National Journal of Multidisciplinary Research and Development
ISSN: 2455-9040; Impact Factor: RJIF 5.22
Received: 25-04-2019; Accepted: 31-05-2019
www.nationaljournals.com
Volume 4; Issue 3; July 2019; Page No. 16-24

Aerodynamic measures of maximum phonation duration and S/Z ratio in professional voice users

Meghana S[1], Dr. Reeny Roy[2]
[1-2] Department of Speech Language Pathology and Audiology, Naseema Institute of Speech and Hearing, Bangalore University, Naseema Institute of Speech and Hearing, Bangalore, Karnataka, India

Abstract
Earlier literature have a dearth of comparative studies on a group of professional voice users. The aim of the study is to investigate the pre and post aerodynamics across professional voice users in the age range 25-45 years. This study comprised of total 100 subjects without any voice complaint. The subjects were divided into five professional voice users (Group I- Teachers, Group II- Singers, Group III-Speech language pathologist, Group IV- Lawyers and Group V Call-centers). Each group was further divide into 10 males and 10 females. All subjects were measured pre and post aerodynamic measures (MPD & s/z ratio) manually. The Group V Callcentres showed high negative impact of MPD and s/z ratio in the post recording compared to pre-recording. Across gender comparison, females showed highest negative impact compared to males. This study concluded that it is very essential and important to assess the aerodynamics characteristics of voice in all professional voice users. This will helpful in the assessment and management protocol for different professional voice users.

Keywords: aerodynamic measures, maximum phonation duration, professional voice users, voice

1. Introduction

A professional voice user may be defined as someone who uses his/her voice as a primary means of occupational communication [1]. Lawyers, politicians, singers, actors, telephone operators, teachers, announcers, speech therapists, vendors, preachers and sales person are the group of professional voice users in this era. Professional voice users are more prone to laryngeal pathologies than the general population due to their nature of work and life style [2].

Structural disorders involve something physically wrong with the mechanism, often comprising tissue or fluid of the vocal folds (cysts, granuloma, contact ulcer, papilloma, nodules, polyps and laryngitis). Neurogenic voice disorders are termed to be a problem in the nervous system as it interacts with the larynx (spasmodic dysphonia, paralysis/paresis and voice problems caused by another neurological disorder such as Parkinson's disease, Myasthenia Gravis, Amylo Latero Sclerosis etc).

The perceptual evaluation of aerodynamic measure is maximum phonation duration and s/z ratio. The maximum phonation duration is the longest time that a client can sustain a vowel sound at a comfortable pitch and loudness on a deep breath. Normative studies of MPD provide a variety of suggested guidelines for this measure [3, 4]. For children, the average normative ranges reflect from 13.1s to 16.2s, up to eight years of age. For adults, average values for females vary from 16.7s to 25.7s and for males from 22s to 34.6s.

The s/z ratio is to assess for glottal insufficiency, which may be indicative of laryngeal pathology [5]. The s/z ratio is an indicator of laryngeal and respiratory pathology. The subject was asked to prolong the sound /s/ for as long as one could and then asked to produce sound /z/ in the similar fashion. The s/z ratio was then computed by taking the ratio between the /s/ and /z/ sound (approximately 1.0) as the normal speaking subjects. If the s/z ratio was greater than the normative value, results will indicate laryngeal pathology.

Maximum Phonation Duration was analyzed in a study on occupational voice disorders in teachers. The study group comprised of 425 female teachers and 83 non teachers. All participants were subjected to a survey and laryngological, phoniatric and video stroboscopic examination. The results on mean maximum phonation time indicated shorter duration in teachers (14.3s) than non-teachers (15.9s) after the vocal loading [6].

A study on professionally active teachers revealed the VHI outcome on teachers was found to have vocal fatigue. The female teachers showed 66% of moderate vocal disability. Assessment on maximum phonation duration was decreased (average 13seconds). Decrease in this aerodynamic parameter shows insufficiency of voice apparatus. The results on acoustic parameters before and after vocal loading revealed significant difference in frequency perturbation parameters such as jitter, RAP and PPQ. The values showed an increase after vocal loading. Amplitude perturbation such as Shimmer increased after vocal loading in hyper-functional voice [7].

