

# **The effect of vocal hygiene education programs on voice quality in professional voice users: A systematic review**

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## **Abstract**

**Purpose.** The study aimed to critically appraise recent peer-reviewed, scientific evidence on the effect of vocal hygiene education on voice quality and function directly and indirectly measured by auditory-perceptual, acoustic and self-report measures in professional voice users.

**Method.** A systematic review was conducted utilising the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA-P) guidelines. Five databases were searched using the keywords “vocal hygiene”, “vocal hygiene education”, “vocal health”, “vocal quality”, and “voice quality” with Boolean phrases “AND” and “OR”. Twenty-three studies that met the eligibility criteria were included. Scoring was based

on American Speech-Language-Hearing Association's levels of evidence and quality indicators, as well as the Newcastle Ottawa Scale (NOS) for assessing the risk of bias.

**Results.** Four studies (17%) linked low awareness of vocal hygiene or insufficient vocal hygiene education to self-reported acute and chronic voice symptoms as well as a greater perception of voice handicap amongst professional voice users. Numerous studies (n = 10; 43%) showed adequate voice training or vocal hygiene education was linked to positive voice outcomes. Six studies (6,26%) however, demonstrated that vocal hygiene education is more effective when combined with direct voice therapy. When vocal hygiene education is presented in isolation the superiority of a direct voice therapy approach, with or without vocal hygiene education, is seen over a vocal hygiene education program alone (indirect treatment).

**Conclusions.** Recent literature demonstrates mixed results obtained through auditory-perceptual, acoustic and self-rating measures on the effects of vocal hygiene instruction on vocal quality and function in professional voice users. However, the compelling positive outcomes presented do warrant implementation of vocal hygiene education programs in combination with direct voice therapy for professional voice users.

**Key Words:** PRISMA-P; Professional voice users; Systematic review; Vocal hygiene education; Voice quality.

## 1 INTRODUCTION

Currently, more than one-third of the global workforce requires integrity of the voice to meet their occupational demands and are therefore considered professional voice users (PVUs) (Pomaville, Tekerlek, & Radford, 2019; Reed & Sims, 2017; Wingate, Brown, Shrivastav, Davenport, & Sapienza, 2007). PVUs are required to use their voices for extended periods, frequently with increased loudness and varying pitch, (Sezin, Özcebe, Aydinli, Köse, & Günaydin, 2020) and often have to perform their occupational tasks in environments that are less than optimal for vocal health (Pomaville et al., 2019). This makes PVUs vulnerable to phonotrauma (Sezin et al., 2020; Van Lierde, Bonte, Baudonck, Van Cauwenberge, & De Leenheer, 2008).

Although vocal load, voice quality, and vocal sophistication may differ within and across professions, all PVUs depend on vocal endurance (Rangarathnam, Paramby, & McCullough, 2018a). High vocal demands, phonotraumatic voice use and inadequate knowledge on vocal care can cumulatively lead to voice disorders in PVUs (Rangarathnam, Paramby, & McCullough, 2018b). Recent literature indicates a direct link between voice disorders and long-term professional voice use (Faham et al., 2016). In turn, voice disorders have subsequent negative effects on voice quality and vocal range (Porcaro, Howery, Suhandron, & Gollery, 2019), work performance, efficiency, job satisfaction, absenteeism, loss of income (Faham et al., 2016), and psychosocial well-being in the PVU (Aiken & Rumbach, 2018; Behlau & Oliveira, 2009; Rangarathnam et al., 2018b).

To prevent voice disorders in PVUs, the implementation of vocal hygiene education (VHE)<sup>1</sup> program is endorsed. VHE is a therapeutic and preventive approach based on behaviour modification thought to preserve and protect the vocal fold tissue and normal vibratory characteristics of the vocal folds (Behlau & Oliveira, 2009; Faham et al., 2016; Pomaville et al., 2019). A VHE program generally includes education regarding voice production, identification and elimination of phonotraumatic behaviours, emphasise the importance of adequate hydration, and teaches strategies for voice production (Achey, He, & Akst, 2016; Behlau & Oliveira, 2009; Pomaville et al., 2019), particularly for PVUs (Behlau & Oliveira, 2009; Pomaville et al., 2019). Although some PVUs are briefly trained on aspects of VHE, their needs for vocal health protection, vocal hygiene, and vocal techniques are lifelong (Sezin et al., 2020). A VHE program is frequently recommended for the prevention and treatment of voice disorders in PVUs, yet current research supporting the effectiveness of a VHE program is mixed (Pomaville et al., 2019). Some studies have found that VHE has minimal effect on vocal quality when used alone in PVUs with and without voice disorders for prevention and treatment purposes (Rangarathnam et al., 2018b; Rodríguez-Parra, Adrián, & Casado, 2011a). Others, however, have demonstrated the positive preventative effect VHE has on long term vocal health in PVUs without voice disorders (Nusseck, Spahn, Echternach, Immerz, & Richter, 2018; Rodero, Diaz-Rodriguez, & Larrea, 2018). Previous research on vocally healthy PVUs also argued that VHE used for treatment purposes is effective but only when combined with other direct treatment approaches (Liu et al., 2020). Thus, further exploration is needed to

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<sup>1</sup> Referred to in literature as vocal hygiene education and vocal health education interchangeably will be referred to as vocal hygiene education (VHE) in this article for ease of reference.

find conclusive results on the effects of VHE on voice quality in PVUs with and without voice disorders.

