

Effects of Vocal Loading Task and Hydration on Voice Quality in Adults from Kerala: A Pilot Study

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ABSTRACT

Vocal fold hydration is essential for optimal voice production. This study aimed to understand the effects of systemic and surface hydration on acoustic and perceptual voice measures following a vocal loading task in adults aged 18-58 years. A total of 40 healthy adults (20 males, 20 females) were divided into two age groups (18-38 years and 38-58 years). Participants completed a 45-minute vocal loading task, followed by either systemic hydration (oral fluid intake) or surface hydration (5-minute isotonic saline nebulization). Acoustic parameters (F0, jitter, shimmer, HNR) were measured using PRAAT software and perceptual measures were assessed using the Vocal Fatigue Index (VFI) and Vocal Tract Discomfort Scale (VTDS) at pre-fatigue, post-fatigue and post-hydration conditions. The result showed that Vocal loading significantly increased F0, jitter and shimmer while decreasing HNR indicating vocal fold instability and breathiness. Both hydration types restored all acoustic parameters to near-baseline levels with no significant differences between systemic and surface hydration. Perceptual scores (VFI and VTDS) showed highly significant increases post-fatigue and returned to baseline after hydration. No significant age-group differences were observed for most parameters, though gender differences were noted for F0 and jitter. Hence, both systemic and surface hydration are equally effective in mitigating vocal fatigue and restoring vocal function following vocal loading. These findings support incorporating both hydration strategies into vocal hygiene programs for voice professionals and individuals at risk of vocal fatigue.

Keywords: Voice, Hydration, Vocal fatigue, Vocal loading task, Vocal fatiguing index, vocal tract discomfort scale.

INTRODUCTION

Hydration of the vocal folds is the process of maintaining the required level of water in our body specifically within the vocal folds tissues which ensures that a proper amount of vibration and lubrication in the laryngeal area while speech or singing. Thus, adequate hydration of the vocal folds is vital for optimal voice production. Vocal hydration is majorly divided into two types- superficial or surface hydration and systemic hydration. Sivasankar and Leydon (2011) states that the superficial hydration is the mucous layer lining the vocal folds and the interior of the larynx. Systemic hydration involves the internal regulation of optimal water levels across the body's tissues, cells and organs which is crucial for overall physiological well-being.

Surface hydration or the superficial hydration mainly targets the outermost moisture layer on vocal folds and it is through the following ways systemic hydration can be achieved: nebulization using saline solution (NaCl), steam inhalation, humidification and nasal breathing. Whereas systemic hydration is the body's balanced water content (euhydration) and is attained by drinking water daily in small frequent sips, eating water rich foods, limiting the amount of caffeine /alcohol.

The level of hydration can influence the stiffness and viscosity of the vocal fold lamina propria and also insufficiently hydrated vocal folds may lead to the onset of dysphonia and a decline in voice performance, as reduced fluid levels can result in a thick, viscous mucus layer that may disrupt normal vocal fold vibration (Santana et al., 2017). Systemic hydration primarily affects the deeper layers of the vocal folds, enhancing vocal endurance and stability, while surface hydration improves lubrication of the vocal cords and decreases the effort required for phonation.

Dehydration of the vocal fold's causes increase in stiffness of the vocal folds. (Wu & Zhang, 2024) aimed to understand the effects of systemic dehydration on voice production and found that a high degree of dehydration causes significant changes like increase in F0, reduction in glottal opening, PTP, efficiency of the glottis and intensity which result in increased phonatory efforts.

Superficial dehydration can be caused by insufficiently conditioned inhaled air, mouth breathing and low humidity may lead to increased friction, reduced phonatory effort and also dryness in the laryngeal area. The results shows that the phonation threshold increased after oral breathing and reduced phonation threshold after nasal breathing. Therefore, breathing humid air and using nasal breathing helps facilitate in superficial hydration which is recommended to promote laryngeal hydration (Sivasankar & Fisher, 2002). It is through systemic hydration (via adequate daily fluid intake) and superficial hydration (e.g., humidified air, steam, avoiding drying agents like caffeine/alcohol) mucosal integrity, phonatory effort, and protection of voice and airway function can be maintained.

Vocal fatigue is defined as a gradual rise in the effort required to produce voice along with gradual decline in the ability to phonate effectively (McCabe & Titze, 2002). The major symptoms seen in people with vocal fatigue are increased effort to speak, tightness or tiredness of voice, lowered volume and difficulty controlling pitch. Vocal load or vocal fatigue can be elicited using high demand activities such as reading aloud at a loud volume, sustaining vowel sounds or speaking in noisy environments. These demanding activities are referred to as vocal loading tasks or vocal fatiguing tasks.

Vocal loading tasks are associated with increased effort to phonate, less stable pitch, and symptoms including hoarseness, roughness, strain, and throat pain as well as decreased vocal efficiency and also the acoustic analysis typically showing increased F0, jitter, shimmer and HNR. It is through proper hydration that vocal fatigue can be reduced by lowering the viscosity of the vocal folds making them more pliable and efficient. Franca and Simpson (2009) reported that after hydration the jitter and shimmer values decreased significantly which showed a positive impact in the individuals voice performance.

Hydration by providing adequate fluid lowers PTP and reduces the effort needed to phonate, which can partially reverse the increased effort and jitter following a vocal loading task. Surface hydration directly moistens the vocal fold surface improving mucosal wave and reducing the dryness and irritation that contribute to post task hoarseness and discomfort. Superficial hydration gives a more immediate subjective relief (less dryness, less strain) even before systemic water has been fully distributed, making it useful right after a fatiguing task.

Vocal fatigue can be assessed using the aerodynamic, acoustic and perceptual analysis which helps in evaluating the onset of laryngeal tiredness, discomfort and changes in voice over time. The aerodynamic

and acoustic measurement provide objective assessment of efficiency and voice quality respectively. Perceptual measurement of voice is the subjective evaluation of vocal characteristics such as pitch, volume, quality, roughness, breathiness and intelligibility by a listener and it can be conducted as either clinician-based assessment or client-based assessment.

Aerodynamic assessment is defined as the measurement of airflow, air pressure and how they relate to each other during phonation. Aerodynamic measures like translaryngeal airflow, subglottal pressure and translaryngeal resistance directly reflect laryngeal physiology and can distinguish between normal and abnormal voicing patterns (Rosenthal, 2014). The common parameters that are used to assess the aerodynamic measurement are PTP and airflow. The normative values for PTP and airflow are 3-6 cm H₂O (depending on pitch/loudness) and averages 120-160 mL/second in connected speech respectively.

The acoustic analysis involves measuring sound information within the voice, and its results can help assess the severity of a voice disorder (Hegde et al., 2019). The key measures used in the acoustic analysis of voice signals include: Variations in the fundamental pitch period and peak amplitude, Vocal noise present in the signal, Waveform changes from one cycle to the next, Average frequency properties and Signal transition characteristics. Acoustic voice analysis has been widely applied in the assessment of voice disorders enabling the classification of voices into normal and pathological categories and the identification of vocal characteristics such as pitch, loudness and hoarseness. It provides clinicians with an objective baseline for monitoring treatment progress.

Acoustic parameters include fundamental frequency (F0), intensity, perturbation measures such as jitter and shimmer, spectral-based measures such as HNR and noise-to-harmonic ratio (NHR). Acoustic measurement provides a non-invasive method for assessing vocal quality as well as the effectiveness of interventions. According to Felipe, Grillo and Grechi (2006) the most commonly measured acoustic parameters are F0, jitter, shimmer and HNR.

The F0 refers to the total number of vocal fold cycles per second. It arises from the interplay of vocal fold length, mass and tension during speech (Morris & Brown, 1996) and reflects how high or low a person's voice sounds. Compared with other acoustic parameters, F0 is the most consistent and least affected by recording conditions (Carson, Ingrisano & Eggleston, 2003). It changes depending on gender, age and the state of the vocal folds. Children and babies have an even higher F0. According to Hippargekar et al. (2021), the normative F0 values for the Indian population are 131 ± 9.58 Hz for males and 226 ± 17 Hz for females.

Vocal folds vibrate over a sustained period, they naturally display slight variations in frequency and amplitude from one cycle to the next cycle. This cycle-to-cycle fluctuation in frequency is referred to as frequency perturbation or jitter. It is the measure of perturbation in vocal fold vibration, opposite to shimmer (Wang & Huang, 2004). The greater the jitter, the more deviant the voice quality. Jitter levels exceeding 1-2% can result from various pathological conditions affecting the vocal folds such as nodules, polyps or weak laryngeal musculature. In the Indian population, the normative jitter values are 0.30 ± 0.12 for males and 0.37 ± 0.15 for females [Hippargekar et al., 2021].

