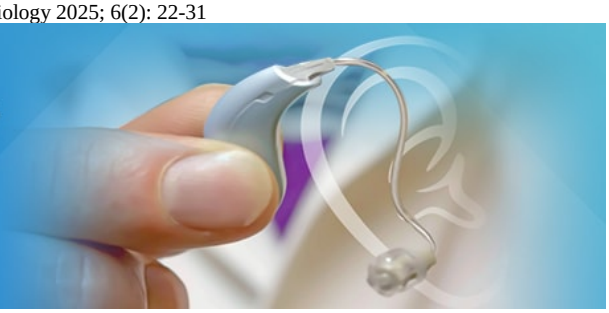
International Journal of Speech and Audiology



E-ISSN: 2710-3854
P-ISSN: 2710-3846
IJSA 2025; 6(2): 22-31

Journal's Website
Received: 05-05-2025
Accepted: 12-06-2025

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Determinants of voice disorder in professional users: A systematic review

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DOI: https://www.doi.org/10.22271/27103846.2025.v6.i2a.82

Abstract
Summary: The identified risk factors or determinant of voice disorders were sub-divided into different categories based on best evidence quality namely medical and health related factors, socioeconomic factors, environmental factors and demographic factors. Further good quality research is required to identify the strong correlation between determinants of voice disorder and professional users.
Introduction: Voice is a crucial part of our life which helps us to express our emotion and views in words. The disorders or issues with voice in professional user affect their daily functions and tasks. Voice abnormalities are deviations of a specific sound in relation to tone, intensity, volume, or variability of speech from of the voices of people of common gender, age, and ethnic groups. It is found that voice problems contribute to psychiatric illnesses such as depression, fatigue, and insecurity. It also adversely affects professional performance, engagement and attitude, contributing to lowered quality and higher incidence of absenteeism.
Methods: The computer assisted Ebscohost-All database, Medline, PubMed and Google scholar from 2009 to 2020 have been used to identify the determinants of voice disorders in professional users. Altogether, 10 articles were found to summaries the results following the best evidence synthesis.
Results: Ten studies were identified for inclusion which reflects the lack of literature in this topic. Types of occupation, loud speech use, psychological stresses, and recurring issues of upper tract infections, thyroid problems, and gastrointestinal acid reflux and background noises were found to be strongly related to voice issues. Further age, sex, gender, smoking and alcohol were weakly identified as risk factors for voice disorder in professional users.
Conclusion: Due to the identification of few conflicting correlations between risk factors and voice disorders, it is recommended to perform comprehensive cohort study among professional users. Further, limited good quality evidence exists to identify the socioeconomic factors as a determinant of voice disorder in professional users.

Keywords: Voice disorder, professional voice users, voice determinants, disorders associated with voice, occupational voice disorders, systematic review

Introduction

Voice can be defined as the sound that has been produced by the vocal cords when air expels from the lungs. Vocal cords are made up of two tissue folds and located within the larynx. It is also known as the voice box of human beings. Each individual has their own unique voice and plays a crucial role in the lives of many people. Various studies found that almost 25% of working people use voice as an important component of their profession (Hazlett, Duffy, and Moorhead, 2011) [8]. A person whose voice is associated with their professional career, and an integral part of their earning considered as the professional user. Moreover, their livelihood depends on their voice. All the teachers, motivational speakers, singers, actors, salesperson, telemarketer, politicians, lawyers and stage performers come under the broad range of professional voice users (Pestana, Vaz-Freitas and Manso, 2017) [12]. Lately, there has been an enormous demand of professional voice users because of the advanced technology and popularity of professional voice users. It should be kept in mind that voice disorders can threaten, shorten or even end the careers of professional users which may influence the emotional and psychological wellbeing of the person. Maintaining a healthy voice is important for professional users as it directly affects their livelihood (Sheikhany, Atef, Refaat & Ali, 2019) [15]. A voice disorder is a condition where there is a change in the volume, pitch, tone, loudness and other attributes of view which can be characterized by

hoarseness, sore throat, vocal fatigue, voice instability and weak voice. Further, studies suggest that people suffering from Vocal Resonator Dysfunction experience mixed resonance, hyper nasality, hypo nasality and cul-de-sac resonance, but people with neck muscle hypertension will get muscle tightness, strain in turning head, pain in certain position, spasm and muscle stiffness (American Speech-Language-Hearing Association, 2020) [2].