It may be widely assumed that PVUs, such as singers and those in the performing arts, would naturally acquire more information on the anatomy, physiology, and care of the vocal mechanism compared to other professions due to their particular dependence on voice quality (D'haeseleer et al., 2017; Hackworth, 2006; Latham et al., 2017). Several studies have explored the type and amount of VHE that students of various vocal performance professions receive (D'haeseleer et al., 2017; Hackworth, 2006; Latham et al., 2017). Ultimately, research indicates that VHE has previously been insufficient in the curriculum of future PVUs (Bolbol, Zalat, Hammam, & Elnakeb, 2017; Fuentes-López, Fuente, & Contreras, 2019; Jałowska, Wośkowiak, & Wiskirska-Woźnica, 2017; Neto & Meyer, 2017; Rumbach, 2013a; Zuim, Lloyd, Gerhard, Rosow, & Lundy, 2019). A study conducted on stage actors found that vocal hygiene knowledge and vocal training did not significantly impact vocal quality measures (Rangarathnam et al., 2018a). The authors concluded that although VHE may have some impact on voice quality, it is not considered the best preventive strategy for potential phonotrauma in this subject population (Rangarathnam et al., 2018b). Similarly, another study on dysphonic PVUs found that direct voice therapy showed more positive effects than VHE therapy in 50% to 60% of continuous measures of voice (Maximum phonation time, Maximum exhalation time, Maximum phonation time during connected speech, Jitter, Well-being, Self-voice, Hygiene and Anxiety) (Rodríguez-Parra et al., 2011a).

A study describing the voice quality of student teachers who received VHE training reported poorer voice quality in the control group compared with that of the trained group, whose voice quality improved significantly ( $p = .032$ ) (Nusseck, Immerz, Spahn, Echternach, & Richter, 2019). Also, the trained teachers significantly increased in awareness of voice use and their mental health compared to the nontrained group (Nusseck et al., 2019). VHE programs can thus have a positive impact on the voice quality of student teachers (Nusseck et al., 2019). Similarly, journalism students who attended a VHE course achieved improved vocal quality when comparing pre and post-test measures (Rodero et al., 2018).

Other studies found VHE effective for modifying vocal quality when combined with direct voice treatment (Liu et al., 2020). A study on vocally healthy primary school teachers indicated that a combination of VHE and resonant voice therapy significantly improved the voice quality of PVUs whereas the PVUs who only received VHE as treatment did not show significant improvement in voice quality (Liu et al., 2020). Although VHE did not consistently yield improvement of vocal quality studies have shown that PVUs and future PVUs still recognize the importance of voice care and are interested in VHE programs (Barnes-Burroughs & Rodriguez, 2012; Braun-Janzen & Zeine, 2009). Mixed results found on the effect of vocal hygiene programs on vocal quality, warrant a systematic review to critically appraise recent evidence. Most studies to date have also only focused on singular occupational groups namely, vocal performers and teachers (Pomaville et al., 2019; Porcaro et al., 2019). Currently, there is no consensus about the efficacy of voice education and voice hygiene education specifically (Faham et al., 2016) on overall voice quality or vocal behaviours. As a result, the literature should be critically appraised to determine the effect and/or

perceived impact of vocal hygiene programs as an approach to improve voice quality for PVUs.

## **2 METHOD**

### **2.1 Aim**

This study aims to critically appraise recent peer-reviewed, scientific evidence on the effect of vocal hygiene education through perceived changes in professional voice users' voice quality over time (PICO).

### **2.2 Study design**

A systematic review was completed by following the Preferred Reporting Items for Systematic Review and Meta-Analyses Protocols (PRISMA-P) (Shamseer et al., 2015). This study has been registered on PROSPERO, registration ID: CRD42021251934.

### **2.3 Study inclusion criteria**

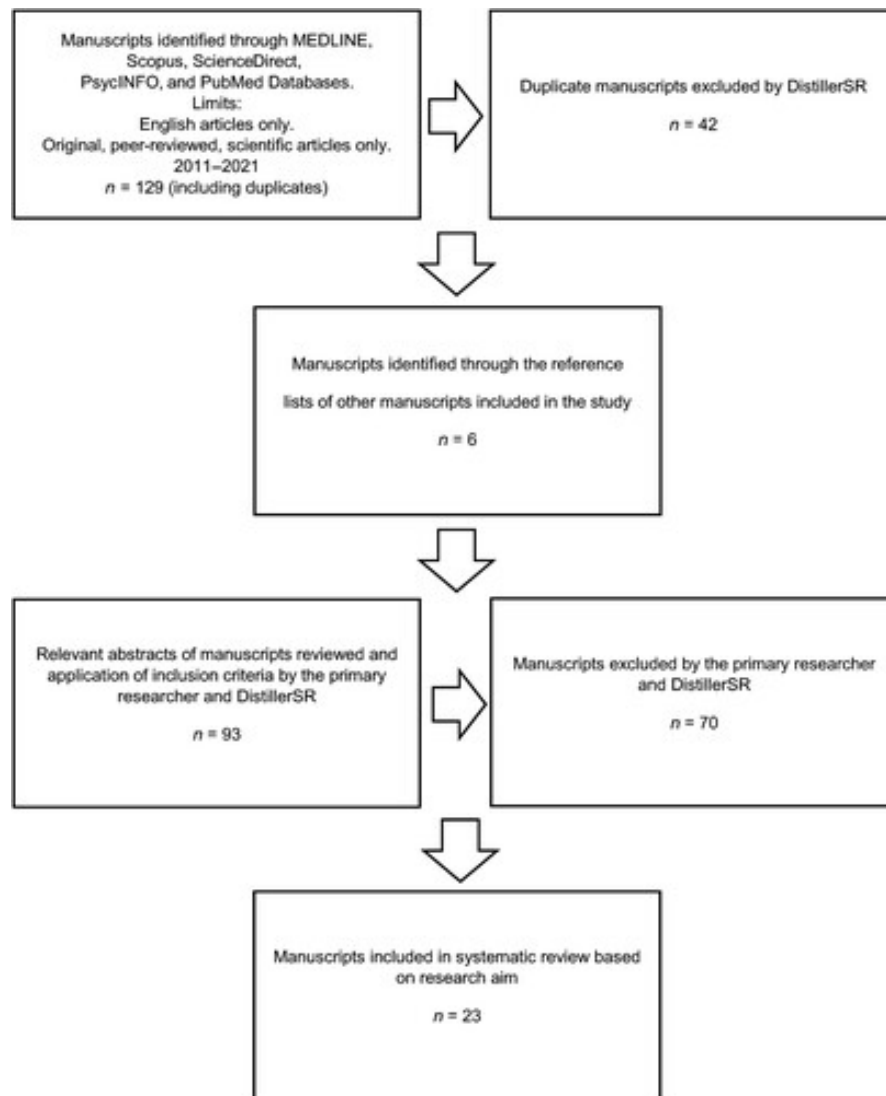
All studies selected were published in English, due to the authors' proficiency in English and because it is considered the universal language. Only original research data published within the last 10 years (2011–2021) were included in order to report on recent literature. All studies had to be scientific, human studies, and peer-reviewed to be included. Reviews were excluded to prevent reporting bias. Participant groups included are PVUs such as, but not limited to, singers, actors, teachers, telemarketers, journalists and group fitness instructors.