A study on voice characteristic in female physical education student teachers was evaluated. The study investigated subjective and objective voice measures in teachers during baseline, middle and end of the semester. The results showed that acoustic measures such as F0, absolute jitter and shimmer increased at the middle and end of the semester. The MPT decreased and s/z ratio increased at the end of the semester [8].

A comparison of Dysphonia severity index in female elementary school teachers with and without voice complaint was assessed to determine the objective vocal quality (DSI) and acoustic characteristic of female teachers with and without voice complaint. The results indicated that MPT in teachers with voice complaint was significantly lower than teachers without voice complaint. Jitter and F0 values were significantly higher in teachers with voice complaint than teachers without voice complaint [9].

A study on vocal impact of a prolonged reading task in dysphonic versus and normophonimic female teachers was carried out. This study evaluated the effect of a 2 hours reading task in 16 normophonic and dysphonic female teachers with vocal nodules. Objective measurements and subjective self-rating were collected before and every 30 minutes during the reading. Results revealed that VHI shows significant differences between these groups. MPT shows a decrease in post reading task. Acoustic measures shows increase in F0, decrease in shimmer and no significant difference in jitter in post reading task [10].

A pilot study on 20 elderly college teachers was carried out to investigate voice characteristic by using a comprehensive voice assessment tool where Stroboscopy revealed discoloration of vocal folds, incomplete closure, and reduced mucosal waves. On GRBAS scale, the subjects were rated as predominantly breathy, asthenic, and strained. Subject showed reduced Maximum Phonation Time, increased s/z ratio, reduced mean intensity and increased shimmer [11].

Ninety dysphonic teachers were inquired about their voice, co morbidities, and work conditions where the researchers underwent vocal auditory-perceptual evaluation (maximum phonation time and GRBAS scale), acoustic voice analysis, and video laryngoscopy. The results were compared with a control group consisting of 90 dysphonic non teachers, of similar gender and ages, and with professional activities excluding teaching and singing. In both groups, there were 85 women and five men (age range 31–50 years). In the controls, the majority of subjects worked in domestic activities, whereas the majority of teachers worked in primary (42.8%) and secondary school (37.7%). Teachers and controls reported, respectively: vocal abuse (76.7%; 37.8%), weekly hours of work between 21 and 40 years (72.2%; 80%), under 10 years of practice (36%; 23%), absenteeism (23%; 0%), sinonasal (66%; 20%) and gastroesophageal symptoms (44%; 22%), hoarseness (82%; 78%), throat clearing (70%; 62%), and phonatory effort (72%; 52%). In both groups, there were decreased values of maximum phonation time, impairment of the G parameter in the GRBAS scale (82%), decrease of F_0 and increase of the rest of acoustic parameters. Nodules and laryngopharyngeal reflux were predominant in teachers; laryngopharyngeal reflux, polyps, and sulcus vocalis predominated in the controls. It was found that vocal symptoms, co morbidities, and absenteeism were predominant among teachers [12].

A survey of voice acoustic parameters in Iranian female teachers was reported. In the survey, 90 female elementary teachers and 90 non teachers were taken and assessed their voice characteristic by using Dr. Speech and GRBAS scale. The results showed that increase of F0 in teachers (210.03Hz) than non-teachers (194.11Hz). The perturbation measures were higher in teachers (jitter-0.32%, shimmer-4.63%) than non-teachers (jitter 0.22%, shimmer-3.15%), but HNR and MPT values for non-teachers showed higher values [13].

A study was to observe the effects of isometric-isotonic vocal function exercise in practice regimen of singers. A total 20 participants were divided into experimental group and control group. Each subject was assessed by acoustic and aerodynamic measures, video stroboscopic rating and subjective evaluation. The results reported that there were significant pre and post-test differences in MPT (increased) at low, comfortable and high pitch. There were no significant differences in pre and post-test fundamental frequency. There were a significant pre and post-test difference in jitter (increased) at low and comfortable level [14].

Measures of respiratory and glottal efficiency in normal classical singers were collected from a pool of 40 classically trained singers. The results revealed that mean MPT for spoken /a/ in males was reduced to 22.64s during post compared to pre phonation (24.7s, 30.2s, 34.6s). The mean MPT for female was reduced to 18.98s [15].

