Has Research Failed to Identify Risk Factors for Voice Disorders? A Systematic Review of Evidence in Teachers☆

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SUMMARY: Objectives. Dysphonia poses a major occupational risk for teachers. Despite the growing interest in this area of research, there is still no comprehensive understanding of the risk factors.

Methods. This systematic review examined risk factors for voice disorders among K-12 teachers. It analyzed 111 publications from 33 countries that were published between January 2013 and February 2024. The novel SIMU Matrix was used to categorize the factors as social/individual or modifiable/unmodifiable.

Results. Based on the proportion of studies that reported significant associations, 10 factors demonstrated the strongest association with voice disorders. Unmodifiable social factors included elementary teaching (14/29 studies). Unmodifiable individual factors included gender (21/40 studies), age (12/41 studies), and professional experience (12/34 studies). Notably, a paradox regarding gender emerged: women reported more voice problems through self-assessments yet demonstrated better vocal health through laryngological and acoustic examinations. Modifiable social factors included workload (13/31 studies) and noise exposure (14/21 studies). Modifiable individual factors included ENT symptoms (17/23 studies), chronic stress (12/15 studies), loud speaking (11/14 studies), and frequency of sick leave (11/13 studies). Assessment methods varied considerably, with a concerning reliance on single-item measurements, despite the fact that voice disorders are recognized as multidimensional conditions.

Conclusions. This review identified numerous factors associated with voice disorders in teachers, demonstrating the complexity of this issue. Some of these factors are modifiable, offering concrete intervention opportunities regarding workplace conditions and health behaviors. However, despite extensive research investigating an even broader range of potential influences, there is still no consensus on key risk factors. This may reflect methodological limitations, including heterogeneous assessments, inadequate statistical corrections, and predominantly cross-sectional designs. Future research requires standardized assessment approaches, appropriate statistical rigor, and longitudinal designs to establish causal relationships and inform evidence-based prevention strategies.

Key Words: Voice disorders–Dysphonia–Teachers–Occupational health–Risk factors–Systematic review.

INTRODUCTION

Voice disorders represent an occupational hazard for teachers, who rely extensively on their vocal apparatus as a primary tool in their professional practice. Voice disorders are referred to as dysphonia, which is "characterized by altered vocal quality, pitch, loudness, or vocal effort that impairs communication and/or quality of life."[1] Teachers face disproportionate risk compared with other professions, making vocal health preservation a critical occupational priority. Identifying specific factors associated with voice disorders in teaching professionals is not merely academic research, but an essential step toward developing effective preventive strategies—interventions that should take precedence over treatment approaches. Beyond professional implications, vocal impairments often coincide with broader health concerns, including stress, sleep disturbances, and upper respiratory tract conditions.[2–6] Understanding contributing factors enables a more comprehensive approach to health promotion among educators. Additionally, the economic burden of voice disorders—through work absences and medical treatments—presents a substantial cost that could be mitigated through targeted preventive measures.[7–10]

Recent reviews of teacher vocal health have identified numerous risk factors while highlighting important research gaps. Cantor-Cutiva et al[11] conducted the first systematic review in 2013, examining 23 publications that revealed connections between classroom acoustics and vocal disorders, though they noted methodological inconsistencies across studies. The authors recommended future investigations incorporate objective measurements of workplace conditions (eg, reverberation time and speech intelligibility) alongside objective voice function assessments to complement self-reported data. Additionally, the authors emphasized the urgent need for longitudinal studies examining how vocal disorders develop, their occupational risk factors, and their effects on teaching performance over time.

One year later, Martins et al[12] published a narrative review identifying environmental conditions, ambient sound

levels, and personal health as primary contributors to voice problems among teachers. They emphasized the importance of evaluating prevention program effectiveness.

Through meta-analysis, Byeon[13] established several risk factors: "gender, upper airway problems, caffeine consumption, speaking loudly, number of classes per week, and resignation experience due to voice problems." Their work highlighted the necessity of precalculated sample sizes and standardized assessment protocols to enable cross-country comparisons.

Carrillo-Gonzalez et al[6] expanded research focus with a systematic review on specific factors, demonstrating that elevated stress levels corresponded with increased vocal difficulties, while adequate sleep duration was associated with improved vocal function. Due to the limited quality of included studies, the authors advocated for additional research in this area.

Since previous reviews relied on earlier data and included expectations for future research, this study provides an updated analysis of the literature to identify current risk factors for voice disorders among teachers, which complements a current meta review. In addition to examining these risk factors, we evaluate whether the expectations outlined in prior reviews have been met, focusing particularly on assessment methodologies, longitudinal investigations especially on prevention programs. Through this approach, we aim to map the current research landscape and highlight existing knowledge gaps in the field of teacher vocal health.

This systematic review addresses therefore the following research questions:

1. What are the current identified risk factors for voice disorders among teaching professionals based on research published since the last systematic reviews?
2. In recent research, to what extent have recommendations from previous reviews been implemented, particularly with regard to methodological improvements in assessing and measuring voice disorders and their risk factors in teacher populations?

METHOD

The study protocol was prospectively registered with PROSPERO under the identifier CRD42024604667. A comprehensive search of both PROSPERO and Cochrane databases was conducted to verify the absence of existing systematic reviews addressing identical research objectives. Supplementary materials are available through the Open Science Framework (OSF) project repository (https://osf.io/9jgtp/).

Literature search

A comprehensive literature search was conducted on February 12, 2024, using three major databases: PubMed/MEDLINE and the two Web of Science Core Collections, "Science Citation Index Expanded" and "Social Sciences Citation Index" to achieve creditable results. The study acknowledges the presence of alternative databases such as IEEE Xplore, ACM Digital Library, ScienceDirect, JSTOR, EBSCO, and Taylor & Francis. However, we found through sample verification that most publications from these sources are already contained within the Web of Science or PubMed/MEDLINE databases. For the Web of Science, we searched within the "Topic" field, applying "Article" as a refinement category, while in PubMed, we searched within the "Title/Abstract" field with no further refinement. The search was limited to publications from January 2013 to February 2024, written in English or German. We constructed a search string using the following terms: (teacher* OR teaching OR lehr*) AND ("vocal health" OR "voice screening" OR "vocal fatigue" OR "voice disorder*" OR "voice problem*" OR "vocal load" OR "vocal loading" OR "vocal dose" OR "voice handicap" OR hoarseness OR stimm* OR dysphonie OR heiserkeit).

Literature selection

Selection involved a two-step screening process conducted independently by each author to select articles with an eye toward maximizing inclusion. The first round of screening assessed based on title and abstract whether the focus was voice health of K-12 teachers (primary and secondary education). Relevant, retrievable publications advanced to the second round of screening, which involved full-text review using predefined exclusion criteria. Those encompassed both formal and thematic dimensions. Formally, we required empirical studies published in peer-reviewed journals. Thematically, we excluded studies that: (1) deliberately recruited individuals with pathological conditions, (2) did not predominantly focus on K-12 teachers, or (3) did not assess vocal health or dysphonia. A PRISMA flow diagram documented the selection process and coded studies.

Content coding

All publications were read in their entirety and assessed for answers to review questions. Basic information was recorded, including country of study, study design (cross-sectional or longitudinal), study timeframe, sample size, and teachers' grade level.

For each statistical analysis using vocal health as the dependent variable, we systematically coded:

1. Assessment method (eg, VHI-10, VHI-30, VFI, and laryngoscopic examination)
2. Statistical model (eg, mean difference, multifactorial regression)
3. Risk factor (eg, gender, age, and workload)
4. Statistical significance ($P < 0.05$ or $P \geq 0.05$)

Similar risk factors received identical codes. We additionally coded interventions or environmental changes (eg, COVID-19, school building renovations). Our coding conventions further specified that: (1) associations

between two measures of voice health were not coded, and (2) fundamental frequency was coded as a risk factor and not as a measure of voice health, as we assume that fundamental frequency represents a physiological characteristic of voice production rather than a direct indicator of vocal health or pathology.

To ensure coding reliability and reduce some risk of bias, the first 10% of articles (*n* = 12) were coded independently by all four researchers. Using MAXQDA 2024,[14] segment overlap was calculated for all six coder pair combinations for each article, with a minimum code overlap threshold of 95%. Kappa[15] was used as the agreement metric to account for chance-based code selection probabilities. Initial high variability (κ < 0.75) prompted coding scheme refinement and additional coder training. A subsequent round of coding (*n* = 6) achieved a sufficient mean agreement of κ = 0.93 (range of all pairwise combinations: 0.77-1.00).

Analytic strategy

Due to the diversity of assessment methods, ranging from single items to comprehensive, validated instruments and objective clinical assessments, a meaningful meta-analytic synthesis could not be achieved without substantially reducing the included literature. Consequently, a systematic review was selected as the optimal approach to offer a thorough examination of the research landscape and illuminate potential risk factors amidst methodological variability. Utilizing MAXQDA 2024 and R (version 4.4.2 "Pile of Leaves"),[16] we examined the code convergence of each coded risk factor and its statistical significance to determine the level of evidence. By simultaneously considering the codes for assessment methods and statistical models, we enabled a more nuanced understanding of the existing evidence.

RESULTS

Sample characteristics

Figure 1 illustrates the identification process for relevant publications. All publications and decisions made at every step can be found in the OSF Appendix Table 1. The literature search yielded 618 potentially eligible publications after removing duplicates. Of these, 416 articles were excluded during the first screening based on title and abstract review. An additional 10 articles were not retrievable in full text. The second screening of full-text articles resulted in 81 further exclusions, with specific reasons detailed in the PRISMA flow diagram. The final analysis included 111 publications on teacher voice health from 33 countries. Brazil dominated the research landscape (*n* = 20), followed by India (*n* = 11) and the United States (*n* = 10). Moderate contributions came from Iran (*n* = 8), China (*n* = 6), Italy (*n* = 5), and Saudi Arabia (*n* = 5). European representation included Finland, Germany, and Spain (each *n* = 4), the United Kingdom (*n* = 3), and Belgium, Latvia, Portugal, and Sweden (each *n* = 2). African research was limited to
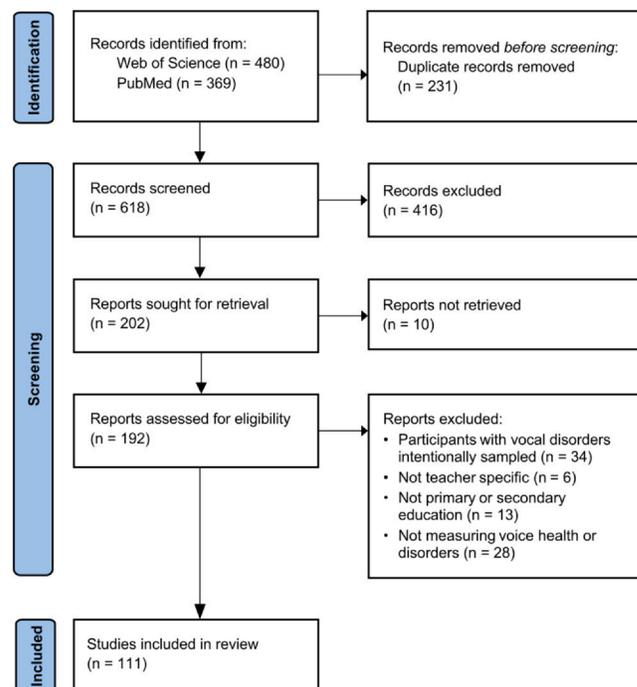

FIGURE 1. PRISMA flow diagram.

