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Summary: Objective. To review the current published available research into the impact of voice training on the vocal quality of professional voice users, to provide implications for vocal health and recommendations for further research.

Design. Literature review with a systematic approach.

Methods. A systematic search of the literature was conducted using electronic databases and the following defined search terms: occupational voice or occupational dysphonia or voice and occupational safety and health. To obtain the comprehensive relevant literature, no studies were excluded on the basis of study design. In total, 10 studies that investigated the impact of a voice training intervention on the vocal quality of professional voice users as a potential prevention strategy for voice disorders were selected for this review.

Results. The 10 studies ranged in design from observational to randomized controlled trials with mainly small sample sizes (N = 11–60). Nine studies showed that voice training significantly (P < 0.05) improved at least one voice-related measurement from the several investigated from baseline. Five studies reported that voice training significantly (P < 0.05) improved at least one measurement compared with no training.

Conclusions. Findings indicate that there is no conclusive evidence that voice training improves the vocal effectiveness of professional voice users, as a result of a range of methodological limitations of the included studies. However, some studies did show that voice training significantly improved the knowledge, awareness, and quality of voice. Therefore, there is a need for robust research to empirically confirm this, with implications for vocal health, and occupational safety and health policies. Key Words: Voice training–Vocal health–Vocal quality–Professional voice users–Occupational voice disorders–Review.

INTRODUCTION

Voice disorders are a global health problem that have been identified as a research and/or clinical priority in recent publications. The reported prevalence of voice disorders varies from the general population between 3% and 9% in the United States and approximately 4% in Australia to very high levels among several occupations, for example, 46% of call-center operators and 20–80% of teachers. The heavy vocal demands associated with particular professions increase the risk of occupational voice disorder, which is considered as a voice disorder because of work-related overuse or abuse and threaten working ability. Thus, voice disorders among the workforce can affect communicative, interactive, and economic efficiency of the organization. This, therefore, voice disorders are an important vocal health issue that needs to be addressed.

A professional voice user can be defined as an individual who depends on a consistent and appealing voice quality as a main tool in their employment. Those who have regular or chronic episodes of voice loss would generally be disadvantaged in their jobs and may need to seek alternative employment. It was identified in the literature that the risk factors of voice disorders for professional voice users within the workplace include background noise, poor air quality (dryness, dust), poor posture, and vocal loading. It has been indicated that these risk factors are cumulative but preventable.

Preventive strategies are recommended to reduce the risk of voice disorders among the working population. One suggested method of primary prevention is voice training for professional voice users. Although singing and acting professionals often receive training in voice care and preservation, the vast majority of professional voice users, such as teachers, are unaware of how to maintain or improve on their voice, which is their greatest professional asset and communication tool. The literature among the teaching profession reported that one of the main factors contributing to the high prevalence of voice disorders is the lack of voice training especially during teaching training courses.

A systematic review included studies related to the prevention of voice disorders and concluded that there is no evidence that voice training prevents voice disorders. Furthermore, as this was a systematic review, only randomized controlled trials...
(RCTs) were considered, and the more recently published RCTs were not included. At present, there is no review focusing solely on the impact of voice training for professional voice users, including various study designs. Therefore, the objective of this paper was to review the current published available research into the impact of voice training on the vocal quality of professional voice users, to provide implications for vocal health and recommendations for further research. In the literature, voice therapy and voice training are often used interchangeably as the same methods/techniques are used in both. For the purposes of this review, training is referred to as prevention, whereas therapy is used for treatment of voice disorders. This review will focus on studies (with various study designs) investigating the impact of voice training as a potential prevention strategy for voice disorders among professional voice users.

METHODS
A systematic search of the literature to locate studies was conducted on 18th February 2009 using the following electronic databases: CSA Illumina (earliest to 2009), Cochrane Library (earliest to 2009), EBSCO Host CINAHL (1981–2009), ISI Web of Knowledge: Web of Science (1970–2009); OvidSP Embase (1980–2009), OvidSP Medline (1950–2009), OVIDSP PsychINFO (1967–2009), and PubMed Central (earliest to 2009). These searches were performed using the following defined search terms: occupational voice or occupational dysphonia or voice and occupational safety and health. From these searches, 2653 studies were identified and then screened for inclusion in this review using the selection criteria below.