## **2.4 Search methods for identification of the studies**

Five online electronic databases were searched on the 5<sup>th</sup> of February 2021. The databases used were MEDLINE, Scopus, Science Direct, PsycINFO, and PubMed, based on their relevance to medical literature. Consensus was reached by the three authors regarding search phrases and eligibility criteria. The final search phrase used consistently across the databases was “(vocal hygiene AND voice quality), (vocal hygiene education AND voice quality), (vocal health AND voice quality)” and received a total of 129 results across the databases.

To manage the data, the web-based software DistillerSR (Evidence Partners) was used. Duplicates found during the search were removed by DistillerSR (n = 42). Thereafter, the primary researcher screened the remaining article abstracts for eligibility criteria. The reference lists of the included articles were scanned to identify related articles (n = 6) and served as a secondary literature search. After this, all unrelated reports (n = 70) were excluded. The remaining reports (n = 23) were reviewed in full by the primary researcher to confirm all inclusion criteria were met. To avoid bias, consensus was reached between the three authors regarding the final inclusion of the articles (n = 23). Figure 1 represents the process of manuscript identification.





**Figure 1.** Process of data collection adapted from the Preferred Reporting Items for Systematic review and Meta-Analyses Protocols (PRISMA-P) statement (Shamseer et al., 2015).

## 2.5 Data collection, extraction and evaluation

Each of the final 23 articles was analysed for the following data items: title; authors; year of publication; the country in which the study was conducted; the number of participants; participant age range, gender, occupation; the methodology; level of evidence; level of vocal hygiene education and validity of programme used; as well as auditory-perceptual, acoustic, and self-rating outcome measures directly and indirectly

reflecting voice quality. DistillerSR was used to develop a custom data extraction form from the study characteristics template which was used to record data items from the final selection. Data entry errors are minimized through the automated management of data (Shamseer et al., 2015). The American Speech-Language-Hearing Association's (ASHA) level of evidence rating scale and the quality indicators in the ASHA levels of evidence scheme were used to rate and score the articles (American Speech-Language-Hearing Association, 2004).

## **2.6 Basic principles of Vocal Hygiene Education (VHE) programs in studies**

Basic principles in VHE reviewed variably included education on the vocal mechanism, adequate hydration, vocally healthy diet (caffeine, medication, alcohol, spicy foods, dairy etc.), posture and alignment, phonotraumatic vocal behaviours, reflux control, voice rest and ideal speaking environment (Bolbol et al., 2017; Faham et al., 2017; Liu et al., 2020; Nallamuthu, Boominathan, Arunachalam, & Mariswamy, 2021; Nanjundeswaran et al., 2012; Nusseck et al., 2019; Pomaville et al., 2019; Porcaro et al., 2019; Rangarathnam et al., 2018b; Richter, Nusseck, Spahn, & Echternach, 2016; Rodríguez-Parra, Adrián, & Casado, 2011b; Rumbach, 2013b; Sezin et al., 2020).

## **2.7 Risk of bias**

The Newcastle-Ottawa Scale (NOS) for case-control studies as well as the adapted version of the NOS for cross-sectional studies was used to evaluate the quality of non-randomized studies included in this review (Wells et al., 2014). Each study was independently appraised by the primary researcher while the two co-authors rated 20% of all included studies. The third author also mitigated situations of disagreement. The same articles were reviewed by all three authors and a 100% consensus was reached. A star rating system was employed when evaluating the methodologic quality using the NOS, which is based on three perspectives: selection, comparability, and exposure or outcome. Scores ranged from 0 stars (worst) to 8 stars (best).

## **2.8 Data synthesis**

The data obtained were described and summarised using descriptive statistics. Inferential statistics were employed to analyse, organize, and synthesize the information extracted from the appraised articles to describe the findings quantitatively. Thematic synthesis was employed to extract and describe the qualitative findings.

