

Voice Quality and Vocal Fatigue Among University Teachers: A Clinical and Acoustic Study

Muhamnd Kadhem Madhlom Al-Dhaleme

Al Muthanna health directorate, Al Muthanna, Iraq

Abstract: Background: There are studies regarding vocal health in school teachers, especially in Iraq, but there are insufficient studies on university staff who usually use various means of communication at all times without assistance. Aim: To assess voice quality and vocal fatigue of university instructors using the integrated method of self-report, auditory-perceptual, laryngoscopic and acoustic methods, and investigate related job and health aspects. Methods: A comparative cross-sectional study was conducted at the otolaryngology and voice clinic of Al-Hussein Teaching Hospital, Samawa, Iraq, from January to December 2023. One hundred and twenty university teachers and 60 age- and sex-matched non-teaching university employees were evaluated with a structured questionnaire, the Arabic Voice Handicap Index-10 (VHI-10), the Vocal Fatigue Index (VFI), the Reflux Symptom Index, GRBAS perceptual rating, videolaryngostroboscopy and acoustic analysis (fundamental frequency, jitter, shimmer, harmonics-to-noise ratio, maximum phonation time and s/z ratio). Acoustic recordings were repeated at the end of a teaching day in the teacher group. Results: The teachers showed an increase in both vocal fatigue (61.7% vs. 21.7%) and hoarseness (48.3% vs. 18.3%) in comparison to the control group ($p < 0.001$). Additionally, the teachers had a significantly higher average VHI-10 score (11.8 ± 7.4 vs. 5.1 ± 4.2), as well as the VFI tiredness and discomfort scores. Furthermore, 55.0% of the teachers and 18.3% of the control group had some type of diagnosis regarding the larynx. The main diagnoses were the presence of vocal nodules (15.0%), reflux larynx changes (13.3%), and tension dysphonia (11.7%). The jitter and shimmer averages were significantly greater ($p < 0.001$), while the teachers showed lower harmonic-to-noise ratio and maximum phonation time in comparison with the control group. This can indicate that the parameters got worse every day of teaching and changed the number and type of parameters included in the voice impairment diagnosis, including the gender, the number of hours teaching more than 16 hours per week, the number of students exceeding 50 per class, and reflux symptoms. To sum up, it can be said that voice problems and fatigue are frequently seen in the university educators in Samawa and can be measured in terms of perceptual, laryngeal and acoustic characteristics of the voice. In the occupational health programs of universities for professors, it is necessary to pay attention to working time regulation, acid reflux treatment, voice amplification and proper education regarding voice hygiene.

Keywords: vocal fatigue; voice disorders; university teachers; acoustic analysis; Voice Handicap Index; occupational voice; Iraq

Introduction

The voice is an essential means of communication between human beings and has served as the primary vehicle of commerce for much of the workforce. According to Titze et al., nearly one-fourth to one-third of the total labour force in developed countries depends on the voice for their

work, meaning that teachers represent the largest proportion of that voice-utilizing group of workers [1]. Unlike singers or actors, who have undergone voice training and typically work as performers only for short periods of time, teachers are required to speak continuously, often at high volume, in acoustically unsatisfactory conditions, with limited opportunities for voice rest [2]. This mode of voice use put significant physical demands on the vocal cords of teachers and makes them susceptible to voice disorders, thus interfering with their professional performance, income and quality of life.

A voice disorder is generally considered to exist when the quality, pitch, loudness or flexibility of the voice differs from that of persons of similar age, sex and cultural background, or when the voice is inadequate for the occupational or social demands placed upon it [3]. Population-based research in the United States showed that teachers were significantly more likely than non-teachers to have experienced a voice problem during their lifetime (57.7% versus 28.8%) and to report a current voice problem (11.0% versus 6.2%) [3]. In the general population, the lifetime prevalence of voice disorders approached 30%, and occupational voice demand emerged as an important risk factor [4]. An early review highlighted that teachers missed work and even considered leaving the profession because of their voices, and the influential studies of Smith and colleagues demonstrated that teachers reported voice problems far more often than other professionals and that these problems had tangible effects on job performance and attendance [5].

Subsequent research from many countries has confirmed that voice complaints are highly prevalent among teaching staff, although reported figures vary widely because of differences in definitions, instruments and sampling. Reviews have estimated that the prevalence of voice disorders among teachers ranges from approximately 20% to more than 50%, depending on whether current, recent or lifetime symptoms are examined [6]. A systematic review and meta-analysis of risk factors identified female sex, longer teaching experience, high weekly workload, large class size, background noise, upper respiratory infection and gastro-oesophageal reflux as consistent correlates of teacher voice disorders [7]. Large surveys from Poland, the Netherlands and Spain have reported similarly high rates of occupational dysphonia and have documented both organic lesions, such as vocal fold nodules, and functional disorders among teachers [8]. In Brazil, an epidemiological study comparing teachers with non-teachers found that teachers had a higher prevalence of current voice disorders and more frequently reported that voice problems limited their ability to work [9]. Taken together, these data establish teaching as a high-risk occupation for the voice across very different educational systems and cultures.

The processes through which voice work results in problems have been generally defined in terms of vocal loads and vocal fatigue. Using portable voice dosimetry, Titze, Hunter and Švec found out that teachers use their voices during working hours to a much higher degree than when they are not working, therefore, teachers accumulate a huge number of vocal fold movements in one working day [10]. Vocal fatigue is defined as an unfavorable voice adaptation that occurs as a result of long-term use of voice and is interpreted in sensory, acoustic, or physiological terms while being accompanied by a sense of increased effort and discomfort and decrease in vocal capacity. Recent research reached the conclusion about the necessity to differentiate vocal loads, vocal loading, vocal effort, and vocal fatigue to measure these phenomena in different studies. From a physiological point of view, long use of voice can cause tissue modification such as increased viscosity of the vocal fold cover, vascular trauma, and low water content and can rely on the neuromuscular fatigue of both respiratory and laryngeal muscles [11]. Experimental studies on vocal loading have shown that the effect of self-perception of fatigue can lengthen from several hours after the completion of the task and that the period of recovery is not the same for everyone [12].