Egypt (*n* = 2) and Nigeria (*n* = 1). Single publications originated from Chile, Cyprus, Denmark, France, Ireland, Jordan, Korea, New Zealand, Poland, Taiwan, Turkey, and the United Arab Emirates.

The review encompassed 30 longitudinal and 81 cross-sectional studies. Longitudinal investigations examined teachers' voices over different periods of time. Short-term studies measured changes within a single hour or day, typically assessing voice before and after teaching or vocal loading tasks.[17–24] Medium-term research spanned weeks to months, often evaluating intervention effects.[25–36] The longest studies tracked teachers from one to ten years.[37–43] Notably, only half of the longitudinal studies (15 out of 30) focused on intervention evaluation.

As shown in Figure 2, publications spanned from 2013 to 2025, with one additional manuscript listed as "in press". These figures represent print dates rather than online publication dates, which for some journals can precede print publication by up to 2 years, explaining why some studies appear with print dates beyond the original search
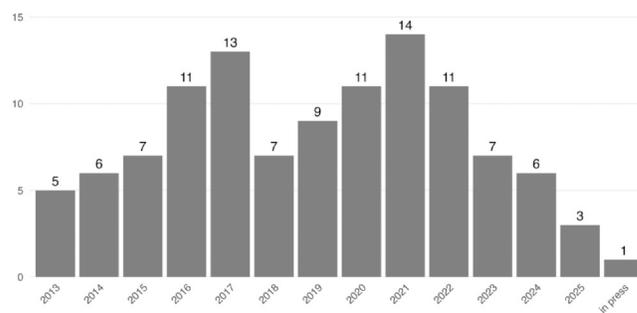

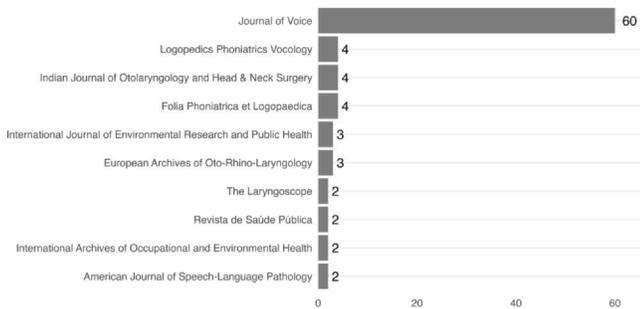**FIGURE 2.** Number of publications by year.

FIGURE 3. Number of publications by journal with more than two publications.

timeframe. Research output demonstrated an overall upward trend from 2013 ($n = 5$) to a peak in 2021 ($n = 14$), with occasional fluctuations.

Figure 3.

Sample sizes across the selected studies exhibited substantial heterogeneity, ranging from small-scale investigations with fewer than 20 participants to large cohorts of 47 823 participants.[44] Gender distribution revealed a pronounced female predominance, with 17 studies recruiting exclusively female cohorts.

Assessment methods

From the 111 publications identified in our systematic review, 88 papers contained codable information beyond basic study characteristics and were selected for in-depth analysis (Table 1 for the 88 studies and OSF Appendix Table 2 for all 111 studies). The remaining 23 papers lacked substantive information relevant to our research questions (eg, studies only correlated different voice health measures without risk factors, studies lacked statistical analysis of risk factors). Our coding revealed considerable heterogeneity in assessment tools across studies (for a detailed list, see OSF Appendix Table 3). The most frequently employed instruments included validated questionnaires such as the Voice Handicap Index (VHI) in various forms (VHI-30, VHI-12, VHI-11, and VHI-10), the Vocal Fatigue Index (VFI), and the Voice-Related Quality of Life (V-RQOL). Some studies utilized acoustic parameters, including jitter, shimmer, harmonics-to-noise ratio (HNR), noise-to-harmonics ratio (NHR), and maximum phonation time (MPT). Perceptual evaluations commonly involved the GRBAS scale, while physiological examinations included laryngoscopy. Notably, numerous studies relied on single-item questions or self-designed questionnaires.

SIMU matrix of risk factors

To categorize the multifaceted risk factors affecting vocal health in educational settings, we developed the SIMU Matrix (Social, Individual, Modifiable, Unmodifiable; see Figure 4). This framework organizes factors along two dimensions—social versus individual and modifiable versus unmodifiable—creating four quadrants that provide a structured approach to understanding variables influencing vocal health outcomes:

- *System Constants* (Unmodifiable and Social): These represent structural elements of the educational system that remain relatively fixed and are determined at a societal level, including aspects of school organization and institutional parameters.
- *Individual Prerequisites* (Unmodifiable and Individual): These factors constitute the unchangeable individual characteristics that form the foundation of a person's vocal profile, including sociodemographic variables and occupational background.
- *Societal Scope of Action* (Modifiable and Social): This domain encompasses environmental and workplace conditions that can be altered through collective action or institutional policy changes, such as organizational factors and classroom acoustics.
- *Individual Scope of Action* (Modifiable and Individual): This quadrant contains factors under individual control to varying degrees, including physical and mental state of health, vocal usage patterns, lifestyle habits, and pedagogical choices.

In the following sections, we report all coded risk factors for each of the four areas of the SIMU Matrix. We included variables that appeared in more than two papers, resulting in a total of 57 categories (for a detailed list including paper references, see OSF Appendix Table 4).

System constants (social and unmodifiable)
Age-based educational level
Of the 29 studies investigating grade level and type of school, which were grouped together due to their shared focus on the age of pupils, 14 ($N = 120$-47 823) demonstrated significant relationships with voice health indicators. Nine studies found elementary school teachers faced more voice problems compared with other school types, measured via VHI-30,[39,70] VHI-10,[102] VFI,[58] VTD,[101] and single items.[87,45,78,91] Conversely, two studies reported contradictory findings.[49,84] Additionally, three studies found that kindergarten was associated with lower voice problem risk compared with elementary and secondary schools,[44,70,102] whereas one study noted the opposite trend.[77] For secondary school variations, a Korean study found more frequent hoarseness among middle school teachers than high school teachers.[79] Importantly, two studies revealed gender-specific patterns, with school-type effects observable only in female teachers.[58,87]

School location
Among eight studies exploring school location, three revealed significant results. One study ($N = 47 823$) found rural teachers experienced more voice problems than urban teachers through comprehensive medical examinations.[44] Another ($N = 140$) revealed teachers in schools near other schools reported more voice

TABLE 1.
Overview of the 88 Studies With In-Depth Analysis

First Author (Year)	Country	Teachers	Nonteachers	Dependent Variable
Abo-Hasseba (2017)[45]	Egypt	85 F, 55 M		Single item
Acurio (2014)[17]	Chile	18 F, 9 M		VHI-30, jitter, shimmer, HNR, NHR, MPT, and GRBAS
Akinbode (2014)[46]	Nigeria	275 F, 66 M	128 F, 27 M[b]	Self-designed questionnaire
Alanazi (2018)[47]	Saudi Arabia	186 F/M	260 F/M[b]	VHI-10
Alarfaj (2024)[48]	Saudi Arabia	262 F, 73 M		VHI-10, single item
Alarouj (2022)[49]	Kuwait	988 F, 832 M	357 F, 398 M[b]	VHI-10
Albustan (2018)[50]	Kuwait	180 F, 180 M	50 F, 50 M	VHI-30
Alexander (2019)[23]	India	15 F, 15 M		Jitter, shimmer, and HNR
Alkhunaizi (2025)[51]	Saudi Arabia	271 F, 224 M		VHI-10
Alrahim (2018)[52]	Saudi Arabia	103 F, 84 M		Single item
Alshuhayb (2025)[53]	Saudi Arabia	229 M, 375 F		Single item
Alva (2017)[54]	India	88 F, 17 M		Single item
Andriollo (2023)[25]	Brazil[a]	56 F		MPT
Arya (2022)[18]	India[a]	50 F, 50 M		Vocal Fatigue Questionnaire, single item, jitter, shimmer, and HNR
Banks (2018)[55]	United States	506 F		VFI
Banks (2025)[56]	United States	593 F, 147 M		VFI
Bottalico (2017)[57]	Italy	24 F, 2 M		Holistic medical examination
Bovo (2013)[26]	Italy[a]	40 M		VHI-30, VAS
Cantarella (2023)[58]	Italy	195 F		VFI
Cantor-Cutiva (2015)[59]	Colombia	441 F, 180 M	34 F, 27 M	Self-designed questionnaire
Cantor-Cutiva (2016)[38]	Colombia	407 F, 167 M		GRBAS
Cantor-Cutiva (2016)[60]	Colombia	407 F, 167 M		Single item
Cantor-Cutiva (2017)[61]	Italy	27 F		VAS
Cantor-Cutiva (2022)[62]	United States	542 F, 124 M		VFI
Cardoso (2021)[63]	Portugal	18 F, 6 M		Self-designed questionnaire
Cardoso (2021)[64]	Portugal	18 F, 6 M		Self-designed questionnaire
Chowdhury (2019)[65]	India	60 F/M		VHI-10
de Brito Mota (2019)[66]	Brazil	160 F, 48 M		SIVD
de Magalhães (2025)[67]	Brazil	526 F, 108 M		SIVD
Devadas (2017)[68]	India	622 F, 122 M		Single item
Faham (2016)[27]	Iran	127 F		VHI-30
Faham (2017)[69]	Iran	99 F		Single item
Feng (2022)[70]	China	2758 F, 382 M		VHI-30
Fu (2023)[44]	China	35617 F, 12206 M		Holistic medical examination
Gadepalli (2019)[71]	United Kingdom	356 F, 98 M	191 F, 113 M	VHI-10
García-Real (2024)[72]	Spain	65 F, 25 M		Multidimensional Vocal Scale for Teachers
Gassull (2020)[28]	Spain	22 F/M		VHI-10, self-designed questionnaire, and GRBAS
Hermes (2016)[73]	Brazil	335 F, 59 M		Single item
Herndon (2019)[19]	United States[a]	9 F, 3 M		VAS, single item, CPP, and low/high ratio
Hunter (2017)[74]	United States	518 F, 122 M		VFI
Hunter (2020)[75]	United Kingdom	96 F, 26 M		VFI
Joshi (2022)[76]	India	200 F		Laryngoscopy
Karatayli Ozgursoy (2022)[30]	Turkey	81 F, 28 M		VHI-10, self-designed questionnaire, single item, VSRS, and multivariate assessment
Karjalainen (2020)[31]	Sweden	23 F, 2 M		VHI-11, VAS
Khoramshahi (2021)[20]	Iran	129 F, 50 M	15 F, 14 M[b]	VTD, VFI
Kristiansen (2014)[21]	Denmark	35 F/M		Single item
Kyriakou (2020)[77]	Cyprus	422 F, 27 M		VHI-12
Leão (2015)[78]	New Zealand	1363 F, 516 M		Self-designed questionnaire, single item
Lee (2018)[79]	Korea	789 F, 512 M		Single item

TABLE 1 (*Continued*)