A study on relationship between aerodynamics measures of glottal efficiency and stroboscopic findings was conducted in asymptomatic singing students which consisted of 65 students were recruited through written announcement and talks during their classes. MPT was tested by having subjects sustained both a spoken and sung tone for /a/ long as possible in one breath. The results revealed that overall mean MPT was 17.34s for the sung /a/ and 20.29s for the spoken /a/ sound. The spoken MPT were significantly longer than sung /a/ sound. The males show significantly longer MPT in both tasks than females [16]. Another similar study was reported to determine whether systemic hydration has beneficial outcome on the voice quality of female singing students between 18 and 32 years of age without a history of voice pathology. Acoustic and perceptual data were collected before and after 2-hour singing rehearsal. The results indicated that hypo hydrated condition had a significant increase in jitter and maximum phonation time (MPT) [17].

There are few studies in Indian context that have reported aerodynamic measures of maximum phonation (MPD) and s/z ratio on professional voice users. The present study also compares the pre and post results of MPD and s/z ratio in five professional voice users such as teachers, singers, speech language pathologist, lawyers and call-centre representatives. Hence, this will provide the speech language pathologists/voice therapists in better assessment and management of various professional voice users.

2. Method

2.1 Participants

Hundred professional voice users participated in the study. The participants were divided into 5 groups of professional voice users as shown in Table 1. Each group consisted of 20 participants and was further divided into sub groups containing 10 males and 10 females. All the participants were briefed about the study and a written informed consent was obtained. Table 1 shows the various professional voice users classified into the following five groups.

Table 1*:* Various groups of professional voice users

Groups	Professional voice users
Group I	Primary school teachers
Group II	Singers
Group III	Speech Language Pathologists
Group IV	Lawyers
Group V	Call Centre Representatives

The participants included in the study should have at least 2 year of experience in their profession. The duration and exposure of voice in each profession should have been at least 1 hour and 30 minutes per day. Participants were excluded from the study based on any history of voice problems or unhealthy habits of smoking and alcohol.

2.2 Procedure

A detailed case history was administered to all the participants. Subjects were assessed, using both MPT and s/z ratio in both pre and post conditions. Participants were instructed to prolong the vowel /a/ as long as one could. Three trials were taken, trials which had maximum duration with accuracy was taken into consideration for maximum phonation time. If the values were lower than the normative scores, it would indicate respiratory and glottal insufficiency. Subjects were asked to prolong the sound /s/ for as long as one could and then asked to produce sound /z/ in the similar fashion. The s/z ratio was then computed by taking the ratio between the /s/ and /z/ sound (approximately 1.0) as the normal speaking subjects. If the s/z ratio was greater than the normative value, results will indicate glottal inefficiency.

2.3 Analysis

The pre and post aerodynamic measures of MPT and S/Z ratio was carried out manually. The duration was noted using stopwatch. All the recordings were obtained before and after voice usage among the different professional voice users to determine the changes of respiratory and glottal efficiency in voice usage among the five groups.

3. Results and Discussion

The aim of the present study is to investigate the pre and post aerodynamic measures of voice characteristics across professional voice users in the age range of 25-45 years. Both males and female participants were assessed within and across the five groups.

3.1 Maximum Phonation Duration (MPD)

3.1.1 Pre and post MPD scores in Professional voice users

The mean and standard deviation of MPD was calculated for all five groups of Professional Voice Users in both pre and post condition as shown in Table 2 and Figure 1.

Table 2: Pre and post MPD values of mean and SD in Professional Voice Users

PVU's	Teachers		Singers		SLPs		Lawyers		Call-centers	
Conditions	**pre**	**post**	**pre**	**post**	**pre**	**post**	**pre**	**post**	**pre**	**post**
Mean & S.D	20.75 (3.61)	10.45 (2.32)	20.45 (3.53)	13.85 (2.42)	19.10 (3.47)	13.35 (2.98)	19.55 (3.28)	17.15 (3.23)	19.95 (3.23)	10.30 (1.86)