In some people, temporary or permanent loss of voice can be seen. Prolong use or abuse of voice disturbs the normal phenomena of voice production and affects the professional activity. The cause of voice disorder is multidimensional, and occupational risk factors have a vital role in the progression of vocal problems in professional users (Lee *et al*., 2010) [9]. Further, the onset of vocal dysfunction varies from profession to profession, and depends on other variable factors like smoking habits, sociodemographic profile, years of experience, stress and other occupational environmental factors. Particularly, teachers and singers are at more risk of developing occupational voice disorder because of their continuous vocal use. Voice disorders have been the major cause of absence leave in most of the professional users, especially among teachers (Przysiezny & Przysiezny, 2015) [13].

Voice is often taken for granted by many individuals, including those whose professions rely heavily on vocal use. Due to negligence and lack of proper attention, many professional voice users develop significant voice problems that impair their ability to perform their job effectively. Frequently, such individuals postpone therapeutic intervention until the condition becomes severe or unbearable. Various studies suggest that high vocal demands in the workplace can lead to health complications for employees. The prevalence of voice dysfunction among excessive voice users and the recognized need for vocal education highlight the importance of identifying the determinants of voice disorders. Understanding and examining the possible risk factors not only increase awareness but also support the development of preventive measures. Improving the vocal health of those in vocally demanding professions is critical. Thus, this systematic review is important to explore and understand the factors directly or indirectly associated with voice dysfunctions in professional users, so that appropriate interventions can be designed for both prevention and treatment.

Previous research analyzing the risk factors of voice disorders has often been limited by geographic, cultural, and occupational boundaries, neglecting comprehensive consideration of lifestyle, sociodemographic profiles, vocal symptoms, and general health status. These limitations emphasize the need for a systematic review that can provide evidence-based insights across diverse populations and professions. Most existing studies have focused on specific groups such as teachers or singers, whereas many other professional voice users remain understudied. Furthermore, the field of voice disorders remains underrepresented in occupational health research, where other conditions have established management frameworks. The onset and duration of symptoms, along with confounding variables and preventive factors, require critical evaluation across various professional settings. Scientific literature on voice disorders in professional users is still incomplete, necessitating a broader understanding of risk factors and onset patterns within different vocally demanding jobs. Collectively, these gaps reinforce the importance of systematically reevaluating the determinants of voice disorders in professional users to build a more complete and applicable understanding of the subject.

The aim of this study is to identify and explore the determinants of voice disorders in professional users. It seeks to categorize the various risk factors contributing to these disorders, including occupational, lifestyle, medical, and demographic variables. In addition, the study intends to evaluate the prevalence of vocal dysfunction across different vocally demanding professions and to analyze the gaps in awareness and therapeutic intervention. Ultimately, it aims to recommend evidence-based strategies for the prevention and management of voice disorders to enhance the vocal health and professional efficacy of individuals in high voice-use occupations.

Materials and Methods

This systematic review includes research articles published in English between January 2001 and 2020. Only studies that provide either qualitative or quantitative data on the determinants and risk factors associated with voice disorders among professional voice users were considered. The review incorporates data from studies conducted globally, ensuring a wide geographical representation. Studies were excluded if they were published in languages other than English, did not focus on the determinants of voice disorders as a primary outcome, used purely descriptive research methods without analytical value, or were published prior to January 2001.

Search Strategy

The E-Library of Torrens University has been used to search the articles for this systematic review. ‘Ebscohost-All database’ search engine was the main source for article review. Further, medical topic key words were used to simplify the existing literature study in a search method with "OR," "AND." Still, extra information was checked for the references of scientific articles.

Voice disorder: "Voice disorder", "Voice load", "Issue with voice" "Prolonged use of voice"

OR/AND

'Time dose' AND 'voice disorder' 'environmental impact' AND 'voice disorder'

AND / OR

Determinant: "Determinant", "Predisposing Factor" "Risk factor"

OR/AND

Frequency: "Prevalence" "Incidence" "Occur”

Article Abstraction

Database sources (January 2001- 2020)	Ebscohost-All database Medline PubMed Google scholar NCBI Science Direct
Identified 25 citations	5 excluded - duplicate articles which are obviously not pertinent to scope of study 4 excluded - out of scope of study design 2 excluded - the design doesn't match cross-sectional or cohort study of voice disorder 1 excluded- focused on theoretic aspect of voice changes 1 excluded- irrelevant to theme of this review objective
Reviewed 3 reference lists and citations	1 identified from reference lists of research
Reviewed 15 complete articles	3 excluded -no related information of determinant of voice disorders 2 excluded - same paper on two databases
10 articles were selected for full-paper review	

Methodological Quality

The methodological quality of the various studies including cohort study, cross-sectional study and case-control study has been collected, reviewed and assessed. A list of Criterion items has been assigned to assess each study. A scoring system previously applied by Lievense has been used to effectively assess the studies. All the quality articles have been scored with respect to the criterion items where '1' indicates positive and '0' indicates negative, while 'N/A' represents the criteria is not applicable to respective study. Hence, the total score in percentage has been identified each quality article collected.