Shimmer refers to the cycle-to-cycle variation in the amplitude (vertical component) of the F0. Like jitter, shimmer is a finer component of the fundamental frequency and reflects the subglottic air pressure involved in voice production. (Baken & Orlikoff, 2000). When someone tries to sustain a steady pitch while singing, slight fluctuations in loudness over time are inevitable. Similar to how jitter is measured, shimmer is quantified by tracking changes in loudness or amplitude across successive sound waves produced by vocal fold vibration. Elevated shimmer levels (above 3%, for instance) may result from

various conditions affecting the vocal cords such as nodules, polyps or weakness of the laryngeal muscles. In the Indian population, normative shimmer values are 3.15 ± 0.76 for males and 3.31 ± 1.56 for females [Hippargekar et al., 2021].

HNR describes the relationship between two components of the acoustic waveform of a sustained vowel: the periodic component which reflects regular vocal fold vibration and the noise component arising from the vocal tract (Ferrand, 2002). A high HNR indicates a predominantly periodic signal with minimal noise, characteristic of normal voice quality. Dysphonia introduces additional noise into the signal, thereby lowering the HNR. PRAAT specifies that a healthy voice producing the vowel /a/ or /i/ should yield an HNR of 20, while phonation of /u/ should yield an HNR of 40. An HNR below 20 suggests perceptible hoarseness. Normative HNR values for the Indian population are 21.60 ± 1.71 for males and 22.18 ± 2.01 for females (Hippargekar et al., 2021).

These measures can be computed using software tools such as Dr Speech, VAGMI, Ling WAVES, PRAAT a free open-source speech analysis program (Boersma & Weenink, 2001) or MDVP (Multi-Dimensional Voice Program) a flexible program that extracts more than 30 acoustic speech parameters from a single signal and was developed in collaboration with the Computerized Speech Lab (Kay Elemetrics Corp.). These tools help create a comprehensive report for voice quality assessment using acoustic parameters. They have been widely studied and are increasingly used in both research and clinical settings to describe various vocal conditions. In the present study, we used PRAAT software to compare the acoustic characteristics of pre-fatigue, post-fatigue and after hydration conditions. According to Goldman (2004), PRAAT is designed to accommodate a variety of needs, featuring an easy-to-use interface, numerous default options that allow learning through trial, a searchable manual, and a wide range of analysis, manipulation, and labeling capabilities.

Perceptual analysis of voice specifically auditory-perceptual assessment is the gold standard for evaluating voice disorders by listening to vocal quality, pitch, loudness, and strain. It can be conducted both formally and informally. The informal aspect takes place during the initial history-taking, where the clinician engages the patient in spontaneous conversation while gathering relevant information. During this process, key vocal parameters can be evaluated including voice quality, pitch range, resonance (normal, hyponasal or hypernasal), loudness, prosody and articulation.

Voice can be perceptually evaluated through either client-based or clinician-based methods, the clinician-based approach uses auditory-perceptual instruments such as the GRBAS-Hirano (1981) assessing Grade, Roughness, Breathiness, Asthenia and Strain and CAPE-V (Kempster et al., 2002) which enable the clinician to provide standardized, professional judgments about the patient's voice quality. Client-based approach is mainly based on patient-reported outcome measures like the VHI-Jacobson et al (1997), Voice-Related Quality of Life (V-RQOL, Hogikyan & Sethuraman, 1999) and Vocal tract discomfort scale (VTDS - Matheison et al., 2007 and Vocal fatigue index (VFI-Nanjundeswaran et al, 2015) to document how the patient personally experiences their voice problem and how it affects their everyday life.

VTDS (Mathieson, 2007) is a self-reported patient outcome measure designed to evaluate vocal tract discomfort symptoms in individuals with voice disorders. VTDS is important because voice disorders significantly affect individuals' physical, functional, and emotional well-being, making comprehensive assessment tools for vocal discomfort essential. Additionally, discomfort symptoms play a key role in how patients perceive the overall impact of their voice problem. The VTDS consists of two subscales that evaluate the frequency and severity of vocal discomfort symptoms. It measures eight vocal discomfort sensations, each rated on two dimensions (frequency & severity): burning, tightness, dryness, aching,

tickling, sore, irritable and lump in the throat. Each item is rated on a 7-point Likert scale (0 = never/none, 2 = sometimes/mild, 4 = often/moderate, 6 = always/extreme), yielding higher scores indicate greater discomfort. The tool reliably differentiates patients with voice disorders from vocally healthy individuals, and is typically administered pre- and post-therapy to objectively measure treatment outcomes.

VFI (Nanjundeswaran et al., 2015) is a self-report questionnaire used to detect people who may be experiencing vocal fatigue and to describe the specific nature of their voice-related complaints. VFI questionnaire consist of version 1 of 21 questions which was subsequently reduced to 19 questions in version 2. The two items were removed due to poor item-to-total correlations. It is used by clinicians to detect and assess vocal fatigue and specifically evaluates patient-reported symptoms across three main factors: tiredness and voice avoidance, physical discomfort and symptom improvement with rest. Factor 1: Tiredness and Voice Avoidance (11 items) measures how often the voice feels tired, weak, or strained and how often speaking is avoided to prevent vocal strain. Factor 2: Physical Discomfort (5 items) measures physical sensations during speaking such as tightness, dryness or burning/aching in the throat or neck. Factor 3: Symptom Improvement with Rest (3 items) measures how much vocal symptoms improve after periods of voice rest. The VFI consists of a 19-item questionnaire scored on a 5-point Likert scale (0 = never, 1=almost never, 2= sometimes, 3=almost always & 4 = always).

SLPs hold a pivotal role in assessing vocal fatigue and hydration status. They evaluate the frequency and severity of symptoms, hydration levels, and provide counselling on contributing factors such as extended voice use, dry surroundings, or insufficient fluid intake. SLPs pinpoint risk factors including mouth breathing, dry throat, habitual throat clearing, loud speaking and poor vocal hygiene practices and correlate these acoustic and perceptual indicators of fatigue like vocal roughness, strain, and diminished endurance. They also play an important role in vocal hygiene practice and hydration counselling as they educate regarding adequate systemic hydration (oral fluids), surface-mucosal hydration (humidified air, steam), and avoiding dehydrants (caffeine, alcohol, antihistamines), emphasizing that proper hydration can reduce phonatory effort and mitigate some of the adverse effects of vocal loading tasks.

Hydration helps in speedy recovery from vocal fatigue, reduce vocal effort and protects the vocal fold from strain caused by the fatigue. Hence increased use of hydration helps in improving phonation thresholds, jitter and shimmer and also reduces the symptoms like hoarseness, dryness and throat pain. Yiu and Chan (2003) evaluated the hydration effect on the vocal fatigue among amateur karaoke singers and found that there were significant changes in the jitter value and pitch during singing. They proposed that hydration and vocal rest are among the most effective strategies for preserving voice function and quality.

WESTERN LITERATURE

Solomon et al (2003) examined whether drinking water protects against vocal fatigue in men during prolonged loud talking following earlier work that suggested some benefit in women. Four men with normal untrained voices aged 19- 29 years, read aloud for two hours under both well-hydrated and underhydrated conditions. All subjects showed vocal deterioration after the task, as indicated by increases in PTP and self-perceived phonatory effort. However, the hydration effect was inconsistent: two men benefited from drinking water (PTP rose more when underhydrated), while the other two showed the opposite pattern. Drinking water benefits vocal function in men, though all subjects studied both men and women consistently showed detrimental vocal effects from prolonged loud talking.

Franca and Simpson (2009) studied the impact of hydration on vocal performance. Using 18-35-year-old participants with no history of voice disorders, the researchers analysed changes in jitter and shimmer, which represent variations in vocal fold vibration. Through repeated measures analysis, results showed a significant decrease in jitter and shimmer after systemic hydration, indicating that adequate hydration positively influences vocal stability and quality.

Franca and Simpson (2012) assessed the influence of systemic hydration on vocal acoustics in females aged 18 to 35 years by testing dehydration (12-hour fast from food/liquids) versus rehydration (1 L water in 20 min post-pretest) in participants. Vowel samples were recorded pre- and post-vocal tasks for acoustic analysis. The result showed a significant impact on the shimmer values after hydration condition, suggesting that hydration positively impact the shimmer values.