Inclusion criteria
- Investigated the impact of voice training-related intervention as a prevention strategy for voice disorders
- Study participants from any professional/occupational groups either qualified or in training
- All study participants not diagnosed or complained of voice disorders, that is, nonclinical population
- Study participants of working age (18–65 years)
- All study designs
- All outcome measures
- All types of interventions

Exclusion criteria
- Full paper not available in the English language

To obtain the comprehensive relevant literature, no studies were excluded on the basis of study design, study quality, outcome measures, type of intervention, or profession/occupation. References from the articles were also reviewed. Although 2653 potential publications were identified and screened, 2643 were excluded on the basis of the title and abstract not relevant, duplications or they did not fulfill the selection criteria (Figure 1). One study was rejected, as the full paper was not available in the English language. In total, 10 studies that investigated the impact of a voice training intervention on the vocal quality of professional voice users as a potential prevention strategy for voice disorders were selected for this review. The included studies and extracted data were independently determined and agreed by two authors (S.A.M. and O.M.D.). Figure 1 displays this study selection procedure.

RESULTS
Description of the studies
The description (design, participants, intervention groups, measurements, and measurement collection time points) of the 10 studies in this review is displayed in Table 1. The 10 studies had a diverse range of professional voice users, methodologies, training programs, and outcome measurements, and thus this made comparison between studies difficult.

Intervention—voice training
The participants in the intervention groups received voice training, whereas those in the control groups received no training (Table 1). The details of the voice training program in each of the 10 studies are presented in Table 2. The training program consisted of two main types of training: indirect and direct.

Impact of voice training on the voice of professional voice users
The impact of voice training on voice-related parameters from the 10 studies is summarized in Table 3. Although all of the 10 studies reported that voice training had a beneficial effect on voice, nine studies showed that training significantly \((P < 0.05)\) improved at least one voice-related measurement from baseline. In addition, five studies reported that training significantly \((P < 0.05)\) improved at least one measurement compared with control group, that is, no training.

From the 10 studies, the acoustic parameters were reported as the most frequent type of measurement to indicate significant differences between the groups of participants (Table 3). Duffy and Hazlett, and Ilomäki et al reported that direct training was more beneficial than indirect training among the postgraduate student teachers and primary school teachers, respectively, but this was only significant in the Ilomäki et al study. While Pasa et al showed that indirect training...
<table>
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<tr>
<th>Study</th>
<th>Design</th>
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<th>Intervention Groups</th>
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<th>Measurement Collection Time Points</th>
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</thead>
</table>
| Chan, 1994*20         | Comparative     | 25 female kindergarten teachers   | 1. Experimental—training (N = 12)  
2. Control—no training (N = 13) | 1. Acoustics (using Sonagraph):  
   - RAP  
   - Ratio of energy in 0- to 1-kHz band to energy in 1- to 5-kHz band in LTAS  
2. Electroglossotgraphic (using Laryngograph); EGG  
3. Voice diary (experimental group only) | 1. Baseline  
2. Posttraining—2 mo later |
| Stemple et al, 1994*21 | RCT             | 35 female graduate students      | 1. Experimental—training (N = 12)  
2. Placebo—placebo training (N = 11)  
3. Control—no training (N = 12) | 1. Acoustics (using Visi-Pitch):  
   - Fundamental frequency  
   - Jitter  
   - Frequency range  
2. Aerodynamics (using Visi-Pitch):  
   - Phonation volume  
   - Flow rate  
   - Maximum phonation time  
3. Clinical examination: Laryngeal video stroboscopic (using a rigid scope, stroboscopic lighting, and Wolf Station Tube Camera) | 1. Baseline  
2. Posttraining—28 d later |
| Broaddus-Lawrence et al, 2000*22 | Observational | 11 untrained singers (eight females; three males) | One group—all the participants received training (N = 11) | Questionnaires (N = 2):  
   - Knowledge of vocal hygiene  
   - Daily vocal habits and abuses, voice problems, and symptoms | 1. Baseline  
2. Posttraining—approximately 6 wk later |
| Lehto et al, 2003*18  | Observational   | 48 call-center customer service advisors (38 females; 10 males) | One group—all the participants received training (N = 48) | 1. Questionnaires (N = 2):  
   - Subjective voice problems and symptoms  
   - Impact of training (only completed after training)  
2. Clinical examination: perceptual voice analysis and laryngeal examination with a mirror by a Phoniatrician (one occasion) | 1. Baseline  
2. Posttraining—3 wk later |
| Duffy & Hazlett, 2004*12 | RCT            | 55 student teachers              | 1. Control—no training (N = 23)  
2. Indirect training (N = 20)  
3. Direct training—received indirect and direct training (N = 12) | 1. Questionnaires (N = 2):  
   - Vocology Screening Profile (VSP)  
   - Voice Handicap Index (VHI)  
2. Acoustic: voice quality using Dysphonia Severity Index (DSI) | 1. Baseline  
2. Posttraining—approximately 8 wk later |