Table 1: Criteria list for the assessment of study quality, adapted from Lievense *et al*. (2002) [17]

Item and Criterion	Study type
Study population	
• Participants representative of the target population • Cases and Controls drawn from the same population	C/CS CC
Assessment of risk factor	
• Exposure assessment blinded • Exposure measured identically for cases and controls	C/CC/CS CC
Assessment of outcome	
• Voice Disorder assessed identically in studied population	C/CC/CS
Study design	
• Prospective design used • Follow-up time > 24 months • Withdrawals < 20%	C/CC/CS C C
Analysis and data presentation	
• Appropriate analysis techniques used • Confounding variables considered in the design	C/CC/CS C/CC/CS

C = applicable to cohort studies, CC = applicable to case-control studies,
CS = applicable to cross-sectional

Study Characteristics of the Included Manuscripts

Table 2: Study Characteristics of the Included Manuscripts**.**

Author (year) and study design	Sample size	Follow-up	Study setting	Voice Disorder determinants are:	Quality Score
Claros *et al*. (2019) [5] • Cohort	1495	18 months	Barcelona, Spain	• Sociodemographic factors like age and sex • History of neck trauma • Use of medication that affects voice • Previous intubations, head, neck surgery that caused voiced disorder • current sickness and seasonal allergies • Symptoms of GER • Vocal load outside work	87.5%
Cercal *et al*. (2018)[4] 1. Cohort	235	9 months	Brazil	• Increase work overload • Phonatory effort • Neuromuscular inefficiency • Misuse or vocal abuse • Lack of vocal training • Emotional and psychosocial impairments • Length and frequency of teaching • Vocal load	75%

				• History of organic dysphonia	
Lee *et al*. (2010) [9] 2. Cross sectional	714	N/A	Hong Kong	• Age and sex • Occupation • Teaching environment • Length of service • Voice disorder education • Appropriate treatment • Respiratory infections	66.7%
Moy *et al*. (2015) [11] 3. Cross sectional	242	N/A	Malaysia	• Socio-demographic characteristics • Teaching characteristics • Depression • Anxiety • Stress Scale • Health education • Psychological stress • Thyroid problem • Emotions • Quality of life	66.7%
Devadas *et al*. (2017)[6] 4. Cross sectional	1082	N/A	India	• Presence of background noise • Stress while teaching • Medical conditions like Thyroid problems, respiratory tract infections such as laryngitis, cold and pharyngitis. • Smoking • Alcohol • Caffeinated drinks • Length of service • Psychological stress • Improper breath management • Noise pollution	50%
Cantor Cutiva *et al*. (2016) [3] 5. Cross sectional	574	N/A	Colombia	• Number of students per classes • Types of school • Smoking habit (passive or active) • Laryngopharyngeal reflux • Hearing problem • Stress • Family history • Comorbidity of HTN, DM, asthma, allergy and thyroid diseases) • Recurring cold and throat issues	66.7%
Rosi-Barbosa *et al*. (2016) [14] 6. Cross sectional	226	N/A	State of Minas Gerais, Brazil	• Acute disorder • Chronic disorder • Alcohol consumption • Smoking • Age • Sex • Economic characteristics • Socio-demographic characteristics	50%
Akinbode *et al*. (2014)[1] 7. Cross sectional	496	N/A	Nigeria	• Abuse of voice • Prolonged use of voice • Dysphonia • Hoarseness • Repetitive throat clearing • Upper respiratory infection • High pitch of voice • Caffeinated drinks • Vocal health education	50%
Luce *et al* (2014) [10] 8. Case Control	157 Cases 75 Controls	N/A	Milan, City of Italy	• Occupational vocal load • Behavioral and life-style factors - smoking, alcohol and coffee consumption • Noisy environment • Physical and mental stress • Upper respiratory tract infection	70.4%
Giannini *et al*. (2013) [7] • Case Control	167 Cases 105 Controls	N/A	Brazil	• Noisy environment • Mental disorder • Respiratory disease	70.4%

				• Gastroesophageal reflux • Sociodemographic aspects	

Quality Score of Included Studies

Table 3: Quality scores of the included studies.