## **3 RESULTS**

The study characteristics and main findings are summarized and presented in Table 1. Seventeen of the studies (n = 17; 74%) were conducted in high-income countries (HICs), such as the United States (n = 9; 39%), Australia (n = 1; 4%), Chile (n = 1; 4%), Spain (n = 2; 8,6%), Poland (n = 1; 4%), Sweden (n = 1; 4%), and Germany (n = 2; 8%). Six studies were conducted in upper (UMICs) and lower-middle income

**Table 1.** Study characteristics and main findings.

Study title	Author and date published	Country	Participant voice characteristics	ASHA's level of evidence	Profession of participants in study (PVU)	Study design	Outcome measures used	Main findings
A joyful noise: The vocal health of worship leaders and contemporary Christian singers (Neto & Meyer, 2017)	Neto L. & Meyer D. (2017)	USA	Normal	III	Contemporary Christian singers and worship leaders	Cross-sectional	Questionnaire (self-rating)	Acute vocal symptoms were linked to low awareness of VH principles.
Vocal problems of group fitness instructors: Prevalence of self-reported sensory and auditory-perceptual voice symptoms and the need for preventative education and training (Rumbach, 2013)	Rumbach A. F. (2013)	Australia	Normal	III	Group fitness instructors	Cross-sectional	Questionnaire (self-rating)	Acute and chronic vocal symptoms were linked to lack of VHE and voice training.
Vocal hygiene habits and vocal handicap among conservatory students of classical singing (Achey et al., 2016)	Achey M. A., He M. Z., & Akst L. M. (2016)	USA	Normal	III	Classical singing students	Cross-sectional	Singing Voice Handicap Index-10 (SVHI-10)	Due to the inconsistent implementation of VH practices, students may have elevated risk for dysphonia and voice disorders that is not effectively addressed through common vocal hygiene recommendations alone.
Associations of education and training with perceived singing voice function among professional singers (Zuim et al., 2021)	Zuim A. F., Lloyd A. T., Gerhard J., Rosow D., & Lundy D. (2021)	USA	Normal	III	Professional singers	Cross-sectional	Questionnaire, and Evaluation of the Ability to Sing Easily (EASE)	Significantly lower (better) EASE scores ( $p < .05$ ) were linked to those participants who received VHE.
Inadequate vocal hygiene habits associated with the presence of self-reported voice symptoms in telemarketers (Fuentes-López et al., 2019)	Fuentes-López E., Fuente A., & Contreras K. V. (2019)	Chile	Normal	III	Telemarketers	Cross-sectional	Vocal hygiene habits, and vocal symptoms questionnaire	The frequency of unfavorable vocal hygiene habits was correlated to the number of vocal symptoms reported.
The effects of a voice education program on VHI scores of elementary school teachers (Faham et al., 2016)	Faham M., Ahmadi A., Drinnan M., Saadatmand N., Fatahi E., & Jalalipour M. (2016)	USA	Normal	Ib	Teachers	Randomized control trial	VHI	A VH education program can have positive effects on the voice of teachers, even without dysphonia.
A training model for improving journalists' voice (Rodero et al., 2018)	Rodero E., Diaz-Rodriguez C., & Larrea O. (2018)	Spain	Normal	Ib	Student journalists	Randomized control trial	Acoustic analysis	Participants were thus able to enhance their main vocal and prosodic elements and, therefore, their expressiveness when maintaining optimal vocal hygiene practices.

(table continues)

**Table 1.** (Continued).

Study title	Author and date published	Country	Participant voice characteristics	ASHA's level of evidence	Profession of participants in study (PVU)	Study design	Outcome measures used	Main findings
Evaluation of the results of the prevention program "Protect your voice" implemented by The Greater Poland Center of Occupational Medicine of Poznan (Jalowska et al., 2017)	Jalowska M., Wośkowiak G., & Wiskirska-Woźnica B. (2017)	Poland	Dysphonic	Ib	Teachers with occupational voice disorders	Randomized control trial	Phoniatric examination, videostroboscopy, and questionnaire (self-rating)	A combination of vocal training, VHE, and breathing exercises prove to be an effective method in the prevention of voice disorders in teachers.
Impact of vocal hygiene training on teachers' willingness to change vocal behaviors (Porcaro et al., 2021)	Porcaro C. K., Howery S., Suhandron A., & Gollery T. (2021)	USA	Normal	III	Teachers	Cross-sectional	Questionnaire (self-rating)	The effect of vocal hygiene training on teachers' willingness to implement vocally hygienic behaviors was statistically significant ( $d \geq 0.80$ ). An increase in perceived desire to engage in vocal hygiene behaviors was seen in nearly 90% of the targeted vocal hygiene behaviors. Teachers benefit from receiving VHE and show willingness to incorporate these techniques into their daily lives.
Preliminary data on prevention and treatment of voice problems in student teachers (Nanjundeswaran et al., 2012)	Nanjundeswaran C., Li N. Y. K., Chan K. M. K., Wong R. K. S., Yiu E. M. L., & Verdolini-Abbott K. (2012)	USA	Normal	Ib	Student teachers	Randomized control trial	VHI	The VH program prevented the worsening of VHI scores that occurred in all control participants over the 4–8 weeks of student teaching. A VH program may be sufficient to prevent voice problems in healthy student teachers. However, for student teachers with existing voice problems, voice therapy may be required to optimize results.

(table continues)

Table 1. (Continued).