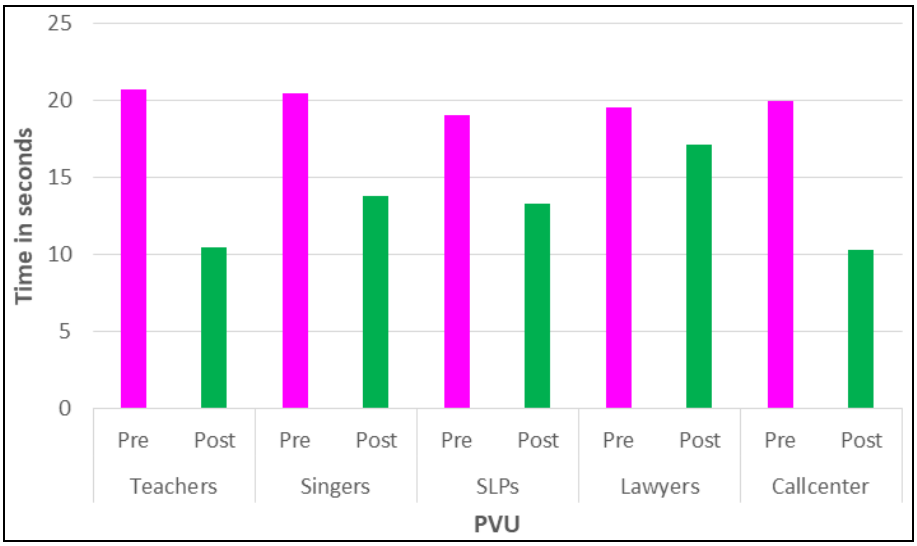

Fig 1: Pre and post MPT in professional voice users

Figure 1 showed the Mean scores among the 5 groups of professional voice users during pre and post conditions of MPD. For all the above professional voice users, it could be seen that before vocal loading, the MPD values followed the normative scores. After vocal loading of approximately 1.5 hours, the MPD scores showed a drastic reduction. As seen in Table 2, a whopping 50% reduction in the post recording mean scores of MPD compared to the pre vocal recording were observed for teachers (10.45secs) and call center representatives (10.3) followed by 75% reduction in MPD in singers (13.85) and speech language pathologists (13.35) and only a 25% reduction in MPD scores in lawyers (17.15). As seen in Table 3, on statistical analysis, one way ANOVA was conducted to determine the effect of MPD (pre & post) across the voice professionals.

Table 3: Comparison of pre and post MPD scores among 5 professionals voice users using ANOVA

ANOVA						
		Sum of squares	**df**	**Mean square**	**F**	**Sig.**
MPD pre	Between groups	35.44	4	8.860	.753	.559
	Within groups	1118.40	95	11.773		
	Total	1153.84	99			
MPD post	Between groups	637.16	4	159.290	23.396	.000
	Within groups	646.80	95	6.808		
	Total	1283.96	99			

As seen in the Table 3, On statistical analysis ANOVA results revealed that there is a significant difference in post MPD scores, F (4, 95) = 23.396, p = 0.000 between and within the group of professional voice users. However, there was no significant effect on Pre MPD scores among the professionals, F (4, 95) = 0.753, p = 0.559. Table 4, displays the multiple group comparisons of post MPD scores across the professional voice users using Tukey HSD.

Table 4: Multiple Group Comparison of post MPD scores among professional voice users

Multiple comparisons						
(I) Professional	**(J) Professional**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
Group I Teacher	Singer	-1.55	.569	.058	-3.13	.03
	SLP	-.63	.569	.807	-2.21	.96
	Lawyer	-2.75*	.569	.000	-4.33	-1.17
	call centre	.47	.569	.919	-1.11	2.06
Group II Singer	Teacher	1.55	.569	.058	-.03	3.13
	SLP	.93	.569	.485	-.66	2.51
	Lawyer	-1.20	.569	.225	-2.78	.38
	call centre	2.02*	.569	.005	.44	3.61
Group III SLP	Teacher	.63	.569	.807	-.96	2.21
	Singer	-.93	.569	.485	-2.51	.66
	Lawyer	-2.13*	.569	.003	-3.71	-.54
	call centre	1.10	.569	.307	-.48	2.68
Group IV Lawyer	Teacher	2.75*	.569	.000	1.17	4.33
	Singer	1.20	.569	.225	-.38	2.78
	SLP	2.13*	.569	.003	.54	3.71
	call centre	3.22*	.569	.000	1.64	4.81
Group V Call centre	Teacher	-.47	.569	.919	-2.06	1.11
	Singer	-2.02*	.569	.005	-3.61	-.44
	SLP	-1.10	.569	.307	-2.68	.48
	Lawyer	-3.22	.569	.000	-4.81	-1.64