Fujiki et al (2016) conducted a study to understand the effect of vocal loading and surface hydration on voice in an environmentally humid condition. About 16 healthy adults (8 females & 8 males) performed a 30-minute vocal loading task in low and also moderate humidity. The task includes a reading task in the presence of 65 dB babble noise. The cepstral peak prominence, perceived phonatory and the rating of the perceived tiredness showed significant effects and no effect of humidity was also seen.

Alves et al (2019) performed a systematic review on the effect of hydration on adult voice quality. The results suggested that due to fasting and no fluid ingestion causes systemic dehydration which negatively affect the noise to harmonic ratio (NHR), jitter, frequency, shimmer, and s/z ratio. Hydration significantly improved the shimmer, jitter, frequency and maximum phonation time. Caffeine showed no negative effect in the jitter, NHR. PTP and PPE and shimmer. The study suggests that the systemic hydration is the most cost-efficient way to improve the quality of voice in adults.

INDIAN LITERATURE

Ghosh et al (2021) conducted a study on impact of hydration on vocal loading on 60 normophonic individuals (30 males and 30 females), using the phonetogram version 4.0 measurement of the voice range profile (VRP) and speech range profile is taken and the parameter analysed were Fo, max-F, min-F, SPL, max- I, min -I, area and semitone. The result showed an improvement after hydration in all the parameter except female max-F VRP and min- F VRP and area VRP, min -F VRP and max -I VRP. The impact on vocal loading on vocal folds was negative.

Supreetha and Jayakumar (2025) aimed to analyse the effect of systemic hydration among the voice quality among SLPs using thermal and multi-dimensional perspectives, about 20 healthy female SLPs were provided with a passage and are asked to read aloud the passage for 1 hour and are given water to drink during the vocal loading task. The thermal, acoustic, aerodynamic, perturbation, and PPE and perceived vocal tiredness (PVT) were analysed and found that significant increase in thermal acoustic, PPE, PVT and the aerodynamic measures decreased. A positive effect on the voice quality after systemic hydration is seen and SLPs are recommended in using hydration in their clinical practice.

NEED OF THE STUDY

Voice use is a critical part of daily communication for many adults, especially teachers, call-center workers, singers, sales professionals and public speakers, who are at higher risk of vocal fatigue and voice problems due to prolonged voice use. Vocal fatigue can reduce speech intelligibility, vocal endurance and overall communicative effectiveness, which in turn may affect occupational performance and quality of life. Hydration is one of the most commonly recommended, low-cost strategies for voice care, but its

actual impact on measurable voice parameters during and after vocal loading is still not fully studied. Both systemic hydration (fluids taken orally) and surface hydration (e.g., nebulized saline to directly moisten the vocal fold surface) are believed to improve vocal fold vibration and reduce phonatory effort by optimizing the vocal folds. However, there is limited evidence comparing these two approaches within the same individuals, particularly using objective acoustic measures (F0, jitter, shimmer and HNR) alongside perceptual and self-report tools such as the VFI and VTDS.

Age and sex are known to influence laryngeal structure, vocal fold tissue characteristics and respiratory support, which may in turn alter susceptibility to vocal fatigue and response to hydration. Comparing younger adults (18-38 years) and middle-aged adults (38–58 years), as well as males and females, can help clarify whether hydration strategies need to be tailored to specific demographic groups. There is limited research on vocal fatigue and hydration in healthy adults in Kerala, and hence the present study aims to examine the effects of both systemic and surface hydration following a vocal loading task, with the objective of generating evidence that can inform voice care practices and the development of vocal hygiene programs.

AIM OF THE STUDY

The aim of the present study was to examine the effect of hydration (systemic & surface) on voice quality after performing vocal loading task and to evaluate differences in vocal measures across age, gender and hydration type in individuals voice characteristics in the age range 18-58 years.

PARTICIPANTS:

A total of 40 healthy adults (20 Males & 20 Females) aged between 18 -58 years without any voice disorders were selected for the study. All participants were native Malayalam speakers and were residents of the Ernakulam district in Kerala.

The individuals are divided into 2 age groups:

Group I: Young adults (18 -38 years)

Group II: Middle aged adults (38-58years)

A total of 20 individuals each is selected from two groups - young adults and middle-aged adults and also about 10 males and 10 females in each group are selected randomly.

Inclusion criteria

- Adults aged between 18 - 58 years.
- Both males and female individuals without any voice problem.
- Native or long-term residents of Kerala.

\Exclusion criteria

- Subjects with a history of psychiatric, neurological impairments.
- Individuals with voice complaints who have undergone laryngeal surgery or any major voice treatment.
- Individuals who smoke, use alcohol or take medications affecting vocal hydration.

PHASES OF THE STUDY

Phase I: Participant selection and baseline assessment

- Select 40 healthy adults aged 18-58 years from Ernakulam, Kerala. Divide into Group I (18-38 years)

and Group II (38-58 years) with 20 participants in each group and 10 male and 10 female in each group.

- Record baseline voice measures: Acoustic characteristics using Fo, Jitter, shimmer, HNR and perceptual measure using VFI- Nanjundeswaran et al. (2015), VTDS-Mathieson et al. (2009)

Phase II: Performing the Vocal loading task and post-fatigue assessment

- Participants perform a vocal loading task for approximately 45 minutes – loud reading, sustaining a vowel and speaking loudly in presence of loud music.
- Immediately after the task, obtain post-fatigue measurements of F0, jitter, shimmer, HNR, VFI and VTD.

Phase III: Hydration procedure and post-hydration assessment

- All participants receive both systemic hydration (increased oral fluid intake) and surface hydration (5 minutes of isotonic saline nebulization after mild induced laryngeal dehydration, e.g., mouth breathing).
- After hydration condition, repeat voice assessments (F0, jitter, shimmer, HNR, VFI, VTD) to compare effect of pre and post hydration changes.

INSTRUMENTATION AND TOOLS:

Acoustic analysis involves measuring and quantifying the sound characteristics of a voice (Hegde et al, 2019). PRAAT software (version 6.4.27) was used to record the voice samples and the acoustic parameters chosen for the present study were F0, Jitter, Shimmer and HNR. The normative value for the acoustic parameters: F0 (Males: 131 ± 9.58 Hz & Females: 226 ± 17 Hz), Jitter (Male- 0.30 ± 0.12 , Female- 0.37 ± 0.15), Shimmer (Male- 3.15 ± 0.76 , Female- 3.31 ± 1.56) and HNR (Male- 21.60 ± 1.71 & Female- 22.18 ± 2.01) [Hippargekar et al, 2021].

To assess individuals pre and post assessment carried out using perceptual materials like VTDS and VFI. VTDS (Mathieson, 2009) is a patient-reported questionnaire used to subjectively evaluate voice disorders by measuring the frequency and severity of vocal discomfort symptoms in the throat. The symptoms assessed are burning, tight, dry, aching, tickling, sore, irritable and lump in the throat. The scoring is carried out using 7-point Likert scale for both frequency and severity (0 = never/none, 1, 2 = sometimes/mild, 3, 4 = often/moderate, 5, 6 = always/extreme).

VFI (Nanjundeswaran et al., 2015) is a standardized, psychometrically validated self-report questionnaire designed to identify individuals with vocal fatigue and characterize their complaints. The scoring of VFI is a 5-point Likert scale: 0 = never, 1 = almost never, 2 = sometimes, 3 = almost always, 4 = always.

PROCEDURE:

The data was collected as follows:

Instructions regarding the procedure were explained to the participants before testing. Participants sat comfortably in a quiet room while voice recordings were made with a microphone placed 3 cm from the mouth and connected to a Lenovo ThinkPad. A baseline acoustic voice sample was recorded using PRAAT software, participants took a deep breath and produced a sustained /a/ vowel at comfortable pitch and loudness for as long as possible and an examiner demonstration was provided. Also, a baseline perceptual analysis was taken using the VFI and VTDS questionnaire. The vocal loading task (about 45 minutes) included sustained vowels (/a/, /u/, /i/) and standardized reading passages (Grandfather Passage),

participants could switch tasks when they felt bored or tired. During the loading task, loud background music was played through speakers. Immediately after the loading task, a second PRAAT recording was obtained and the perceptual analysis was carried out using VFI and VTDS post-loading task. Participants then received systemic or surface hydration for vocal fold recovery and a third PRAAT recording was taken post-hydration to evaluate hydration effects on acoustic voice measures.