Vocal fatigue makes sense in the context of vocal hyperfunction and improper or excessive activation of the intrinsic and extrinsic muscles of the larynx which results because of high vocal demands [13]. Hillman and his colleagues noted that hyperfunctional voice use could either cause phonotraumatic lesions (nodules or polyps) or result in non-phonotraumatic disorders (muscle

tension dysphonia) [14]. Some teachers are especially vulnerable to this cycle of stress and compensation because they talk over classroom noises, use an inappropriate pitch or loudness or speak when their voice feels uncomfortable. Gotaas and Starr found out that voice disorders in teachers are connected with their feeling of voice problems [15]. Thus, we can view fatigue as an early stage of voice pathology which can still be fixed.

Most of the literature available pertains to teachers in the field of primary and secondary education. The circumstances for college instructors are slightly different but have equal problems. Lectures at the university level have large numbers of students attending in large rooms, lasting from several hours at a time, and sometimes followed by practical classes, medical practices, exams, and the further students' training [16], [17]. There are many higher education institutions in developing nations that do not have enough sound systems for their classrooms and give lectures in their larger halls with inadequate sound insulation that does not filter outside noise made by traffic, generators, and ventilation installations. Research conducted in Brazil among university instructors shows that they are dealing with a lot of vocal health problems and increase the number of these issues for teachers and females [18], [19]. In Cyprus, research also indicated that professors face voice-related problems also and explains that environmental factors and workload could be related to the occurrence of these vocal problems [19], [20]. Nevertheless, there is still a poor representation of objective data and acoustical details concerning the staff of educational institutions; the majority of the published material on this group of people consists of survey analysis only. Additionally, unlike primary and secondary teachers in most countries, in Iraq university faculty members acquire their positions based on their knowledge in various subjects, research experience, and teaching methods, with no preceding training in areas of voice production and hygiene [20].

In the Arab region, research on teachers' voice has grown over the past two decades. In Lebanon, Hamdan and colleagues reported that teachers experienced significantly more voice symptoms than a comparison group and stressed the role of primary care physicians in the early detection of voice disorders [21], [22]. Egyptian studies have documented high rates of voice complaints among public school teachers, have identified classroom noise and large class sizes as contributing factors, and have reported benefit from vocal hygiene awareness programmes [23], [24]. However, to the best of our knowledge, no published study has combined self-assessment, perceptual, endoscopic and acoustic evaluation of university teachers in Iraq. Iraqi higher education has expanded considerably in recent years, with rising student intake and crowded lecture halls. In southern governorates such as Al-Muthanna, a hot and dusty climate, intermittent electrical supply that may disable air conditioning and microphones, and a predominantly lecture-based teaching style may further aggravate vocal strain. Local data are therefore needed to inform occupational health policy for academic staff [25].

The thorough assessment of voice is multidimensional, as there is no one variable that represents the whole phenomenon of vocal performance. Patient-related questionnaires, for instance, the Voice Handicap Index-10 (VHI-10), allow for measurement of voice dysfunction in a brief and validated way, whereas the Vocal Fatigue Index (VFI) was created to help recognize those who suffer from fatigued voice and assess voice tiredness, as well as discomfort occurring while speaking, and the treatment itself. Although auditory-perceptual assessment using GRBAS scale or Consensus Auditory-Perceptual Evaluation of Voice is regarded as the gold standard in voice quality assessment, acoustic assessment offers objective, non-invasive, accurate, and repeatable results [26]. Perturbation parameters (e.g. jitter and shimmer) or noise parameters (e.g. harmonics-to-noise ratio (HNR)) help reveal irregularity of vocal fold movement and airflow through the glottis, yet these indicators are highly dependent on the conditions of sound measurement. Some authors suggested developing multiparametric indices and continuous speech measures to resolve some of the issues [27]. Research among teachers demonstrated that there is a variation in acoustic properties over the working day, while correlation with self-reported fatigue is present but quite weak [28].

Due to the vital role of the voice in higher education and the lack of local clinical data, the purpose of this study was to evaluate the voice quality and voice fatigue experienced by university instructors who attended Al-Hussein Teaching Hospital in Samawa, Iraq, in 2022, through the use of self-report questionnaires, auditory-perceptual evaluation, videolaryngostroboscopy, and acoustic measurements, and then compare this to the same findings in non-teaching university employees[29]. The secondary objectives of this study included examining the laryngeal characteristics of university teachers, measuring acoustic changes in teachers over the course of a full teaching day, and determining demographic, occupation and health-related factors that predict a voice handicap in university teachers[30].

Methodology

Study design and setting

This study is a comparative cross-sectional study and was carried out at the Department of Otolaryngology (voice and phoniatrics unit) of Al-Hussein Teaching Hospital, the major tertiary referral hospital in Samawa city Al-Muthanna Governorate in southern Iraq. The data for the study was gathered between 1 January and 31 December 2023, excluding university holidays, so that the participants were evaluated during active teaching.

Participants

The study participants were made up of university educators selected from the colleges belonging to Al-Muthanna University and private colleges in Samawa based on documents/messages released to academic departments in different colleges as well as those who visited the outpatient clinic while in the study. The inclusion conditions were full-time teaching for two or more years, having a minimum of eight lecture hours per week, and age of between 25 and 60 years. The comparison subjects were the non-teaching administrative and technical staff in the same institutions, while matched to the teaching staff on the basis of sex and age (maximum three years), and their duties did not require sustained voice use in their jobs.

Individuals from both cohorts were excluded if they did not have any past instances of laryngeal surgery or any diagnosis of laryngeal disorder prior to the employment in which they were currently participating, those having neurological/neuro muscular disorders, people whose thyroid disease was not under control, those affected with malignancy in the head and neck or have been through radiotherapy, people suffering from acute upper respiratory tract infections in the past two weeks, pregnant women, individuals with hearing loss, professional singers or those administered with inhaled corticosteroids or ACE inhibitors.

