
Voice Disorders in Teachers and the General Population: Effects on Work Performance, Attendance, and Future Career Choices

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To examine the frequency and adverse effects of voice disorders on job performance and attendance in teachers and the general population, 2,401 participants from Iowa and Utah ($n_1 = 1,243$ teachers and $n_2 = 1,279$ nonteachers) were randomly selected and were interviewed by telephone using a voice disorder questionnaire. Teachers were significantly more likely than nonteachers to have experienced multiple voice symptoms and signs including hoarseness, discomfort, and increased effort while using their voice, tiring or experiencing a change in voice quality after short use, difficulty projecting their voice, trouble speaking or singing softly, and a loss of their singing range (all odds ratios [ORs] $p < .05$). Furthermore, teachers consistently attributed these voice symptoms to their occupation and were significantly more likely to indicate that their voice limited their ability to perform certain tasks at work, and had reduced activities or interactions as a result. Teachers, as compared with nonteachers, had missed more workdays over the preceding year because of voice problems and were more likely to consider changing occupations because of their voice (all comparisons $p < .05$). These findings strongly suggest that occupationally related voice dysfunction in teachers can have significant adverse effects on job performance, attendance, and future career choices.

KEY WORDS: teachers, voice disorders, voice-related occupational effects

More than three million elementary and secondary school teachers in the United States use their voice as a primary tool of trade (Digest of Education Statistics, 2000, Table 4). Teachers often speak loudly for long periods in noisy classrooms without much time for vocal fold tissues to rest or recover. It appears that this prolonged and often intense occupational voice use contributes to high prevalence rates for voice disorders among teachers (Lejska, 1967; Marks, 1985; Russell, Oates, & Greenwood, 1998; Pekkarinen, Himberg, & Pentti, 1992; Smith, Gray, Dove, Kirchner, & Heras, 1997; Smith, Kirchner, Taylor, Hoffman, & Lemke, 1998; Smith, Lemke, Taylor, Kirchner, & Hoffman 1998). Prevalence refers to the number of cases of voice disorders within a particular group at a specified time. And, in the largest epidemiological study to date, Roy and colleagues (Roy et al., 2004) reported the prevalence of current voice disorders to be significantly higher in teachers (11%) compared with nonteachers (6.2%), as was the prevalence of voice disorders during teachers' lifetime (i.e., 57.7% teachers vs. 28.8%

nonteachers). Despite the relative frequency of voice disorders in both teachers and the general population, the effects of those disorders on work-related activities, job performance, attendance, and career choices have been explored in only a handful of studies. For instance, Smith et al. (1997) compared the frequency and effects of voice symptoms in teachers to a group of individuals employed in other occupations. Teachers were significantly more likely to report having a voice disorder and to experience more specific voice symptoms and more symptoms of voice-related physical discomfort. Over 20% of teachers, but none of the nonteachers, had missed 1 or more days of work in the past year due to voice-related problems. Smith and colleagues concluded that teaching is a high-risk occupation for voice disorders, and this occupation-related health problem contributes to significant job-related and economic consequences. In a later study, Smith, Kirchner, et al. (1998) reported that over 38% of teachers studied complained that teaching had an adverse effect on their voice, and 39% of those teachers had to reduce teaching activities as a result. The authors warned that these voice symptoms likely affect teachers' effectiveness in the classroom and contribute to considerable economic burdens for the teacher and the school system, because of costs related to sick leave, voice therapy, and/or surgical management. Similarly, Russell et al. (1998) reported that almost 22% of teachers surveyed experienced regular voice problems that interfered with their ability to use their voices as they wish, and 38.7% of teachers reported missing at least 1 day of work in the past year as a result of their voice disorder. In addition, Sapir, Keidar, and Mathers-Schmidt (1993) reported that more than 50% of teachers reported multiple symptoms of vocal attrition. Vocal attrition, as defined by the authors, referred to the gradual decline in vocal capabilities over time. More than one third of those teachers who reported vocal attrition admitted that their effectiveness at work was adversely affected by voice problems, and one third reported absence from work due to voice problems.