First Author (Year)	Country	Teachers	Nonteachers	Dependent Variable
López (2017)[80]	Spain	85 F, 31 M		VHI-10, jitter, shimmer, NHR, MPT, GRBAS, PPQ, and RAP
Lu (2017)[81]	China	569 F, 295 M		VHI-10, V-RQOL
Lyberg-Åhlander (2014)[82]	Sweden	24 F, 4 M		Single item
Marie (2014)[83]	Jordan	140 F, 149 M	50 F, 50 M[b]	VHI-10
Menon (2021)[84]	India	651 F, 51 M		VHI-30, single item
Moy (2015)[85]	Malaysia	5066 F, 973 M		VHI-10
Munier (2016)[86]	Ireland	304 M/F		Self-designed questionnaire
Narasimhan (2022)[22]	India	15 F, 15 M		VFI, jitter, shimmer, HNR, and CPP
Nusseck (2020)[87]	Germany[a]	400 F, 136 M		VHI-12, single item, laryngoscopy, and DSI
Nusseck (2021)[41]	Germany	67 F, 21 M		VHI-12, DSI
Patjas (2021)[88]	Finland	106 F, 15 M		VHI-10, single item
Penha (2023)[33]	Brazil[a]	39 F, 20 M		V-RQOL, SIVD, and VHHQ
Pereira (2015)[34]	Brazil	24 F, 7 M		VHI-10, noise/Rauschen, jitter, shimmer, and GNE
Phadke (2019)[89]	Egypt	85 F, 55 M		Single item
Pizolato (2013)[35]	Brazil	63 F, 7 M		V-RQOL
Putus (2024)[42]	Finland	1296 F, 320 M		Single item
Remacle (2018)[43]	France	22 F		Jitter, shimmer, and HNR
Remacle (2021)[90]	Belgium	66 F, 21 M		VHI-30, single item
Rezende (2023)[91]	Brazil	5078 F, 1246 M		Single item
Rocha (2013)[92]	Brazil	525 F, 50 M		VHI-30
Rocha (2015)[93]	Brazil	525 F, 50 M		VHI-30
Rocha (2017)[39]	Brazil	277 F, 22 M		VHI-30
Rocha (2021)[40]	Brazil	144 F, 8 M		VHI-30
Rocha (2021)[94]	Brazil	245 F, 20 M		VHI-30
Rosow (2015)[95]	United States	728 F, 167 M		Single item
Rossi-Barbosa (2016)[96]	Brazil	226 F		Single item
Santos (2020)[97]	Brazil	283 F, 42 M		SIVD
Seifpanahi (2016)[98]	Iran	69 F, 35 M	41 F/M[b]	Self-designed questionnaire
Sharp (2024)[99]	United Kingdom	967 F, 233 M, 1 not specified, and 4 missing data		VoiSS
Silva (2017)[100]	Brazil	23 F		Holistic medical examination
Sundram (2019)[36]	Malaysia	62 F, 24 M		VHI-10
Tahamtan (2023)[101]	Iran	60 F, 60 M		VTD
Tao (2020)[102]	China	393 F, 21 M		VHI-10, single item
Thomas (2022)[103]	India	60 F		VFI
Trinite (2017)[104]	Latvia	522 F/M		VHI-30, VHI-10, and single item
Trinite (2021)[105]	Latvia[a]	41 F	20 F/M[b]	Self-designed questionnaire
Usha (2022)[24]	India[a]	20 F		Jitter, shimmer, HNR, and MPT
Vertanen-Greis (2020)[106]	Finland	970 F, 228 M		
Żurek (2021)[107]	Poland	112 F, 16 M		VTD, single item, and NRS

a Country based on affiliation of first author.
b Nonteachers were not included in the review analysis.

problems than those by quiet streets.[89] A Brazilian study (*N* = 6 324) showed northern/northeastern teachers reported greater voice limitations than southeastern counterparts.[91]

School authority

In the analysis of six studies examining school authority (public vs private), three studies (*N* = 140-496) from Egypt,

Nigeria, and Saudi Arabia consistently demonstrated that teachers working in public schools reported more voice problems than their colleagues in private institutions. Voice problems were assessed by a single item[45,52] or custom questionnaires.[46]

In summary, the findings for system constants show that the school environment is strongly associated with teachers' voice health. Elementary school teaching is particularly frequently linked to increased voice problems. Limited
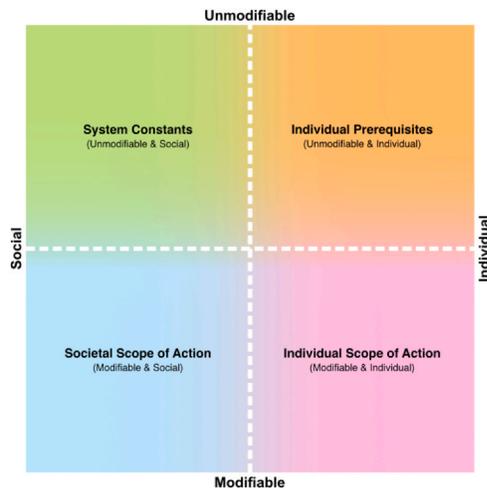
FIGURE 4. SIMU Matrix.

studies on school location and authority type suggest possible associations.

Individual prerequisites (individual and unmodifiable)

Sociodemographic

Age. Of 41 studies that examined age, 12 (N = 87-3 140) revealed significant associations with voice health indicators. Eight studies demonstrated that advanced age correlated with diminished voice health, as measured through VTD,[101] VFI,[74] VHI-30,[70,90] VHI-12,[87] VoiSS,[99] GRBAS,[38] and laryngoscopic examination.[76] One study identified gender differences, with age-related voice deterioration present in females but not in males.[87] Conversely, four studies reported alternative patterns, with middle-aged cohorts showing increased VHI-10[51] and VFI[55] scores, and increased vocal difficulties in the 30-39[88] or 50-59[78] age groups (both single items).

Gender. Among 40 gender-focused studies, 21 (N = 105-47 823) revealed significant findings. Females demonstrated more voice problems across perceptive or self-reported measures: VFI,[74,75] VHI-30,[50,70] VHI-10,[49,51,81,71] VoiSS,[99] SIVD,[67] GRBAS,[38] custom questionnaires,[106] and through single items.[42,87,78,91,79,54,53,104] Strikingly, objective assessments contradicted these findings: females exhibited fewer physiological vocal problems (videolaryngostroboscopy), and superior DSI scores compared with males,[87] and had a lower prevalence of throat and voice disorders.[44]

Ethnicity. A total of three studies investigated ethnicity, but in different ways, with two studies revealing significant results. The first (N = 6 039) revealed differences in VHI-10 scores across Malaysian ethnic groups, with Chinese participants showing the highest scores.[85] The other (N = 6 324) found that non-White teachers reported more voice problems based on a single item.[91]

Socioeconomic status. None of the four investigations examining socioeconomic status found significant associations with voice health indicators. However, three of these studies utilized the identical sample.[39,40,92]

Marital status. Only 1 out of 10 studies examining marital status revealed that partnered teachers had higher rates of vocal difficulties than their single counterparts.[67]

Own children. None of the seven studies examining the number of own children as a risk factor for voice disorders reported significant findings.

In summary, age and gender are the sociodemographic factors that demonstrate the strongest associations with voice health. Despite objective measures indicating lower actual prevalence rates, women consistently report higher rates of voice problems compared with men. The relationship between age and voice health remains inconclusive. Ethnicity, socioeconomic status, marital status, and number of children show limited or inconsistent associations with voice disorders.

Occupational background

Level of education. Out of 10 studies examining teachers' educational level, only 1 (N = 3 140) found that higher levels of education were associated with higher VHI-30 scores.[70]

Previous voice training. Of eight studies that examined voice training, two (N = 1 082-1 879) reported significant but conflicting results: whereas longer singing education was associated with more voice problems,[68] teachers with more than 10 hours of voice training had fewer voice problems.[78]

Teaching subjects. Among 11 studies examining teaching subject area, five (N = 23-3 140) revealed that voice health risk varies by subject discipline. Art, music, and science teachers demonstrate increased VHI-10 scores,[49] increased vocal pathology (single item),[53,79] and greater self-perceived voice alteration (single item, VAS).[100] Physical education presents contradictory findings.[70,79,53] Language teaching shows variable risk patterns, with Islamic studies (single item)[53] and Chinese instruction (VHI-10)[70] showing increased vulnerability.

Professional experience. Among 34 studies examining professional experience, 12 (N = 87-47 823) reported significant findings. Similar to age-related findings, the results showed mixed patterns: eight studies found increased professional experience associated with more voice problems measured by comprehensive medical examination,[44] single item,[89,104,68,96] VHI-30,[70] SIVD,[66,67] and laryngoscopic examination.[76] Gender differences also appeared in studies showing effects only in women.[76,96]

Unlike age findings, two studies report inverse relationships for professional experience measured via VHI,[90] and Multidimensional Vocal Scale for Teachers.[72] One additional study finding has no specific direction.[106]

In summary, teachers' occupational background shows inconsistent relationships with voice health, with limited or conflicting findings across educational level, voice training effects, teaching subjects (though arts, music, and science teachers appear at higher risk), and professional experience, suggesting no clear trend in how these career-related factors influence voice problems.

Family history of voice problems

Among four studies examining family history of voice disorders, three Saudi Arabian investigations ($N = 187$-604) showed that teachers with voice disorders in their family reported higher VHI-10 scores,[51] and more voice problems assessed by single items.[52,53]

Societal scope of action (social and modifiable)
Workplace conditions

Violence and crime in schools. Among the three studies examining violence, vandalism, and theft, two Brazilian studies ($N = 634$-6 324) found that teachers experiencing student violence had higher scores on the SIVD,[67] and that both verbal and physical violence from students were associated with greater voice-related limitations, as measured by a single item.[91]

Workload. The literature reviewing 31 studies on workload (eg, number of lessons per week) indicates that 13 ($N = 60$-47 823) identified significant correlations between increased teaching demands and deteriorated voice health indicators. These findings were established through VHI-30,[70] VHI-10,[102,49,65] SIVD,[67] single items,[91,79,54,53,104,107] laryngoscopic examination,[76] and comprehensive medical assessments.[44] Furthermore, the emotional subscale of the VHI-10 particularly correlated with heightened workload in one study.[65]

Class size. Of 25 studies that examined class size, nine ($N = 140$-47 823) showed a correlation between larger classes and increased voice disorders as assessed through comprehensive medical examinations,[44] VoiSS,[99] SIVD,[67] custom questionnaires,[86] and single items.[91,84,89,52,104] This association was particularly evident among female teachers in one investigation.[44]

Teaching format. Among four studies examining teaching format (face-to-face/hybrid/digital), two ($N = 128$-3 140) demonstrated a negative correlation between online teaching and vocal health: one revealed elevated VHI scores associated with virtual teaching,[70] whereas the other indicated that extended online instruction (> 6 months) corresponded with increased vocal difficulties as assessed by a single item.[107]

Nonteaching duties. Among three studies exploring the relationship between nonteaching duties and voice disorders, only 1 ($N = 1$ 879) identified a higher prevalence of regular voice disorders among secondary school teachers serving as homeroom teachers, though this relationship was only significant in univariate analysis.[79]

Working conditions. Significant relationships emerged in 6 of 8 studies ($N = 140$-6 324) exploring work environments, where five studies established correlations between deteriorated vocal health and suboptimal working conditions: lack of structural and material resources,[67] unfavorable working environments,[76] open doors and windows,[89] excessive work demands with limited social support,[91] and excessive work requirements.[86] Additionally, presenteeism negatively impacted hoarseness and voice loss.[79] Interestingly, one study found protective factors within work environments (eg, sufficient time for task completion, work autonomy) correlating with fewer voice limitations.[91]

In summary, the findings regarding workplace conditions reveal preliminary evidence suggesting a link between voice problems and factors such as class size, higher workloads, and inadequate resources. Additionally, the first evidence of supportive conditions that protect voice health is emerging.

Environmental conditions

Ambient temperature. Of four studies examining ambient temperature, none demonstrated significant relationships with voice health indicators.