Study (Year of Publication)	Criterion										Score	Total Score Achievable (Total Score %)
	1	2	3	4	5	6	7	8	9	10		
Cohort												
Claros *et al*. (2019)[5]	1	n/a	1	n/a	1	1	0	1	1	1	7	8 (87.5%)
Cercal *et al*. (2018)[4]	1	n/a	0	n/a	1	1	0	1	1	1	6	8 (75%)
Cross-sectional												
Lee *et al*. (2010) [9]	*1*	*n/a*	*0*	*n/a*	*1*	*0*	*n/a*	*n/a*	*1*	*1*	4	6 (66.7%)
Moy *et al*. (2015) [11]	1	n/a	0	n/a	1	0	n/a	n/a	1	0	4	6 (66.7%)
Devadas *et al*. (2017)[6]	1	n/a	0	n/a	1	0	n/a	n/a	1	0	3	6 (50%)
Cantor Cutiva *et al*. (2016) [3]	1	n/a	0	n/a	1	0	n/a	n/a	1	1	4	6 (66.7%)
Rosi Barbosa *et al*. (2016) [14]	1	n/a	0	n/a	1	0	n/a	n/a	1	0	3	6 (50%)
Akinbode *et al*. (2014) [1]	0	n/a	0	n/a	1	0	n/a	n/a	1	1	3	6 (50%)
Case-Control												
Luce *et al*. (2014) [10]	n/a	1	0	1	1	0	n/a	n/a	1	1	5	7 (70.4%)
Giannini *et al*. (2013)[7]	n/a	1	0	1	1	0	n/a	n/a	1	1	5	7 (70.4%)

Ethical Consideration

This systematic review has followed all the required guidelines of ethical aspect of research design. Approval of the instructor was taken prior to the beginning of the study and frequent discussion was held to reduce any conflicting issues. Any conflicting ideas or information was first discussed between two independent researchers and the logical conclusion drawn from the talk was assumed to be consensus.

Results

A total of 5388 respondents within ten studies has been included in this systematic review. Different aspects of determinants of voice disorder among professional users were included in this systematic review. The studies represent the wide varieties of a region of the country and the study types. Among ten studies, two of them are prospective cohort studies, where six studies are cross-sectional studies and two are case-control studies. The factors associated with voice disorders as revealed by the existing literature, includes socio-demographic and economic factors, health factors, health behaviours, voice disorder related disease and occupational environment. A summary of results applicable to the factors identified are presented below.

Possible Determinants of Voice Disorder

Table 4: Summary of Possible Determinants of Voice Disorder.

Socio-demographic and economic factors	Health behaviours	Medical & health factors	Diseases associated with voice disorder	Occupational Environment
• Gender • Age • Marital status • Ethnicity • Health education • Vocal health education • Poverty • Illiteracy	• Smoking habit • Alcohol consumption • Caffeine consumption • Daily exercise • Lack of enough sleep	• Depression and anxiety • Mental disorder • Gastroesophageal reflux • Asthma • Thyroid problems • Physical and mental stress	• Upper respiratory tract infection • Vocal impairments • Laryngitis • Dysphonia • Hoarseness	• Noisy environment • Occupational vocal load • Excess use and abuse of voice • Length of service • Noise pollution

Socio-demographic and economic Factors

Sociodemographic factors associated with voice disorder include age, gender, ethnicity, marital status and so on. According to Moy *et al*. (2015) [11], there is no correlation between gender and voice disorder; however, other studies Lee *et al*. (2010) [9], Devadas *et al*. (2017) [6], Luce *et al*. (2014) [10], & Claros *et al*. (2019) [5]
revealed that females are more likely to diagnose with voice disorder than males. Further, Moy *et al*. (2015) [11] also suggested that there is a high risk of voice disorder to the people who are divorced or widowed compared to married people. In addition, the study also revealed that Indian teachers are less likely to develop voice disorder compared to Chinese and Malaysian teachers. Moreover, teachers of age group 40 - 49 years old are more likely to diagnose with voice disorder than other age groups (Moy *et al*., 2015) [11]. Similarly, Claros *et al*. (2019) also revealed that the people older than 40 years old are at high risk of voice disorder than younger people. Health education is another significant factor which cannot be neglected without any consideration. Only 24.4% of teachers are aware of voice health education and seek medical care (Akinbode *et al*., 2014) [1].

Health Behavior Factors

Health behaviour such as smoking, alcohol consumption,

caffeine consumption is another substantial risk factor of voice disorder. According to Rosi-Barbosa *et al*. (2016) [14], the amount of alcohol consumption is directly proportional to the risk of developing voice disorder. Similarly, Luce *et al*. (2014) [10] revealed that smokers are more likely to diagnose with voice disorder than non-smokers. The studies also state the detrimental effects of caffeine consumption, which significantly higher the risk of developing voice disorder. Further, Moy *et al* (2015) [11] revealed that people who do not exercise regularly have increased risk of voice disorder, and people who sleep less than six hours are at high risk of developing voice disorder. In addition, drinking excess amounts of water lowers the risk of voice problems (Claros *et al*., 2019).