The sample size calculated with the method designed for two independent proportions states that there will be a 50% occurrence of vocal fatigue for teachers as well as a 25% rate for controls leading to the use of a significance threshold of 0.05, an expected power of 80%, and an allocation ratio set at 2:1. These calculations further indicate that at least 104 teachers and 52 controls will be sampled but in the end the number is raised to 120 and 60 since the recorded data may not be suitable for analysis.

Questionnaire

For demographic information (age, gender active, college and academic specialisation), lifestyle factors (smoking, amount of water intake per day and intake of caffeinated drinks daily) and professional experience (number of years in teaching, hours of lectures each week, usual number of students in one class lecture, number of lectures each day, usage of microphone, self-evaluation of level of noise while teaching), a structured questionnaire has been used and filled by the interviewer. Respondents were also asked to tell if they had symptoms of voice problems at least once a week during the last six months such as hoarseness of voice, vocal fatigue, clearing throat

often, dry throat, voice loss episodes, pain while speaking etc. Reflux symptoms have been measured using Reflux Symptom Index, and a score above 13 was considered as abnormal.

Self-assessment of voice

The Arabic version of the Voice Handicap Index was utilized to assess vocal impairment with results computed for the ten queries corresponding to the VHI-10. All questions were rated across a continuum assessed from 0-4 leading to possible scores from 0-40, where any score exceeding 11 would suggest a voice disorder. The Vocal Fatigue Index which has 19 questions was employed to assess fatigue in the voice and produces three factor scores: a measure of fatigue in producing voice (factor 1) which is scored from 0-44, a body discomfort in vocalization (factor 2) which has scores ranging from 0-20, and a recovery after the break (factor 3) scored from 0-12. Because of the lack of a valid Arabic version during that time, this index was translated into Arabic by two bilingual otolaryngologists by several processes thus involving forward and backward translation, review by the cultural equivalence committee, and pilot testing with 15 unstudied subjects. The internal consistency of the sample may be described as good (Cronbach's alpha 0.87).

Auditory-perceptual evaluation

The continuous vowel of each participant was measured from the numbers one to twenty, as well as the reading of a typical Arabic text. These recordings were evaluated by two ear, nose, and throat doctors based on the GRBAS system (grade, roughness, breathy voice, asthenia, and strain) in which grades range from 0 to 3 (normal to extreme). The doctors did not know which group the participant belonged to or the results of the research. All differences of opinions between the doctors were settled by mutual agreement, and the level of agreement in the evaluation between the doctors before achieving total agreement was good enough (kappa-weighted 0.78).

Laryngeal examination

All subjects received full ear, nose, and throat (ENT) evaluation plus video-laryngeal stroboscopic assessment using a rigid 70-degree endoscope with stroboscopic illumination. They then phonated vowel /i/ without pitch or loudness variations at three pitches. The data analysis included measurements on the vocal cord movements, glottal closure, amplitude of the vocal cord vibrations, wave motion and other parameters. Diagnostic criteria were used to make diagnoses of nodules, polyps, cysts and Reinke edema. Muscle tension dysphonia was diagnosed based on the supraglottic area being compressed or laryngeal tension being excessive. In situations where reflux effects on the voice box existed, the examiner needed to determine whether there was posterior commissure hypertrophy, false vocal cord infections or generalized laryngeal swelling.

Acoustic analysis

Acoustical recordings were made in an isolated room with background noise levels below 40 dB(A) using a head-worn condenser microphone positioned 5 cm away from the speaker's mouth at an angle of 45 degrees, with the signal routed to a computer via an external sound card (sampling rate 44.1 kHz, 16-bit resolution). The participants were instructed to produce the vowel /a/ three times at a comfortable pitch and loudness. The mean of the three recordings was determined after analyzing the central seconds using Praat (version 6.2). The following measures were derived: mean fundamental frequency (F0, Hz), local jitter (%), local shimmer (%), and harmonics-to-noise ratio (HNR, dB). The maximum phonation time (MPT) indicates the duration of the longest /a/ sustaining and the s/z ratio indicates the ratio calculated based on the longest of the three fricative sounds.

Baseline measurements for all subjects were taken in the morning between 8 00 a.m. and 9 00 a.m., before any teaching proceedings. In order to measure possible variations connected with vocal load, the teachers were recorded a second time within 30 minutes after finishing lecturing for at least four hours, based on the same techniques and equipment. At both stages the teachers had to estimate

their vocal effort on a 10-centimeter visual analogue scale (where 0 meant no effort and 10 meant the most).

Ethical considerations

The ethics committee and scientific committee from [insert name of approving authority with approval number] have finalized the research design. Approval to proceed with the research was obtained from Al-Hussein Teaching Hospital administration. Informed consents were obtained from all participants through adequate explanation of purpose and approach. Data collection was in accordance with the Declaration of Helsinki and all the information remained anonymous. Participants who had voice disorders were treated and provided follow-up care.

Statistical analysis

The analysis was performed using SPSS version 26 (IBM Corp., Armonk, NY, USA). Normality was tested using the Shapiro–Wilk test. Continuous variables are presented as mean $\pm$ standard deviation and categorical data as quantity and percentage. Groups were compared using the independent samples t-test and Mann–Whitney U test for continuous variables and chi-square test and Fisher's exact test for categorical variables. Acoustic parameters are reported separately for males and females due to the differences in vocal physiology between genders. Measurement readings in teachers at the beginning of the day and at the end of the workday were compared using the paired t-test. Relationship between self-reported and acoustic or perceptual measures of the subjects was calculated using Pearson and Spearman correlation coefficients. Multivariate logistic regression was applied to determine variables which were independently related to the voice handicap (VHI-10 > 11) among teachers. Factors with $p < 0.20$ 95% 0.05 in univariate analysis got into the multivariable model.