Air quality. Among nine studies examining air quality, four ($N = 121$-1 198) demonstrated that subjectively perceived poor air quality, including high humidity, correlated with increased voice problems, as measured through VHI-10,[88,102] a custom questionnaire,[106] and a single item.[104]

Dust. Of six studies that looked at dust exposure, only 1 ($N = 522$) found a significant effect showing that exposure to chalk dust was associated with voice problems measured with a single item.[104]

Noise. Among 21 studies examining noise exposure, 14 ($N = 35$-47, 823) studies demonstrated significant relationships with voice health indicators. Thirteen studies showed that increased noise exposure correlated with voice problems, as measured through comprehensive medical examinations,[44] VHI-12,[77] VHI-10,[51,88] custom questionnaires,[59,106] and single items.[21,91,89,104,68,96,60] The noise sources varied across studies, including classroom noise,[51,106,60] external noise,[77,96,59] and student-generated noise.[104] However, not all studies distinguished between different types of noise. One study found that discussing

noise management strategies was associated with fewer voice problems (VoiSS).[99]

Room acoustics. Among seven studies examining room acoustics, three (*N* = 449-682) demonstrated that poor acoustics correlated with voice problems measured by a custom questionnaire,[59] a single item,[60] and VHI-12.[77]

In summary, environmental factors associated with voice disorders demonstrate a clear hierarchy of importance, with noise exposure and poor air quality showing the most consistent relationships to voice problems, followed by room acoustics, while minimally researched dust exposure and ambient temperature appear to have negligible to no significant impact on voice health.

Individual scope of action (individual and modifiable)
Physical well-being
Overweight. Of three studies that examined body weight, only 1 (*N* = 27) found that normal-weight individuals had lower HNR values after vocal stress, while overweight individuals had increased HNR values.[17]

ENT condition. Among 23 studies examining ear, nose, and throat (ENT) conditions, 17 (*N* = 105-1 721) demonstrated significant associations with voice disorder symptoms. Upper respiratory tract infections showed clear links,[77,52,46,54] as did asthma[42,88,71,106] and thyroid conditions, especially hypothyroidism.[42,106,68] Additional conditions linked to voice disorder symptoms included nasal septum deviation,[54] allergic rhinitis,[88] (chronic) respiratory diseases,[88,104,73] throat pain,[82,104] throat discomfort,[78] nasal obstruction,[63] respiratory problems,[82,96] and self-reported illnesses.[92] Interestingly, one study observed that non-medically confirmed respiratory infections increased vocal symptoms, whereas medically confirmed cases had fewer symptoms than those without infection.[99] Assessment methods varied across studies, utilizing VHI-30,[92] VHI-12,[77] VHI-10,[71] VoiSS,[99] custom questionnaires,[46,106,63] and single items.[42,78,52,88,54,104,68,96,73,82]

Hearing problems. Among the ENT conditions examined, hearing problems were coded separately. Among five studies examining hearing problems, two studies (*N* = 187-495) found that hearing problems correlated with voice problems, as measured through VHI-10[51] and a single item.[52]

Non-ENT condition. Out of 15 studies investigating non-ENT diseases, eight (*N* = 109-634) indicated associations between voice disorders and self-reported health status,[30,67,104,93] particular conditions including gastrointestinal,[38] digestive/spinal problems,[73] endocrine dysfunction,[104] and other comorbidities.[52,76] Voice disorders were assessed through GRBAS,[38] SIVD,[67] VHI-30,[93] laryngoscopic examination,[76] and single items.[30,52,104,73]

Reflux/GERD. In 12 studies on reflux, eight (*N* = 105-47 823) identified significant associations with voice health indicators. These studies demonstrated that people with reflux symptoms had higher voice problems, as measured through VHI-10,[49,51] VFI,[62] VoiSS,[99] single items,[106,54,68] and comprehensive medical examination.[44]

Allergies. Among 12 studies, eight (*N* = 200-1721) reported significant associations between allergies and voice problems, as measured through laryngoscopic examination,[76] VHI-12,[77] VHI-10,[51] VFI,[62] custom questionnaires,[106] and single items.[42,104,96] Specifically, these studies found associations between voice disorders and various allergic conditions: atopic dermatitis,[42,106] respiratory, nasal, or seasonal allergies,[42,77,51,104,96] and recurrent allergies.[76]

Neck and shoulder tension. Among four studies examining neck and shoulder tension, all (*N* = 24-47 823) showed associations with voice issues using comprehensive medical examinations,[44] custom questionnaires,[63] and single items.[68,104] Findings indicated that shoulder tension,[44,104] and neck pain during speaking[63] all correlated with voice problems. One study found this relationship specifically in females.[44]

In summary, there is strong evidence that respiratory and ENT-related factors (including allergies and reflux), as well as musculoskeletal issues such as neck and shoulder tension, consistently correlate with indicators of voice health. Family history, hearing problems, and non-ENT conditions show some association, but the evidence on relationships with body weight remains unclear.

Mental well-being
Job satisfaction. Among three studies examining job satisfaction, all revealed significant relations (*N* = 208-1721) and demonstrated that poor job satisfaction correlated with voice problems, measured through single-question assessments[42,104] or SIVD.[66]

Health-related quality of life. Among three studies examining health-related quality of life, all demonstrated that voice problems correlated significantly with diminished quality of life (*N* = 105-6 039). Voice problems were assessed with VHI-10,[85] SIVD,[97] and a single item.[54] Specifically, voice problems were associated with lower quality of life,[54] poorer mental health,[85] and reduced health satisfaction.[97]

Chronic stress. Among 15 studies examining chronic stress, 12 (*N* = 247-47 823) found significant associations. Ten studies demonstrated that higher stress levels correlated with increased self-reported voice problems as measured through VHI-12,[77] VHI-10,[51,88,71] custom questionnaires,[106,64,105] and single items.[52,104,68,82] Supporting these findings, one large-scale study (*N* = 47 823) with comprehensive medical

examination further demonstrated that higher stress levels corresponded with increased voice problems among female participants.[44]

Burnout. Among three studies examining burnout symptoms, all studies demonstrated that burnout correlated with voice problems ($N = 90$-634), as measured through SIVD[66,67] and the Multidimensional Vocal Scale for Teachers.[72]

Depression. The same three (out of four) studies also showed that depressive symptoms,[67] current depressive episodes,[93] and history of depression[72] were associated with increased voice problems.

Anxiety. Among five studies examining anxiety, three studies ($N = 90$-495) demonstrated that increased anxiety correlated significantly with diminished voice health, as measured through VHI-12,[77] VHI-10,[51] and the Multidimensional Vocal Scale for Teachers.[72]

In summary, the evidence consistently demonstrates strong associations between all the mental well-being factors examined and the voice health indicators assessed in teachers. It is worth noting that both voice problems and mental health were mostly assessed through self-reports.

Managing illness

Medication use. Among eight studies examining medication use, four ($N = 495$-6324) revealed significant relationships with voice health indicators. General medication use was associated with voice problems assessed with VHI-10,[51] and a single item.[68] More specifically, one study showed that use of anxiolytics or antidepressants was linked to greater voice-related limitations,[91] and another found that bronchodilators and corticosteroids were associated with voice problems as measured by a custom questionnaire.[106] These relationships are closely linked to other analyses representing the different diseases.

Medical assistance. Poorer voice health indicators were associated with seeking or receiving professional intervention in five studies ($N = 105$-758) out of the seven examined. Specifically, teachers with voice problems more frequently sought professional help,[54] while those who had sought or received professional assistance showed higher VHI-10 scores.[51,71] Additionally, physician visits for voice problems were associated with more acute and chronic voice problems,[96] and a history of vocal cord surgery was linked to hoarseness.[52]

Sick leave. Among 13 studies examining illness-related absences, 11 ($N = 105$-6039) identified significant relationships. Ten studies demonstrated that voice-related absences correlated with more voice disorder symptoms as measured through VHI-30,[39,92,93] VHI-12,[77] VHI-10,[51,71,85] and single items.[52,54,96] One study established a relationship between voice problem severity and absences.[78]

In summary, a consistent relationship emerged indicating that various aspects of illness management were significantly associated with poorer voice health indicators among teachers. Those factors may also closely relate to the mental and physical well-being of teachers.

Lifestyle and habits

Smoking. Among 24 studies examining smoking, 7 ($N = 109$-47 823) demonstrated that smoking correlated with increased voice problems, as measured by a comprehensive medical examination,[44] laryngoscopic examination,[76] VHI-12,[77] and single items.[30,79,52,53] Notably, in two studies, smoking was significantly associated with voice symptoms only in univariate analyses but not when controlling for other factors in multivariate models.[30,79] Additionally, one study identified effects for both active and passive smoking exposure.[52] It is worth noting that smoking prevalence was relatively low in some samples, with single-digit percentages.[53,76]

Alcohol consumption. Out of 10 studies on alcohol consumption, significant correlations with voice health indicators were discovered in only two studies ($N = 226$-47 823). The first study found that consuming more than one unit of alcohol correlated with chronic and acute vocal alterations, though consumption frequency was not significant in multivariate models.[96] The second large-sample study showed alcohol consumption was associated with voice problems through comprehensive medical examination.[44]

Caffeine intake. Among nine studies investigating caffeine consumption, only two ($N = 200$-496) reported significant associations with dysphonia assessed by laryngoscopic examination,[76] and a custom questionnaire.[46]

Dietary habits. None of the three studies investigating dietary habits (eg, eating flavored food) demonstrated significant associations with voice health indicators.

Water intake. Among 11 studies examining water consumption, only two ($N = 226$-477 823) demonstrated significant associations with voice health indicators. One study using a single item found that lower water consumption (< 4 glasses per day) was associated with acute voice problems; however, this relationship did not extend to chronic voice issues.[96] In contrast, another study revealed that frequent water consumption during teaching activities correlated with fewer voice problems (comprehensive medical examination) compared with occasional drinking, though this effect was statistically

significant only in male participants and solely in univariate analysis, not in the multivariate model.[44]

Physical activity. From five studies assessing physical activity, significant associations with voice health indicators were observed in three Brazilian studies (N = 23-6324). Two studies demonstrated that lack of physical activity was associated with voice problems, as measured through comprehensive medical examination[100] and SIVD.[67] Conversely, one study revealed that engaging in physical activity reduced perceived limitations due to voice problems, as assessed by a single item.[91]

Sleep. Among six studies examining sleep, two (N = 1301-6324) revealed significant associations with voice health indicators. One study demonstrated that sleeping less than 6 hours was associated with regular hoarseness or voice loss.[79] Another study showed that sleep loss due to worrying correlated with greater perceived voice-related limitations, both measured through single self-report items.[91]

In summary, the evidence indicates that smoking, the most extensively studied lifestyle factor, is most consistently associated with indicators of voice health. Physical activity and sleep, which have been studied moderately, also demonstrate notable associations. In contrast, there is less consistent evidence for the relationships between voice health and alcohol, caffeine, water consumption, and dietary habits.