STATISTICAL ANALYSIS:

The data was subjected to statistical analysis using four-factor repeated measures ANOVA performed followed by Bonferroni post hoc analysis. For non-normally distributed data, Wilcoxon signed-rank test and Mann-Whitney U test was performed. All statistical analyses were performed using SPSS version 23.0 software. The level of statistical significance ($p < 0.05$).

ETHICAL CONSIDERATION

The present study was carried out by obtaining the consent from the participants ensuring their permission. The aim of the study, objective, duration and method of the assessment procedure were fully explained to all participants, prior to the testing. They were informed that participation was voluntary and that strict confidentiality would be maintained. A copy of the written ethical consent is provided in the Appendix.

RESULTS AND DISCUSSION

The aim of the study was to evaluate the effect of hydration on vocal loading task in individuals aged 18-58 years in Kerala. The obtained data was subjected to statistical analysis to understand the effect of hydration on vocal loading task.

Table 4.1:

Shows the changes in F0 across pre-fatigue, post-fatigue and after hydration conditions on vocal loading task.

Acoustic parameters	Gender	Age group	Hydration type	PRE - FATIGUE	POST-FATIGUE	AFTER HYDRATION
Fo (Hz)	Females	18- 38	Systemic	246.1	433.4	268.4
			Surface	251.1	427.3	242.3
		38-58	Systemic	209.9	413.0	215.6
			Surface	212.4	388.3	215.3
	Males	18- 38	Systemic	150.5	293.5	167.5
			Surface	156.0	283.6	144.1
		38-58	Systemic	110.5	224.3	114.3
			Surface	114.2	238.5	118.2

Figure 4.1:

Shows the changes in F0 across pre-fatigue, post-fatigue and after hydration conditions on vocal loading task.

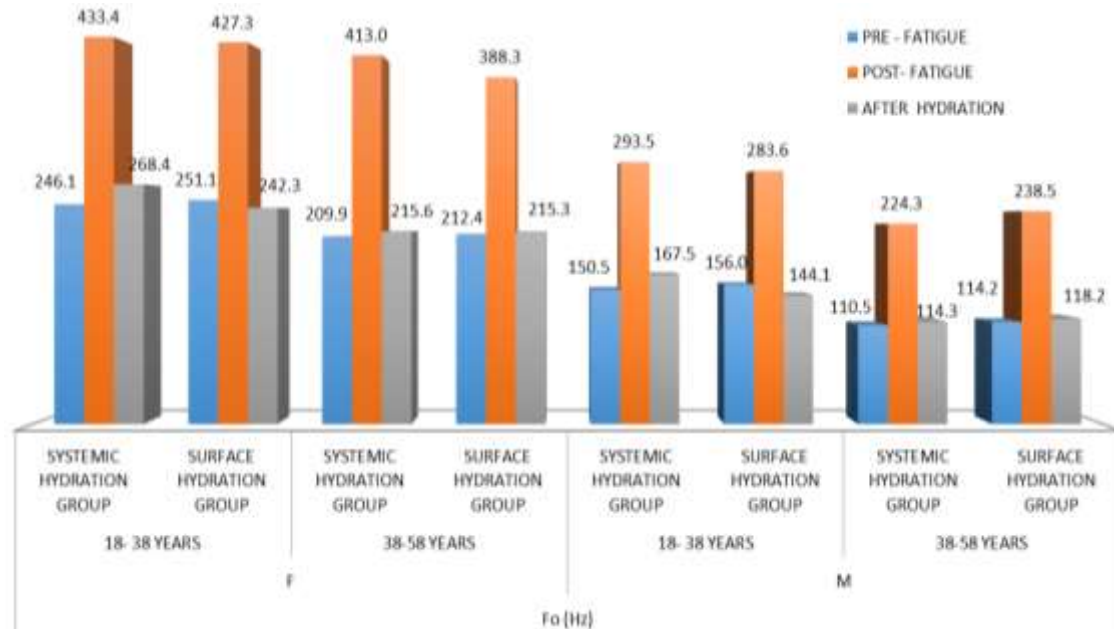


Table 4.1 & Figure 4.1 shows the effect of hydration on F0 across the pre-fatigue, post-fatigue, and post-hydration conditions. At baseline, F0 shows normal voice characteristics with females showing higher F0 than males in both age groups (18-38,38-58 years). Post fatigue, F0 increases in all age, gender and hydration groups indicating greater laryngeal tension and vocal fold stiffness following vocal loading task. After hydration, F0 decreases toward baseline in both systemic and surface hydration groups suggesting recovery of vocal fold function. Thus, both hydration types improved the F0 acoustic parameter.

Table 4.2:

Shows the changes in jitter (%) across pre-fatigue, post-fatigue and after hydration conditions on vocal loading task.

Acoustic parameters	Gender	Age group	Hydration type	PRE - FATIGUE	POST- FATIGUE	AFTER HYDRATION
JITTER (%)	Females	18- 38	Systemic	0.29	3.46	0.38
			Surface	0.50	3.46	0.50
		38-58	Systemic	0.43	4.05	0.46
			Surface	0.63	2.05	0.41
	Males	18- 38	Systemic	0.45	2.35	0.44
			Surface	0.59	2.21	0.49
		38-58	Systemic	0.78	2.21	0.75
			Surface	0.49	2.77	0.47

Figure 4.2:

Shows the changes in jitter (%) across pre-fatigue, post-fatigue and after hydration conditions on vocal loading task.

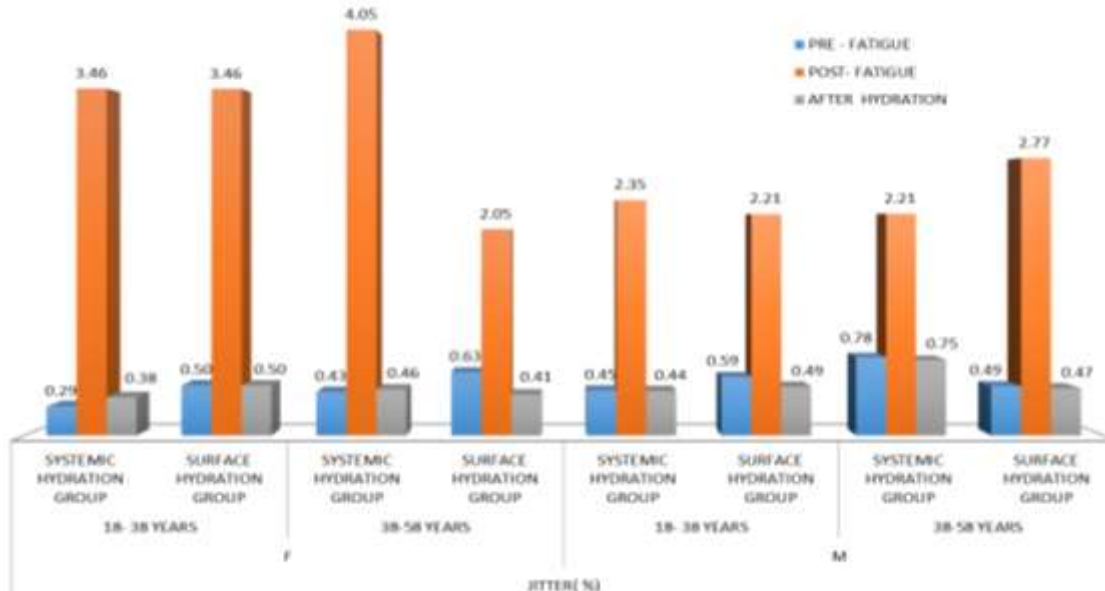


Table 4.2 & Figure 4.2 show the effect of hydration on jitter (%) across the pre-fatigue, post-fatigue, and post-hydration conditions. At baseline (pre-fatigue), jitter shows normal voice characteristics indicating stable vocal fold vibration frequency and no consistent gender differences between females and males in both age groups. Post-fatigue, jitter increases dramatically in all age, gender, and hydration groups indicating greater cycle-to-cycle frequency variability, vocal fold instability and increased laryngeal tension following the vocal loading task. After hydration, jitter decreases toward baseline in both systemic and surface hydration groups suggesting recovery of vocal fold mucosal function and improved frequency stability. Thus, both hydration types improved the jitter parameter.