Although these investigations are helpful, small sample sizes, the absence of a referent group for comparison purposes, and/or nonrandomly selected participants limited the interpretation and value of most of these studies. Therefore, additional information is needed regarding the extent to which voice symptoms interfere with or restrict teachers' and nonteachers' occupational voice use and job performance.¹ Such information will

¹In the World Health Organization's (WHO) International Classification of Impairments, Disabilities, and Handicaps (ICIDH; WHO, 1980), possible consequences of voice disorders would be captured by the terms *impairment*, *disability*, and *handicap*. Impairment was defined as "any loss or abnormality of psychological, physiological, or anatomical structure or function"; disability was defined as "any restriction or lack of ability (resulting from an impairment) to perform an activity in the manner or within the range considered normal for" (*cont'd next column*)

lead to more realistic estimates of the effects of voice disorders on teachers, and on the organizations for which they work, and will also provide occupational health and safety organizations information that will allow them to address the problem (Mattiske, Oates, & Greenwood, 1998; Russell et al., 1998). Therefore, this investigation explored the extent to which voice disorders interfere with or restrict teachers' and nonteachers' occupational voice use and job performance and influence absenteeism and future career choices.

Method

Sampling Procedures

Teachers and nonteachers in Utah and Iowa were selected for study. The State Office of Education for the State of Iowa provided a list of currently employed elementary and secondary school teachers (grades K to 12), ages 20–66 years. A similar list of teachers was provided by specific school districts in Utah. The lists included information about current school assignment, address and telephone number, teacher age, gender, race and education, number of years taught, current subjects taught, type of school (public, private, parochial), and employment status (i.e., full- or part-time). All of the individuals contacted completed a half-hour telephone interview conducted by Iowa State Statistical Laboratory interviewers. The initial contact was made through a mailing to the teacher's home, describing the study and human subject requirements. About 5 days later, contact was made with the potential interviewee by telephone. At this time, the study was briefly described again, questions were answered, and a convenient time was scheduled to conduct the telephone interview.

The general (nonteacher) population was randomly sampled and surveyed so that population-based prevalence estimates of voice disorders, and their effects, could be generated. This sample consisted of both working and nonworking individuals in each state who met the age criterion (i.e., 20–66 years) and had never taught at any educational level or type (e.g., college, aerobic instructor). The Iowa State Statistical Laboratory also conducted the telephone interviews of this nonteacher referent group using the identical questionnaire. Details

(*cont'd from previous column*) a human being"; and handicap was defined as "a disadvantage for a given individual, resulting from an impairment or a disability, that limits or prevents the fulfillment of a role that is normal for that individual" (WHO, 1980, pp. 25–29). Therefore, in part, this study aimed to evaluate the consequences of voice disorders with respect to disability and handicap. More recently however, the WHO replaced the concepts of disability and handicap with the concepts of "activity limitations" and "participation restrictions." In this newer framework, difficulties experienced by a teacher such as projecting voice or a loss of singing range might be considered activity limitations, whereas voice-related absenteeism or change of occupation might be considered participation restrictions (ICIDH-2; WHO, 2000).

of this procedure and the sampling method used (i.e., the random digit dialing procedure) are described elsewhere (Roy et al., 2004). Response rates for both the teacher and nonteacher groups were very high in both states. Response rates of completed interviews in Iowa were 95% for teachers and 92% for nonteachers. Corresponding response rates in Utah were 98% for teachers and 87% for nonteachers. In both states, the nonresponses were due to lack of an identifiable home telephone number for the telephone interview and to lack of interest or time because of other burdens.