Vocal usage and hygiene

Microphone/camera usage. Among nine studies investigating the use of microphones or cameras, five (N = 60-6039) reported significant associations with voice health indicators. Three studies found that microphone use was associated with teachers experiencing more voice problems, as measured through a single item,[54] VHI-10,[85] and VFI.[56] Conversely, one study demonstrated that teachers who taught without microphones also exhibited higher VHI-10 scores.[65] Regarding camera usage during teleteaching, one study found no clear trend, though teachers who mostly kept cameras on tended to have higher VHI-10 scores.[51]

Speaking pitch. In the examination of speaking fundamental frequency across 10 studies, significant associations with voice health indicators emerged in five (N = 23-574). Two studies demonstrated that reduced fundamental frequency was associated with more voice problems as measured by GRBAS[38] and VFI.[103] Conversely, two studies indicated that elevated pitch corresponded to higher VHI-30[90] and VHI-10 scores.[102] Additionally, individuals with dysphonia demonstrated greater pitch deviations based on comprehensive medical examination.[100]

Speaking volume. Among 14 studies examining speaking loudness, 11 (N = 23-47 823) revealed significant relations with voice health indicators. Ten studies demonstrated that higher speaking loudness was associated with diminished voice health, as measured through comprehensive medical examinations,[44,100] VHI-12,[77] VHI-10,[51,102] VoiSS,[99] and single items.[46,53,104,82] Specifically, self-reported loud speaking,[44,51,53] frequent loud classroom speech,[102,46,104] and disciplining students loudly[77] were linked to increased voice issues. Additionally, one study found associations between having more voice problems and higher sound pressure-level variability.[61] Except for three studies,[100,82,61] all relied on teachers' self-assessments of loudness.

Speaking duration. Out of nine studies, seven examining speaking duration revealed significant relations with voice health indicators (N = 26-1198). Six studies demonstrated that longer speaking duration correlated with diminished voice health, as measured through comprehensive medical examination,[57] multivariate assessment (VHI-10 and VSRS),[30] visual analog scale,[61] VHI-10,[102] and single items.[82,96] One additional study found that individuals with voice disorder symptoms (custom questionnaire) exhibited different voice usage patterns during leisure time, though the direction remained unclear.[106] Of all the studies, just three objectively measured speaking duration.[82,61,57]

Speaking breaks. Of the four studies examining speech pauses, 3 (N = 26-575) demonstrated significant associations with voice health indicators. One study showed that individuals with organic voice disorders had longer speech pauses (> 1 second) compared with those without disorders,[57] while two studies found that insufficient pause time was associated with higher VHI-30[92] and VHI-12 scores.[77]

Nonteaching voice use. Only one study (N = 522) out of six that examined extracurricular voice use (eg, coaching duties, choir, or music group outside working hours) found it to be associated with voice problems (single item).[104]

Music/singing. Among three studies examining music and singing, only one study (N = 47 823 N) demonstrated that teachers who never sang outside of their teaching duties had more voice problems (comprehensive medical examination).[44]

Vocal habits. Among eight studies examining vocal habits, six (N = 414-47 823) revealed significant relations with voice health indicators. Assessment methods included the VHI-12,[102] VHI-30,[77,93] comprehensive medical examination,[44] and single-question assessments.[68,104] The results showed that negative voice behaviors correlated with diminished voice health, particularly throat clearing,[44,102,77,104,68] coughing,[68,77] inappropriate breathing

management,[68] speaking beyond the natural breathing cycle,[77] monotone voice,[68] classroom shouting,[104] and low jaw angle.[68]

In summary, the evidence consistently shows that increased vocal load factors, such as loud speaking, extended speaking duration, insufficient speech pauses, and negative vocal habits like throat clearing, are linked to poorer voice health among teachers. However, findings regarding microphone use, fundamental frequency, and extracurricular vocal activities are inconclusive.

Pedagogical factors

Among four studies examining teaching methods, the only risk factor in this category, two (N = 105-3140) revealed significant relations with voice health indicators. One study found teachers with voice problems (single question) were more likely to change their teaching methods compared with colleagues without issues.[54] A second study showed teachers with voice disorders (VHI-30) used multimedia teaching less frequently and relied more on blackboard or combined methods.[70]

DISCUSSION

This systematic review synthesized evidence on risk factors for voice disorders in teachers, identifying 59 risk factor categories across 88 publications. Our first research question identified 10 risk factors with the strongest evidence base for voice disorders among teachers, determined by studies reporting significant associations (minimum 10 studies per factor). The SIMU Matrix provides a structured approach to understanding these priority factors across modifiability and scope dimensions, offering practical implications for prevention and intervention strategies.

This discussion first addresses unmodifiable risk factors, both social and individual, that cannot be easily changed. One variable falls within the *System Constants* quadrant: educational level based on age, comprising relatively fixed structural elements of the school system. It showed significant correlation with voice problems in 14 of 29 studies, with elementary school teachers representing a particular risk group. Three factors belong to the *Individual Prerequisites* quadrant, encompassing given characteristics. Gender was analyzed as a sociodemographic risk factor in 40 studies, with 21 showing significant associations. Women reported voice problems more frequently and exhibited hoarser voices, despite performing better in laryngological and acoustic examinations than men. Age emerged as a significant factor in 12 of the 41 studies, indicating that either middle-aged or older teachers were more likely to experience voice problems. Professional experience showed significant correlations with voice health in 12 of 34 studies, with similar findings to those for age.

Turning to modifiable risk factors, several significant associations were identified. Two risk factors can be assigned to the *Social Scope of Action* as they relate to workplace conditions or environmental factors that can potentially be modified. Higher workload was associated with poorer voice health in 13 of 31 studies. Additionally, 14 of 21 studies demonstrated significant correlation between noise exposure (eg, classroom noise, external noise) and voice problems. Four risk factors can be assigned to the *Individual Scope of Action* quadrant, which can be influenced to varying degrees. ENT symptoms such as upper respiratory tract infections, throat pain, and chronic respiratory diseases correlated significantly with voice problems in 13 of 20 studies. Chronic stress level showed significant correlations with both perceived and medically diagnosed voice problems in 12 of 15 studies. Regarding vocal usage and vocal hygiene, loud speaking voice use correlates significantly with reduced vocal health or increased vocal problems in 11 of 14 studies. Finally, 11 of 13 studies found significant correlation between the frequency of absence from work and the severity or frequency of voice problems.

Turning to our second research question, which focuses on the extent to which recommendations from previous reviews have been implemented—particularly with regard to methodological improvements in the assessment and measurement of voice disorders and their risk factors in teacher populations—our review revealed substantial methodological heterogeneity. This limits the ability to draw definitive conclusions about risk factor relationships and may explain why there are contradictory findings throughout the literature.

The field's reliance on a variety of assessment instruments, ranging from comprehensive medical examinations to various validated scales such as the VHI-30, VHI-12, and VHI-10, complicates cross-study comparisons. Most studies relied on self-reported symptoms, and there were substantial differences in the recall period. Some studies extended beyond the recommended maximum of 12 months to avoid recall bias.[11,108] Of greater concern is the widespread use of single-item measurements to evaluate voice phenomena, even though other clinical domains advocate that "scales should be validated for at least construct validity, internal consistency, and interrater reliability."[109] This is despite the fact that well-established definitions recognize voice disorders as complex, multidimensional conditions involving physical, functional, and psychosocial components. This mismatch between conceptual understanding and measurement practice potentially leads to inconsistent findings across studies where the effects of voice training, microphone usage, and speaking pitch all show conflicting results.

The limited use of objective assessment methods, with only three studies in our review employing instrumental assessments through videolaryngoscopy or indirect laryngoscopy, represents a significant gap in the literature. As Cantor-Cutiva and colleagues emphasized over 10 years ago, objective voice assessments such as laryngoscopy and acoustic analysis provide valuable information on vocal status and physiology. These assessments offer much-needed complementary data to

self-reports.[11,110,111] This is particularly important because there are substantial differences between subjective and objective assessment methods, which lead to contradictions in the literature. Self-reports may be affected by symptom awareness, health-seeking behaviors, occupational pressures, or cultural norms. In contrast, objective measurements evaluate physiological parameters that may not align with functional limitations or perceived challenges. This mismatch in measurements is especially evident in gender-related findings in voice research[69,112,113] as well as in other health domains.[114–121]

Beyond methodological concerns regarding assessment approaches, the statistical analysis methods employed across studies present equally problematic issues. Most studies employ multiple univariate analyses without proper correction procedures, substantially inflating Type I error probability. With 40 tests at $\alpha = 0.05$, the probability of at least one false positive reaches 87%—suggesting many "significant" findings may merely represent statistical noise. Multivariate approaches would better account for shared variance among risk factors while establishing more robust causal pathways, while multiple comparisons necessitate correction methods such as Bonferroni adjustments to maintain appropriate statistical rigor.

Sampling considerations further affect interpretation of findings and generalizability across different contexts. The gender imbalance in study samples may limit our understanding of potential gender-specific risk factors, as female-predominant samples can restrict statistical power for analyses involving male participants and may obscure important occupational or physiological differences between genders. The geographic distribution of studies—concentrated in Brazil, India, and the United States—raises questions about the generalizability of findings across different educational systems, cultural voice norms, native language phonetic demands, and working conditions. Cultural factors may influence both voice disorder development and reporting patterns, as different societies may have varying expectations for vocal use, tolerance for voice problems, and help-seeking behaviors. Additionally, teaching circumstances such as type of teaching equipment, duty to provide virtual and in-person teaching, school building quality, type of employment, regular working hours, and social standing of the teaching profession may differ between countries and regions, potentially affecting vocal health outcomes. Age-related sampling effects may also introduce remediation selection bias, potentially explaining the counterintuitive finding that middle-aged teachers show higher voice disorder prevalence than older cohorts in some studies. This pattern may reflect early career departure among teachers with severe voice problems, as general population data clearly demonstrate increasing voice symptoms with age.[122] The systematic underrepresentation of older teachers with voice disorders in occupational samples may therefore mask the true age-related progression of voice problems in the teaching profession. It is worth noting that by limiting our review to English and German publications, we may have overlooked valuable research published in other languages, potentially contributing to this geographic bias.

Despite growing literature on teacher voice health, longitudinal research remains scarce, showing only modest progress since Cantor-Cutiva's 2013 systematic review. As they noted, "longitudinal studies are urgently required to get more insight into the development of voice disorders, their work-related determinants, and the consequences of these voice disorders for functioning and work performance among teachers."[11] Our findings confirm this gap persists, with only 30 longitudinal studies compared with 81 cross-sectional designs in the current literature. Moreover, the existing longitudinal research varies widely in scope—from single-day voice loading experiments to rare multiyear investigations—with half focused solely on intervention evaluation rather than establishing causal pathways of voice disorders. The few studies spanning 1 to 10 years[37–43] represent promising but insufficient steps toward understanding the long-term trajectory of teacher voice disorders. This limited longitudinal focus not only hinders progress in distinguishing whether identified conditions are antecedents or consequences of voice disorders among teachers, but also prevents investigation of protective factors and resilience mechanisms that allow some teachers to maintain vocal health despite occupational demands.

Enhancing methodological transparency presents several promising opportunities for addressing the limitations identified in current research. The adoption of pre-registration protocols for hypotheses, primary outcomes, and analytical strategies may help safeguard against post hoc alterations and selective reporting that contribute to the current statistical noise in the literature. Publishing study protocols prior to data collection could establish clear methodological commitments while reducing researcher degrees of freedom and improving reproducibility. Furthermore, open data practices constitute a particularly valuable approach for facilitating secondary analyses and replication attempts, potentially accelerating scientific discovery through collaborative investigation and enabling more robust meta-analytic syntheses despite the current methodological heterogeneity.

Interdisciplinary collaboration between voice medicine, speech science, educational psychology, and occupational health may facilitate a more comprehensive understanding of voice disorder etiology in teachers, potentially leading to more effective, theoretically grounded interventions for this occupationally vulnerable population. Such collaborative approaches could bridge the gap between self-reported experiences and objective voice measurements, develop culturally sensitive assessment tools, and create intervention strategies that address both individual and systemic risk factors identified through the SIMU Matrix.

LIMITATIONS

This systematic review has several limitations that merit consideration when interpreting our findings. Despite our comprehensive search strategy, publication bias remains a concern, as studies with significant results tend to be published more frequently, potentially amplifying the apparent

strength of associations between risk factors and voice disorders.

