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Vocal tasks for acoustic and/or auditory perceptual analysis for discriminating individuals with and without voice disorders: a systematic review protocol

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ABSTRACT

Objective The primary objective of the present systematic review is to: (1) identify the current vocal tasks being used for acoustic and/or auditory perceptual analysis to differentiate between individuals with and without voice disorders. The secondary objectives are to: (2) evaluate the evidence of the sensitivity, specificity and accuracy of those vocal tasks for acoustic and/or auditory perceptual analysis in discriminating the individuals with voice disorders from those without; and (3) compare the values between the vocal tasks in discriminating individuals with voice disorders from those without.

Method and analysis We search the following electronic databases: MEDLINE, EMBASE, CINAHL, Scopus, Web of Science Core Collection, PubMed Central and Google Scholar. Grey literature searches will include ProQuest Dissertations and Theses, ClinicalTrials.gov and the Cochrane Register of Controlled Trials. Websites of professional organisations and textbooks will be hand searched for relevant information related to the research question. Study screening, selection and data extraction will be conducted independently by two reviewers. Any disagreements will be resolved by discussion or by involving a third reviewer.

The methodological quality of the included studies will be appraised using the relevant Critical Appraisal Tools by JBI. The clinical guidelines and recommendations for voice assessment by professional bodies will be appraised using the Reporting Items for practice Guidelines in HealThcare (RIGHT) checklist. The findings will be presented in the form of an information matrix with the tasks identified tabulated against the nature of the task, dimensions being tested, and their accuracy, sensitivity, and specificity in identifying individuals with voice problems.

Ethics and dissemination Formal ethics approval is not required. The findings will be presented at national and international conferences and published in a peer-reviewed journal.

PROSPERO registration number CRD42023431634.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The systematic review will follow a robust procedure to identify the tasks from scientific articles, textbooks, as well as recommendations and guidelines by professional organisations for otorhinolaryngologists and speech-language pathologists.
⇒ This systematic review will identify the different tasks being used for acoustic and/or auditory perceptual analysis to differentiate individuals with voice disorders from those without. Further, it will provide evidence of the sensitivity, specificity and accuracy of those vocal tasks.
⇒ The findings of the review will be presented as an information matrix that will be a useful evidence-based guide for task selection in acoustic and/or auditory perceptual analysis.
⇒ Only articles written in the English language will be included in the review.

INTRODUCTION

An individual is suspected to have a voice disorder when their voice pitch, quality or loudness differs compared with others of the same age, gender, ethnic background or geographical location.[1] The presence of voice disorders can impact communication and have a negative impact on the overall well-being of the individual and their quality of life.[2 3] Delays in referrals and increased wait times increase the burden on healthcare systems, while early assessment, diagnosis and access to treatment can help in reducing healthcare costs.[4] Voice disorders can be broadly classified into organic voice disorders, functional (psychogenic) voice disorders and muscle tension voice disorder. The organic voice disorders include voice disorders that include pathological changes in structure and/or movement of the larynx. These are further subclassified into structural, inflammatory, neuromuscular and trauma. The functional (psychogenic) voice disorders include loss of voluntary motor control over and/or loss of self-regulation for initiation of voice and include aphonia/dysphonia and puberphonia. The muscle tension voice disorders include a visible and

palatable tension of laryngeal musculature and muscular imbalance. These include primary, secondary and adaptive.[5]

Research in voice and laryngology has recommended multidimensional assessments using a comprehensive test battery when assessing a voice disorder. These include case history, laryngeal imaging, auditory perceptual evaluation, acoustic analysis, aerodynamic analysis and patient-reported outcome measures regarding the impact of the voice disorder on the patient's life.[6–8]