Study title	Author and date published	Country	Participant voice characteristics	ASHA's level of evidence	Profession of participants in study (PVU)	Study design	Outcome measures used	Main findings
Vocal health education and medical resources for graduate-level vocal performance students (Latham et al., 2017)	Latham K., Messing B, Bidlack M., Merritt S., Zhou X, & Akst L. M. (2017)	USA	Normal	III	Vocal performance students	Cross-sectional	Questionnaire (self-rating)	Singers strongly agree that vocal physiology and vocal health should be taught in graduate voice curricula, and that knowledge of vocal health might help PVUs limit injuries. Overall, the amount and quality of the instruction provided in respective institutions was perceived positively. However, there are several perceived barriers to incorporating vocal health education into graduate singing programs such as limited time in the curriculum, lack of financial support, and lack of availability of a medical professional.
The effectiveness of vocal hygiene education for decreasing at-risk vocal behaviors in vocal performers (Pomaville et al., 2020)	Pomaville F., Tekerlek K., & Radford A. (2020)	USA	Normal	III	Vocal performers	Single-group pretest–posttest study	Questionnaire (self-rating)	Participation in a VHE program increases knowledge of voice production and vocal hygiene; can positively influence intake of water, caffeine, and alcohol; can increase healthier responses to laryngeal irritation and symptoms of vocal fatigue; and may decrease negative symptoms associated with voice use.
Comparing voice-therapy and vocal-hygiene treatments in dysphonia using a limited multidimensional evaluation protocol (Rodríguez-Parra et al., 2011) Direct voice-therapy treatment is shown to have more positive effects than vocal hygiene-based therapy in 4 to 5 of the 8 continuous measures of voice disorder analyzed.	Rodríguez-Parra M. J., Jose A. J. A., & Casado J. C. (2011)	Spain	Dysphonic	Ib	Mixed PVUs: teachers, singers, television, announcers, sales people, beauticians, and administrators	Randomized control trial	Acoustic analysis, spectrographic evaluation, perceptual (GRBAS),	laryngostroboscopic assessments, and self-rating

(table continues)

Table 1. (Continued).

Study title	Author and date published	Country	Participant voice characteristics	ASHA's level of evidence	Profession of participants in study (PVU)	Study design	Outcome measures used	Main findings
"Prologues to a bad voice": Effect of vocal hygiene knowledge and training on voice quality following stage performance (Rangarathnam et al., 2018)	Rangarathnam B., Paramby T., & McCullough G. H. (2018)	USA	Normal	III	Stage actors	Single-group pretest–posttest study	Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V), and acoustic analysis	Stage performances impact vocal outcomes with a reduction in quality and efficient use of airflow for voice production. Knowledge and practice of vocal hygiene have some impact on these changes; however, vocal hygiene alone may not be the best "shield" to prevent these changes.
Effects on vocal range and voice quality of singing voice training: The classically trained female voice (Pabon et al., 2014)	Pabon P., Stalling R., Sodersten M. & Ternstrom S. (2014)	Sweden	Normal	III	Classical singers	Single-group pretest–posttest study	Voice range profile (VRP), and questionnaire (self-rating)	VRP can positively change in shape, size, and quality pattern as a result of vocal training and VHE in classically trained singers, although the students self-reporting did at times contradict the findings.
Effectiveness of a voice training program for student teachers on vocal health (Richter et al., 2016)	Richter B., Nusseck M., Spahn C., & Echternach M. (2016)	Germany	Normal	Ila	Student teachers	Nonrandomized controlled study	Dysphonia severity index (DSI), and vocal loading test (VLT), VHI	A VHE training program improved the voice quality of the trained group compared with that of the control group, whose voice quality declined. The trained group could also better sustain their voice quality across the VLT.
Long-term effects of a voice training program for teachers on vocal and mental health (Nusseck et al., 2021)	Nusseck M., Immerz A., Spahn C., Echternach M., & Richter B. (2021)	Germany	Normal	Ila	Teachers	Nonrandomized controlled study	Acoustic analysis, German VHI-12, and assessment of the voice self-concept (FESS)	Those trained in VHE increased in DSI over all three surveys, whereas the nontrained teachers decreased in DSI with a significant interaction effect. The trained teachers also significantly increased the awareness of voice use and their mental health compared to the nontrained group.
Drama students with and without vocal complaint: Vocal health and hygiene data, symptoms and voice handicap (Cruz et al., 2019)	Dos Santos M., R., Amarante Cruz A., Yamasaki R., Pacheco C., De Menezes Borrego M. C., & Behlau M. (2019)	Brazil	Group 1 = vocal complaints (WVC); Group 2 = No vocal complaints (NCG)	III	Upper- and lower-middle-income countries Drama students	Cross-sectional	Voice Symptom Scale (VoISS), and Voice Handicap Index (VHI-10)	Increased voice symptoms and a greater perception of voice handicap were correlated with poor knowledge of vocal hygiene.

(table continues)

Table 1. (Continued).