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<tr>
<th>Study</th>
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<tbody>
<tr>
<td>Timmermans et al, 2004</td>
<td>Comparative</td>
<td>46 students of a school for audiovisual communication (33 males; 13 females)</td>
<td>1. Trained—training (N = 23)</td>
<td>1. Perceptual evaluation—Grade, Roughness, Breathiness, Asthenia, Strain (GRBAS) scale</td>
<td>1. Baseline</td>
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<td>2. Untrained—no training (N = 23)</td>
<td>2. Acoustics:</td>
<td>2. Posttraining—18 mo later</td>
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<td>• Lowest intensity using Multi-Dimensional Voice Program (MDVP)</td>
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<td>• Highest frequency using MDVP</td>
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<td>• Jitter using MDVP</td>
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<td>• Voice quality using Dysphonia Severity Index (DSI)</td>
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<td>3. Aerodynamic: maximum phonation time</td>
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<td>4. Questionnaires (N = 2):</td>
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<td>• Voice Handicap Index</td>
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<td>• Daily habits (risk factors), oral hygiene, medication, medical history (baseline only)</td>
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<td>5. Clinical examination: Videolaryngostroscopy (90°C Von Stuckraki rigid endoscope and stroboscopic light source; one occasion)</td>
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<tr>
<td>Lehto et al, 2005</td>
<td>Observational</td>
<td>45 call-center customer service advisors (35 females; 10 males)</td>
<td>One group—all participants received training (N = 45)</td>
<td>1. Questionnaires (N = 2):</td>
<td>1. Baseline</td>
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<td></td>
<td></td>
<td>• Subjective voice problems and symptoms</td>
<td>2. Postraining—2 wk after training (5 wk later)</td>
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<td>• Impact of training (only completed after training)</td>
<td>3. Follow-up—1.5 y after training</td>
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<td>2. Clinical examination: perceptual voice analysis and laryngeal examination with a mirror by a Phoniatrician (one occasion)</td>
<td>Data collection at all the time points at four different times of a day—morning, before, and after lunch break and at end of the working day</td>
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<td></td>
<td>controlled</td>
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<td>2. Control—no training (N = 20)</td>
<td>2. Acoustics (using The Computer Speech Laboratory; two occasions 3 mo apart):</td>
<td>2. Postraining—3 mo later</td>
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<td>• Fundamental frequency</td>
<td>3. Follow-up—12 mo later</td>
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<td>• Jitter</td>
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<td>• Shimmer</td>
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<td>• Noise-to-harmonic ratio</td>
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<td>3. Perception evaluation—GRBAS scale</td>
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<td>4. Aerodynamic (using The Computer Speech Laboratory; two occasions 3 mo apart):</td>
<td>maximum phonation time</td>
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<td>maximum phonation time</td>
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<tr>
<td>Study</td>
<td>Design</td>
<td>Participants</td>
<td>Measures</td>
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</table>
| Pasa et al, 2007      | RCT    | 37 primary school teachers (males and females) | 1. Vocal hygiene training (N = 13)  
2. Vocal function exercises (N = 10)  
3. Control—no training (N = 14) | 1. Questionnaires (N = 2):  
- Voice Handicap Index  
- Course benefit (3 and 12 mo)  
2. Questionnaires (N = 4):  
- Voice knowledge  
- Vocal use patterns at work  
- Vocal capabilities  
- Perceived benefit of intervention |
| Ilomäki et al, 2008    | RCT    | 60 female primary school teachers | 1. Voice training (N = 30)  
2. Voice Hygiene Lecture (N = 30) | 1. Acoustics (using Intelligent Speech Analyzer; two occasions before and after normal working day):  
- Fundamental Frequency  
- Equivalent sound level  
- Alpha ratio  
- Jitter  
- Shimmer  
2. Perception evaluation—using Judge Program (two occasions before and after normal working day):  
- Voice quality  
- Firmness of phonation  
3. Questionnaire [Visual Analogue Scales (VAS); before and after normal working day; and start and end of the term]:  
- Tiredness of throat  
- Voice quality and ease of phonation  
- Effects of intervention on voice quality, endurance, audibility and knowledge, support forms |