Medical and Health Factors

According to Giannini *et al*. (2013) [7], people who are experiencing mental disorder or who have experienced mental disorder in the past are at high risk of developing voice disorder. Further, other studies Cercal *et al*. (2018) [4] Cantor Cutiva *et al*. (2016) [3], Luce *et al*. (2014) [10] & Moy *et al*., (2015) [11] also revealed that teachers who experienced depression, anxiety, physical and mental stress are more likely to develop voice disorder. Besides, Moy *et al*. (2015) [11] stated that the risk of voice disorder increased to the people with thyroid problems.

Diseases associated with Voice Disorder

Several studies Giannini *et al*. (2013) [7], Luce *et al*. (2014) [10], Akinbode *et al*. (2014) [1], Devadas *et al*. (2017) [6], Moy *et al*. (2015) [11], Cercal *et al*. (2018) [4] & Claros *et al*. (2019) suggested that people who have experienced upper respiratory tract infection have increased risk of developing voice problems. Further, Moy *et al*. (2015) [11] also demonstrated the direct impact of voice disorder on people with thyroid problems. Similarly, Claros *et al*. (2019) and Cercal *et al*. (2018) [4] also states that people who experienced laryngitis or laryngeal discomfort have high risk of vocal problems. In addition, there is a high chance of developing voice disorder to the people who suffered gastroesophageal reflux Giannini *et al*. (2013) [7]

Occupational Environment

According to Moy *et al*. (2015) [11], people with teaching professionals have notably extreme voice problems compared to others, i.e. 51.2% and 27.4% respectively. The study also demonstrated that the primary teachers experience excessive vocal load and are at more risk of voice disorder compared to secondary and higher secondary teachers. Further, teachers with more than 15 years (Lee *et al*., 2010) [9] or 20 years (Luce *et al*., 2014) [10] of experience have increased the risk of developing vocal problems. In addition, a noisy environment is directly related to the risk of voice disorder Giannini *et al*. (2013) [7], Luce *et al* (2014) [10], Devadas *et al*. (2017) [6], & Lee *et al*. (2010) [9]. Besides, aerobics instructors are at high risk of voice disorder as they require to instruct their clients both verbally and physically concurrently. According to Luce *et al* (2014) [10], 44% of aerobics instructors are facing voice problems; while 42.6 of them have partial loss of voice (Luce *et al*., 2014) [10]. The study also demonstrated that only a minimum number of instructors are aware of voice disorder and have information about vocal hygiene. Moreover, Cercal *et al*. (2018) [4] revealed the detrimental effect of use of heavy vocal load on singer professionals, who are highly dependent upon vocal mechanism and are likely to experience vocal impairment. The study revealed that the singers who have self-reported of dysphonia is 46.09% (Luce *et al*, 2014) [10]. In addition, Luce *et al*. (2014) [10] also stated that teacher singers are at higher risk of voice disorder than student singers (i.e, 55.15% and 21.76% respectively). Similarly, classical singers are less likely to develop vocal problems compared to non-classical singers (i.e, 40.53% and 46.96% respectively).

Best Evidence Synthesis and Strength of Association

Table 5: Summary Table of Breastfeeding Determinants discussed in reviewed study.

Author	Definition of Voice Disorder Variables	Outcome	Summary of significant associations
Claros *et al*. (2019) [5]	• Non-singing group vs Singing groups • Functional voice disorder (non-singer vs singer) • female singer vs male singer	• 32.4% vs 15.6%. • difference, 16.8%. • 95% CI,12.3% - 21.4% • 20.2% vs 9.4%. • difference, 10.8%. • 95% CI, 7.2%-14.3% • 12.2% vs 6.1%. • difference, 6.1%. • 95% CI, 2.6%-9.6%	• Non-singing groups are more likely to experience voice disorder. • With respect to functional voice disorder, non-singers are at high risk compared to singers. • Similarly, female singers are more likely to develop vocal problems compared to male singers.
Cercal *et al*. (2018) [4]	• Tiredness and avoidance of voice use • Improvement of symptoms with rest • Health problems (depression, anxiety	• p<0.001 • p=0.001 • p=0.027 • OR = 3.07, 95% CI = 1.51 - 6.62;	• The factors of tiredness of voice and avoidance of voice use are significantly associated with voice disorder in professional users. • Improvement of symptoms with rest is significantly associated with the

