers' voice use, a paired Student's t-test was performed for each parameter. The significance level was set at $p < .05$.

RESULTS

For the fundamental frequency, the paired t-test showed a significant difference between the professional and the non-professional voice use for F0 average (t = 8.02; $p < .001$) and for F0 mode (t = 6.23; $p < .001$). Teachers spoke higher at work (F0 average = 258.7 Hz, SD = 20.5 Hz; F0 mode = 229.7 Hz, SD = 18.3 Hz) than not-at-work (F0 average = 239.6 Hz, SD = 20.1 Hz; F0 mode = 213.3 Hz, SD = 20.6 Hz).

For the SPL, the paired t-test showed a significant difference between the professional and the non-professional voice use (t = 10.21; $p < .001$). Teachers spoke louder at work (80.6 dB; SD = 4.9 dB) than not-at-work (74.5 dB; SD = 5.2 dB).

For the $D_{t\%}$, the paired t-test showed a significant difference between the professional and the non-professional voice use (t = 11.13; p < .001). Teachers spoke more at work (20.3%; SD = 4.2%) than not-at-work (10.4%; SD = 3.8%).

For the D_c, the paired t-test showed a significant difference between the professional and the non-professional voice use (t = 17.61; p < .001). The total number of vocal folds' oscillations per day was higher at work (1,195,834; SD = 255,696) than not-at-work (425,102; SD = 194,338).

For the D_d, the paired t-test showed a significant difference between the professional and the non-professional voice use (t = 12.40; p < .001). The daily distance traveled by the vocal folds was higher at work (4,247 m; SD = 1,476 m) than not-at-work (1,173 m; SD = 527 m).

DISCUSSION

The aim of this study was to determine the differences between professional and non-professional vocal load of teachers. The results demonstrated significantly greater values for all parameters in the professional environment than in the non-professional environment. These findings corroborate the results of two American studies that monitored teachers over two weeks using the National Center for Voice and Speech dosimeter [6-7].

The higher F0 and SPL found in the professional environments could be due to the loud background noise at school measured in previous studies [8]. The higher F0 values at school versus not-at-school might also be due to acoustic convergence behavior or accommodation. Convergence is a tendency of talkers to imitate various features of one another's speech so that they are more similar [9]. Teachers may speak higher at school to imitate the children's pitch.

In accordance with previous studies [6-7], the $D_{t\%}$ found in teachers was twice as high in the professional environment as in the non-professional environment (20.3% vs 10.4%). Teachers have fewer opportunities for voice rest at work than after work.

These results showed that, on average, the vocal folds collided with each other more than 1 million times a day at work, plus an additional half million times after work. The distance traveled by the vocal folds was, on average, 4 km at work, plus an additional 1 km after work. Although non-professional voice use in teachers is lower than the professional voice use, it is important to take it into account when evaluating vocal load because of its additional effect. Hunter and Titze [6] point out that non-professional voice use "would not only leave little time for significant vocal rest but also would add more vocal load to an already vocally overloaded voice."

CONCLUSION

Comparisons between professional and non-professional environments showed significantly greater vocal load in the professional environment, meaning that teachers' voice demands are higher at work than elsewhere. The results confirmed that teachers have a very vocally demanding profession. Concerning the clinical implications, these data encourage the reduction of vocal load in teachers who present symptoms of an overloaded voice, not only at work but also in non-professional environments.

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