Acoustic analysis of voice provides objective or quantifiable measures in relation to the vocal function, loudness, pitch and quality. It includes non-invasive procedures that are commonly used in clinical assessment for detecting the presence or absence of a voice disorder.[7] Protocols are available for functional assessment of voice,[6] while recent consensus documents provide specific recommendations on data acquisition, technical specifications, examination procedures and tasks that can be used for acoustic analysis.[8] Guidelines based on scientific literature have also been suggested for recording and analysis in specific conditions such as dysarthria of movement disorders[9] and muscle tension dysphonia.[10] Studies on acoustic analysis of voice have proposed using wide variety of tasks ranging from sustained phonation, variations in sustained phonation with respect to pitch and intensity, reading sentences or passages, or counting numbers.[6 8 9 11] Auditory perceptual evaluation of voice is often considered the gold standard and refers to the method of rating a voice and its associated qualities by listening to it. Auditory perceptual evaluation is subjective and influenced by several factors related to the listener, such as their experience, bias, stimuli and rating procedure being used.[12–14]

Previous systematic reviews and meta-analyses in conditions such as amyotrophic lateral sclerosis,[15] dysarthria[16] and stroke[16 17] have provided valuable insight to responsible healthcare professionals. The findings of these reviews can be used for practical and clinical scenarios that aid better assessment and treatment outcomes while managing these conditions. As there is a range of vocal tasks available, the findings of the present review provide a detailed overview of the different tasks and their sensitivity and specificity in identifying individuals with voice problems. This will also help the professionals in selecting specific tasks that are evidence based and better suited for their clinical and research requirements.

Studies have been carried out to identify the optional tasks for the acoustic and/or auditory perceptual analysis of voice.[18–20] However, we do not have a comprehensive understanding about the vocal tasks being used for acoustic and/or auditory perceptual analysis to differentiate between individuals with and without voice disorders. A preliminary search was conducted on MEDLINE, PROSPERO, JBI Evidence Synthesis and Google Scholar, and no existing reviews or registered protocols on tasks for acoustic and/or auditory perceptual analysis were identified.

Review questions

What are the current vocal tasks being used for acoustic and/or auditory perceptual analysis to differentiate between individuals with and without voice disorders?

What is the available evidence of the sensitivity, specificity and accuracy of those vocal tasks for acoustic and/or auditory perceptual analysis in discriminating the individuals with and without voice disorders? Are there differences in the vocal task values between individuals with and without voice disorders?

METHODS AND ANALYSIS

The systematic review protocol follows methodology suggested by the Preferred Reporting Items for Systematic review and Meta-Analysis Protocols (PRISMA-P).[21] The completed PRISMA-P checklist has been provided. The protocol has been published in the International Prospective Register of Systematic Reviews database (PROSPERO 2023; CRD42023431634). The final review will be reported as per the Preferred Reporting Items for Systematic review and Meta-Analysis statement.[22]

Formal activities for this review have commenced in July 2023. The analysis and writing should conclude by June 2024.

Patient and public involvement

None. The present protocol and the subsequent review are based on published data. Thus, no approval from any ethics committee or consent from patients is required. The results will be disseminated through a peer-reviewed publication.

Study selection criteria

Participants

Studies comparing individuals with and without voice disorders using acoustic and/or auditory perceptual evaluation of voice will be included. No limits will be placed on either the age range, gender or language of the participants or their geographical region or ethnicity.

Concept

Inclusion

Studies in human subjects exploring vocal tasks for acoustic and/or auditory perceptual analysis of voice across clinical and laboratory-based settings will be considered. Only studies that compare individuals with and without voice problems will be considered. Only studies that have performed a statistical analysis, such as sensitivity or specificity, to discriminate between the two groups, will be included.

Exclusion

Studies using animal models, involving users of alaryngeal speech, artificial or machine-generated tones will not be included. Studies evaluating effectiveness of any interventions or therapeutic approaches will not be included. Studies in individuals with any speech sound disorders or articulation disorders will not be included.

Study design

No filters for study design will be used.