Description of the Interview/ Questionnaire

To determine the prevalence and effects of voice disorders in teachers and the general population, a standardized questionnaire was administered. For the purpose of this study, we defined a voice disorder for the participants as the experience of the voice not working, performing, or sounding as it normally should, so that it interfered with communication.² The interview instrument was designed to be similar to those used in the periodic United States Public Health Service National Health and Nutrition Examination Survey prevalence surveys of health status in random samples of the U.S. population, which are also conducted by telephone, and which serve as the standard for many epidemiological studies. Validation information and a complete description of the questionnaire are reported in Roy et al. (2004). To assess the functional impact of voice disorders in teachers and the general population, specific questions were included in the interview to elicit the participant's opinion of the effects of the voice symptoms/disorder on their employment and career. These questions were asked to determine: (a) the frequency of selected voice symptoms and signs, and (b) how frequently participants had experienced adverse work-related effects due to a voice disorder. Specific questions elicited information regarding (a) the presence and frequency of 10 specific current or past voice symptoms/signs typically associated with voice disorders (e.g., hoarseness, vocal fatigue, trouble speaking or singing softly, difficulty projecting the voice, loss of singing range, discomfort while using the voice, monotone voice, increased effort associated with speaking, chronic throat dryness, and chronic throat soreness) and 4 other laryngopharyngeal symptoms/signs (frequent throat clearing, bitter or acid taste, swallowing difficulties, a wobbly or shaky voice); (b) whether the participant attributed the aforementioned symptoms/signs to their occupation; (c) whether the participant's

²The precise definition of a voice disorder, as provided by the interviewer to the respondents was, "For the purposes of this study, we consider a voice problem to be any time your voice does not work, perform, or sound as you feel it normally should, so that it interferes with communication."

voice affects, limits, or restricts his or her ability to perform various tasks or work-related activities; and (d) whether the participant reports past and/or anticipated occupation/career changes due to a voice disorder.

Demographic variables considered in this study were age and gender. Because the association between the percentage of participants with voice disorders and age was not linear, we categorized this variable as 20–29, 30–39, 40–49, 50–59, and 60 years and older. Race/ethnicity was not considered in the study because of the very high percentage of participants who were White, non-Hispanic (i.e., 97.9% of teachers and 94.4% of nonteachers).

Statistical Methods

Cross-tabulations were used to perform bivariate analyses between selected variables, with statistical significance based on the chi-square test for independence (Fienberg, 1977). The *t* statistic was used for testing the null hypothesis of equality of means between groups, with the *t* statistic computed using approximate degrees of freedom from Satterthwaite's approximation when the variances between the two groups are unequal (Satterthwaite, 1946). Factor analysis was used to describe covariance relations among the symptom/sign variables in terms of a few underlying, but unobservable, random quantities called factors (Mulaik, 1972; Harman, 1976). The method used for factor extraction was principal components analysis. Factors were retained based on the MINEIGEN greater than or equal to 1 rule. When more than one factor was identified, factors were presented according to an orthogonal varimax prerotation. In addition, unadjusted and adjusted (controlling for the presence of other variables) odds ratios (ORs) were estimated using logistic regression. In this study the odds of reporting specific voice symptoms or signs were determined for teachers versus nonteachers. Nonteachers were considered the standard, or low risk group, compared with teachers. An OR of 1.0 means no association between occupational status and voice disorders, an OR greater than 1.0 means teachers have a greater chance of a particular voice symptom/sign than nonteachers, and an OR less than 1.0 means that nonteachers have a greater chance of a specific voice symptom than teachers. ORs greater than 1.0 indicated a positive association and ORs less than 1.0 indicated a negative association. Confidence intervals (CIs) were computed and, when the CI did not overlap 1.0, statistical significance was indicated. Two-sided tests of significance were based on the .05 level against a null hypothesis of no association. Analyses were performed using SAS version 8.2. Procedure statements used in SAS for assessing the data were PROC FREQ, PROC FACTOR, and PROC LOGISTIC.

Results

There were 2,531 participants who completed the voice disorder interview in Iowa and Utah during 1998 to 2000. Of this number, 130 nonteachers (10.1%) were unemployed at the time of the interview. Because this investigation aimed to evaluate voice-related effects on work performance and attendance, these unemployed nonteachers were dropped from the analysis. The remaining 2,401 participants consisted of 51.8% teachers ($n = 1,243$) and 48.2% nonteachers ($n = 1,158$); 36.2% were men ($n = 868$) and 63.8% were women ($n = 1,533$), and 83.3% were from Iowa and 16.7% were from Utah. Participants ranged in age from 20 to 66 years ($M = 43.9$, $SD = 10.5$). Teachers were significantly more likely than nonteachers to be females (69.0% vs. 58.4%), $\chi^2(1) = 29.0$, $p < .001$, and teachers were significantly older than nonteachers ($M = 45.4$ years vs. 42.4 years), $t(2269) = -7.08$, $p < .001$.