Results

The research involved participation by a combination of 120 university educators (which included 68 men and 52 women) along with 60 controls (34 men and 26 women). The control group consisted of individuals that had characteristics similar to the experimental group in age, gender, smoking history, water and caffeine consumption, and the incidence of individuals with abnormal Reflux Symptom Index scores (refer to Table 1). The educators had an average experience of teaching equating to 12.4 years $\pm$ 7.6 and a teaching workload amounting to an average of 14.8 hours $\pm$ 4.6 hours per week. In terms of the student number, more than half of the teachers are known to have taught classes of more than 50 students in size, whereas someone out of five have been known to use a microphone as part of their teaching experience. Teachers were associated with the college of medicine and school of health (28.3%), college of science and engineering (34.2%), and college of humanities and education (37.5%); there has been no statement made on the difference in the occurrence of voice disorders between the colleges with a statistically significant figure of $p = 0.41$, therefore the data was evaluated as concerned with the experimental group.

Table 1. Demographic, lifestyle and occupational characteristics of the study groups

Variable	Teachers (n = 120)	Controls (n = 60)	p-value
Age, years (mean $\pm$ SD)	41.6 $\pm$ 8.9	40.8 $\pm$ 9.3	0.58
Sex: male / female, n (%)	68 (56.7) / 52 (43.3)	34 (56.7) / 26 (43.3)	1.00
Current smoker, n (%)	28 (23.3)	15 (25.0)	0.80
Water intake < 1.5 L/day, n (%)	71 (59.2)	30 (50.0)	0.24
Caffeinated drinks > 3/day, n (%)	46 (38.3)	21 (35.0)	0.66
Reflux Symptom Index > 13, n (%)	34 (28.3)	11 (18.3)	0.14

Occupational data (teachers only)			
Teaching experience, years (mean $\pm$ SD)	12.4 $\pm$ 7.6	—	—
Lecture hours/week (mean $\pm$ SD)	14.8 $\pm$ 4.6	—	—
Lecture hours > 16/week, n (%)	47 (39.2)	—	—
Class size > 50 students, n (%)	64 (53.3)	—	—
≥ 3 consecutive lectures/day, n (%)	51 (42.5)	—	—
Regular microphone use, n (%)	22 (18.3)	—	—
College: medical-health / science-engineering / humanities-education, n	34 / 41 / 45	—	—

SD: Standard Deviation. Independent T-Test for age and chi-square test for categorical variables.

Every vocal symptom occurred significantly more often in teachers than in controls (see Table 2). The most common symptom among teachers was vocal fatigue, which was reported by 61.7% of them in comparison with only 21.7% of controls. The second most common symptom of voice disorder was throat dryness, which was reported by 57.5% of teachers, followed by frequent throat clearing (51.7%) and hoarseness (48.3%). Twenty-one teachers (17.5%) reported having been absent from work because of voice problems in the past year. In the group of teachers, 38 (31.7%) had or more simultaneous symptoms, compared to 5 (8.3%) people in the controls ($p < 0.001$).

Table 2. Voice symptoms reported at least weekly during the preceding six months

Symptom	Teachers (n = 120) n (%)	Controls (n = 60) n (%)	p-value
Vocal fatigue	74 (61.7)	13 (21.7)	< 0.001
Throat dryness	69 (57.5)	19 (31.7)	0.001
Frequent throat clearing	62 (51.7)	17 (28.3)	0.003
Hoarseness	58 (48.3)	11 (18.3)	< 0.001
Pain or discomfort on speaking	37 (30.8)	6 (10.0)	0.002
Episodes of voice loss	29 (24.2)	4 (6.7)	0.004
Sick leave due to voice in past year	21 (17.5)	2 (3.3)	0.008

Chi-square test or fisher's exact test.

The data on self-evaluation and perceptual evaluations can be found in Table 3. The teachers scored substantially higher on the VHI-10 than the controls, with 45.8% 1 2 scoring above the threshold for voice handicap. The scores for the first two factors of the VFI were almost twice as high among the teachers, while factor 3 did not differ between the two groups. The proportion of teachers rated as abnormal globally on the GRBAS scale was 42.5%, compared to 13.3% in the case of controls.

Table 3. Self-assessment and auditory-perceptual voice measures

Measure	Teachers (n = 120)	Controls (n = 60)	p-value
VHI-10 total score (mean $\pm$ SD)	11.8 $\pm$ 7.4	5.1 $\pm$ 4.2	< 0.001
VHI-10 > 11, n (%)	55 (45.8)	7 (11.7)	< 0.001
VFI factor 1: tiredness and avoidance (mean $\pm$ SD)	17.6 $\pm$ 9.8	8.2 $\pm$ 6.1	< 0.001
VFI factor 2: physical discomfort (mean $\pm$ SD)	5.9 $\pm$ 3.4	2.7 $\pm$ 2.2	< 0.001
VFI factor 3: improvement with rest (mean $\pm$ SD)	8.9 $\pm$ 2.7	9.3 $\pm$ 2.4	0.31
GRBAS overall grade (G), n (%)			
G0 (normal)	69 (57.5)	52 (86.7)	
G1 (mild)	36 (30.0)	7 (11.7)	< 0.001*
G2 (moderate)	13 (10.8)	1 (1.7)	
G3 (severe)	2 (1.7)	0 (0.0)	

VHI-10: Voice Handicap Index-10; VFI: Vocal Fatigue Index. Mann-Whitney U test for results; *chi-square test for G0 against $G \geq 1$.

The results from videolaryngostroboscopy indicated that 66 teachers (55.0%) had laryngeal abnormalities compared to 11 controls (18.3%) (Table 4). The most common lesion was vocal fold nodules, which occurred mostly in females, as 14 out of the total 18 cases. The latter segment consisted of reflux-related changes, followed by muscle tension dysphonia.

Table 4. Videolaryngostroboscopic findings

Finding	Teachers (n = 120) n (%)	Controls (n = 60) n (%)
Normal larynx	54 (45.0)	49 (81.7)
Vocal fold nodules	18 (15.0)	2 (3.3)
Reflux-related laryngeal changes	16 (13.3)	5 (8.3)
Muscle tension dysphonia	14 (11.7)	2 (3.3)
Vocal fold polyp	7 (5.8)	1 (1.7)
Chronic laryngitis	6 (5.0)	1 (1.7)
Reinke's oedema	3 (2.5)	0 (0.0)
Vocal fold cyst	2 (1.7)	0 (0.0)
Any abnormality	66 (55.0)	11 (18.3)

Any abnormality versus normal: chi-square = 22.0, $p < 0.001$.