Our exclusion of gray literature (such as unpublished studies, conference proceedings, technical reports, and dissertations) may have resulted in relevant data being omitted, further contributing to publication bias. Additionally, restricting our search to English and German publications may have introduced selection bias, particularly given the international scope of research in this domain.

The heterogeneity in methodological approaches, outcome measures, and reporting practices across included studies limited our ability to conduct meta-analyses for many outcomes. Samples may also have differed across studies in important ways, such as age groups or other demographic characteristics, which could influence the generalizability of findings. This heterogeneity also complicated direct comparisons between studies and potentially obscured important nuances in the relationships between risk factors and voice disorders.

Whereas systematic, our synthesis approach involved subjective judgments when categorizing risk factors and evaluating evidence consistency. Alternative categorization frameworks might have yielded different interpretations of the literature.

Finally, the studies included span different time periods, populations, and contexts, potentially limiting the generalizability and applicability of our findings to specific clinical or demographic settings.

CONCLUSION

The distribution of identified risk factors within the SIMU Matrix provides valuable insights for developing targeted prevention and intervention strategies for voice disorders in teaching professionals. The framework reveals that while some factors remain largely unmodifiable, they serve crucial roles in risk identification, whereas others present concrete opportunities for intervention.

One factor classified as *System Constants* (educational level, with primary teachers at elevated risk) and three *Individual Prerequisites* (gender, age, and professional experience) highlight the importance of early identification of vulnerable populations. The paradoxical finding that women report more voice problems despite superior laryngological examinations underscores the need for gender-sensitive approaches that address perceptual, social, and occupational factors. These largely unmodifiable characteristics should guide targeted screening programs and preventive training during teacher education, particularly for primary school teachers.

Four factors within the *Individual Scope of Action* offer direct opportunities for behavioral interventions: ENT symptom management, chronic stress reduction, vocal hygiene practices, and addressing loud speaking habits. Prevention programs should emphasize vocal hygiene education, stress management techniques, and early treatment of ENT conditions. The bidirectional relationship between stress and voice problems suggests that comprehensive approaches addressing both psychological well-being and vocal health are essential.

Two factors in the *Social Scope of Action* (workload and noise exposure) require systemic interventions at institutional and policy levels. Reducing excessive teaching loads, improving classroom acoustics, and implementing noise control measures represent critical environmental modifications. The dose-response relationship between workload and voice problems indicates that institutional policies limiting excessive vocal demands and providing recovery times are necessary for long-term vocal health preservation. This can also have a positive effect on stress perception and voice use.

The SIMU Matrix's multidimensional approach enables precise targeting of preventive measures across different career stages. Initial teacher education should incorporate comprehensive voice training, particularly for high-risk groups, while continuing professional development should address environmental adaptation strategies and long-term vocal health maintenance.

Future prevention frameworks should integrate both individual behavioral modifications and systemic environmental changes, recognizing that effective voice disorder prevention in educational settings requires coordinated efforts across multiple intervention levels.

Methodological challenges significantly limit the field's progress. Despite definitions recognizing voice disorders as complex, multidimensional conditions, researchers rely on single-item measurements that cannot capture this complexity. Heterogeneous assessment instruments, inconsistent recall periods, and limited objective voice evaluations contribute to substantial variation in reported findings. Statistical concerns, including inadequate correction for multiple comparisons, suggest many reported associations may represent statistical noise.

The scarcity of longitudinal research hinders understanding of causal relationships, while geographic concentration in three countries (Brazil, India, and the United States) raises generalizability concerns. Future research priorities include multimodal assessment approaches combining validated measures with objective evaluations; longitudinal studies with appropriate recall periods; and interdisciplinary collaboration to develop theoretically grounded interventions addressing both individual and systemic risk factors.

Declaration of Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Stachler RJ, Francis DO, Schwartz SR, et al. Clinical practice guideline: hoarseness (dysphonia). *Otolaryngol–Head Neck Surg*. 2018;158(S1):S1–S42. https://doi.org/10.1177/0194599817751030.
2. Dietrich M, Verdolini Abbott K, Gartner-Schmidt J, et al. The frequency of perceived stress, anxiety, and depression in patients with common pathologies affecting voice. *J Voice*. 2008;22:472–488. https://doi.org/10.1016/j.jvoice.2006.08.007.

3. Rocha BR, Behlau M. The influence of sleep disorders on voice quality. *J Voice.* 2018;32:771.e1–771.e13. https://doi.org/10.1016/j.jvoice.2017.08.009.

4. Cho J-H, Guilminault C, Joo Y-H, et al. A possible association between dysphonia and sleep duration: a cross-sectional study based on the Korean National Health and nutrition examination surveys from 2010 to 2012. *PLoS One.* 2017;12:e0182286. https://doi.org/10.1371/journal.pone.0182286.

5. Roy N, Bless DM, Heisey D. Personality and voice disorders: a multitrait-multidisorder analysis. *J Voice.* 2000;14:521–548. https://doi.org/10.1016/S0892-1997(00)80009-0.

6. Carrillo-Gonzalez A, Camargo-Mendoza M, Cantor-Cutiva LC. Relationship between sleep quality and stress with voice functioning among college professors: a systematic review and meta-analysis. *J Voice.* 2021;35:499.e13–499.e21. https://doi.org/10.1016/j.jvoice.2019.11.001.

7. de Medeiros AM, de Toledo Vieira M. Ausência Ao Trabalho Por Distúrbio Vocal de Professores Da Educação Básica No Brasil. *Cadernos de Saúde Pública.* 2019;35(Suppl 1):e00171717.

8. Verdolini K, Ramig LO. Review: occupational risks for voice problems. *Logop Phoniatr Vocol.* 2001;26:37–46. https://doi.org/10.1080/14015430119969.

9. Souza CMD, Granjeiro RC, Castro MPD, et al. Desfecho dos professores afastados da Secretaria de Estado de Educação do Distrito Federal por distúrbios vocais entre 2009-2010. *Revista Brasileira de Medicina do Trabalho.* 2017;15:324–328. https://doi.org/10.5327/Z1679443520170044.

10. Jiang G, Xu X, Yu K, et al. The risk factors of voice disorders in non-university teachers: a systematic review and meta-analysis. *J Voice.* 2024. https://doi.org/10.1016/j.jvoice.2024.10.023.(Advance online publication).

11. Cantor-Cutiva LC, Vogel I, Burdorf A. Voice disorders in teachers and their associations with work-related factors: a systematic review. *J Commun Disord.* 2013;46:143–155. https://doi.org/10.1016/j.jcomdis.2013.01.001.

12. Martins RHG, Pereira ERBN, Hidalgo CB, et al. Voice disorders in teachers. A review. *J Voice.* 2014;28:716–724. https://doi.org/10.1016/j.jvoice.2014.02.008.

13. Byeon H. The risk factors related to voice disorder in teachers: a systematic review and meta-analysis. *Int J Environ Res Publ Health.* 2019;16:3675. https://doi.org/10.3390/ijerph16193675.

14. VERBI Software, MAXQDA 2024 Version 24. Berlin, Germany: VERBI Software, 2023.

15. Rädiker S, Kuckartz U. *Analyse Qualitativer Daten mit MAXQDA: Text, Audio und Video.* Wiesbaden, Germany: Springer Fachmedien Wiesbaden: Springer Fachmedien Wiesbaden,; 2019https://doi.org/10.1007/978-3-658-22095-2.

16. R Core Team, R: A Language and Environment for Statistical Computing. manual. Vienna, Austria: R Foundation for Statistical Computing, 2025.

17. Acurio J, Celis C, Perez J, et al. Acoustic parameters and salivary IL-6 levels in overweight and obese teachers. *J Voice.* 2014;28:574–581. https://doi.org/10.1016/j.jvoice.2014.03.002.

18. Arya R, Bagwan S, Relekar S. Vocal fatigue in school teachers and it's relation to the acoustic analysis of voice, Indian. *J Otolaryngol Head Neck Surg.* 2022;74:1979–1988. https://doi.org/10.1007/s12070-020-01943-5.

19. Herndon NE, Sundarrajan A, Sivasankar MP, et al. Respiratory and laryngeal function in teachers: pre- and postvocal loading challenge. *J Voice.* 2019;33:302–309. https://doi.org/10.1016/j.jvoice.2017.11.015.

20. Khoramshahi H, Dehqan A, Scherer RC, et al. Comparison of vocal fatigue and vocal tract discomfort between teachers of normal pupils and teachers of mentally disabled pupils. *Eur Arch Oto-Rhino-Laryngol.* 2021;278:2429–2436. https://doi.org/10.1007/s00405-021-06863-w.

21. Kristiansen J, Lund SP, Persson R, et al. A study of classroom acoustics and school teachers' noise exposure, voice load and speaking time during teaching, and the effects on vocal and mental fatigue development. *Int Arch Occup Environ Health.* 2014;87:851–860. https://doi.org/10.1007/s00420-014-0927-8.

22. Narasimhan SV, Gowda B. Multiparametric analysis of voice following prolonged voice use and voice rest in teachers: evidence from discriminant analysis. *Eur Arch Oto-Rhino-Laryngol.* 2022;279:1397–1404. https://doi.org/10.1007/s00405-021-07144-2.

23. Alexander SA, Shetty PP, Mathew K. Acoustic analysis of indian teachers' voice: pre and post teaching circumstances. *Indian J Otolaryngol Head Neck Surg.* 2019;71:100–103. https://doi.org/10.1007/s12070-017-1129-y.

24. Usha MNK, Bhat JS, Radish Kumar B, et al. Immediate effects of "Ujjayi Pranayama" on aerodynamic, acoustic and self perception parameters of voice in teachers. *J Ayurveda Integr Med.* 2022;13:100490. https://doi.org/10.1016/j.jaim.2021.07.006.

25. Andriollo DB, Frigo LF, Cielo CA. Effect of pompage on vocal and respiratory measurements from female teachers: a randomized clinical trial. *Folia Phoniatr Logop.* 2023;75:295–305. https://doi.org/10.1159/000529832.

26. Bovo R, Trevisi P, Emanuelli E, et al. Voice amplification for primary school teachers with voice disorders: a randomized clinical trial. *Int J Occup Med Environ Health.* 2013;26:363–372. https://doi.org/10.2478/s13382-013-0115-1.

27. Faham M, Ahmadi A, Drinnan M, et al. The effects of a voice education program on VHI scores of elementary school teachers. *J Voice.* 2016;30:755.e1–755.e11. https://doi.org/10.1016/j.jvoice.2015.09.009.

28. Gassull C, Godall P, Polini E, et al. Effects of a voice training program on acoustics, vocal use, and perceptual voice parameters in Catalan Teachers. *Folia Phoniatr Logop.* 2020;72:411–418. https://doi.org/10.1159/000502766.

29. Grillo EU. A Nonrandomized Trial for student teachers of an in-person and telepractice global voice prevention and therapy model with estill voice training assessed by the VoiceEvalU8 App. *Am J Speech*-*Lang Pathol.* 2021;30:566–583. https://doi.org/10.1044/2020_AJSLP-20-00200.

30. Karatayli Ozgursoy S, Buyukatalay ZÇ, Dursun G. The effect of vocal hygiene training via videoconference in teachers' voices. *J Voice.* 2022;38:1523.e17–1523.e26. https://doi.org/10.1016/j.jvoice.2022.04.007.

31. Karjalainen S, Sahlén B, Falck A, et al. Implementation and evaluation of a teacher intervention program on classroom communication. *Logop Phoniatr Vocol.* 2020;45:110–122. https://doi.org/10.1080/14015439.2019.1595131.