Voice Symptoms/Signs in Teachers Versus Nonteachers

Adjusted ORs of “ever having experienced a specific voice symptom/sign” and teacher status, and between whether this voice symptom was perceived as related to their job and teacher status are presented in Table 1. ORs were adjusted for age and gender. Teachers were significantly more likely than nonteachers to have experienced hoarseness, tiring, or change in quality after short use, trouble speaking or singing softly, difficulty projecting their voice, loss of singing range, discomfort while using their voice, a monotone voice, effort required to talk, and bitter or acid taste. There were no significant differences between teachers and nonteachers with respect to chronic dryness of throat, chronic soreness of throat, frequency of throat clearing, swallowing difficulties, and wobbly or shaky voice.

Teachers experienced a substantially higher number of voice symptoms than did nonteachers: 93.7% (15.1% with one symptom, 13.3% with two symptoms, 12.1% with three symptoms, 10.8% with four symptoms, and 42.3% with five or more symptoms) compared with 88.7% (22.5% with one, 18.3% with two, 13.4% with three, 8.7% with four, and 25.8% with five or more), $\chi^2(5) = 101.4$, $p < .001$. The mean number of voice symptoms reported by teachers (4.3) was significantly higher as compared with nonteachers (3.1), $t(2378) = -10.1$, $p < .001$.

Factor analysis identified two factor groupings for the selected symptom/sign variables (see Table 2). The eigenvalues for these factors were 3.83 and 1.21, which together account for 36.0% of the standardized variance. Hoarseness and monopitch had low loadings on both

factors and were subsequently dropped. The first factor (Factor 1) appeared to represent a cluster of voice-related symptoms we labeled “Phonatory Symptoms/Signs,” while the second factor (Factor 2) reflected a cluster of laryngeal and pharyngeal symptoms/sensations, which we labeled “Laryngopharyngeal Symptoms/Signs.” Cronbach’s standardized coefficient alpha was used to indicate how well the items in each factor grouping were correlated with one another. For Factor 1 Phonatory Symptoms/Signs, Cronbach’s standardized coefficient was 0.758, and for Factor 2 Laryngopharyngeal Symptoms/Signs it was 0.614. These findings indicate that the characteristics listed under each category in this table are highly correlated and load specifically onto one of these two independent, underlying factors. In addition, Table 2 also provides information regarding the strength of the contribution to the particular underlying factor; for example, the symptoms “difficulty projecting voice” and “effort to talk” contributed most to Factor 1 Phonatory Symptoms/Signs, whereas the symptom “chronic dryness in the throat” contributed most to Factor 2 Laryngopharyngeal Symptoms/Signs.

Work-Related Voice Symptoms/Signs in Teachers Versus Nonteachers

For every symptom or sign considered, with the exception of “bitter or acid taste,” teachers were significantly more likely than nonteachers to attribute each voice symptom or sign to their job (see Table 1). Teachers were also more likely than nonteachers to attribute one or more of the voice symptoms/signs they experience to their occupation: 60.2% of teachers (15.9% with one, 9.0% with two, 7.6% with three, 6.8% with four, and 20.9% with five or more) compared with 20.5% of nonteachers (8.7% with one, 4.2% with two, 2.7% with three, 1.8% with four, and 3.1% with five or more), $\chi^2(5) = 424.8$, $p < .001$. The average number of symptoms that teachers attributed to their occupation was 2.3. The average number of symptoms that nonteachers attributed to their occupation (0.5) was significantly lower, $t(1846) = -19.7$, $p < .001$.