Table 4.3:

Shows the changes in shimmer (%) across pre-fatigue, post-fatigue and after hydration conditions on vocal loading task.

Acoustic parameters	Gender	Age group	Hydration type	PRE - FATIGUE	POST- FATIGUE	AFTER HYDRATION
SHIMMER (%)	Females	18- 38	Systemic	3.43	9.46	2.88
			Surface	3.15	10.23	3.32
		38-58	Systemic	3.60	8.02	3.62
			Surface	3.48	9.27	3.24
	Males	18- 38	Systemic	3.41	10.22	3.09
			Surface	3.26	8.22	3.31
		38-58	Systemic	3.78	9.37	3.66
			Surface	3.24	9.10	3.14

Table 4.3:

Shows the changes in shimmer (%) across pre-fatigue, post-fatigue and after hydration conditions on vocal loading task.

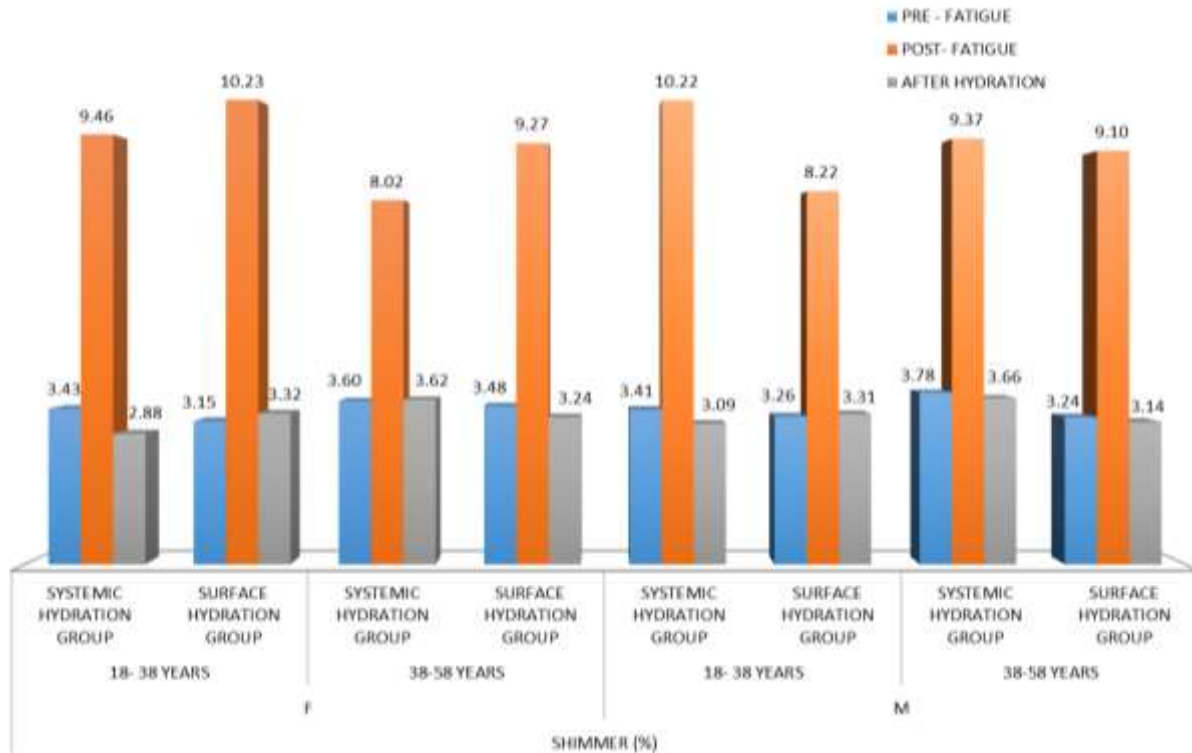


Table 4.3 & Figure 4.3 show the effect of hydration on shimmer (%) across the pre-fatigue, post-fatigue, and post-hydration condition. At baseline (pre-fatigue), shimmer shows normal voice characteristics indicating stable vocal fold vibration amplitude and no consistent gender differences between females and males in both age groups. Post-fatigue, shimmer increases in all age, gender, and hydration groups indicating greater cycle-to-cycle amplitude variability, vocal fold instability and increased laryngeal tension following the vocal loading task. After hydration, shimmer decreases toward baseline in both systemic and surface hydration groups (2.88-3.66%) suggesting recovery of vocal fold mucosal function and improved amplitude stability. Thus, both hydration types improved the shimmer parameter.

Table 4.4:

Shows the changes in HNR across pre-fatigue, post-fatigue and after hydration conditions on vocal loading task.

Acoustic parameters	Gender	Age group	Hydration type	PRE - FATIGUE	POST- FATIGUE	AFTER HYDRATION
HNR (dB)	Females	18- 38	Systemic	18.79	9.50	17.64
			Surface	19.62	10.03	17.81
		38-58	Systemic	18.80	8.71	19.04
			Surface	17.60	9.28	17.49
	Males	18- 38	Systemic	17.63	9.87	17.58
			Surface	19.11	8.85	16.26
		38-58	Systemic	19.97	10.12	19.97

			Surface	17.97	9.10	17.31
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FIGURE 4.4:

Shows the changes in HNR across pre-fatigue, post-fatigue and after hydration conditions on vocal loading task.

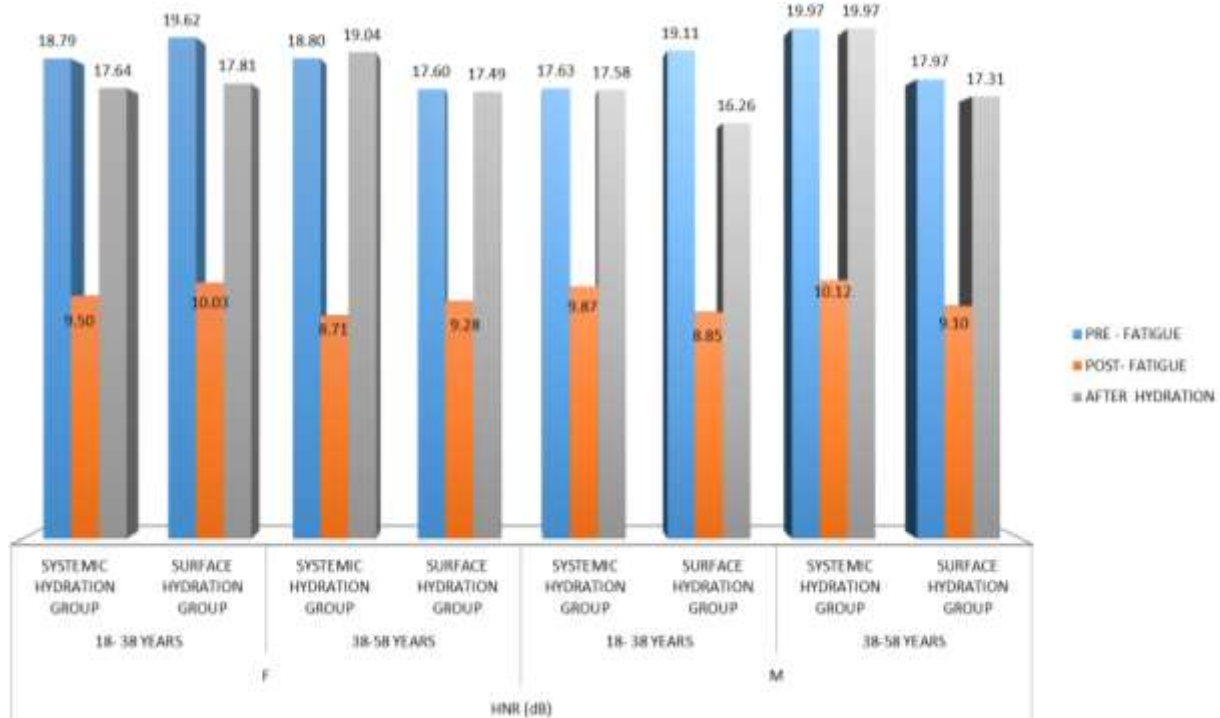


Table 4.4 & Figure 4.4 show the effect of hydration on HNR across the pre-fatigue, post-fatigue, and post-hydration conditions. At baseline (pre-fatigue), HNR shows normal voice characteristics with relatively high values (17.60–19.97 dB) indicating clean, periodic vocal fold vibration, and no consistent gender differences between females and males in both age groups. Post-fatigue, HNR decreases dramatically in all age, gender, and hydration groups (dropping to 8.71–10.12 dB, approximately 50% of baseline), indicating greater laryngeal noise, irregular vocal fold vibration, and increased breathiness following the vocal loading task. After hydration, HNR increases toward baseline in both systemic and surface hydration groups (16.26–19.97 dB), suggesting recovery of vocal fold mucosal lubrication and improved vibration regularity. Thus, both hydration types improved the HNR parameter.