As seen in Table 4, the post hoc test revealed that there was no statistical significance between the Group I Teacher (10.45sec) with Group II Singers (13.85sec), Group III SLPs (13.35sec) and Group V Call-centers (10.30sec). However, Group I Teachers (Mean-10.45sec) had a low significant difference compared to Group IV Lawyers (Mean-17.15sec).

Multiple group comparison results showed that there was no statistical significant difference between Group II Singers (13.85sec) with Group I Teachers (10.45sec), Group III SLPs (13.35sec) and Group IV Lawyers (17.15sec). However, Group II Singers (13.85sec) showed higher statistical significant difference compared to Group V Call-centers (10.30sec). On comparison of MPD scores of Group III SLPs (13.35sec) with Group I Teachers (10.45sec), Group II Singers (13.85sec) and Group V Call-centers (10.30sec) showed no statistical significance. However, on comparison of post MPD scores of Group III SLPs (13.35sec) showed a low significant difference with Group IV Lawyers (17.15sec). It could be assumed that a lawyer requires more respiratory and phonatory support to speak in a wider room set up allowing him/her to increase the vocal output compared to an SLP who usually uses his / her normal respiratory and phonatory support for normal speech conversations that usually do not include raising one's vocal output (no yells or screams) in a small room set up for therapy.

Additionally it is noticed from Table 7 that there was no significant difference between Group IV Lawyers (17.15sec) compared to Group II Singers (13.85sec). However Group IV Lawyers (17.15sec) showed a high significant difference with other 3 Group I Teachers (10.45sec), Group III SLPs (13.35sec) and Group V Call-centers (10.30sec).

Finally Group V (Call-centers) showed no significant difference with Group I Teachers and Group III SLPs. However there was a low significant difference was seen between Group V Call-centers (10.30sec) with Group II Singers (13.85sec) and Group IV Lawyers (17.15sec).

The low MPD scores in Call center representatives could be due to continuous vocal effort throughout the day and reports unhygienic vocal practices of whispering and throat clearing and less consumption of water during work hours. Descriptive statistics for pre and post MPD in male professional voice users is shown in the Table 5

Table 5: Pre and post MPD values of mean and SD in male professional voice users

PVU's		**Teachers**		**Singers**		**SLPs**		**Lawyers**		**Call-centers**	
Conditions		Pre	post	pre	post	pre	post	pre	post	Pre	Post
/a/	Mean& S.D	23.50 (1.08)	11 (2.70)	22.80 (2.57)	14.3 (2.16)	22 (2)	15 (2.90)	22.40 (1.57)	20 (1.56)	22.70 (1.49)	10.70 (1.49)