Effects of Work-Related Voice Problems in Teachers Versus Nonteachers

Teachers were significantly more likely than nonteachers to indicate the occurrence of selected adverse effects due to voice disorders (see Table 3). Teachers were also significantly more likely to indicate that their voice limited their ability to do certain tasks at their current job, and they were more likely to seek professional help for their voice. In addition, teachers experienced a

Table 1. Odds ratios (ORs) and 95% confidence intervals (CIs) of ever having had selected voice symptoms/signs and whether these symptoms were symptoms among teachers versus nonteachers^a

Symptom/sign and teacher status	Ever experienced (yes vs. no)			Job related (yes vs. no)		
	No. ^b	ORs	95% CI	No. ^b	ORs	95% CI
Hoarseness						
Nonteacher	889	—	—	107	—	—
Teacher	1070	1.8*	1.4–2.2	550	8.2*	6.4–10.4
Voice tires or changes quality after short use						
Nonteacher	216	—	—	76	—	—
Teacher	468	2.6*	2.2–3.2	390	10.0*	6.8–14.8
Trouble speaking or singing softly						
Nonteacher	138	—	—	28	—	—
Teacher	248	1.8*	1.4–2.2	150	7.2*	4.2–12.4
Difficulty projecting voice						
Nonteacher	168	—	—	41	—	—
Teacher	394	2.5*	2.0–3.1	268	7.3*	4.7–11.2
Loss of singing range						
Nonteacher	215	—	—	24	—	—
Teacher	440	2.2*	1.8–2.7	210	7.5*	4.7–11.9
Discomfort while using voice						
Nonteacher	282	—	—	55	—	—
Teacher	536	2.3*	1.9–2.8	341	7.2*	5.1–10.3
A monotone voice						
Nonteacher	49	—	—	8	—	—
Teacher	86	1.7*	1.2–2.5	43	5.6*	2.3–13.6
Effort to talk						
Nonteacher	216	—	—	30	—	—
Teacher	482	2.6*	2.2–3.1	286	9.2*	5.9–14.2
Chronic throat dryness						
Nonteacher	177	—	—	43	—	—
Teacher	225	0.9	0.7–1.1	125	4.0*	2.6–6.2
Chronic throat soreness						
Nonteacher	147	—	—	30	—	—
Teacher	157	1.0	0.8–1.3	87	4.5*	2.6–7.6
Frequent throat clearing						
Nonteacher	442	—	—	79	—	—
Teacher	517	0.9	0.8–1.1	227	3.8*	2.7–5.1
Bitter or acid taste						
Nonteacher	282	—	—	35	—	—
Teacher	245	1.3*	1.0–1.6	39	1.3	0.8–2.2
Swallowing difficulties						
Nonteacher	269	—	—	25	—	—
Teacher	308	0.9	0.7–1.1	82	3.0*	1.8–4.8
A wobbly or shaky voice						
Nonteacher	149	—	—	37	—	—
Teacher	177	0.9	0.7–1.1	105	4.5*	2.7–7.4

^aEach OR measuring the relation between the selected sign/symptom variable and the outcome variable was adjusted for gender and age. ^bRepresents the number who have experienced each of these symptoms by teacher status.

*Significant at the .05 level.

Table 2. Factor loadings for the selected symptoms/signs according to whether they ever had a voice disorder (all participants included).

Symptom/sign	Factor 1 (Phonatory)	Factor 2 (Laryngo-pharyngeal)
Effort to talk	0.728	0.083
Difficulty projecting voice	0.724	0.119
A loss of singing range	0.682	0.108
Trouble speaking or singing softly	0.617	0.118
Discomfort while using voice	0.582	0.257
Voice tires or changes quality after short use	0.546	0.194
Hoarseness	0.361	0.182
Monotone voice (monopitch)	0.241	0.190
Chronic dryness of throat	0.109	0.675
Chronic soreness of throat	0.106	0.626
Bitter or acid taste	0.020	0.523
Frequently clear throat	0.291	0.522
Swallowing difficulties	0.232	0.505
Wobbly or shaky voice	0.313	0.436