Context

The review will include relevant data from all geographical locations and settings. All studies published in the English language from 1930 onwards will be included. The year 1930 was selected as it is the year in which formal studies on voice were first reported.[7]

Information sources

The following databases will be searched: MEDLINE via Ovid (biomedical sciences, 1946–present), EMBASE via Ovid (biomedical sciences, 1947–present), CINAHL (nursing and allied health, 1981–present), Scopus (multidisciplinary, 1823–present), Web of Science Core Collection (multidisciplinary, 1900–present), PubMed Central and Google Scholar.

Grey literature searches will include ProQuest Dissertations and Theses, ClinicalTrials.gov and the Cochrane Register of Controlled Trials.

Recommendations and guidelines from websites of professional organisations for otorhinolaryngologists and speech-language pathologists will be included. Textbooks from the field of otorhinolaryngology and speech-language pathology on the assessment of voice will be hand searched for relevant information on tasks.

Outcomes

The primary outcome measure of this review is the identification of different vocal tasks being used for acoustic and/or auditory perceptual analysis of voice for discriminating individuals with voice disorders from those without. The additional outcome measures include sensitivity, specificity and accuracy of the identified vocal tasks in discriminating individuals with and without voice disorders and comparing their values.

Search strategy

In the first step, a preliminary search was conducted on websites of professional organisations, textbooks in voice and laryngology, PubMed and key review papers[5 7 23] to identify a list of concepts and key terms. The search was reviewed by an experienced medicine and health academic liaison librarian at the University of Sydney. The identified concepts and key terms were refined and finalised based on a discussion between all the authors. This first step was carried out to plan for the subsequent steps in the review.

In the second step, a comprehensive search will be conducted using the finalised concepts and keywords across the relevant electronic databases. The finalised concepts and keywords will be adapted to develop search strategies for each database in consultation with the librarian. An example of one of the search strategies has been included as online supplemental appendix 1.

Studies and relevant guidelines that meet the inclusion criteria will be uploaded into Covidence[24] (Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia) for screening after removal of duplicates. The titles and abstracts will be screened by two independent reviewers based on the eligibility criteria. The full text of the studies that meet the eligibility criteria will be retrieved and reviewed by two independent reviewers to determine eligibility for further inclusion. The reasons for excluding any studies at this stage will be noted and reported in the review. Any disagreements will be resolved by involving a third reviewer. The reference lists of the finalised articles will be inspected for any other additional studies.

The websites of the professional organisations will be scrutinised by the first author (DRG) to identify any information pertaining to clinical guidelines and recommendations for voice assessment. Only websites that contain relevant information will be included for further analysis. Thirty per cent of the websites will be reviewed by another author (AMC) to ascertain reliability. Any discrepancies will be resolved through discussions between DRG and AMC. Textbooks from the field of otorhinolaryngology and speech-language pathology on the assessment of voice will be hand searched for relevant information on tasks for acoustic and/or auditory perceptual analysis.

Data extraction and data management

Data will be extracted by at least two independent reviewers from the selected studies. The full text of the selected articles will be uploaded onto the Covidence systematic review platform. The data extraction tool will include details related to the study population, participant details, tasks, contexts, methodology and key findings relevant to the review question. The template for data extraction has been provided as online supplemental appendix 2.

The data extraction tool will be trialled on 10% of the included studies to ensure all the relevant information is being extracted. Any disagreements will be resolved through discussion or by involving a third reviewer. The data will be extracted, entered and maintained on a Microsoft Excel spreadsheet.

Risk of bias (quality) assessment

The methodological quality of the included studies will be appraised using the relevant Critical Appraisal Tools by JBI, such as Checklist for Diagnostic test accuracy studies[25] and Checklist for Analytical Cross-sectional studies.[26] The clinical guidelines and recommendations for voice assessment by professional bodies will be appraised using the Reporting Items for practice Guidelines in HealThcare (RIGHT) checklist.[27] The JBI critical appraisal checklist for text and opinion papers[28] will also be used for clinical guidelines and recommendations from websites of professional organisations and textbooks.