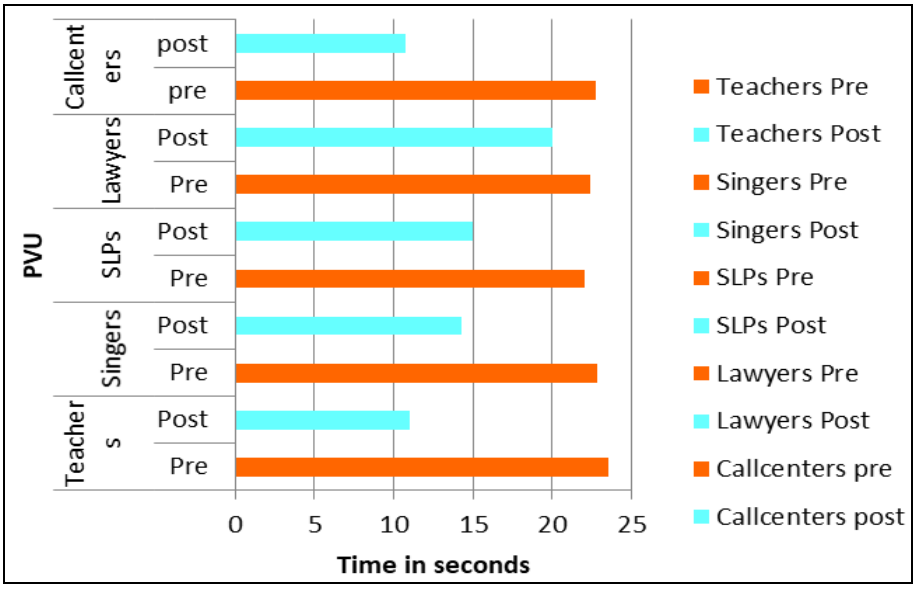

Fig 2: Pre and post MPD in male professional voice users

Figure 2 showed the mean score of males in five group of professional voice users during pre and post condition of MPD. All the male professional voice users shows a normative score of MPD during pre vocal loading and shows a reduction in score during post vocal loading of approximately 1.5 hours. As seen in Table 3, a whopping 50% reduction in mean score of MPD in post vocal loading compared to pre vocal loading were observed for teachers (11sec) and call-centers (10.70) followed by 75% reduction of MPD in speech language pathologists (15sec) and singers 14.3sec) and only 25% reduction seen in lawyers (20sec).

Table 6: Pre and post MPD value of mean and SD in female professional voice users

PVU'S		Teachers		Singers		SLPs		Lawyers		Call-centers	
Condition		pre	post	pre	post	pre	post	pre	Post	Pre	Post
/a/	Mean & S.D	18 (3.09)	9.90 (1.85)	18.10 (2.72)	13.40 (2.67)	16.20 (1.68)	11.70 (2.05)	16.70 (1.49)	14.30 (1.35)	17.20 (1.75)	9.90 (2.18)

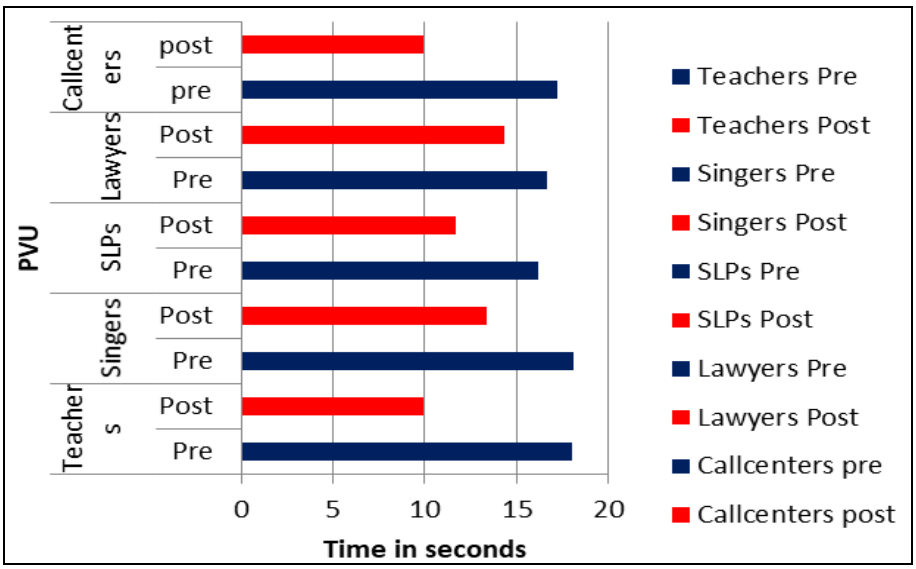

Fig 3: Pre and post MPT in female professional voice users

Figure 3 showed the mean scores of MPD in five groups of female professional voice users. The mean score of MPD is significantly reduced in all female professional voice users after the vocal loading when compared to before vocal loading. Overall usage of MPD in post vocal loading is reduced 50% in teachers (9.90sec) and call-centers (9.90sec) followed by 75% reduction of MPD in speech language pathologists (11.70 sec) and singers (13.40sec) and only 35% reduction of MPD in lawyers(14.30sec).

Table 7: Pairwise comparisons across gender

Pairwise comparison						
(I) Gender	(J) Gender	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval for Difference	
					Lower Bound	Upper Bound
Male	Female	3.900*	.360	.000	3.185	4.615
Female	Male	-3.900*	.360	.000	-4.615	-3.185

Table 7 displays pairwise comparisons across all the professional voice users that showed a significant difference (p=0.000) of pre and post MPD scores between males and females.