Table 4.5:

Shows the within group Comparison of Acoustic Parameters: Pre-Fatigue vs Post-Fatigue vs After-Hydration.

ACOUSTIC PARAMETER S	Gender	Age group	Hydratio n type	Pre Fatigue Vs Post Fatigue	Sig	Pre Fatigue Vs After hydrati on	Sig	Post Fatigue Vs After hydratio n	Sig
				p value		p value		p value	

F0 (Hz)	Female s	18- 38	Systemic	0.002	S	0.093	NS	0.001	S
			Surface	0.004		0.563		0.001	
		38-58	Systemic	0.002		0.072		0.003	
			Surface	0.001		0.234		0.001	
	Males	18- 38	Systemic	0.000	S	0.009	S	0.000	S
			Surface	0.001		0.006		0.000	
		38-58	Systemic	0.000		0.231	NS	0.000	
			Surface	0.000		0.085		0.000	
JITTER (%)	Female s	18- 38	Systemic	0.004	S	0.013	S	0.004	
			Surface	0.004		0.978		0.006	
		38-58	Systemic	0.003		0.350	NS	0.003	S
			Surface	0.007		0.026		0.004	
	Males	18- 38	Systemic	0.009	S	0.956	NS	0.005	S
			Surface	0.009		0.495		0.014	
		38-58	Systemic	0.028		0.307		0.030	
			Surface	0.000		0.873		0.000	
SHIMMER (%)	Female s	18- 38	Systemic	0.000	S	0.053	NS	0.000	
			Surface	0.000		0.427		0.000	
		38-58	Systemic	0.001		0.835		0.001	
			Surface	0.000		0.222		0.000	
	Males	18- 38	Systemic	0.000		0.235		0.000	
			Surface	0.008		0.669		0.006	
		38-58	Systemic	0.002	S	0.109	NS	0.002	S
			Surface	0.000		0.537		0.000	
HNR (dB)	Female s	18- 38	Systemic	0.001	S	0.158	NS	0.000	S
			Surface	0.001		0.060		0.002	
		38-58	Systemic	0.002		0.657		0.002	
			Surface	0.000		0.830		0.000	
	Males	18- 38	Systemic	0.004	S	0.953	NS	0.001	S
			Surface	0.001		0.037		0.000	
		38-58	Systemic	0.003		1.000	NS	0.001	
			Surface	0.000		0.159		0.000	

NS- not significant, S- significant

Table 4.5 reveals that hydration had a significant difference on acoustic parameters (F0, jitter, shimmer, HNR) during the vocal loading task. Most significant differences were observed between pre-fatigue vs post-fatigue and post-fatigue vs after-hydration across both age groups (18-38 years, 38-58 years), both

genders and for systemic and surface hydration. Pre-fatigue vs after-hydration comparisons were generally non-significant indicating hydration largely restored acoustic parameters (F0, jitter, shimmer, HNR) toward baseline. However, a few differences were observed in the pre-fatigue vs after-hydration comparisons: F0 in males aged 18-38 years showed significant differences for both systemic and surface hydration, Jitter in females aged 18-38 years showed significance for systemic hydration and HNR in males aged 18-38 years showed significance for surface hydration. Hence, overall hydration was effective in vocal recovery after the fatiguing task.

Table 4.6:

Shows the comparison of pre/post, age groups, surface vs systemic hydration and gender variables on the acoustic parameter after vocal loading task.

	COMPARISON	F	d.f	p	
F0 (Hz)	Pre-fatigue-Post fatigue-After hydration	507.641	2 and 64	0.000	HS
	Between Age groups	83.845	1 and 32	0.000	HS
	Between Gender	693.800	1 and 32	0.000	HS
Jitter (%)	Pre-fatigue-Post fatigue-After hydration	239.222	2 and 64	0.000	HS
SHIMMER (%)		722.504	2 and 64	0.000	HS
HNR (dB)		492.398	2 and 64	0.000	HS
JITTER (%)	Between Gender	4.261	1 and 32	0.047	Sig
F0 (Hz)	Between surface and systemic hydration	1.083	1 and 32	0.306	NS
JITTER (%)	Between Age groups	0.098	1 and 32	0.757	NS
SHIMMER (%)	Between surface and systemic hydration	1.390	1 and 32	0.247	NS
	Between Age groups	0.062	1 and 32	0.806	NS
	Between surface and systemic hydration	0.768	1 and 32	0.387	NS
	Between Gender	0.003	1 and 32	0.957	NS

HNR (dB)	Between Age groups	0.335	1 and 32	0.567	NS
	Between surface and systemic hydration	2.425	1 and 32	0.129	NS
	Between Gender	0.015	1 and 32	0.902	NS

HS-highly significant, S-significant and NS-not significant.

Table 4.6 compares pre-fatigue, post-fatigue, and after-hydration conditions across age groups, hydration type (surface vs systemic), and gender for four acoustic parameters (F0, jitter, shimmer, and HNR). The results showed significant differences across the pre-fatigue, post-fatigue and after-hydration conditions for all acoustic parameters. For F0, significant differences were observed between age groups and between genders, whereas no significant difference was found between surface and systemic hydration. Jitter showed a significant difference only between genders, while no significant differences were observed for age groups or hydration condition. Shimmer and HNR showed no significant differences across age groups, hydration condition or gender.

Table 4.7:

Shows the comparison of pre and post assessment of VTDS before /after vocal loading task.

HS-highly significant

Table 4.7 indicates that all perceptual voice symptoms in VTDS (burning, tightness, dryness, aching, tickling, soreness, irritability and lump in the throat) assessed in the frequency and severity domains

	Symptoms	Hydration type	Age group		Mean	Std. Deviation	To compare Pre-Post: Wilcoxon signed rank test	
							p value	
FREQUENCY	1.Burning	Systemic	18- 38	Pre	0.00	0.000	0.002	HS
				Post	2.20	1.874		
			38-58	Pre	1.00	0.000	0.000	HS
				Post	3.20	1.135		
		Surface	18- 38	Pre	0.00	0.000	0.000	HS
				Post	2.70	1.252		
			38-58	Pre	0.30	0.483	0.002	HS
				Post	1.80	1.229		
	2.Tight	Systemic	18- 38	Pre	0.00	0.000	0.000	HS
				Post	3.40	0.966		
			38-58	Pre	0.00	0.000	0.000	HS
				Post	3.80	0.919		
		Surface	18- 38	Pre	0.00	0.000	0.000	HS
				Post	3.60	0.699		
			38-58	Pre	0.30	0.483	0.000	HS

			Post	3.20	0.919		
3.Dry	Systemic	18- 38	Pre	0.00	0.000	0.000	HS
			Post	4.50	0.850		
		38-58	Pre	0.00	0.000	0.000	HS
			Post	4.60	0.843		
	Surface	18- 38	Pre	0.00	0.000	0.000	HS
			Post	3.30	0.949		
		38-58	Pre	0.00	0.000	0.000	HS
			Post	4.20	1.033		
4.Aching	Systemic	18- 38	Pre	0.00	0.000	0.000	HS
			Post	4.30	1.636		
		38-58	Pre	0.00	0.000	0.000	HS
			Post	4.30	1.636		
	Surface	18- 38	Pre	0.00	0.000	0.000	HS
			Post	3.40	0.966		
		38-58	Pre	0.00	0.000	0.000	HS
			Post	3.90	1.370		
5.Tickling	Systemic	18- 38	Pre	0.00	0.000	0.000	HS
			Post	2.70	1.889		
		38-58	Pre	0.00	0.000	0.000	HS
			Post	3.40	1.075		
	Surface	18- 38	Pre	0.00	0.000	0.000	HS
			Post	3.00	0.667		
		38-58	Pre	0.10	0.316	0.000	HS
			Post	2.60	1.838		
6.Sore	Systemic	18- 38	Pre	0.00	0.000	0.000	HS
			Post	4.40	1.075		
		38-58	Pre	0.00	0.000	0.000	HS
			Post	4.60	0.966		
	Surface	18- 38	Pre	0.00	0.000	0.000	HS
			Post	3.30	1.059		
		38-58	Pre	0.00	0.000	0.000	HS
			Post	3.70	0.823		
7.Irritable	Systemic	18- 38	Pre	0.00	0.000	0.000	HS
			Post	4.10	1.449		
		38-58	Pre	0.00	0.000	0.000	HS
			Post	4.20	1.398		
	Surface	18- 38	Pre	0.00	0.000	0.000	HS
			Post	3.30	1.059		
		38-58	Pre	0.00	0.000	0.000	HS
			Post	3.70	1.494		
		18- 38	Pre	0.00	0.000	0.000	HS