significantly higher number of days in the past year in which (a) they intentionally reduced their activities or interactions because of their voice, (b) their voice was a problem and did not function as it usually does or as they would like, (c) they missed work because of health, and (d) they missed work because of their voice ($p < .05$). More precisely, more than 43% of teachers reported that they had reduced activities or interactions for at least 1 day during the past year as a result of voice problems, as compared with 16.0% of nonteachers. In addition, 18.3% of teachers had missed at least 1 day of work during the past year because of voice-related dysfunction, as compared with 7.2% of nonteachers. Almost 3% of teachers had missed more than 5 days of work due to voice problems, compared with 1.3% of the general population. Over 35% of teachers reported that their voice had been a problem because it did not function as it usually does or as the teacher had expected it to for more than 5 days over the past year. The corresponding percentage for nonteachers was 22.0%.

Although teachers reported more voice-related work restrictions and disruptions, when queried regarding whether a voice problem had been responsible for changing their job, there was no statistical difference between the percentage of teachers and nonteachers who had changed occupations (see Table 3). On the other hand, teachers, compared with nonteachers, were significantly more likely to indicate that they may need to change their occupation in the future, because of their voice (2.70% vs. 0.78%), $\chi^2(1) = 12.4, p = .002$.

Finally, in a multiple logistic regression model the dichotomous outcome variable was based on the statement, "Your voice limits your ability to do certain tasks at your current job." The odds of the voice limiting one's ability to do certain tasks at their current job was 4.2 (95% confidence interval [CI]: 3.0–5.9) for teachers compared with nonteachers, adjusting for gender and age. A model was also derived that, in addition to teacher status, gender, and age, included the selected voice symptoms/signs shown in Table 1 (see Table 4). Using backward elimination, only voice symptom/sign variables statistically significant at the .3 level were retained in the model. Although variables dropped did not appear to have direct effects on the outcome variable, it is possible they indirectly influenced the outcome through their association with those variables remaining in the model. Several of these voice symptoms/signs have the potential of mediating the relation between teacher status and voice disorders that limited performance of work-related activities. For example, teachers were more likely than nonteachers to experience discomfort while using their voice (see Table 1), which in turn may limit performance of work-related activities. Nevertheless, even after adjusting for these selected voice symptoms shown in Table 4, teacher status continued to have a positive direct effect on limiting work-related activities, indicating that other types of voice symptoms/signs inherent to the occupation (not identified or surveyed in this study) must also be contributing to restricting performance at school.

Discussion

This investigation represents the largest epidemiological study conducted of the nature and effects of voice disorders among randomly sampled teachers and the general working population. The results indicated that teachers appear to be at higher risk of experiencing voice disorders compared with the general population. Teachers, compared with nonteachers, were significantly more likely to have experienced multiple voice symptoms/signs including hoarseness, discomfort, and increased effort while using their voice, tiring or change in voice quality after short use, difficulty projecting their voice, trouble speaking or singing softly, and a loss of their singing range. Furthermore, teachers consistently attributed these voice symptoms/signs to their occupation and were significantly more likely to indicate that their voice dysfunction limits their ability to perform certain tasks at work. Teachers, compared with nonteachers, reported that they were more likely to reduce activities or interactions and to miss more days of work over the past year because of voice-related problems. Because teachers typically use their voice as the primary mode of instruction, these

Table 3. Frequency of adverse effects due to voice disorders by teacher/nonteacher status.

Adverse effects	Teacher		Nonteacher		χ^2	df	p
	No.	%	No.	%			
Voice limits ability to do certain tasks at current job*	138	11.6	36	3.1	60.9	1	<.001
Sought professional help to improve voice*	150	12.1	63	5.4	32.4	1	<.001
Changed occupation or job because of voice	4	0.3	3	0.3	0.081	1	.776
No. of days in past year reduced activities or interactions because of voice*							
0	702	56.6	972	84.0	213.3	2	<.001
1-4	316	25.5	109	9.4			
5+	222	17.9	76	6.6			
No. of days in past year voice was problem because it did not function as usual or as you would like it to*							
0	403	32.6	625	54.2	116.2	2	<.001
1-4	400	32.3	274	23.8			
5+	435	35.1	254	22.0			
No. of days in past year missed work because of health*							
0	386	31.2	461	36.1	28.6	2	<.001
1-4	628	50.8	464	36.1			
5+	222	18.0	229	27.9			
No. of days in past year voice caused work absenteeism all or most of the day*							
0	1015	81.7	1068	92.8	66.6	2	<.001
1-4	192	15.4	66	5.9			
5+	36	2.9	15	1.3			

*Significant differences between teachers and nonteachers, based on the chi-square test and the .05 level of significance.

voice symptoms/signs and the need to restrict or adjust teaching activities as a result presumably have implications for both the quality of teaching and the students' learning experience.