* Information as reported in the publications.
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<th>Study</th>
<th>Indirect Training</th>
<th>Direct Training</th>
<th>Format and Duration of Training</th>
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<tr>
<td>Chan, 1994&lt;sup&gt;20,1&lt;/sup&gt;</td>
<td>Vocal hygiene education (including vocal hygiene education techniques)&lt;sup&gt;36-42&lt;/sup&gt;</td>
<td>N/A</td>
<td>1 × 1.5 h workshop and daily practice of vocal hygiene at home for 2 mo</td>
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<td>Stemple et al, 1994&lt;sup&gt;21,1&lt;/sup&gt;</td>
<td>N/A</td>
<td>Vocal function exercises&lt;sup&gt;43&lt;/sup&gt;</td>
<td>~15–20 min twice daily with two repetitions each time, 7 d per week for 4 wk (28 d)</td>
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<tr>
<td>Broaddus-Lawrence et al, 2000&lt;sup&gt;22,1&lt;/sup&gt;</td>
<td>Education: anatomy and physiology of the phonatory mechanism; vocal abuse and misuse; organic and functional pathologies; etiology of disorders; effects on phonation; typical treatments for various disorders; voice techniques Written materials given</td>
<td>N/A</td>
<td>4 × 1 h class</td>
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<tr>
<td>Lehto et al, 2003&lt;sup&gt;18,1&lt;/sup&gt;</td>
<td>Education: theory of voice production, resonance, and articulation; vocal hygiene; balanced breathing patterns; body posture as a tool to reduce tension when speaking; dietary habits&lt;sup&gt;14&lt;/sup&gt;</td>
<td>Practice vocal exercises, eg, producing voice more economically; warm-up and cool-down voice&lt;sup&gt;44&lt;/sup&gt;</td>
<td>2-d training course + 1-d seminar</td>
</tr>
<tr>
<td>Duffy &amp; Hazlett, 2004&lt;sup&gt;12,5&lt;/sup&gt;</td>
<td>Education: mechanisms of normal voice production; amount and type of voice use; vocal behaviors thought to be phonotraumatic; hydration issues; lifestyle; and diet factors</td>
<td>Vocal techniques focused on posture, respiration, release of tension in the vocal apparatus; resonance; and voice projection</td>
<td>One session of each type of training</td>
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<tr>
<td>Timmermans et al, 2004&lt;sup&gt;19,1&lt;/sup&gt;</td>
<td>Education: voice and technique anatomy, and physiology of the vocal tract; vocal hygiene; rules of pronunciation and diction; hygiene education (emphasized on tobacco smoke, late meals); vocal abuse and stress&lt;sup&gt;15&lt;/sup&gt;</td>
<td>Vocal techniques: relaxation, natural posture, healthy breathing, voice production and voice parameters (loudness, pitch, resonance)&lt;sup&gt;46&lt;/sup&gt;</td>
<td>18 mo (30 h lectures, 60 h workshops, 60 h projects)</td>
</tr>
<tr>
<td>Lehto et al, 2005&lt;sup&gt;15,1&lt;/sup&gt;</td>
<td>Education: theory of voice production, resonance, and articulation; vocal hygiene; balanced breathing patterns; body posture as a tool to reduce tension when speaking; dietary habits&lt;sup&gt;14&lt;/sup&gt;</td>
<td>Practice vocal exercises, eg, producing voice more economically; warm-up and cool-down voice; relaxation of jaw and pharynx while producing nasal-, vowel and humming sounds&lt;sup&gt;44,47&lt;/sup&gt;</td>
<td>2-d training course + 1-d seminar + 6 mo later 1-d refresher course</td>
</tr>
<tr>
<td>Bovo et al, 2007&lt;sup&gt;23,1&lt;/sup&gt;</td>
<td>Education: vocal ergonomics norms Educational pamphlet—30 pages of theoretical notions and 15 pages of illustrated voice exercises</td>
<td>Vocal exercise techniques: training of efficient respiratory behavior through utilization of low abdominal-diaphragmatic breathing; training of laryngeal muscles relaxation using Jacobson-based whole-body relaxation techniques; manual circumlaryngeal therapy&lt;sup&gt;48&lt;/sup&gt;; relaxed voicing with elimination of hard glottal attacks—chewing voicing, yawn-sigh, chant talk, and pitch inflections; proper oral-nasal resonance (Lessac-based resonance therapy), and exercises for developing greater oral opening Record daily vocal abuse</td>
<td>12 h (lectures + group voice therapy) and practice encouraged at home</td>
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</table>
was significantly more beneficial in improving voice parameters compared with direct training in primary school teachers.

