

## Identification of teachers at risk for phonotrauma using ambulatory monitoring of speaking fundamental frequency

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### Introduction

Excessive mechanical stress on the vocal folds – including deformation, oscillation, collision and acceleration [1] – can lead to tissue damage, that is, phonotrauma. Among professional voice users, excessive vibration patterns represent major risk factors for voice disorders [2].

This study evaluates several individual factors together to determine whether they can predict teachers' speaking fundamental frequency [ $f_0$ ] and help to identify those who are most at risk of phonotrauma.

### Methods

The  $f_0$  of 87 teachers (66 women) without voice pathology was assessed every 200 ms during one workweek with the Ambulatory Phonation Monitor (KayPENTAX, Montvale, NJ), using an autocorrelation algorithm. The following individual factors were collected with questionnaires: gender, age, teaching experience, teaching level, tobacco consumption, gastro-esophageal problems, nonoccupational voice activity, voice education (i.e., having received weekly speaking and/or singing training for at least one year), past voice problems, and biopsychosocial impact of voice problems measured using the Voice Handicap Index [VHI [3]]. General linear mixed models were used to determine the effect of individual factors on teachers'  $f_0$  tracked in real-life situations for a total of 431 days (4,479 hours).

### Results

Speaking  $f_0$  depended significantly on gender ( $F(1, 74) = 132.1, p < .001$ ), teaching level ( $F(3, 74) = 12.49, p < .001$ ), nonoccupational voice activity ( $F(1, 74) = 4.34, p = .041$ ) and VHI score ( $F(1, 74) = 8.95, p = .004$ ). Specifically,  $f_0$  was higher in women, in individuals without nonoccupational voice activity, and in individuals with a higher VHI score (increase of 0.7 Hz for each additional point). For females, post hoc comparisons revealed a substantial impact of teaching level: university instructors had deeper voices than kindergarten ( $p < .001$ ), elementary ( $p < .001$ ), or

secondary teachers ( $p = .001$ ), and secondary teachers had deeper voices than kindergarten teachers ( $p = .003$ ).

Individual factor	Females	Males
Gender	224.5	155.9
Without nonoccupational voice activity	229.3	144.0
With nonoccupational voice activity	219.2	140.6
Kindergarten (n=21, all female)	250.2	-
Elementary (n=20, all female)	236.9	-
Secondary (n=35, 20 females)	225.3	138.1
University (n=11, 5 females)	184.5	146.4

Table 1: Estimated marginal means for  $f_0$  (Hz).

### Discussion

The higher-pitched voices of kindergarten and elementary teachers may be due to the Lombard effect, the convergence effect, the characteristics of child-directed speech, and the cognitive and/or emotional load related to occupational stress [4]. On the other hand, lowering the pitch may be a strategy secondary and university teachers use to assert their authority. The lower  $f_0$  of teachers who engage in nonprofessional voice activities may suggest acute inflammation or muscle fatigue due to voice overload. Prevention and early detection should be offered primarily to individuals at risk of phonotrauma due to higher  $f_0$ , namely females, and specifically those teaching at the kindergarten and elementary levels. In addition, self-assessment questionnaires such as the VHI could also help to detect individuals with potentially harmful  $f_0$  patterns.

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