SEVERITY	8.Lump in the throat	Systemic	38-58	Post	2.40	1.265	0.000	HS
				Pre	0.00	0.000		
		Surface	18- 38	Post	2.50	1.269	0.000	HS
				Pre	0.00	0.000		
			38-58	Post	1.70	0.675	0.000	HS
				Pre	0.10	0.316		
	1.Burning	Systemic	18- 38	Post	2.20	1.229	0.000	HS
				Pre	0.10	0.316		
			38-58	Post	1.90	1.524	0.001	HS
				Pre	0.00	0.000		
		Surface	18- 38	Post	2.70	1.337	0.000	HS
				Pre	0.00	0.000		
			38-58	Post	2.00	0.943	0.000	HS
				Pre	0.10	0.316		
	2.Tight	Systemic	18- 38	Post	1.70	1.160	0.001	HS
				Pre	0.10	0.316		
			38-58	Post	3.10	1.287	0.000	HS
				Pre	0.00	0.000		
		Surface	18- 38	Post	3.30	1.059	0.000	HS
				Pre	0.00	0.000		
	3.Dry	Systemic	18- 38	Post	2.80	0.919	0.000	HS
				Pre	0.00	0.000		
			38-58	Post	2.70	0.949	0.000	HS
				Pre	0.00	0.000		
		Surface	18- 38	Post	3.90	1.287	0.000	HS
				Pre	0.00	0.000		
	4.Aching	Systemic	18- 38	Post	4.20	1.398	0.000	HS
				Pre	0.00	0.000		
			38-58	Post	3.30	0.823	0.000	HS
				Pre	0.00	0.000		
		Surface	18- 38	Post	3.70	1.494	0.000	HS
				Pre	0.00	0.000		
	5.Tickling	Systemic	18- 38	Post	3.40	1.430	0.000	HS
				Pre	0.00	0.000		
			38-58	Post	1.80	1.476	0.001	HS
				Pre	0.00	0.000		

			38-58	Pre	0.00	0.000	0.000	HS
				Post	2.10	0.876		
	Surface	18- 38		Pre	0.00	0.000	0.000	HS
				Post	2.00	1.054		
		38-58		Pre	0.00	0.000	0.001	HS
				Post	1.50	1.179		
	6.Sore	Systemic	18- 38	Pre	0.00	0.000	0.000	HS
				Post	4.00	1.054		
			38-58	Pre	0.00	0.000	0.000	HS
				Post	3.30	0.949		
		Surface	18- 38	Pre	0.00	0.000	0.000	HS
				Post	3.10	0.994		
			38-58	Pre	0.00	0.000	0.000	HS
				Post	3.50	1.179		
	7.Irritable	Systemic	18- 38	Pre	0.00	0.000	0.000	HS
				Post	3.70	1.337		
			38-58	Pre	0.00	0.000	0.000	HS
				Post	3.00	0.943		
		Surface	18- 38	Pre	0.00	0.000	0.000	HS
				Post	3.00	0.816		
			38-58	Pre	0.00	0.000	0.000	HS
				Post	3.10	1.287		
	8.Lump in the throat	Systemic	18- 38	Pre	0.00	0.000	0.000	HS
				Post	2.20	1.317		
			38-58	Pre	0.00	0.000	0.000	HS
				Post	2.10	1.197		
		Surface	18- 38	Pre	0.00	0.000	0.000	HS
				Post	1.30	0.483		
			38-58	Pre	0.00	0.000	0.000	HS
				Post	1.90	1.287		

showed a highly significant differences before and after the vocal loading task in both systemic and surface hydration groups. Across both age groups, symptoms such as burning, tightness, dryness, aching, tickling, soreness, irritability, and lump in the throat showed highly significant differences compared to pre-assessment with the post-assessment. Hence, these findings suggest that the vocal loading task showed an impact in the voice symptoms in comparison with pre assessment to the post fatigue assessment regardless of age group or hydration type.

Table 4.8 Shows the comparison of pre and post assessment of VFI before /after vocal loading task.

Questions	Hydration type	Age group		Mean	Std. Deviation	To compare Pre-Post: Wilcoxon signed rank test	
						p value	
Q1	Systemic		Pre	0.00	0.000	0.000	HS

		18-38	Pos t	2.60	1.075		
		38-58	Pre	0.00	0.000		
	Surface	38-58	Pos t	3.40	0.843	0.000	HS
			Pre	0.00	0.000		
		18-38	Pos t	2.80	0.789	0.000	HS
			Pre	0.50	0.707		
Q2	Systemic	38-58	Pos t	2.80	1.033	0.000	HS
			Pre	0.60	0.966		
		18-38	Pos t	3.40	0.699	0.000	HS
			Pre	0.70	0.949		
	Surface	38-58	Pos t	3.60	0.699	0.000	HS
			Pre	0.60	0.966		
Q3	Systemic	38-58	Pos t	2.70	0.675	0.000	HS
			Pre	0.70	0.949		
		18-38	Pos t	3.50	0.527	0.000	HS
			Pre	0.00	0.000		
	Surface	38-58	Pos t	3.60	0.699	0.000	HS
			Pre	0.10	0.316		
Q4	Systemic	38-58	Pos t	2.50	0.527	0.000	HS
			Pre	0.00	0.000		
		18-38	Pos t	3.40	0.699	0.000	HS
			Pre	0.30	0.675		
	Surface	38-58	Pos t	3.70	0.483	0.000	HS
			Pre	0.30	0.675		

Q5	Systemic	18-38	Pos t	3.10	0.738	0.000	HS
		38-58	Pre	0.50	0.707		
		38-58	Pos t	3.40	0.516	0.000	HS
		18-38	Pre	0.30	0.675		
		18-38	Pos t	3.10	0.568	0.000	HS
		38-58	Pre	0.30	0.675		
Q6	Systemic	38-58	Pos t	3.60	0.516	0.000	HS
		18-38	Pre	0.40	0.699		
		18-38	Pos t	2.30	0.675	0.000	HS
		38-58	Pre	0.30	0.675		
		38-58	Pos t	3.20	0.789	0.000	HS
		18-38	Pre	0.60	0.843		
Q7	Systemic	18-38	Pos t	3.30	0.675	0.000	HS
		38-58	Pre	0.60	0.843		
		38-58	Pos t	3.50	0.527	0.000	HS
		18-38	Pre	0.70	0.823		
		18-38	Pos t	2.30	0.675	0.000	HS
		38-58	Pre	0.60	0.843		
Q8	Systemic	38-58	Pos t	3.20	0.632	0.000	HS
		18-38	Pre	0.00	0.000		
		18-38	Pos t	2.60	1.350	0.000	HS
		38-58	Pre	0.00	0.000		
		38-58	Pos t	3.20	0.789	0.000	HS
		18-38	Pre	0.00	0.000		
Q9	Systemic	18-38	Pos t	2.80	0.919	0.000	HS
		38-58	Pre	0.00	0.000		
		38-58	Pos t	2.60	0.843	0.000	HS
		18-38	Pre	0.00	0.000		
		18-38	Pos t	2.80	0.919	0.000	HS
		38-58	Pre	0.00	0.000		
Q10	Systemic		Pre	0.00	0.000	0.000	HS