Study title	Author and date published	Country	Participant voice characteristics	ASHA's level of evidence	Profession of participants in study (PVU)	Study design	Outcome measures used	Main findings
Self-perception of voice symptoms and vocal health and hygiene knowledge in popular and classical singers (Coelho et al., 2020)	Dos Santos Coelho J., Moreti F., Pacheco C., & Behlau M. (2020)	Brazil	Normal	III	Popular singers and classical singers	Cross-sectional	The vocal self-assessment questionnaire for the singing voice, and the Brazilian-validated version of Voice Symptom Scale (VoiSS)	The perception of vocal variation between popular and classical singers seems to have no relation to the degree of vocal hygiene knowledge obtained.
Investigation of the effectiveness of a holistic vocal training program designed to preserve theatre students' vocal health and increase their vocal performances; A prospective research study (Sezin et al., 2020)	Sezin R. K., Ozcebe E., Aydinli F. E., Sen Kose A., & Gunaydin R. O. (2020)	Turkey	Normal	Ib	Conservatory theatre students	Randomized control trial	Acoustic analysis, and CAPE-V	Acoustic findings revealed that the vocal qualities of the control group deteriorated, whereas no change was seen in the study group. Audio-perceptual values were significantly improved for the study group.
Comparison between combination of resonant voice therapy and vocal hygiene education and vocal hygiene education only for female elementary school teachers (Liu et al., 2020)	Liu H., Chen S., Gao L., Li J., Liu B., Raj H., Xie Q., Duan H., Jiang Z., Liu Y., Chen B., Liu Y. & Jiang J. (2020)	China	Normal	Ib	Teachers	Randomized control trial	Acoustic analysis, GRBAS, and VHI-10	A combination of vocal hygiene education and resonant voice therapy can significantly improve the voice function of PVUs and effectively improve their voice quality.
Risk factors of voice disorders and impact of vocal hygiene awareness program among teachers in public schools in Egypt (Bolbol et al., 2017)	Bolbol S. A., Zalat M. M., Hammam R. A. M., & Elnakeb N. L. (2017)	Egypt	Normal	III	Teachers	Cross-sectional	Questionnaire, VHI, and laryngo-videostroboscopy	Increasing awareness about VH improves teachers' quality of work and helps minimize any permanent vocal disability and/or impairments.
Outcomes of vocal hygiene program in facilitating vocal health in female school teachers with voice problems (Nallamuthu et al., 2021)	Nallamuthu A., Boominathan P., Arunachalam R., & Mariswamy P. (2021)	India	Normal	III	Teachers	Single-group pretest–posttest correlational study	GRBAS, acoustic analysis, stroboscopic exam, V-DOP, and VFI	Though a vocal hygiene program (VHP) facilitated improvement in teachers' awareness of phonotraumatic behaviors and vocal health, it's efficiency was limited in producing physiological improvement in teachers' voices.

Note. ASHA = American Speech-Language-Hearing Association; PVU = professional voice user; VH = vocal hygiene; VHE = vocal hygiene education; VRP = voice range profile; VHI = voice handicap index; FESS = The german questionnaire "Fragebogen zur Erfassung des stimmlichen Selbstkonzepts"; WWH = with vocal complaints group; NCG = no complaints group; V-DOP = voice disorder outcome profile; GRBAS = grade, roughness, breathiness, asthenia, strain; VFI = vocal fatigue index.



countries (LMICs) including Brazil (n = 2; 8,6%), Turkey (n = 1; 4%), China (n = 1; 4%), Egypt (n = 1; 4%) and India (n = 1; 4%). Participants' ages ranged from 16 to 65 years across the selected articles. Ten studies (43%) were observational cross-sectional survey-based studies in design. The rest of the studies designs (n = 13; 56%) were experimental randomized control trial studies (n = 7; 30%), single group pre-test post-test studies (n = 4; 17%) and two (9%) non-randomized control studies. Seven studies (30%) achieved a high evidence rating (Ib), two studies achieved an evidence rating of IIa and fourteen studies (60%) achieved a low evidence rating (III) according to ASHA's levels of evidence (Table 1) (American Speech-Language-Hearing Association, 2004).

### 3.1 Risk of bias

The risk of bias assessment is summarized and presented in Table 2. When evaluating all studies, variability in the methodologic quality rating is noted (Poor – two studies; Fair – twelve studies; High – nine studies). Across all studies, the average rating (six stars) indicates a fair methodologic quality across all studies included (Table 2).

**Table 2.** Newcastle–Ottawa Scale (NOS) for assessing the risk of bias (Higgins et al., 2011).

Reference	Selection	Comparability	Outcome/exposure	Total quality
NOS for cohort studies				
Nallamuthu et al. (2021)	**	**	****	8
Rangarathnam et al. (2018)	*	–	***	4
NOS for case–control studies				
Rodríguez-Parra et al. (2011)	*	*	***	7
Jalowska et al., (2017) and Pabon et al. (2014)	**	*	**	5
Richter et al. (2016) and Rodero et al. (2018)	***	*	***	7
Sezin et al. (2020) and Liu et al. (2020)	***	*	**	6
Nusseck et al. (2021)	*	*	**	4
NOS for cross-sectional studies				
Neto & Meyer (2017) and Rumbach (2013)	**	–	*	3
Bolbol et al. (2017)	****	*	***	8
Achey et al. (2016)	***	–	**	5
Zuim et al. (2021) and Latham et al. (2017)	****	–	**	6
Fuentes-López et al. (2019)	**	–	**	4
Faham et al. (2016), Coelho et al. (2020), and Porcaro et al. (2021)	****	*	**	7
Cruz et al. (2019) and Pomaville et al. (2020)	**	*	**	5
Nanjundeswaran et al. (2012)	*****	*	*	7

Note. The asterisks (\*) indicate the NOS star-rating system. The dashes (–) indicate when a “0” was rated on the NOS star-rating system.

## **3.2 Results as per VHE on voice quality**

### *3.2.1 Studies using Questionnaires and self-rating scales*

Four studies (17%) on vocally healthy PVUs found that self-reported acute and chronic voice symptoms, (of which vocal fatigue was the most prevalent (Neto & Meyer, 2017)), as well as a greater perception of voice handicap was linked to respondents' reported low awareness of VHE and/or PVUs not having received sufficient voice training (Coelho, Moreti, Pacheco, & Behlau, 2020; Cruz, Yamasaki, Pacheco, Borrego, & Behlau, 2019; Neto & Meyer, 2017; Rumbach, 2013b). The frequency of unfavourable vocal hygiene habits, such as phonotraumatic behaviours correlated to the number of vocal symptoms reported by PVUs (Fuentes-López et al., 2019). According to PVUs with normal voices in one study (4%), using their voice in noisy environments and talking without taking breaks were both associated with the presence of vocal symptoms, such as "tense or tired voice", "dry throat and mouth" and "needing to clear their throat" (Fuentes-López et al., 2019). Another link was seen (n = 3; 13%) between vocally healthy PVUs who self-reported adequate voice training or those who received VHE and positive voice quality outcomes (Bolbol et al., 2017; Faham et al., 2016; Zuim et al., 2019). One study (n = 1,4%) found that PVUs with normal voices strongly agree that vocal physiology and vocal health should be taught in graduate voice curriculum, and that knowledge of vocal health might help PVUs limit injuries. Overall, the amount and quality of the instruction provided in respective institutions was perceived positively. However, there were several perceived barriers to incorporating vocal health education into graduate programs such as limited time in the curriculum, lack of financial support, and lack of availability of a medical professional to teach (Latham et al., 2017). The effect of vocal hygiene in one study (n = 1,4%) on PVUs' willingness to implement vocally hygienic behaviours was