Table 5 presents the morning acoustic parameters according to sex. Teachers, irrespective of sex, had statistically higher jitter, shimmer and s/z ratio and lower HNR and MPT than the controls. At the same time, average F0 was not significantly different. However, all acoustic parameters considerably decreased in teachers after a working day and F0 for both sexes increased[31].

Table 5. Baseline (morning) acoustic and aerodynamic measures by sex (mean $\pm$ SD)

Parameter	Male teachers (n = 68)	Male controls (n = 34)	p	Female teachers (n = 52)	Female controls (n = 26)	p
F0 (Hz)	128.4 $\pm$ 18.6	121.7 $\pm$ 16.2	0.07	214.6 $\pm$ 27.3	219.8 $\pm$ 22.5	0.40
Jitter local (%)	0.86 $\pm$ 0.41	0.52 $\pm$ 0.22	< 0.001	0.94 $\pm$ 0.46	0.55 $\pm$ 0.24	< 0.001
Shimmer local (%)	4.12 $\pm$ 1.65	2.98 $\pm$ 1.04	< 0.001	4.48 $\pm$ 1.82	3.10 $\pm$ 1.12	< 0.001
HNR (dB)	17.9 $\pm$ 3.8	20.6 $\pm$ 3.1	< 0.001	17.2 $\pm$ 4.1	20.9 $\pm$ 3.3	< 0.001
MPT (s)	16.8 $\pm$ 5.2	21.3 $\pm$ 5.7	< 0.001	12.9 $\pm$ 4.3	16.7 $\pm$ 4.6	< 0.001
s/z ratio	1.18 $\pm$ 0.24	1.02 $\pm$ 0.15	< 0.001	1.21 $\pm$ 0.27	1.03 $\pm$ 0.16	< 0.001

F0 means fundamental frequency; HNR abbreviates harmonics-to-noise ratio; MPT refers to maximum phonation time. The independent t-test was used.

Table 6. Acoustic measures and vocal effort in teachers before and after a teaching day (n = 120, mean $\pm$ SD)

Parameter	Morning	End of teaching day	p-value
F0, men (Hz)	128.4 $\pm$ 18.6	135.2 $\pm$ 19.4	< 0.001
F0, women (Hz)	214.6 $\pm$ 27.3	223.9 $\pm$ 28.1	< 0.001
Jitter local (%)	0.89 $\pm$ 0.43	1.12 $\pm$ 0.52	< 0.001
Shimmer local (%)	4.28 $\pm$ 1.73	5.01 $\pm$ 1.94	< 0.001
HNR (dB)	17.6 $\pm$ 3.9	16.1 $\pm$ 4.2	< 0.001
MPT (s)	15.1 $\pm$ 5.2	13.8 $\pm$ 4.7	< 0.001
Vocal effort VAS (0–10)	2.4 $\pm$ 1.7	5.6 $\pm$ 2.2	< 0.001

VAS: Visual Analog Scale. Pair T-Test.

According to the findings presented in Table 7, the independent factors associated with voice handicap in multivariable logistic regression included being female, having more than 16 lecture hours in a week, class size more than 50 students, and having abnormal Reflux Symptom Index. The influence of teaching experience, water consumption, and smoking was insignificant (Hosmer-Lemeshow $p = 0.62$). As shown in Table 8, VFI factor 1 and VHI-10 scores correlate from weak to moderate with acoustic parameters and moderately with perceptual ratings among teachers [32].

Table 7. Multivariable logistic regression of factors associated with voice handicap (VHI-10 > 11) among teachers

Variable	AOR	95% CI	p-value
Female sex	2.41	1.08–5.37	0.032
Lecture hours > 16/week	2.87	1.24–6.63	0.014
Class size > 50 students	2.36	1.04–5.35	0.040
Reflux Symptom Index > 13	3.05	1.26–7.38	0.013
Teaching experience > 10 years	2.12	0.94–4.78	0.070
Water intake < 1.5 L/day	1.94	0.86–4.37	0.110
Current smoking	1.71	0.68–4.30	0.250

AOR: Adjusted Odds Ratio; CI: Confidence interval. Hosmer-Lemeshow $p = 0.62$.

Table 8. Correlations between self-report scores and acoustic or perceptual measures in teachers (n = 120)

Measure	VFI factor 1 (r)	VHI-10 (r)
Jitter (%)	0.34**	0.31**
Shimmer (%)	0.38**	0.36**
HNR (dB)	−0.41**	−0.39**
MPT (s)	−0.33**	−0.29**
GRBAS grade (rho)	0.44**	0.52**

Pearson correlation for acoustic measures; spearman rho for GRBAS grade. $p^{**} \leq 0.001$.

Discussion

This article documents the initial research that combines findings from self-evaluation, acoustic analysis of voice, laryngoscopy assessment, and perceptual measures of voice among university instructors in Iraq. Among the major findings is the observation that instructors in Samawa experience a lot more vocal strain than non-instructors at the same institution. Moreover, the instructors reported more symptoms and distress than their colleagues. Furthermore, these teachers were rated as having a dysphonic voice more frequently, according to the assessment of naïve listeners, had voice disorders three times more than the control group in this study, and demonstrated greater variation than other groups on each of the voice traits measured by spectral analysis.