	etc.) • Caffeine Consumption (Regular vs rarely)		risk of voice disorder. • People who experience mental disorders are more likely to develop vocal problems. • Professional People who regularly consume excess amounts of caffeine are at higher risk of vocal problems.
Lee *et al*. (2010) [9]	• Noisy environment • Alcohol consumption • Laryngitis • History of asthma	• p < 0.001, a OR = 1.8. • p = 0.027, a OR = 0.4. • p < 0.001, a OR = 4.2. • p = 0.001, a OR = 3.3	• Noisy environment and alcohol consumption significantly increases the risk of voice disorder among professional users. • People with a history of respiratory infection have a high chance of developing voice disorder.
Moy *et al*. (2015) [11]	• Teachers with voice disorder • Male vs female teacher • Married vs single teacher	• 10.4% (95% CI 7.1, 14.9. • OR = 1.60, 95% CI = 1.27, 2.01. • OR = 1.36, 95% CI = 1.07, 1.75	• Teachers are at higher risk of voice disorder than other professionals. • Females are more likely to experience vocal problems than male. • Similarly, married teachers are more likely to develop vocal disorders compared to single, divorced or widowed teachers.
Devadas *et al*. (2017) [6]	• Teacher who experiences Upper Respiratory Tract infection (frequent vs rarely)	• OR = 4.84, 95% CI = 1.33, 17.64	• Teachers who frequently experience upper respiratory tract infection are at higher risk of voice disorder.
Cantor Cutiva *et al*. (2016) [3]	• People with vs without respiratory allergies	• OR = 1.55, 95% CI = 1.11, 2.16	• People who have respiratory allergies are more likely to develop vocal problems.
Rosi Barbosa *et al*. (2016) [14]	• Alcohol Consumption	• OR = 1.55, 95% CI = 1.14, 2.12	• The amount of alcohol consumption is directly proportional to the risk of voice disorder.
Akinbode *et al*. (2014) [1]	• Respiratory infection (Frequent vs sometimes) • Raised voice (Regular vs rarely)	• OR = 3.60, 95% CI = 1.39 - 9.33. • OR = 10.1, 95% CI = 5.07 - 20.2	• People who frequently experience respiratory infection are more likely to develop voice disorder. • People who regularly use heavy vocal load have higher risk of developing vocal problems.
Luce *et al*. (2014) [10]	• Tired voice • Weak voice • Difficulty to use bass tone • Difficulty to use high tone	• 35.56%, p = 0.04. • 31.48%, p = 0.002. • 19.05%, p = 0.004. • 34.48%, p = 0.007	• The permanent vocal loss is significantly associated with tired voice, weak voice, difficulty using bass tone and high tone.
Giannini *et al*. (2013) [7]	• Factors associated with voice disorder • Decreased work ability • Moderate work ability • Age 50 - 60-years-old • Poor acoustic	• OR = 12.2; p<0.001. • OR = 7.7; p<0.001. • OR = 3.7; p=0.006. • OR = 2.7; p=0.007	• Factors such as decreased work ability, moderate work ability, age and poor acoustic are significantly associated with the risk of voice disorder.

Level of Evidence

Table 6: Level of Evidence

Level of Evidence	Criteria for inclusion in best evidence synthesis
Strong evidence	Generally consistent findings in: • 1 high quality cohort study and 1 high quality cross-sectional study OR 1 high quality case-control study • Multiple high-quality cohort studies
Moderate evidence	Generally consistent findings in: • 1 high quality cohort study
Limited evidence	Generally consistent findings in: • 1 high-quality cross-sectional study AND/OR case-control study • multiple cross-sectional studies AND/OR case-control study
Conflicting evidence	Inconsistent findings in <75% of the trials

Relationship between socio-demographic factors and voice disorder

After analyzing the relationship between socio-demographic factors and voice disorder, a significant result has been recorded. Firstly, a cross-sectional study Luce *et al*. (2014) [10] found that BEAT the female teachers constitute 1.6-fold higher risk compared to male teachers (OR = 1.60, 95% CI = 1.27, 2.01). Similarly, a cohort study (Claros *et al*., 2019) found that female singers have a very high chance of developing vocal problems than male singers (12.2% vs 6.1%; difference, 6.1%; 95% CI, 2.6%-9.6%). Further, married teachers are more likely to develop voice disorder which is 1.36 higher than unmarried, divorced or widowed teachers (OR = 1.36, 95% CI = 1.07, 1.75) (Moy *et al*., 2015) [11]. Further, a case-control study Giannini *et al*. (2013) [7] found that people of age between 50-60 have 3.7-fold higher risk of voice disorder than people of other age groups (OR = 3.7; p = 0.006). Hence, we can conclude that there is a limited evidence for the relationship between age, sex and voice disorder.