32. Mailänder E, Mühre L, Barsties B. Lax Vox as a voice training program for teachers: a pilot study. *J Voice.* 2017;31:262.e13–262.e22. https://doi.org/10.1016/j.jvoice.2016.04.011.

33. Penha PBC, de Araújo Lima Filho LM, Ferreira LP, et al. Effectiveness of a blended-learning intervention in teachers' vocal health. *J Voice.* 2023;37:635.e1–635.e13. https://doi.org/10.1016/j.jvoice.2021.03.012.

34. de Pina Pereira LP, Masson MLV, Carvalho FM. Vocal warm-up and breathing training for teachers: randomized clinical trial. *Revista de Saude Publica.* 2015;49:67. https://doi.org/10.1590/S0034-8910.2015049005716.

35. Pizolato RA, Rehder MIBC, Meneghim MDC, et al. Impact on quality of life in teachers after educational actions for prevention of voice disorders: a longitudinal study. *Health Quality Life Outcomes.* 2013;11:28. https://doi.org/10.1186/1477-7525-11-28.

36. Sundram ER, Norsa'adah B, Mohamad H, et al. The effectiveness of a voice care program among primary school teachers in Northeastern Malaysia. *Oman Med J.* 2019;34:49–55. https://doi.org/10.5001/omj.2019.08.

37. Chen B-L, Cheng Y-Y, Lin C-Y, et al. Incidence of voice disorders among private school teachers in Taiwan: a nationwide longitudinal study. *Int J Environ Res Publ Health.* 2022;19:1130. https://doi.org/10.3390/ijerph19031130.

38. Cantor-Cutiva LC, Fajardo A, Burdorf A. Associations between self-perceived voice disorders in teachers, perceptual assessment by

speech-language pathologists, and instrumental analysis. *Int J Speech-Lang Pathol.* 2016;18:550–559. https://doi.org/10.3109/17549507.2016.1143969.

39. Rocha LM, de Lima Bach S, doAmaral PL, et al. Risk factors for the incidence of perceived voice disorders in elementary and middle school teachers. *J Voice.* 2017;31:258.e7–258.e12. https://doi.org/10.1016/j.jvoice.2016.05.018.

40. Rocha LM, Behlau M, de Mattos Souza LD. Risk factors for recurrent perceived voice disorders in elementary school teachers-a longitudinal study. *J Voice.* 2021;35:325.e23–325.e27. https://doi.org/10.1016/j.jvoice.2019.08.030.

41. Nusseck M, Immerz A, Spahn C, et al. Long-term effects of a voice training program for teachers on vocal and mental health. *J Voice.* 2021;35:438–446. https://doi.org/10.1016/j.jvoice.2019.11.016.

42. Putus T, Vilén L, Atosuo J. The association between work-related stress, indoor air quality, and voice problems among teachers is there a trend? *J Voice.* 2024;38:541.e21–541.e29. https://doi.org/10.1016/j.jvoice.2021.09.007.

43. Remacle A, Garnier M, Gerber S, et al. Vocal change patterns during a teaching day: inter- and intra-subject variability. *J Voice.* 2018;32:57–63. https://doi.org/10.1016/j.jvoice.2017.03.008.

44. Fu D, Wang S, Yang F, et al. A general survey of pharynlaryngeal diseases and voice disorders among basic education teachers in Tianjin. *J Voice.* 2023. https://doi.org/10.1016/j.jvoice.2023.11.009. (Advance online publication).

45. Abo-Hasseba A, Waaramaa T, Alku P, et al. Difference in voice problems and noise reports between teachers of public and private schools in Upper Egypt. *J Voice.* 2017;31:508.e11–508.e16. https://doi.org/10.1016/j.jvoice.2016.10.016.

46. Akinbode R, Lam KBH, Ayres JG, et al. Voice disorders in Nigerian primary school teachers. *Occup Med.* 2014;64:382–386. https://doi.org/10.1093/occmed/kqu052.

47. Alanazi R, Alrahim A, Bayounos S, et al. Association between voice handicap index and reflux symptom index: a cross-sectional study of undiagnosed general and teacher cohorts in Saudi Arabia. *Sultan Qaboos Univ Med J.* 2018;18:e350–e354. https://doi.org/10.18295/squmj.2018.18.03.014.

48. Alarfaj A, Alyahya K, Alutaibi H, et al. The effect of online teaching on vocal health among Saudi Teachers during COVID-19 pandemic. *J Voice.* 2024;38:1526.e1–1526.e10. https://doi.org/10.1016/j.jvoice.2022.04.006.

49. Alarouj H, Althekerallah JM, AlAli H, et al. A comparative study utilizing the Voice Handicap Index-10 (VHI-10) in teachers and the general population of Kuwait. *J Voice.* 2022;36:289.e1–289.e10. https://doi.org/10.1016/j.jvoice.2020.05.006.

50. Albustan SA, Marie BS, Natour YS, et al. Kuwaiti Teachers' perceptions of voice handicap. *J Voice.* 2018;32:319–324. https://doi.org/10.1016/j.jvoice.2017.05.003.

51. Alkhunaizi AA, Bukhari M, Almohizea M, et al. Voice problems among school teachers employing the tele-teaching modality. *J Voice.* 2025;39:132–146. https://doi.org/10.1016/j.jvoice.2022.06.028.

52. Alrahim AA, Alanazi RA, Al-Bar MH. Hoarseness among school teachers: a cross-sectional study from Dammam. *J Fam Commun Med.* 2018;25:205–210. https://doi.org/10.4103/jfcm.JFCM_152_17.

53. Alshuhayb BS, Alkhars AZ, AlMaghlouth MK, et al. Voice disorders among teachers in Al-Ahsa, Eastern Region, KSA: vocal complaints, treatment-seeking behaviors, and knowledge of vocal care. *J Voice.* 2025;39:147–157. https://doi.org/10.1016/j.jvoice.2022.07.001.

54. Alva A, Machado M, Bhojwani K, et al. Study of risk factors for development of voice disorders and its impact on the quality of life of school teachers in Mangalore, India. *J Clin Diagn Res.* 2017;11:MC01–MC05. https://doi.org/10.7860/JCDR/2017/17313.9234.

55. Banks RE, Bottalico P, Hunter EJ. The effect of classroom capacity on vocal fatigue as quantified by the Vocal Fatigue Index. *Folia Phoniatr Logop.* 2018;69:85–93. https://doi.org/10.1159/000484558.

56. Banks RE, Cantor-Cutiva LC, Hunter EJ. Factors influencing teachers' experience of vocal fatigue and classroom voice amplification. *J Voice.* 2025;39:113–122. https://doi.org/10.1016/j.jvoice.2022.06.026.

57. Bottalico P, Graetzer S, Astolfi A, et al. Silence and voicing accumulations in Italian Primary School Teachers with and without voice disorders. *J Voice.* 2017;31:260.e11–260.e20. https://doi.org/10.1016/j.jvoice.2016.05.009.

58. Cantarella G, Negri L, Bernardelli G, et al. Vocal fatigue perceived in remote working by teachers of different school grades during COVID-19 pandemic. *Auris Nasus Larynx.* 2023;50:450–457. https://doi.org/10.1016/j.anl.2022.08.009.

59. Cantor-Cutiva LC, Burdorf A. Effects of noise and acoustics in schools on vocal health in teachers. *Noise Health.* 2015;17:17–22. https://doi.org/10.4103/1463-1741.149569.

60. Cantor-Cutiva LC, Burdorf A. Work-related determinants of voice complaints among school workers: an eleven-month follow-up study. *Am J Speech-Lang Pathol.* 2016;25:590–597. https://doi.org/10.1044/2016_AJSLP-14-0191.

61. Cantor-Cutiva LC, Puglisi GE, Astolfi A, et al. Four-day follow-up study on the self-reported voice condition and noise condition of teachers: relationship between vocal parameters and classroom acoustics. *J Voice.* 2017;31:120.e1–120.e8. https://doi.org/10.1016/j.jvoice.2016.02.017.

62. Cantor-Cutiva LC, Banks RE, Hunter EJ. The effect of upper airway ailments on teachers' experience of vocal fatigue. *J Voice.* 2022;36:226–231. https://doi.org/10.1016/j.jvoice.2020.05.024.

63. Cardoso R, Meneses RF, Lumini-Oliveira J, et al. Associations between Teachers' posture, muscle tension and voice complaints. *J Voice.* 2021;35:933.e23–933.e31. https://doi.org/10.1016/j.jvoice.2020.02.011.

64. Cardoso R, Meneses RF, Lumini-Oliveira J, et al. Associations between teachers' autonomic dysfunction and voice complaints. *J Voice.* 2021;35:843–851. https://doi.org/10.1016/j.jvoice.2020.03.013.

65. Chowdhury K, Dawar H. Impact of classroom determinants on psychosocial aspects of voice among school teachers of Indore, India: a preliminary survey. *Indian J Otolaryngol Head Neck Surg.* 2019;71:776–783. https://doi.org/10.1007/s12070-018-1546-6.

66. de Brito Mota AF, Giannini SPP, de Oliveira IB, et al. Voice disorder and burnout syndrome in teachers. *J Voice.* 2019;33:581.e7–581.e16. https://doi.org/10.1016/j.jvoice.2018.01.022.

67. de Magalhães TA, Ferreira ED, de Souza JEM, et al. Voice disorders and mental health of basic education teachers in a Brazilian Municipality. *J Voice.* 2025;39:1135.e21–1135.e29. https://doi.org/10.1016/j.jvoice.2023.02.010.

68. Devadas U, Bellur R, Maruthy S. Prevalence and risk factors of voice problems among primary school teachers in India. *J Voice.* 2017;31:117.e1–117.e10. https://doi.org/10.1016/j.jvoice.2016.03.006.

69. Faham M, Jalilevand N, Torabinezhad F, et al. Relationship between voice complaints and subjective and objective measures of vocal function in Iranian Female Teachers. *J Voice.* 2017;31:507.e1–507.e6. https://doi.org/10.1016/j.jvoice.2016.10.011.

70. Feng S, Weng C, Cai S, et al. The prevalence and risk factors for perceived voice disorders in public school teachers. *Laryngosc Investig Otolaryngol.* 2022;7:790–798. https://doi.org/10.1002/lio2.803.

71. Gadepalli C, Fullwood C, Ascott F, et al. Voice burden in teachers and non-teachers in a UK population: a questionnaire-based survey. *Clin Otolaryngol.* 2019;44:1045–1058. https://doi.org/10.1111/coa.13437.

72. García-Real TJ, Díaz-Román TM, Mendiri P. Vocal problems and burnout syndrome in nonuniversity teachers in Galicia, Spain. *Folia Phoniatr Logop.* 2024;76:68–76. https://doi.org/10.1159/000531982.

73. Hermes EGC, Oliveira Bastos PRH. The prevalence of teachers' vocal symptoms in municipal network of education in Campo Grande, Mato Grosso do Sul, Brazil. *J Voice.* 2016;30:756.e1–756.e7. https://doi.org/10.1016/j.jvoice.2015.09.005.

74. Hunter EJ, Banks RE. Gender differences in the reporting of vocal fatigue in teachers as quantified by the Vocal Fatigue Index. *Ann Otol Rhinol Laryngol.* 2017;126:813–818. https://doi.org/10.1177/0003489417738788.

75. Hunter EJ, Maxfield L, Graetzer S. The effect of pulmonary function on the incidence of vocal fatigue among teachers. *J Voice.* 2020;34:539–546. https://doi.org/10.1016/j.jvoice.2018.12.011.