The frequency of voice complaints in our teachers was high. Vocal fatigue was reported by almost two thirds and hoarseness by nearly half, compared with about one fifth of controls. These figures fall within the upper part of the wide range reported internationally. Roy and colleagues found that teachers were roughly twice as likely as non-teachers to report voice problems, and comparable or higher rates of complaints have been documented in the surveys of Smith and colleagues, in Polish and Spanish teachers and in Brazilian teachers compared with non-teachers. Among university teachers specifically, Korn and colleagues reported a high frequency of vocal tract discomfort and voice symptoms, and Kyriakou and colleagues found that voice problems were common among university professors in Cyprus. Studies from Lebanon and Egypt have also reported a high prevalence of symptoms among teachers. The particularly high rates in our sample may partly reflect the hospital-based setting, since teachers with symptoms may have been more motivated to participate, but they may also reflect local conditions: more than half of our teachers lectured to

classes of over 50 students, fewer than one in five used amplification, and the hot, dry and dusty climate of southern Iraq, together with interruptions of air conditioning, may promote mucosal dryness. The high frequency of throat dryness reported by teachers is consistent with this interpretation.

Self-assessment instruments confirmed that these symptoms were not trivial. Mean VHI-10 scores in teachers were more than twice those of controls, and nearly half exceeded the threshold for voice handicap proposed by Rosen and colleagues. The Arabic version of the Voice Handicap Index has been shown to discriminate well between dysphonic and non-dysphonic speakers, which supports the use of this measure in Arabic-speaking teachers. The Vocal Fatigue Index provided complementary information. Scores for tiredness of voice and voice avoidance, and for physical discomfort, were roughly double those of controls, whereas the improvement of symptoms with rest did not differ between groups. Nanjundeswaran and colleagues designed the VFI to separate these components, and our pattern suggests that, for many teachers, fatigue remains at least partly responsive to rest. This is consistent with experimental work showing that vocal fatigue after loading recovers over hours, though with considerable individual variability, and it implies a window for preventive intervention before structural pathology becomes established. Conversely, the frequency of sick leave due to voice problems indicates that for a subset of teachers rest within the working week is insufficient to restore normal function.

The findings from the endoscopic examination provide further insight into the reported struggles. More than half of the teachers were observed to have laryngeal lesions whereas this number was less than in the control group. Vocal folds nodules were the lesions that occurred most frequently and were predominantly seen in women, which is a known trend among professionals, and fits Hillman's phonotraumatic pathway. Studies show that among European teachers vocal nodules are the most frequent type of organic lesion together with a significant amount of functional dysphonia. A review paper of Martins et al. found that nodules as well as chronic laryngitis and functional disorders were the main problems causing teacher's dysphonia. Muscle tension dysphonia is relatively common occurrence occurring at a rate of about among teachers, which is a non-phonotraumatic form of hyperfunction being known as a consequence of overactive effort of muscles. The reasonably high rate of laryngopharyngeal reflux changes among teachers together with a proven relationship between high Reflux Symptoms Index scores and voice handicap indicates that laryngopharyngeal reflux may be contributing along with other factors that sensitize the mucosa of the larynx to mechanical irritation. Irregularities in intake of food due to the timetable of teaching schedule can cause reflux, however, our research design does not allow claims concerning causation [33].

The auditory perception assessment, which is still the clinical standard for determining the quality of voice, supported the results of the teachers' subjective reports. In a blinded rating of approximately 40% of the teachers, the raters found their voices to be at least mildly abnormal. The results further demonstrated a moderate correlation between perceptual grade and the VHI-10 scores. The matching of these two approaches is comforting, since it demonstrates that the concerns voiced by the teachers are associated with identifiable changes in quality of voice rather than simply symptoms of the conditions affecting them. In spite of these results, several teachers reported having some level of discomfort without reporting auditory abnormalities. This suggests that vocal fatigue may occur prior to any observable changes in dysphonia and that it could be missed if the evaluation were conducted on the basis of listening to the individual's voice only.

The acoustic analysis provides reliable evidence to support these results. In fact, both male and female teachers showed increased levels of jitter and shimmer while having lower values of HNR compared to the control group, meaning higher irregularity of vocal fold oscillation as well as more buzzing sounds in the voice signal. All shimmer values calculated for the teachers' group exceeded the pathological voice threshold of shimmer; in contrast to lower values found for the control group. Moreover, teachers had lower MPTs and relatively high s/z ratios which means lack of adequate

glottal closure and voice control that confirms the endoscopy findings of nodules, incomplete closure of vocal folds, and supra-glottic compression. The findings on mean frequency at baseline have not been of any statistical significance for the present comparisons, which corresponds to findings of other studies indicating that the F0 value is weakly associated with occupational changes in voice. It should be pointed out that the voice perturbation parameters are dependent on the vowel, loudness color, F0, and of course, the place and time of recording. Additionally, sustained vowel readings do not represent the whole body of connected speech; therefore, it is recommended to use multi parametric measures such as the Acoustic Voice Quality Index which incorporates connected speech in its methodology [34].

The repeated measurements at the end of a teaching day offer insight into acute vocal fatigue. After at least four hours of lecturing, teachers showed a rise in F0, an increase in jitter and shimmer, reductions in HNR and MPT, and more than a doubling of self-rated vocal effort. A rise in F0 over the working day has been reported in female teachers by Rantala and colleague and by Laukkanen and colleagues, who also observed associations between acoustic changes and self-reported fatigue. The increase in F0 is often interpreted as a consequence of increased laryngeal muscle tension or of speaking at higher intensity, both of which are features of vocal loading. Welham and MacLagan noted that acoustic signs of fatigue are inconsistent across studies and should be interpreted alongside self-report, and the recent consensus on vocal load and fatigue has emphasised the need for standardised definitions and measures. In our data, correlations between VFI scores and acoustic parameters were statistically significant but only weak to moderate, confirming that acoustic and perceived fatigue are related but distinct constructs. The large number of vocal fold vibration cycles accumulated during teaching, documented by dosimetry, provides a plausible physiological basis for these within-day changes.