positively related and statistically significant ( $d \geq 0.80$ ) (Porcaro et al., 2019). An increase in perceived desire to engage in vocal hygiene behaviours was seen for nearly 90% of the targeted vocal hygiene behaviours in PVUs with normal voices (Porcaro et al., 2019). Another study on vocally healthy PVUs (4%) found a statistically significant improvement in PVUs' reported knowledge regarding the larynx, voice production, and vocal hygiene after the implementation of a VHE program (Pomaville et al., 2019). At post-test PVUs demonstrated improved hydration habits, decreased caffeine and alcohol intake, and healthier responses to symptoms of throat irritation or vocal fatigue (Pomaville et al., 2019). Significantly better ( $p < .05$ ) EASE scores ( $n = 1,4\%$ ) and a statistically significant ( $p < .05$ ) increase in awareness of vocal hygiene ( $n = 1, 4\%$ ) three months after application of vocal hygiene awareness program were observed in vocally healthy PVUs (Bolbol et al., 2017; Zuim et al., 2019). One study (4%) found PVUs with normal voices who were educated in VH ( $n = 1, 4\%$ ) also showed significantly improved VHI scores (from 14.2 to 6.8), whereas those who were not showed a significant worsening (from 10.1 to 13.7) over an eight-week period (Faham et al., 2016). These effects were significant ( $p < .05$ ) for the total VHI score and all subscales (Faham et al., 2016). Another study ( $n = 1,4\%$ ) comparing VHE alone to VHE in combination with direct voice therapy demonstrated that a VHE program prevented worsening of VHI scores occurring in all control participants over 4–8 weeks (Nanjundeswaran et al., 2012). It was found that a VHE program may be sufficient in preventing voice problems in vocally healthy PVUs. However, for PVUs with existing voice problems, voice therapy may be required to optimise results (Nanjundeswaran et al., 2012). It is important to note that future PVUs with normal voices often report ( $n = 1, 4\%$ ) a moderate degree of vocal handicap although they

simultaneously report inconsistent implementation of VH practices (Achey et al., 2016).

### *3.2.2 Studies only using acoustic analysis*

One study (4%) found that PVUs with normal voices can enhance their vocal and prosodic features, and therefore their expressiveness when maintaining optimal vocal hygiene practices (Rodero et al., 2018). After a 30-hour educational course on professional voice care, vocal hygiene, auditory perception, relaxation, postural control, voice production, voice properties, and prosody significant differences ( $p < .05$ ) were observed in voice features such as breathing, articulation, loudness (dB), pitch, jitter, speech rate, pauses, and stress (Rodero et al., 2018).

### *3.2.3 Studies that used a combination of outcome measures*

One study ( $n = 1$ , 4%) found that the voice range profile (VRP) of vocally healthy PVUs positively changed as a result of vocal training and VHE learnt throughout a three-year bachelor's singing curriculum, yet it is important to note that PVUs' self-evaluations ( $n = 1$ , 4%) of their voice changes appear to contradict VRP findings at times (Pabon, Stallinga, Södersten, & Ternström, 2014). It was found that a VHE training program ( $n = 1$ , 4%) improved the voice quality of PVUs with normal voices, compared to those who were not, in whom a reduction in voice quality could be observed (Richter et al., 2016). Vocally healthy PVUs trained in VHE ( $n = 1$ , 4%) were able to better sustain their voice quality across a vocal loading task, increased in DSI score over three surveys and significantly improved ( $p < .05$ ) their awareness of voice use and mental health compared to those who were not trained in VHE (Nusseck et al., 2019). The positive effects of VHE training were maintained for 2 years after completion of training

(Nusseck et al., 2019). Another study (n = 1, 4%) similarly observed vocally healthy PVUs trained in VH outperform PVUs who had not received training with a significant increase in knowledge on vocal hygiene ( $p < .05$ ) and the vocal mechanism ( $p < .05$ ) when questioned (Sezin et al., 2020). In one study (n = 1, 4%), vocally healthy PVUs who had been trained in VHE demonstrated significantly ( $p < .05$ ) improved audio-perceptual values and their vocal quality remained unaffected over time compared to the untrained PVUs, whose vocal qualities deteriorated (Sezin et al., 2020). Two studies (8,6%) have, however, shown that VHE is more effective when combined with direct voice therapy in PVUs with and without voice disorders (Liu et al., 2020; Rodríguez-Parra et al., 2011a). When VHE is presented in isolation, the superiority of a voice therapy (direct treatment) approach without VHE is seen over a vocal hygiene program (indirect treatment) alone in dysphonic PVUs (Rodríguez-Parra et al., 2011a). PVUs receiving only VHE (n = 1, 4%) did not show significant improvement in their voice quality (Liu et al., 2020). The direct treatment approach (n = 1, 4%) is shown to have more positive effects than vocal hygiene-based therapy alone in 4 to 5 of 8 continuous measures of voice (Maximum phonation time, Maximum exhalation time, Maximum phonation time during connected speech, Jitter, Well-being, Self-voice, Hygiene and Anxiety) in PVUs with dysphonic voices (Rodríguez-Parra et al., 2011a). A combination of vocal training, VHE and breathing exercises (n = 1, 4%) also proved to be an effective method in the prevention of voice disorders in PVUs with dysphonia (Jałowska et al., 2017). Though VHE facilitates improvement in awareness and knowledge of phono-traumatic behaviours and vocal health, the use of VHE in isolation was limited in producing improvements based on the Dysphonia Severity Index (DSI) scores and laryngeal videostroboscopic examination (Nallamuthu et al., 2021). Stage performance occupations are easily impacted by undesirable changes in quality of