Ilomäki et al\textsuperscript{25} is the most recent study, and this RCT included the largest number of participants (N = 60). The authors reported that following the interventions, there was an increase in fundamental frequency and difficulty of phonation in the voice hygiene lecture group (indirect), with decreased perturbation, increased alpha ratio, easier phonation, and improved perceptual and self-reported voice quality in the voice training group (direct).

Three studies investigated and reported that voice training continued to have a positive effect on voice after the intervention was completed.\textsuperscript{15,23,24} Lehto et al\textsuperscript{15} showed a significant reduction in reported feeling of vocal strain, hoarseness, and voice impairment during the working day in female customer service advisors 1.5 years after the 2-day course and 1-day seminar, and 1-day refresher course 6 months later. Bovo et al\textsuperscript{23} reported a significant improvement in voice parameters, such as jitter, shimmer, maximum phonation time, Voice Handicap Index, and reduction in the global dysphonia rates up to 12 months after a training course with over 12 hours class time plus exercises at home. Pasa et al\textsuperscript{24} showed a significant improvement in reported voice knowledge and symptoms among teachers after a 10-week training schedule of a total of 3.5 hours during four sessions.

**DISCUSSION**

From a search of the literature, 10 studies were selected for inclusion in this review on the impact of voice training on the vocal quality of professional voice users to provide implications for vocal health and recommendation for further research. Although the studies included in this review indicated that a voice training program may be effective, these studies have not met the criteria to fully confirm the significance and validity of evidence presented. As there is no published well-designed, controlled, and powered study, preferably RCT comparing groups of participants on the voice training program with those who do not receive training. Nine studies showed that voice training significantly improved voice measurements, but this was reported for at least one measurement of the several investigated.\textsuperscript{15,18,19,21,23,25} On the basis of the results from the studies in this review, there is not enough evidence to conclude that voice training improves the vocal quality of professional voice users. This was because of the methodological limitations of the included studies, the main ones were low participant numbers (N = 11–60), poorly defined risk variables, and limited RCTs in the research area. However, these studies were of an experimental nature, and those that included RCTs were able to provide findings based on randomized and controlled conditions, allowing for comparisons with different methods of training.\textsuperscript{12,21,23–25} Sampling methods were mainly convenience sampling, with only one study reporting a power calculation.\textsuperscript{24} However, some studies did show that voice training significantly improved the quality of voice.\textsuperscript{15,18,19,21,23,25} Studies showed a significant improvement in the range of voice-related parameters (ie, voice knowledge; voice symptoms; vocal
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<th>Study</th>
<th>Effect of Training</th>
<th>Results</th>
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<tr>
<td>Chan, 1994^20</td>
<td>Significant improvements in RAP, and ratio of energy in 0- to 1-kHz band to energy in 1- to 5-kHz band in LTAS and duty cycle (EGG parameter)</td>
<td>RAP, LTAS, and duty cycle significantly improved in training group compared with nontraining group</td>
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<tr>
<td>Stemple et al, 1994^21</td>
<td>Significant improvements in phonation volume, flow rate, maximum phonation time, and frequency range</td>
<td>Phonation volume, flow rate, maximum phonation time, and frequency range significantly improved in training group compared with control (no training) and placebo training groups</td>
</tr>
<tr>