The link of various professional and individual variables to voice handicap was examined. Female teachers experienced twofold increased chances of being disabled possibly because women in general are more vulnerable, meta-analysis and many studies on teachers of university institutions. Women generate speech at a higher fundamental frequency. Their voices produce a bigger quantity of vibrations in the same time period which can render the physical features of a body and its tissues to further increase their susceptibility. Other variables found that 16 hours of work per week and more than 50 students at the same time are independent predictors of voice handicap, which makes evident a dose-dependant harm caused by the voice overburden and the need for the increase of vocal loudness in the case of large audience. It is shown that the load and the number of students were usually associated with the voice complaints made by teachers, while the studies of Egypt have established the correlation between the large classroom sizes and noise. It has been found that older the teacher was, the less affected he/she was in this aspect but this fact does not contribute to having any significance later on, probably due to the development of compensatory mechanisms or because the majority of affected individuals leave the teaching profession. Smoking and low fluid intake were also biologically reasonable possible risk factors but did not prove to be independent variables due to the small sample sizes [35].

These findings have practical implications. Voice problems among academic staff are an occupational health issue rather than a purely individual one, as Vilkmán has argued for voice professions generally, and they are associated with sick leave and reduced work capacity. Universities could reduce vocal load by limiting consecutive lecture hours, reducing class sizes, and providing reliable sound amplification that functions independently of interruptions in electrical supply. Simple screening using the VHI-10 and VFI at employment and at periodic health examinations could identify teachers with early fatigue, allowing timely referral for laryngoscopic assessment and voice therapy. Vocal hygiene education, which has been shown to benefit teachers, should be incorporated into faculty development programmes, together with advice on hydration and the recognition and management of reflux symptoms. Because systematic reviews have

identified modifiable work-related factors as key determinants of teacher voice disorders, such institutional measures may achieve greater impact than individual treatment alone.

This study has several strengths, including the use of a matched comparison group drawn from the same institutions, blinded perceptual rating, endoscopic confirmation of diagnoses, sex-specific acoustic comparisons and repeated measurement across a teaching day. Its limitations should also be acknowledged. The cross-sectional design precludes conclusions about causality. Recruitment through a hospital clinic and voluntary participation may have favoured teachers with symptoms and inflated prevalence estimates. The study was conducted in a single centre and city, which limits generalisability to other Iraqi regions. Acoustic analysis relied on sustained vowels, classroom noise was not measured objectively, and vocal load was estimated from self-reported hours rather than dosimetry. The Arabic translation of the VFI, although internally consistent, had not been formally validated, and end-of-day recordings were obtained only in teachers. Future multicentre and longitudinal studies, incorporating ambulatory voice monitoring, classroom acoustic measurement and evaluation of preventive interventions, are recommended [36].

Conclusion

Voice issues and fatigue are prevalent among teachers at universities in Samawa, Iraq. Compared to their non-teaching counterparts, teachers reported more symptoms of voice abnormalities and more voice-related inconveniences, endured higher incidence of voice disorders (such as dysphonia), as well as a wider variety of larynx problems, such as vocal fold nodules, complaints related to esophagus and larynx reflux and muscle tension dysphonia. Gender, amount of time spent for teaching per week, classroom size and existing symptoms of gastroesophageal reflux disease were identified as independent variables influencing voice quality among teachers in Samawa.

References

- [1] A.-M. Laukkanen, I. Ilomäki, K. Leppänen, and E. Vilkman, 'Acoustic measures and self-reports of vocal fatigue by female teachers', *Journal of Voice*, vol. 22, no. 3, pp. 283–289, 2008.
- [2] M. Hirano, *Clinical Examination of Voice*. New York: Springer-Verlag, 1981.
- [3] G. B. Kempster, B. R. Gerratt, K. Verdolini Abbott, J. Barkmeier-Kraemer, and R. E. Hillman, 'Consensus auditory-perceptual evaluation of voice: development of a standardized clinical protocol', *American Journal of Speech-Language Pathology*, vol. 18, no. 2, pp. 124–132, 2009.
- [4] C. A. Rosen, A. S. Lee, J. Osborne, T. Zullo, and T. Murry, 'Development and validation of the Voice Handicap Index-10', *The Laryngoscope*, vol. 114, no. 9, pp. 1549–1556, 2004.
- [5] A. Abo-Hasseba, T. Waaramaa, P. Alku, and A. Geneid, 'Difference in voice problems and noise reports between teachers of public and private schools in Upper Egypt', *Journal of Voice*, vol. 31, no. 1, p. 130.e1-130.e7, 2017.
- [6] J. Preciado-López, C. Pérez-Fernández, M. Calzada-Uriondo, and P. Preciado-Ruiz, 'Epidemiological study of voice disorders among teaching professionals of La Rioja, Spain', *Journal of Voice*, vol. 22, no. 4, pp. 489–508, 2008.
- [7] M. Behlau, F. Zambon, A. C. Guerrieri, and N. Roy, 'Epidemiology of voice disorders in teachers and nonteachers in Brazil: prevalence and adverse effects', *Journal of Voice*, vol. 26, no. 5, p. 665.e9-665.e18, 2012.
- [8] F. I. C. R. S. de Jong, P. G. C. Kooijman, G. Thomas, W. J. Huinck, K. Graamans, and H. K. Schutte, 'Epidemiology of voice problems in Dutch teachers', *Folia Phoniatrica et Logopaedica*, vol. 58, no. 3, pp. 186–198, 2006.