In addition, factor analysis involving voice signs and symptoms identified two factors: the first represented a cluster of voice-related symptoms and the second represented a cluster of laryngeal and pharyngeal symptoms/sensations. Factor 1 included symptoms such as increased effort to talk, voice tiring or changing after use, difficulty projecting the voice, and loss of singing range, whereas Factor 2 included symptoms such as chronic throat dryness or soreness, bitter or acid taste, and frequent throat clearing. Teachers, compared with nonteachers, were more likely to experience the phonatory symptoms (Factor 1), but not the laryngopharyngeal

symptoms/sensations (Factor 2). This finding likely reflects the heavy occupational demands placed on the larynx during teaching. Furthermore, the symptoms "difficulty projecting the voice" and "effort required in talking" contributed most to Factor 1, and were most frequently reported by teachers. By understanding the specific types of voice problems that teachers are more likely to experience (as provided by the factor analysis), important information is acquired that can help guide the development of prevention or treatment programs for teachers with voice disorders. For instance, amplifying the teachers' voice in the classroom would presumably reduce the need to project the voice (i.e., increase voice loudness levels), with a desirable reduction in overall vocal loading and voice-related or respiratory effort levels (Jonsdottir, Rantala, Laukkanen, &

Table 4. Adjusted ORs and 95% CIs of voice symptoms/signs that limited performance of work-related activities (all participants included).

Variables	OR ^a	95% CI	Wald χ^2 p value
Teacher vs. nonteacher	2.8*	1.9–4.1	<.001
Voice tires or changes quality after short use ^b	1.7*	1.2–2.3	.003
Trouble speaking or singing softly ^b	1.7*	1.2–2.4	.003
Difficulty projecting your voice ^b	1.8*	1.2–2.6	.002
A loss of singing range	1.1	0.8–1.6	.462
Discomfort while using your voice ^b	1.8*	1.2–2.5	.002
To make an effort to talk ^b	2.1*	1.4–3.0	<.001
Chronic dryness in your throat ^c	1.5*	1.0–2.1	.042
Chronic soreness in your throat ^c	1.6*	1.1–2.4	.014
To frequently clear your throat ^c	1.8*	1.3–2.6	<.001
A wobbly or shaky voice ^c	1.4*	1.0–2.1	.050

^aORs adjusted for all other variables listed in the table as well as gender and age. ^bYes versus no.
^cEver versus never.
*Significant at .05 level.

Vilkman, 2001). In fact, Jonsdottir (2002) recently evaluated the effects of voice amplification on teachers and students. Thirty-three non-voice-disordered teachers used a cordless voice amplification system in the classroom for at least 1 week. Teachers and students were subsequently surveyed regarding opinions of the amplification. Ninety percent of teachers reported easier voice production, and 82% reported improved vocal endurance. Furthermore, 84% of students found listening easier, and 63% reported their concentration improved when amplification was used. Additionally, two recent randomized clinical trials have provided evidence to support the suggestion that voice amplification may be an effective approach for reducing voice handicap levels reported by teachers with voice disorders (Roy et al., 2002, 2003). Therefore, voice amplification may represent a relatively efficient means to address some of the phonatory symptoms/signs contributing to Factor 1 that appear to contribute most to limiting work performance.