<td>Broadus-Lawrence et al, 2000^22</td>
<td>Significant improvement in stops in a phrase and fatigues easily after training Minimal improvements in vocal hygiene behaviors and perceptual voice characteristics but were nonsignificant</td>
<td>N/A</td>
</tr>
<tr>
<td>Lehto et al, 2003^18</td>
<td>Significantly were less vocal fatigue, hoarseness, and worsening of the voice and also improved vocal quality but these effects were greater in females</td>
<td>N/A</td>
</tr>
<tr>
<td>Duffy &amp; Hazlett, 2004^12</td>
<td>Minimal nonsignificant improvement in voice quality using Dysphonia Severity Index for both indirect and direct training groups and also minimal nonsignificant improvement in Vociology Screening Profile and Vocal Handicap Index for direct training group but not indirect training group</td>
<td>Voice quality using Dysphonia Severity Index slightly improved for both indirect and direct training groups compared with nontraining group but not significant and also Vociology Screening Profile slightly improved for direct training group compared with nontraining group but not significant</td>
</tr>
<tr>
<td>Timmermans et al, 2004^19</td>
<td>Significant improvements in voice quality using the Dysphonia Severity Index, G score on GRBAS for trained group, and Voice Handicap Index for both trained and untrained groups</td>
<td>Voice quality using the Dysphonia Severity Index significantly improved in training group compared with nontraining group, significant improvements of G score on GRBAS for trained group, and Voice Handicap Index for both trained and untrained groups</td>
</tr>
<tr>
<td>Lehto et al, 2005^15</td>
<td>Significant reduction in reported feeling of vocal strain, hoarseness, and voice impairment during the working day</td>
<td>N/A</td>
</tr>
<tr>
<td>Bovo et al, 2007^23</td>
<td>Significant improvement in jitter, shimmer, maximum phonation time, Voice Handicap Index, and amelioration in the global dysphonia rates</td>
<td>Jitter, shimmer, maximum phonation time, Voice Handicap Index, and amelioration in the global dysphonia rates significantly improved in training group compared with nontraining group</td>
</tr>
<tr>
<td>Pasa et al, 2007^24</td>
<td>Improvement in voice knowledge and symptoms for vocal hygiene group (indirect) and vocal function exercises group (direct) but only significant for vocal hygiene group (indirect)</td>
<td>Voice knowledge and symptoms significantly improved in vocal hygiene training group (indirect) compared with nontraining group (control)</td>
</tr>
<tr>
<td>Ilomäki et al, 2008^25</td>
<td>Significant increase in fundamental frequency and difficulty of phonation in the voice hygiene lecture group (indirect) and decreased perturbation, increased alpha ratio, easier phonation, improved perceptual and self-reported voice quality in the voice training group (direct)</td>
<td>N/A</td>
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* Information as reported in the publications.

fatigue; hoarseness; worsening of the voice; vocal quality; vocal strain; voice impairment; fundamental frequency; perturbation; alpha ratio; perceptual; phonation volume; maximum phonation time; flow rate; frequency range; jitter; shimmer; Voice Handicap Index; amelioration in the global dysphonia; relative average perturbation [RAP]; ratio of energy in 0- to 1-kHz band to energy in 1- to 5-kHz band in long-time average spectrum [LTAS]; duty cycle—EGG parameter) following
voice training, and concluded that training may be beneficial for the professionals sampled. Therefore, there is a clear indication that voice training may have a beneficial effect on the vocal quality (as measured by Dysphonia Severity Index and GRBAS) of professional voice users. Furthermore, with more published studies, especially RCTs, there is a growing evidence that voice training is beneficial for professional voice users, especially improved voice knowledge and acoustic parameters, with less reported voice symptoms. However, there is a need for robust research with powered sample sizes to confirm that voice training improves the vocal quality of professional voice users.