		18-38	Pos t	2.10	1.449	0.000	HS
		38-58	Pre	0.00	0.000		
			Pos t	3.20	0.789		
	Surface	18-38	Pre	0.00	0.000		
			Pos t	2.30	0.949		
		38-58	Pre	0.30	0.675		
			Pos t	2.20	1.033		
Q9	Systemic	18-38	Pre	0.00	0.000	0.000	HS
			Pos t	2.90	1.197		
		38-58	Pre	0.00	0.000		
			Pos t	3.50	0.707		
	Surface	18-38	Pre	0.00	0.000	0.000	HS
			Pos t	2.80	0.919		
		38-58	Pre	0.10	0.316		
Q10	Systemic	18-38	Pre	0.00	0.000	0.000	HS
			Pos t	2.90	0.738		
		38-58	Pre	0.00	0.000		
			Pos t	3.50	0.707		
	Surface	18-38	Pre	0.00	0.000	0.000	HS
			Pos t	2.00	0.943		
		38-58	Pre	0.20	0.422		
Q11	Systemic	18-38	Pre	0.30	0.675	0.000	HS
			Pos t	3.20	0.919		
		38-58	Pre	0.30	0.675		
			Pos t	3.50	0.527		
	Surface		Pre	0.30	0.675	0.000	HS

Q12	Systemic	18-38	Pos t	2.60	0.699	0.000	HS
		38-58	Pre	0.30	0.675		
		38-58	Pos t	3.40	0.516	0.000	HS
			Pre	0.00	0.000		
		38-58	Pos t	3.00	0.816	0.000	HS
			Pre	0.00	0.000		
Q13	Systemic	18-38	Pos t	2.30	1.160	0.000	HS
		38-58	Pre	0.20	0.422		
		38-58	Pos t	3.30	0.823	0.000	HS
			Pre	0.00	0.000		
		38-58	Pos t	3.50	0.707	0.000	HS
			Pre	0.00	0.000		
Q14	Systemic	18-38	Pos t	3.10	0.738	0.000	HS
		38-58	Pre	0.20	0.422		
		38-58	Pos t	3.00	0.667	0.000	HS
			Pre	0.00	0.000		
		38-58	Pos t	3.80	0.422	0.000	HS
			Pre	0.00	0.000		
Q15	Systemic	18-38	Pos t	2.50	0.850	0.000	HS
		38-58	Pre	0.00	0.000		
		38-58	Pos t	3.60	0.516	0.000	HS
			Pre	0.00	0.000		
		38-58	Pos t	3.60	0.516	0.000	HS
			Pre	0.00	0.000		

		18-38	Pos t	3.30	0.949		
		38-58	Pre	0.00	0.000		
	Surface	38-58	Pos t	3.60	0.699	0.000	HS
			Pre	0.00	0.000		
		18-38	Pos t	3.00	0.667	0.000	HS
			Pre	0.00	0.000		
Q16	Systemic	38-58	Pos t	3.30	0.823	0.000	HS
			Pre	0.00	0.000		
		18-38	Pos t	3.30	0.675	0.000	HS
			Pre	0.00	0.000		
	Surface	38-58	Pos t	3.50	0.527	0.000	HS
			Pre	0.10	0.316		
Q17	Systemic	38-58	Pos t	3.70	0.483	0.000	HS
			Pre	0.00	0.000		
		18-38	Pos t	2.60	0.516	0.000	HS
			Pre	0.00	0.000		
	Surface	38-58	Pos t	3.30	0.675	0.000	HS
			Pre	0.10	0.316		
Q18	Systemic	38-58	Pos t	3.70	0.483	0.000	HS
			Pre	0.00	0.000		
		18-38	Pos t	3.90	0.316	0.000	HS
			Pre	0.00	0.000		
	Surface		Pre	0.00	0.000	0.000	HS

Q19	Systemic	18-38	Post	2.80	0.422	0.000	HS
		38-58	Pre	0.10	0.316		
		38-58	Post	3.40	0.699	0.000	HS
			t				
		18-38	Pre	0.00	0.000	0.000	HS
		38-58	Post	3.80	0.422		
			t			0.000	HS
		38-58	Pre	0.00	0.000		
	Surface	38-58	Post	3.70	0.483	0.000	HS
			t				
		18-38	Pre	0.00	0.000	0.000	HS
		38-58	Post	2.70	0.675		
			t			0.000	HS
		38-58	Pre	0.20	0.422		
		38-58	Post	3.30	0.675		
			t				

HS-highly significant

Table 4.8 indicates the comparison of pre- and post-assessment scores of the VFI after a vocal loading task across age groups, gender and hydration type revealed that individuals aged 18-38 years and 38-58 years showed highly significant differences between pre- and post-assessment across all 19 VFI questions for both systemic and surface hydration.

DISCUSSION

The present study aimed to assess the effect of hydration on vocal loading task in individuals aged 18-58 years in Kerala using acoustic and perceptual parameters. The findings of the present study revealed that vocal loading task significantly altered the acoustic and perceptual parameters. So, through hydration recovery can be facilitated across acoustic and perceptual parameter. After vocal loading task, significant difference in voice quality was observed with increased F0, Jitter, Shimmer and decreased HNR indicating vocal fold stiffness, instability and breathiness. Both through systemic and surface hydration the acoustic and perceptual parameter were returned to the baseline and the non-significant pre-fatigue vs. after-hydration comparisons results indicate complete recovery, suggesting that hydration can restore vocal function to near-baseline levels. There is a lack of significant difference between systemic and surface hydration suggests that both hydration methods are equally effective in promoting vocal recovery. These findings show important clinical implications as surface hydration (nebulization) may be more practical and immediately accessible for voice professionals experiencing acute vocal fatigue, providing rapid local lubrication without requiring systemic absorption. However, no significant age group differences were found for most acoustic and perceptual parameters, suggesting that vocal fatigue and hydration recovery occur similarly across the 18-58-year age range. The significant difference in F0 likely reflects age and gender related changes in vocal fold elasticity and laryngeal muscle function.

The highly significant increases in VTDS symptoms post-fatigue for all 8 symptoms in both frequency and severity domains confirm that vocal loading produces both objective acoustic changes and subjective perceptual experiences of fatigue. The 19 VFI questions showed highly significant differences between

the pre and post assessment of vocal fatigue suggesting that vocal fatigue is a multidimensional experience affecting voice quality, effort, and function. Hence, hydration should be incorporated into vocal hygiene programs for voice professionals and individuals at risk of vocal fatigue including PVUs, singers, teachers and individuals with voice disorders. Using both systemic and surface hydration suggests that nebulization may be an effective alternative when systemic hydration is not immediately practical or when rapid recovery is needed. Therefore, the present study is in accordance with previous studies Franca and Simpson (2012), Fujiki et al. (2016) and Ghosh et al. (2021).

SUMMARY AND CONCLUSION

Vocal hydration refers to maintaining adequate water balance throughout the body, particularly in the larynx, to ensure the vocal fold mucosal lining remains lubricated, flexible, and healthy. This process is crucial for reducing vocal fatigue, decreasing the impact forces between vocal folds during vibration, and enhancing overall voice quality. Since the human voice is produced through vocal fold vibrations, adequate lubrication is necessary to minimize friction and prevent tissue damage.

The present study aimed to assess the effect of hydration on vocal loading task in individuals aged 18-58 years in Kerala. A total of 40 participants were selected and was divided into two hydration groups (systemic hydration & surface hydration) across two age groups (18-38 years & 38-58 years) including both genders (male & female).

Acoustic parameters like F0, jitter, shimmer, HNR were assessed across three conditions: pre-fatigue, post-fatigue and after hydration. The perceptual parameter was assessed using VTDS, VFI questionnaire and the result suggests that Vocal loading task significantly degrades voice quality across all acoustic parameters (F0, Jitter, Shimmer and HNR), Both systemic and surface hydration effectively restore voice function to near-baseline levels. No significant age differences were found for acoustic parameters across 18-58 years and gender differences was observed in F0 and jitter showing significant differences compared to that of other variables like age and hydration type.

Perceptual measurements using VTDS and VFI shows highly significant increase in vocal fatigue post-assessment when compared to the pre-assessment. Therefore, this study demonstrates that hydration (both systemic and surface) is effective in mitigating vocal fatigue and promoting recovery of vocal function following vocal loading. Both hydration types significantly improved F0, jitter, shimmer and HNR parameters, making hydration a clinically valuable, accessible, and equally effective intervention for vocal health across age groups and genders.

LIMITATION

1. Sample size was limited
2. Vocal loading task duration can be increased
3. Surface hydration(nebulization) could be given for 10 minutes

FUTURE DIRECTION

1. Effect of hydration on PVUs after vocal loading task.
2. Effect of hydration on smoker's voice after vocal loading task.
3. Large sample size.
4. Studies conducted in other districts of Kerala to enhance generalizability.

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