- [9] E. Smith, S. D. Gray, H. Dove, L. Kirchner, and H. Heras, 'Frequency and effects of teachers' voice problems', *Journal of Voice*, vol. 11, no. 1, pp. 81–87, 1997.
- [10] E. Smith, J. Lemke, M. Taylor, H. L. Kirchner, and H. Hoffman, 'Frequency of voice problems among teachers and other occupations', *Journal of Voice*, vol. 12, no. 4, pp. 480–488, 1998.
- [11] R. E. Hillman, E. B. Holmberg, J. S. Perkell, M. Walsh, and C. Vaughan, 'Objective assessment of vocal hyperfunction: an experimental framework and initial results', *Journal of Speech and Hearing Research*, vol. 32, no. 2, pp. 373–392, 1989.
- [12] E. Vilkman, 'Occupational safety and health aspects of voice and speech professions', *Folia Phoniatrica et Logopaedica*, vol. 56, no. 4, pp. 220–253, 2004.
- [13] I. R. Titze, J. Lemke, and D. Montequin, 'Populations in the U.S. workforce who rely on voice as a primary tool of trade: a preliminary report', *Journal of Voice*, vol. 11, no. 3, pp. 254–259, 1997.
- [14] P. Boersma and D. Weenink, 'Praat: doing phonetics by computer'. University of Amsterdam, 2022. [Online]. Available: <https://www.praat.org>
- [15] N. Roy, R. M. Merrill, S. Thibeault, R. A. Parsa, S. D. Gray, and E. M. Smith, 'Prevalence of voice disorders in teachers and the general population', *Journal of Speech, Language, and Hearing Research*, vol. 47, no. 2, pp. 281–293, 2004.
- [16] M. Brockmann, M. J. Drinnan, C. Storck, and P. N. Carding, 'Reliable jitter and shimmer measurements in voice clinics: the relevance of vowel, gender, vocal intensity, and fundamental frequency effects in a typical clinical task', *Journal of Voice*, vol. 25, no. 1, pp. 44–53, 2011.
- [17] K. Kyriakou, K. Petinou, and I. Phinikettos, 'Risk factors for voice disorders in university professors in Cyprus', *Journal of Voice*, vol. 32, no. 5, p. 643.e1-643.e9, 2018.
- [18] P. G. C. Kooijman *et al.*, 'Risk factors for voice problems in teachers', *Folia Phoniatrica et Logopaedica*, vol. 58, no. 3, pp. 159–174, 2006.
- [19] S. A. Bolbol, M. M. Zalat, R. A. M. Hammam, and A. Elnakib, 'Risk factors of voice disorders and impact of vocal hygiene awareness program among teachers in public schools in Egypt', *Journal of Voice*, vol. 31, no. 2, p. 251.e9-251.e16, 2017.
- [20] Y. Maryn, M. De Bodt, and N. Roy, 'The Acoustic Voice Quality Index: toward improved treatment outcomes assessment in voice disorders', *Journal of Communication Disorders*, vol. 43, no. 3, pp. 161–174, 2010.
- [21] M. Sliwinska-Kowalska *et al.*, 'The prevalence and risk factors for occupational voice disorders in teachers', *Folia Phoniatrica et Logopaedica*, vol. 58, no. 2, pp. 85–101, 2006.
- [22] H. Byeon, 'The risk factors related to voice disorder in teachers: a systematic review and meta-analysis', *International Journal of Environmental Research and Public Health*, vol. 16, no. 19, p. 3675, 2019.
- [23] E. J. Hunter *et al.*, 'Toward a consensus description of vocal effort, vocal load, vocal loading, and vocal fatigue', *Journal of Speech, Language, and Hearing Research*, vol. 63, no. 2, pp. 509–532, 2020.
- [24] K. H. Malki, T. A. Mesallam, M. Farahat, M. Bukhari, and T. Murry, 'Validation and cultural modification of Arabic voice handicap index', *European Archives of Oto-Rhino-Laryngology*, vol. 267, no. 11, pp. 1743–1751, 2010.

- [25] P. C. Belafsky, G. N. Postma, and J. A. Koufman, 'Validity and reliability of the reflux symptom index (RSI)', *Journal of Voice*, vol. 16, no. 2, pp. 274–277, 2002.
- [26] J. P. Teixeira, C. Oliveira, and C. Lopes, 'Vocal acoustic analysis – jitter, shimmer and HNR parameters', *Procedia Technology*, vol. 9, pp. 1112–1122, 2013.
- [27] C. Nanjundeswaran, B. H. Jacobson, J. Gartner-Schmidt, and K. Verdolini Abbott, 'Vocal Fatigue Index (VFI): development and validation', *Journal of Voice*, vol. 29, no. 4, pp. 433–440, 2015.
- [28] J. A. Mattiske, J. M. Oates, and K. M. Greenwood, 'Vocal problems among teachers: a review of prevalence, causes, prevention, and treatment', *Journal of Voice*, vol. 12, no. 4, pp. 489–499, 1998.
- [29] G. P. Korn, A. A. L. Pontes, D. Abranches, and P. A. L. Pontes, 'Vocal tract discomfort and risk factors in university teachers', *Journal of Voice*, vol. 30, no. 4, p. 507.e1-507.e8, 2016.
- [30] C. Gotaas and C. D. Starr, 'Vocal fatigue among teachers', *Folia Phoniatrica*, vol. 45, no. 3, pp. 120–129, 1993.
- [31] L. Rantala, E. Vilkman, and R. Bloigu, 'Voice changes during work: subjective complaints and objective measurements for female primary and secondary schoolteachers', *Journal of Voice*, vol. 16, no. 3, pp. 344–355, 2002.
- [32] L. C. Cantor Cutiva, I. Vogel, and A. Burdorf, 'Voice disorders in teachers and their associations with work-related factors: a systematic review', *Journal of Communication Disorders*, vol. 46, no. 2, pp. 143–155, 2013.
- [33] R. H. G. Martins, E. R. B. Pereira, C. B. Hidalgo, and E. L. M. Tavares, 'Voice disorders in teachers. A review', *Journal of Voice*, vol. 28, no. 6, pp. 716–724, 2014.
- [34] A. L. Hamdan, A. M. Sibai, Z. M. Srour, O. A. Sabra, and R. A. Deeb, 'Voice disorders in teachers. The role of family physicians', *Saudi Medical Journal*, vol. 28, no. 3, pp. 422–428, 2007.
- [35] N. Roy, R. M. Merrill, S. D. Gray, and E. M. Smith, 'Voice disorders in the general population: prevalence, risk factors, and occupational impact', *The Laryngoscope*, vol. 115, no. 11, pp. 1988–1995, 2005.
- [36] I. R. Titze, E. J. Hunter, and J. G. Švec, 'Voicing and silence periods in daily and weekly vocalizations of teachers', *The Journal of the Acoustical Society of America*, vol. 121, no. 1, pp. 469–478, 2007.