This outcome is similar to the finding from a previous systematic review of studies on the prevention of voice disorders. This previous systematic review included two prevention studies, which both were in this present review. The authors concluded that there is no evidence of effectiveness of voice training in preventing voice disorders. This conclusion was based on a lack of RCTs and study methodology limitations, including low sample sizes. This present review considered the research area further and investigated the current published available research into the impact of vocal training on the vocal quality of professional voice users (all study designs; N = 10), to provide implications for vocal health and recommendations for the further research.

Although the occupational risk factors for voice disorders are identified in the literature, it is unknown if occupation is a cause, exacerbates individual factors, or is combination of both, among professional voice users. In addition, it is unclear whether a particular occupation perpetuates or predisposes employees to voice disorders. There is no published study that investigated the vocal quality of employees before and after withdrawing from their occupation. Furthermore from the current voice research literature, there are inconsistencies in the definitions of assessment and methodologies, and also there are medical and sociocultural inconsistencies. Therefore, there is a need to develop more consistent methodologies to allow comparison of findings across studies.

The occupations included in the studies were teaching (50%), singing, customer service, and audiovisual communication and graduate students. There is a substantial epidemiological and physiological evidence that these groups especially teachers and telephone users (customer service) are at risk of occupational voice problems. In addition in voice research, there is a need for clarity between prevalence studies and efficacy studies, and also risk evidence and training evidence. Thus, there is a need for further research in these areas.

The studies used a range of questionnaires, acoustics/aerodynamics, or clinical examinations as their measurement tools, which were those commonly cited in the voice research literature. Many of the studies developed their own questionnaires. The Voice Handicap Index was included in three studies, two studies analyzed voice quality using the Dysphonia Severity Index, and two studies evaluated voice perception using the GRBAS scale. Furthermore, few studies used the same measurement tools and thus it was difficult to compare studies. Thus, there is a need for the development of more validated standardized measurement tools for voice research and for studies to more consistently use these validated tools.

The voice training in these studies included indirect and direct methods. Although there was no clear evidence on the difference between indirect and direct voice training, two studies indicated that direct training appears to be more beneficial than indirect training for voice quality, whereas another study reported the opposite effect among the teaching profession. The method of delivery of training was mainly in a formal setting, but two studies reported that the participants were encouraged to practice the techniques at home. Although daily practice of techniques may be useful to encourage and sustain effective vocal behaviors, the issue of compliance can be difficult to measure in research studies. The impact of the different methods of delivery is unknown as this was not reported or investigated in any study. The duration of the training varied enormously among the studies; however, this depended upon the aims of the studies, for example, training was introduced in the work environment where time may be limited compared with a formal course delivered to students. There was not enough evidence to confirm if a longer period of training would improve vocal quality, or to prevent vocal deterioration. However, the optimum duration of a training program has not been investigated.

The vast majority of the studies in this review were published quite recently within the last decade indicating that voice training for professional voice users is a relatively new and growing research area. Therefore, further research is required, which will have implications for vocal health, and occupational safety and health policies.

Implications for vocal health
There is a defined population of professional voice users, which includes individuals who depend on good vocal quality as a main tool for their employment, such as teachers (students or qualified), call-center customer service advisors, or audiovisual communicators. With a growth in communication industries, such as contact centers, this population will continue to increase. Furthermore with a growing communication industry, vocal demands will increase among this population thus potentially increasing the risk of vocal health problems and voice disorders. On the basis of the findings from this review, the implications for vocal health are below.