Relationship between health behaviors and voice disorder

A cohort study Cercal *et al*. (2018) [4] revealed that the caffeine consumption has a detrimental impact on voice disorder which increases the risk by 3.07-fold (OR = 3.07, 95% CI = 1.51 - 6.62). In addition to putting more emphasis on this fact, a cross-sectional study (Rosi Barbosa *et al*. (2016)) [14] demonstrated that the amount of alcohol consumption is directly proportional to the risk of voice disorder which higher the risk by 1.55-fold (OR = 1.55, 95% CI = 1.14, 2.12). Further, another cross-sectional study (Lee *et al*., 2010) [9] also stated that people who regularly consume alcohol have 0.4-fold higher risk of vocal problems compared to other people (p = 0.027, a OR = 0.4). Thus, considering the most substantial insights specified here, it can be concluded that there is a limited evidence for the relationship between the human behavior and voice.

Relationship between health factors and voice disorder

One cohort study Cercal *et al*. (2018) [4] and two cross-sectional studies (Lee *et al*., 2010 & Cantor-Cutiva *et al*., 2016) [9, 3] found significant association between health factors and voice disorder. Cercal *et al*. (2018) [4] demonstrated that the people experiencing health problems like depression or anxiety are more likely to experience vocal problems (p=0.002). Further, a cross-sectional study (Lee. *et al*.) stated that the people with history of asthma have 3.3-fold higher chance of developing voice disorder (p = 0.001, a OR = 3.3). In addition, Cantor Cutiva *et al*. (2016) [3] revealed that people with respiratory allergies are more likely to experience vocal problems which is 1.55-fold higher risk than others (OR = 1.55, 95% CI = 1.11, 2.16). Hence, we have one cohort study and multiple cross-sectional studies revealing a significant relationship of health factors with vocal issues, which concludes that there is a strong clear evidence for the association between health factors and voice disorder.

Relationship between diseases associated with voice and voice disorder

A cohort study Cercal *et al*. (2018) [4], multiple cross-sectional studies (Lee *et al*., 2010, Devadas *et al*., 2017 & Akinbode *et al*., 2014) [9, 6, 1] and 2 case-control studies Giannini *et al*. (2013) [7] & Luce *et al*., 2014) [10] found significant association between voice disorder and the diseases associated with voice. Cercal *et al*. (2018) [4] revealed that the people with tired voices are at high risk of diagnosing with vocal disorder (p<0.001). In addition, Lee *et al*. (2010) [9] demonstrated that people who experienced laryngitis have 4.2-fold higher risk of voice disorder (p < 0.001, aOR = 4.2). Further, Devadas *et al*. (2017) [6] stated that the people who frequently experience upper tract respiratory infection are more likely to develop vocal problems which is 4.84-fold higher than others (OR = 4.84, 95% CI = 1.33, 17.64). Similarly, Akinbode *et al*. (2014) [1] revealed that people with respiratory infection have 3.6-fold higher risk of voice disorder (OR = 3.60, 95% CI = 1.39 - 9.33). In addition to putting more emphasis, Luce *et al*. (2014) [10] stated that there is a high chance of diagnosing voice disorder to the people who have tired voices (35.56%, p=0.04), weak voices (31.48%, p=0.002), difficulty to use bass tone (19.05%, p=0.004) and difficulty to use high tone (34.48%, p=0.007). Similarly, Giannini *et al*. (2013) [7] also demonstrated the risk of voice disorder to the people with poor acoustic, which is 2.7-fold higher than others (OR = 2.7; p=0.007). Hence, we can conclude that there is strong evidence for the relationship between vocal disorder and the diseased associated with voice.

Relationship between occupational environment and voice disorder

A significant result has been recorded after carefully analysing the association between occupational environment

and voice disorder. Two cross-sectional studies (Akinbode *et al*., 2014 & Lee *et al*., 2010) [1, 9] found a significant relationship between voice disorder and occupational environment. First cross-sectional study (Akinbode *et al*., 2014) [1] revealed that the people who regularly use heavy vocal load due to occupational environment have a 10.1-fold higher risk of voice disorder than others (OR = 10.1, 95% CI = 5.07 - 20.2). Similarly, the second cross-sectional study (Lee *et al*., 2010) [9] stated that the people who work in noisy environments are more likely to develop voice disorder which is 1.8-fold higher than others ($p < 0.001$, OR = 1.8). Thus, as we have only two cross-sectional studies to support this fact, it can be concluded that there is limited evidence for the relationship between occupational environment and voice disorder.