76. Joshi AA, Mukundan P, Dave VJ, et al. Prevalence of voice disorders in indian female secondary school teacher population-a cross sectional study. *Indian J Otolaryngol Head Neck Surg.* 2022;74:2324–2330. https://doi.org/10.1007/s12070-020-02160-w.

77. Kyriakou K, Theodorou E, Petinou K, et al. Risk factors for voice disorders in public school teachers in Cyprus. *J Prev Med Hyg.* 2020;61:E221–E240. https://doi.org/10.15167/2421-4248/jpmh2020.61.2.1403.

78. Leão S, Oates JM, Purdy SC, et al. Voice problems in New Zealand Teachers: a national survey. *J Voice.* 2015;29:645.e1–645.e13. https://doi.org/10.1016/j.jvoice.2014.11.004.

79. Lee Y-R, Kim H-R, Lee S. Effect of teacheras working conditions on voice disorder in Korea: a nationwide survey. *Ann Occup Environ Med.* 2018;30:43. https://doi.org/10.1186/s40557-018-0254-8.

80. López JM, Catena A, Montes A, et al. Effectiveness of a short voice training program for teachers: a preliminary study. *J Voice.* 2017;31:697–706. https://doi.org/10.1016/j.jvoice.2017.01.017.

81. Lu D, Wen B, Yang H, et al. A comparative study of the VHI-10 and the V-RQOL for quality of life among Chinese Teachers with and without voice disorders. *J Voice.* 2017;31:509.e1–509.e6. https://doi.org/10.1016/j.jvoice.2016.10.025.

82. Lyberg-Åhlander V, Pelegrín-García D, Whitling S, et al. Teachers' voice use in teaching environments: a field study using ambulatory phonation monitor. *J Voice.* 2014;28:841.e5–841.e15. https://doi.org/10.1016/j.jvoice.2014.03.006.

83. Marie BS, Natour YS, Haj-Tas MA. Jordanian teachers' perceptions of voice handicap. *Logoped Phoniatr Vocol.* 2014;39:81–86. https://doi.org/10.3109/14015439.2013.821521.

84. Menon UK, Raj M, Antony L, et al. Prevalence of voice disorders in school teachers in a district in South India. *J Voice.* 2021;35:1–8. https://doi.org/10.1016/j.jvoice.2019.07.005.

85. Moy FM, Hoe VCW, Hairi NN, et al. Determinants and effects of voice disorders among secondary school teachers in Peninsular Malaysia using a validated Malay Version of VHI-10. *PLOS One.* 2015;10:e0141963. https://doi.org/10.1371/journal.pone.0141963.

86. Munier C, Farrell R. Working conditions and workplace barriers to vocal health in primary school teachers. *J Voice.* 2016;30:127.e31–127.e41. https://doi.org/10.1016/j.jvoice.2015.03.004.

87. Nusseck M, Spahn C, Echternach M, et al. Vocal health, voice self-concept and quality of life in german school teachers. *J Voice.* 2020;34:488.e29–488.e39. https://doi.org/10.1016/j.jvoice.2018.11.008.

88. Patjas M, Vertanen-Greis H, Pietarinen P, et al. Voice symptoms in teachers during distance teaching: a survey during the COVID-19 pandemic in Finland. *Eur Arch Oto-Rhino-Laryngol.* 2021;278:4383–4390. https://doi.org/10.1007/s00405-021-06960-w.

89. Phadke KV, Abo-Hasseba A, Švec JG, et al. Influence of noise resulting from the location and conditions of classrooms and schools in Upper Egypt on Teachers' Voices. *J Voice.* 2019;33:802.e1–802.e9. https://doi.org/10.1016/j.jvoice.2018.03.003.

90. Remacle A, Lefèvre N. Which teachers are most at risk for voice disorders? Individual factors predicting vocal acoustic parameters monitored in situ during a workweek. *Int Arch Occup Environ Health.* 2021;94:1271–1285. https://doi.org/10.1007/s00420-021-01681-3.

91. Rezende BA, Abreu MNS, Assunção AÁ, et al. Factors associated with the limitation at work because of the voice: study with teachers of basic education in Brazil. *J Voice.* 2023;37:79–91. https://doi.org/10.1016/j.jvoice.2020.11.003.

92. Rocha LM, de Mattos Souza LD. Voice Handicap Index associated with common mental disorders in elementary school teachers. *J Voice.* 2013;27:595–602. https://doi.org/10.1016/j.jvoice.2012.10.001.

93. Rocha LM, Behlau M, Souza LDDM. Behavioral dysphonia and depression in elementary school teachers. *J Voice.* 2015;29:712–717. https://doi.org/10.1016/j.jvoice.2014.10.011.

94. Rocha LM da, Amaral PL do, Lima Bach S de, et al. Incidence of common mental disorders in teachers: is there a relationship with voice disorders? *J Voice.* 2021;35(3):432–437. https://doi.org/10.1016/j.jvoice.2019.10.009.

95. Rosow DE, Szczupak M, Saint-Victor S, et al. The economic impact of vocal attrition in public school teachers in Miami-Dade County. *Laryngology.* 2015;126. https://doi.org/10.1002/lary.25513.

96. Rossi-Barbosa LAR, Barbosa MR, Morais RM, et al. Self-reported acute and chronic voice disorders in teachers. *J Voice.* 2016;30:755.e25–755.e33. https://doi.org/10.1016/j.jvoice.2015.08.003.

97. Santos EC, Espinosa MM, Marcon SR, et al. Factors associated with health dissatisfaction of elementary school teachers. *Revista Brasileira de Enfermagem.* 2020;73:e20190832. https://doi.org/10.1590/0034-7167-2019-0832.

98. Seifpanahi S, Izadi F, Jamshidi A-A, et al. Prevalence of voice disorders and associated risk factors in teachers and nonteachers in Iran. *J Voice.* 2016;30:506.e19–506.e23. https://doi.org/10.1016/j.jvoice.2015.05.019.

99. Sharp E, Cook R. Voice symptoms and Wellbeing in School Teachers in England. *J Voice.* 2024;38:1252.e1–1252.e10. https://doi.org/10.1016/j.jvoice.2022.02.005.

100. Silva BG, Chammas TV, Zenari MS, et al. Analysis of possible factors of vocal interference during the teaching activity. *Revista de Saúde Pública.* 2017;51:124. https://doi.org/10.11606/S1518-8787.2017051000092.

101. Tahamtan M, Kakavandi A, Scherer RC, et al. Vocal tract discomfort symptoms in elementary and high school teachers. *J Voice.* 2023;37:68–78. https://doi.org/10.1016/j.jvoice.2020.11.009.

102. Tao Y, Lee CT-C, Hu Y-J, et al. Relevant work factors associated with voice disorders in early childhood teachers: a comparison between kindergarten and elementary school teachers in Yancheng, China. *Int J Environ Res Publ Health.* 2020;17:3081. https://doi.org/10.3390/ijerph17093081.

103. Thomas SA, Maruthy S. Comparison of habitual and high pitch phonation in teachers with and without vocal fatigue. *J Voice.* 2022;36:141.e1–141.e9. https://doi.org/10.1016/j.jvoice.2020.04.016.

104. Trinite B. Epidemiology of voice disorders in Latvian School Teachers. *J Voice.* 2017;31:508.e1–508.e9. https://doi.org/10.1016/j.jvoice.2016.10.014.

105. Trinite B. Investigating voice differences in teachers with and without self-reported voice disorders, and healthcare workers without self-reported voice disorders. *Logop Phoniatr Vocol.* 2021;46:47–54. https://doi.org/10.1080/14015439.2020.1727565.

106. Vertanen-Greis H, Löyttyniemi E, Uitti J. Voice disorders are associated with stress among teachers: a cross-sectional study in Finland. *J Voice.* 2020;34:488.e1–488.e8. https://doi.org/10.1016/j.jvoice.2018.08.021.

107. Żurek M, Jasak K, Rzepakowska A. Comparison of teachers' voice disorders before and during COVID-19 pandemic. *Polish J Otolaryngol.* 2021;76:34–41. https://doi.org/10.5604/01.3001.0015.6495.

108. Coughlin SS. Recall bias in epidemiologic studies. *J Clin Epidemiol.* 1990;43:87–91. https://doi.org/10.1016/0895-4356(90)90060-3.

109. Giordano V, Edobor J, Deindl P, et al. Pain and sedation scales for neonatal and pediatric patients in a preverbal stage of development: a systematic review. *JAMA Pediatr.* 2019;173:1186. https://doi.org/10.1001/jamapediatrics.2019.3351.

110. Behrman A, Orlikoff RF. Instrumentation in voice assessment and treatment: What's the use? *Am J Speech-Lang Pathol.* 1997;6:9–16. https://doi.org/10.1044/1058-0360.0604.09.

111. Sataloff RT, Hawkshaw MJ, Divi V, et al. Physical examination of voice professionals. *Otolaryngol Clin N Am.* 2007;40:953–969. https://doi.org/10.1016/j.otc.2007.05.004.

112. Hauck J, Gegner C, Giglberger M, et al. Effectiveness of a mobile phone application in managing voice health for teachers: a randomized controlled trial. *Digital Health.* 2025;11:1–15. https://doi.org/10.1177/20552076251351805.

113. Hanschmann H, Lohmann A, Berger R. Comparison of subjective assessment of voice disorders and objective voice measurement. *Folia Phoniatr Logop.* 2010;63:83–87. https://doi.org/10.1159/000316140.

114. Slobodin O, Davidovitch M. Gender differences in objective and subjective measures of ADHD among clinic-referred children. *Front Human Neurosci.* 2019;13:441. https://doi.org/10.3389/fnhum.2019.00441.

115. LeBlanc AGW, Janssen I. Difference between self-reported and accelerometer measured moderate-to-vigorous physical activity in youth. *Pediatr Exercise Sci.* 2010;22:523–534. https://doi.org/10.1123/pes.22.4.523.

116. Wilson OWA, Bopp CM, Papalia Z, et al. Objective vs self-report assessment of height, weight and body mass index: relationships with adiposity, aerobic fitness and physical activity. *Clin Obes.* 2019;9:e12331. https://doi.org/10.1111/cob.12331.

117. Baker M, Stabile M, Deri C. What do self-reported, objective, measures of health measure? *J Human Resour.* 2004;XXXIX:1067–1093. https://doi.org/10.3368/jhr.XXXIX.4.1067.

118. Säynäjäkangas P, Mänttäri S, Selander K, et al. Home care workers' objective and subjective recovery from work. *J Occup Environ Med.* 2024;66:161–165. https://doi.org/10.1097/JOM.0000000000003013.

119. Pieretti S, Di Giannuario A, Di Giovannandrea R, et al. Gender differences in pain and its relief. *Annali DellaIstituto Superiore di Sanita.* 2016;52:184–189. https://doi.org/10.4415/ANN_16_02_09.

120. Fillingim RB, King CD, Ribeiro-Dasilva MC, et al. Sex, gender, and pain: a review of recent clinical and experimental findings. *J Pain.* 2009;10:447–485. https://doi.org/10.1016/j.jpain.2008.12.001.

121. Kvachadze I, Tsagareli MG, Dumbadze Z. An overview of ethnic and gender differences in pain sensation. *Georgian Med News.* 2015;238:102–108.

122. Lyberg-Åhlander V, Rydell R, Fredlund P, et al. Prevalence of voice disorders in the general population, based on the Stockholm Public Health Cohort. *J Voice.* 2019;33:900–905. https://doi.org/10.1016/j.jvoice.2018.07.007.