1. Prevention rather than treatment of voice disorders among the professional voice user population

There is an emerging universal agreement among researchers within this area that preventive measures for voice disorders should be taken. Potential preventive strategies, such as voice screening, vocal health education, and voice training, may be required for voice disorders among the professional voice user population. These potential preventive strategies could be developed as prevention tools for professional voice users. Research suggests that educating professional voice users, such as...
teachers to become aware of voice problems, and take appropriate action may contribute to prevent the development of voice disorders. In addition, it is a duty of care for the employer to consider the potential occupational risks for employees, such as voice disorders. Therefore, resources should be used in the prevention rather than only in the treatment of voice disorders. Therefore, employers would fulfill legal obligations and improve the vocal health of employees. This could provide further benefits for the individual and company in terms of communication (eg, effective interaction, clearer speech, higher first time call resolution), health (eg, less days of work on sick leave, improved vocal and psychological health, and well-being), and economically (eg, higher production levels, lower staff absenteeism, reduction in recruitment costs) to prevent rather than to treat voice disorders.

2. Identification of the levels of risk of voice disorders among professional voice users

There is a need to identify levels of risk of developing voice disorders within occupations and professional contexts to determine individuals who are most susceptible to voice disorders. Professional voice users at higher risk of developing voice disorders are perhaps most likely to benefit from interventions, such as voice training. Therefore, if the higher risk professional voice users are identified and given an intervention, thus this may lead to a more cost-effective prevention strategy.

3. Occupational safety and health policies on occupational voice disorders should be established and reviewed regularly

The risk factors for occupational voice disorders, such as background noise and poor air quality, can be considered as a health and safety issue within the workplace. According to the Health and Safety Executive, and current UK, European, and U.S. occupational safety and health regulations, employers are obliged to provide resources to prevent occupational risks, thus based on these reports, professional voice users should be provided with a safe working environment and/or with information on vocal care.

In the UK, The Industrial Injuries Advisory Council published a position paper on occupational voice loss, which considered the risk of voice loss in those employed in occupations with high levels of noise. The report concluded that although there is a number of research studies published, there is insufficient current evidence for occupational voice loss to meet the requirements for prescription by the Council. With further research within the area, there may be the possibility of adequate evidence for occupational voice loss to meet the requirements for prescription by this Council in the future.

A recent study indicates that policy and practice among the teaching profession needs to be considered to improve the vocal health of teachers. The authors’ suggestions included that the management teams of schools should be aware of how voice health can contribute to teachers’ absenteeism and to monitor the vocal health of teachers. Teachers should be made aware of the vocal health facilities available, and those identified with voice problems should be given advice on available support within the school. Therefore, occupational safety and health policies on occupational voice disorders should be established and reviewed regularly in accordance to emerging evidence.

Recommendations for further research
Following the review of 10 studies investigating voice training for professional voice users, the existing research raises more research questions that need to be addressed. Further research is required to:

- Determine an universal accepted definition of voice disorders;
- Determine definitions of assessment and methodologies, which should be used consistently;
- Determine standardized measurement tools, which can be used universally;
- Determine if occupation is a cause or exacerbates voice disorders among professional voice users;
- Conduct a large-scale risk assessment to identify the prevalence of precipitating and perpetuating factors contributing to occupational voice disorders and to classify the levels of “risk” of occupational voice disorders;
- Confirm that voice training improves the vocal quality of professional voice users using a well-designed, controlled, and powered study, preferably RCT;
- Investigate different types of voice training programs;
- Determine the most effective voice training program in terms of format, method of delivery, and duration;
- Investigate cost-effective methods of providing voice training to professionals with high vocal demand.

CONCLUSION
This article reviewed the published literature focusing solely on the impact of voice training on vocal quality of professional voice users, and providing implications for vocal health and recommendations for further research. This review remains inconclusive because of the methodological limitations of the included studies. However, all the studies within this review concluded that voice training may be beneficial (as indicated by a range of voice-related parameters) for professional voice users. Some studies did show that voice training significantly improved the knowledge, awareness, and quality of voice. Therefore, there is a need for robust research with powered sample sizes to confirm whether voice training improves the vocal quality and efficiency of professional voice users. Furthermore, this research has implications for vocal health, including preventive care within occupational safety and health policies.

REFERENCES