voice and airflow for voice production (Rangarathnam et al., 2018b). Knowledge and practice of vocal hygiene have shown to have some impact on these changes; however, it was concluded that vocal hygiene alone may not be the best prevention measure to safeguard performers against these changes (Rangarathnam et al., 2018b).

#### **4 DISCUSSION**

Critical appraisal of recent peer-reviewed, scientific evidence on the effect of vocal hygiene education on professional voice users' voice quality showed the following. Most of the studies (n = 13; 68%) were conducted in HICs, indicating that the majority of research on VHE and vocal quality is centralised in HICs. This may not only result in insufficient spread of access to evidence supporting practice but also a disparity in the participant population groups shaping the findings presented. Although many studies (n = 10; 43%) reviewed were survey-based studies using a cross-sectional design known to provide a lower level of evidence, the majority of studies provided strong levels of evidence (n = 13; 56%) as they made use of experimental randomized control trial studies (n = 7; 30%), single group pre-test post-test studies (n = 4; 17%) and non-randomized control studies (n = 2; 8%) for the research design. Nine of the studies reviewed (39%) scored a high evidence level rating of Ib (n = 7; 30%) or IIa (n = 2; 9%) whereas fourteen (61%) scored a lower evidence level rating (III) according to ASHA's levels of evidence (American Speech-Language-Hearing Association, 2004). Assessment on the risk of bias confirmed an overall fair quality of evidence observed across all studies included.

From the results reviewed on VHE and vocal quality, the following can be concluded. Positive effects of VHE training in PVUs are increased awareness on vocal hygiene and knowledge on the vocal mechanism<sup>4,22,23</sup>, better sustained voice quality across a vocal loading task, improved DSI scores, better mental health (Nusseck et al., 2019), increased perceptual voice quality values as well as enhancement of associated vocal and prosodic features (such as breathing, articulation, loudness, pitch, jitter, speech rate, pauses, and stress) (Rodero et al., 2018). Some studies observed the lasting effects of VHE maintained in PVUs after training had ceased, emphasizing the importance of VHE as a long-term investment for a voice-related healthy working life (Nusseck et al., 2019). The research reviewed suggests that increasing awareness about occupational vocal hygiene will help to improve PVUs' voice-related quality of work and to minimize any permanent vocal disability and/or impairments (Bolbol et al., 2017).

Many studies highlighted the need for regular vocal training and VHE in PVUs as well as the negative effects on vocal outcomes when lacking. This lack of VHE is directly linked to the prevalence of self-reported acute and chronic voice symptoms and a greater perception of voice handicap amongst PVUs (Aiken & Rumbach, 2018; Coelho et al., 2020; Cruz et al., 2019; Neto & Meyer, 2017). Yet it is important to note that PVUs who have been exposed to VHE still report poor self-evaluations of their voices in contradiction to acoustic findings and admit inconsistent implementation of VH practices (Achey et al., 2016; Pabon et al., 2014). The reviewed studies found that a combination of direct voice treatment and VHE should be used for optimal outcomes as PVUs and future PVUs with and without voice disorders have elevated risk for dysphonia and voice disorders that are not effectively addressed through common

vocal hygiene recommendations alone (Achey et al., 2016; Liu et al., 2020; Nallamuthu et al., 2021; Rangarathnam et al., 2018b; Rodríguez-Parra et al., 2011b). Limitations of the current systematic review include possible language bias as only articles written in English or translated to English were included leading to the possible omission of some studies. Although the VHE programmes utilized in the studies selected are based on the same principles, the programmes varied which may have affected the study outcomes.

## **5 CONCLUSION**

Recent peer-reviewed, scientific literature demonstrates mixed results, obtained through auditory-perception, acoustic analysis and self-rating scales, on the effect of VHE on vocal quality in PVUs. Yet, the positive outcomes presented are compelling enough to warrant implementing VHE programs for PVUs in combination with various direct voice training or therapy. Future research should aim to identify optimal combinations of direct and indirect (VHE) treatment approaches for PVUs and the unique challenges they face regarding occupational voice demands. VHE should be viewed as not only part of the treatment approach when an existing voice disorder is identified but also as a prevention tool implemented by the PVU in daily life. A future meta-analysis on the effect of VHE on various voice parameters should be explored. Future research from LMICs is essential as divergent contextual factors will influence vocal treatment approaches and therapy outcomes.



## 6 DATA AVAILABILITY STATEMENT

Data will be stored electronically for 15 years in a code-protected room (room 3-19) within the Communication Pathology building, University of Pretoria (UP) as well as in the UP data repository. All data will thus be stored on password- and user-protected UP drive.

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## **LEARNING OUTCOMES**

As a result of this activity/article, the participant will be able to list the negative effects of a voice disorder seen in PVUs.

As a result of this activity/article, the participant will be able to explain which self-reported acute or chronic vocal symptom was most prevalent amongst PVUs.

As a result of this activity/article, the participant will be able to assess whether vocal hygiene programs should be used alone or in combination with direct voice therapy for optimal treatment outcomes.