Data synthesis

The findings will be presented in the form of an information matrix with the tasks identified tabulated against the nature of the task, vocal function dimensions being

tested, acoustic and/or auditory perceptual analysis parameters being obtained, and their accuracy, sensitivity, and specificity in identifying individuals with voice problems. Specific tasks (if any) that are used or recommended for specific conditions/populations will be identified. If some of the studies are homogeneous in terms of their design, a meta-analysis using suitable statistics may be conducted depending on the distribution of data.

ETHICS AND DISSEMINATION

Formal ethics approval is not required as the review will analyse secondary data and not use any data from individual patients. The results of the review will be presented at national and international scientific meetings as well as published in reputed peer-reviewed scientific journal.

Contributors All authors have contributed to the development of the protocol. DRG is the lead investigator and has written the protocol. AMC, DDN and CM have provided critical comments and modifications to the drafts of the protocol.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

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Appendix 1: Search strategy

The following search concepts and terms will be adapted to suit each of electronic database, with limits of year 1930 to present day and English language.

The search strategy will include '*vocal tasks*' AND '*assessment*' AND '*voice problem*'

CONCEPT AREA	RELATED SEARCH TERMS
Vocal tasks	– voice task* – vocal task* – phonat* – sustained vowel* – prolonged vowel* – reading passage* – rainbow passage* – grandfather passage* – zoo passage* – consensus auditory perceptual evaluation – CAPE-V sentence* – CAPE-V phrase* – continuous speech – counting number* – loudness (OR volume OR amplitude OR intensity) range – dynamic range – pitch range – pitch glide – plosive fricative nasal – sing (OR song OR sung) – singing scale*OR musical scale* – diadochokinetic rate* – alternative motion rate OR sequential motion rate
Assessment	– voice assessment (OR evaluation OR analysis OR measure*) – instrumental OR objective – subjective – acoustic assessment (evaluation OR analysis OR measure*) – auditory perceptual – time domain* – frequency domain* – fundamental frequency – perturbation – glottal noise – harmonic – fundamental

	– voice spectrum – spectral tilt – spectral slope* – formant – energy ratio* – cepstrum – non-linear voice acoustic – voice acoustic index – linear prediction* – acoustic prediction* – voice discrimination* – voice discriminant analys* – grade – roughness – breathiness – quality – strain – asthenia
Voice disorders	– voice disorder* – voice problem* – voice pathology – pathological voice – aphonia – dysphonia – hoarseness

Appendix 2: Data extraction templates

Data extraction template for studies identified from electronic databases	
Study details and study characteristics	
Citation details: (Authors, publication year, journal name, volume, pages)	
Country where study was carried out,	
Study design	
Participant details (Age, gender distribution, setting, diagnosis)	
Details extracted from the study	
Acoustic analysis instrument/software (Name, specifications)	
Auditory-perceptual evaluation procedure (Rating scale)	

Task (Instructions, type – habitual/performance-based)	
References for the tasks	
Recording protocol (Name, standardized/non-standardized, any other specifications)	
Dimensions of voice being assessed (Quality, intensity, frequency, time, consistency, endurance)	
Measures/parameters being measured	
Information on accuracy, sensitivity, and specificity	
Key findings relevant to the review	
Data extraction template for guidelines and recommendations of professional organizations	
Details related to website (Name of organization, type of organization (SLP/ENT), website URL, contact details)	
Voice assessment information (Available or not available, if available – voice assessment protocol recommended)	
Acoustic analysis details (instrument/software specifications, tasks, recording protocol, acoustic measures/parameters being measured,	
Auditory-perceptual evaluation procedure (rating scale, tasks, parameters)	
Any other relevant information	
Data extraction template for textbooks	
Details related to textbook (Name, author, edition, publishers, chapter name, authors for the chapter)	
Voice assessment information (Available or not available, if available – voice assessment protocol discussed)	
Acoustic analysis details (instrument/software specifications, tasks, recording protocol, acoustic measures/parameters being measured)	
Auditory-perceptual evaluation procedure (rating scale, tasks, parameters)	
Any other relevant information	