It is also important to recognize that for many teachers, the adverse effects of voice problems were not limited to loss of work. In this study, teachers reported that voice problems interfered with their effectiveness at work and also imposed limitations on job performance. The impact of such dysfunction on teachers and their students may be substantial. Our results indicated that over a third of teachers complained that their voice did not function as it usually does or as they would like it to for more than 5 days of the school year. Despite teachers admitting that voice problems prevented them from doing certain tasks at their job, the majority did not seek help, and most did not take time off work to recover (Roy et al., 2004). One wonders about the possible effects of these voice problems on the quality of instruction the

students receive, because the teacher likely limits classroom activities as a result of vocal dysfunction. Furthermore, because the voice is the primary tool of instruction in the classroom, it is essential that students hear and understand the teacher without difficulty. However, poor acoustic environments and high ambient noise levels characterize many elementary and secondary school classrooms, potentially obscuring an already distorted voice signal (Crandell & Smaldino, 1999; Howard & Angus, 2001; Pekkarinen & Viljanen, 1991). In this regard, Morton and Watson (2001) recently evaluated the effect of disordered voice quality on children's ability to process spoken language. A group of 24 school-aged children listened to a series of recorded passages spoken by a female with normal voice and a female with a voice disorder. Children were subsequently tested for their ability to recall words and draw inferences regarding the spoken material. Children performed better on both of these tasks when listening to the normal voice. Thus, the negative effects of a dysphonic voice, combined with voice-related disruptions on students' learning may be substantial.

The results from this study are in general agreement with those from an earlier report by Smith et al. (1997), wherein teachers ($n = 242$) were compared with a nonteacher referent group ($n = 178$). The pattern of the results reported by Smith and colleagues indicated that teachers versus nonteachers were more likely to report multiple voice symptoms, attribute these symptoms to their occupation, and miss work more often because of voice problems. We found that 18.3% of teachers missed at least 1 day of work during the past year due to voice problems, and Smith et al. reported that 20% of their teachers missed work. The major differences between

our results and those of the Smith investigation involve the nonteacher referent group. In the present study, we tended to identify more voice-related problems among the nonteachers (which also tended to affect work performance) than were identified in the earlier Smith investigation. For example, we found that 7.2% of our nonteachers had missed at least 1 day of work in the preceding year because of voice problems, whereas Smith et al. reported that none of their nonteachers surveyed had missed any workdays in the past year due to a voice problem. In a later study, Smith, Lemke, and colleagues (1998) compared a random sample of elementary and high school teachers ($n = 554$) to individuals working in other occupations ($n = 220$) and reported that 20% of teachers versus 4% of nonteachers had missed work because of voice problems, comparable to our current findings. Our results indicate that although the prevalence of voice problems in the general population remains small, a large number of people in the United States do experience some voice-related absenteeism.

One purpose of an epidemiologic study is to verify the consistency of prevalence findings. The similarity of our findings with those of other smaller studies suggests that teaching, as an occupation, can produce a high risk of adverse voice problems that seem to cross a variety of geographic boundaries (Jonsdottir, Boyle, Martin, & Sigurdardottir, 2002; Russell et al., 1998; Yiu, 2002). Although epidemiologic studies cannot establish causality, the results reported here and elsewhere suggest that many voice problems are highly occupation-related, making the argument for prevention and early intervention programs compelling. Because of lost workdays, use of sick benefits, replacement costs for substitute teachers, and treatment expenses, Verdolini and Ramig (2001) estimated the societal costs in the United States alone to be \$2.5 billion annually for teachers. Although evidence from recent clinical trials research has identified several effective treatment alternatives for teachers with voice disorders, including voice amplification, vocal function exercises, and resonance voice therapy (Roy et al., 2001, 2002, 2003), our results clearly indicate that education, prevention, and treatment programs need to be developed and assessed in order to lessen the occurrence of adverse voice conditions related to this high-risk profession (Russell et al., 1998).

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This article is dedicated to the memory of Steven D. Gray, MD, our dear friend and colleague who passed away in September 2002. Dr. Gray dedicated his professional life to helping individuals with voice disorders. It was a privilege to have known and worked with Steve. His deep commitment to his family, his faith, and science served as a model and inspiration for all of us. Steve's wisdom, sense of humor, and

truly unselfish character will be missed more than words can convey.

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