Discussion

Among the 10 reviewed articles, (2 cohorts, 2 Case control and 6 cross-sectional studies) provided the quality of evidence in relation to identification of risk factors associated with voice disorders. Study by Claros *et al*. 2020, Devdas *et al*. and Luce *et al*. 2014 [10] identified sex as the determinant of voice issues. All of research concluded female professional users have higher risk of voice disorders as compared to male. However, the study by Moy *et al*. 2015 [11] found no correlation of age and sex related risk associated to professional users. On comparison between telemarketer and community student, it was found that smoking habit and alcohol consumption impacts voice disorders in professional users like Telemarketers (Rosi Barbosa *et al*., 2016) [14]. Further, age was also linked as determinant of occupational voice disorders with limited evidences. We should therefore infer that there is compelling evidence of substantial correlation between working profession (i.e. teachers), and sex (female) as a risk factor for voice disorder while slight evidence of relationship between smoking habit with voice disorder. Even though few articles mentioned smoking and alcohol drinking as risk factors, further studies are to be conducted to obtain conclusive evidence. The psychological stress, recurring event of upper tract infections, gastrointestinal acid reflux and sinus problems were evidently identified as risk factors for voice disorder among the professional voice users (Cercal *et al*. & Cantor Cutiva *et al*.).

Various environmental factors were identified as key for voice problem in professional users like teacher and occupational workers. Giannini *et al*. (2013) [7], Luce *et al*., 2014 [10] and Devadas *et al*. (2017) [6] pointed out key role of yelling and shouting on development of voice disorders in users. Further, Cercal *et al*. 2020 [4] found that teachers involved in loud speech use such as chemistry class and different drama classes are likely to develop voice related issues. Thus, it can be mentioned that the use of loud speech, background noises have direct impact in voice disorders in professional users. However, Moy *et al*. 2015 [11] suggest the use of amplifiers and interventions to reduce voice issues such as rising classroom sizes or role of a teacher were correlated significantly with issues of voice. Using an amplifier can minimize a need for instructors to produce their sound above background noise, and also this reduces vocal load and stress.

Awareness of contributing factors linked with the voice disorders may aid in the developing and formulating preventive health measures aimed at reducing the issue in professional user. This research has identified various variable having strong or weaker correlation with the issue of voice problem. The factors were subdivided into 4 categories namely medical and health related factors, demographic factors, environmental factors and socio-economic factors. This systematic analysis revealed clear correlation evidence for factors like psychological stress, upper tract infections, gastrointestinal acid reflux, gender (female) type of occupation majorly teaching and loud use of voice for yelling and shouting as strong risk associated with voice disorders. However, the risk associated with smoking habit, alcohol consumption, age reveals ambiguous risk factors as few articles significantly identified positive correlation whereas other found no correlation.

Conclusion

In conclusion, the voice use in professional users are is highly affected by various factors. The medical and health condition of gastrointestinal acid reflux, recurring issues of upper tract infections such as cold, and sinuses and stress are found to be risk factor among the professional user. This have direct impact to physiology of vocal cords and alters the structures involved in voice flow and circulation. Similarly, the environmental factors like background noise, yelling and participation in intense speech use affect the voice of individual. The use of amplifier or reduction in classroom size has be identified as effective method of reducing the environmental risk factors. Also, the age, gender, alcohol use and smoking habit are found to be weakly associated with voice disorders. So, to deal with the determinant of voice disorders in professional users, the preparation of the strategies for should therefore focused on these three major factors. In addition to this factors, further consideration should be given to risk factors like environmental allergies, teaching experience and types of occupation while planning the strategies against the variables.

Limitation

Even though, detailed web-based search was performed using different primary databases and online platform, this review fails to include few of the key factors in the study. One of such factors affecting was inadequate availability of resources related to specific topic. Most of the research conducted were systematic reviews or descriptive studies which were irrelevant to this review's scope of design. Another, identified issue was heterogeneity in research study and limited sample sizes with possible biasedness and inaccurate estimates. In addition, the articles selected lacks exposure assessment blinding as a result, the data may be prejudices by participant result. Lastly, although minimal work has been carried out in a number of contexts, it is very important to understand the multiple factors linking to voice disorders so that future interventions and plans and policies could be comprehensive and target wider range of population.

Future Direction

While the results indicated a clear correlation of various risk factors like stress, recurring upper tract infections, environmental factors and type of occupations as risk factors for voice disorders in professional users, still more work is recommended by the use of longitudinal research design across the different places as well as among different

distinct demographic groups. It is recommended due to contradictory results among result within or across the studies performed globally.

Acknowledgment
We would like to acknowledge Dr. Fahad Hanna for the valuable support.

Funding
The review has not been funded by any third party.

Ethics approval and consent to participate
Not applicable in this review

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