Table 8: Comparison of pre and post MPD scores in male and female professional voice users using ANOVA

Tests of Within-Subjects Contrasts					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
MPT	2408.180	1	2408.180	1038.506	.000
MPT * Professional	407.770	4	101.943	43.962	.000
MPT * Gender	118.580	1	118.580	51.137	.000
MPT * Professional * Gender	36.770	4	9.193	3.964	.005

Table 9: Comparison of pre and post MPD score in male and female across professional voice users.

Tests of Between-Subjects Effects					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	54384.020	1	54384.020	8399.797	.000
Professional	264.830	4	66.207	10.226	.000
Gender	760.500	1	760.500	117.462	.000
Professional * Gender	57.950	4	14.487	2.238	.071

As seen in the Table 8, On statistical analysis ANOVA results revealed that there is a significant difference in the pre and post MPD scores, F (1, 4) = 1038.506, p = 0.000. There is a significant difference in the pre and post MPD scores, F (1, 4) = 43.962, p = 0.000 across the professional voice users. There is a significant difference in the pre and post MPD scores, F (1, 4) = 51.137, p = 0.000 between gender. Overall, a significant difference was seen within MPD scores, within the professional voice users and within gender, F (1, 4) = 3.964, p = 0.005. In pre- and post MPD conditions, For Group I (male Teachers), Group II (male-Singers), Group III (male- SLPs), Group IV (male-Lawyers) and Group V (male-Call centre's) showed significant difference compared to females across the professional voice users.

As seen in the Table 9, On statistical analysis ANOVA results revealed that there is a significant difference in the pre and post MPD scores across professional voice users, F (1, 4) =10.226, p = 0.000. There is a significant difference in the pre and post MPD scores, F (1, 4) = 117.462, p = 0.000 between gender. Overall, there was no significant difference of pre and post MPD scores, across professional voice users and across gender, F (1, 4) = 2.238, p = 0.071.

There was no significant difference between the males and females within the professions indicating the normal respiratory and phonatory efficiency of pre scores of MPD that followed the normative MPD values (Tavares *et al.*, 2012). However, changes were observed in the post MPD recordings indicating poor glottal and respiratory efficiency after vocal loading. This correlates with the findings of Sliwinska-Kowalska *et al*. (2006) that compared MPD scores between teachers and non-teachers after vocal loading and reported that there was more reduction in MPD is seen in teachers than non-teachers after the vocal loading. Another supporting study was done by Elizebath *et al*. (2009) have found that decreased MPD at the end of the semester compared to baseline and middle of the semester in female physical education student teachers. A comparison study reported by Agadoost *et al*. (2012) also reflected the same ie, reduced MPD is more in female elementary teachers with voice complaint than teachers without voice complaints. In addition, Boominathan *et al*. (2012) has also reported reduced maximum phonation time seen in elderly college teachers after the class session. Mohseni and Sandoughdar (2015) have also suggested the same results in Iranian female elementary teachers. Similarly, studies done on singers (Carrol *et al*., 1995) reported mean MPD was reduced in males (22.64s) and was increased in females (18.98s) during post condition. However, some contracting studies also reported by Lundy *et al*. (1999) have found that longer MPD in males after the singing practise and Liel Van Wyk *et al*. (2017) have reported that female singing students have increased MPT after the practise because of systemic hydration effect.

3.2 S/Z Ratio

The Mean and Standard Deviation (SD) of s/z ratio was computed for all groups of professional voice users, both male and female in pre and post condition. As shown in table 10 and figure 4 indicate the descriptive statistics of pre and post s/z ratio across each professional voice users.

Table 10: Mean score of s/z ratio in five professional voice users

PVU'S		Teachers		Singers		SLPs		Lawyers		Call-Centers	
condition		Pre	post	Pre	post	pre	post	pre	post	Pre	Post
S/z	Mean & S.D	1 (0.02)	1.07 (0.28)	1.01 (0.22)	1.05 (0.32)	0.90 (0.16)	1.04 (0.22)	0.98 (0.17)	1.03 (0.11)	0.98 (0.12)	0.99 (0.31)

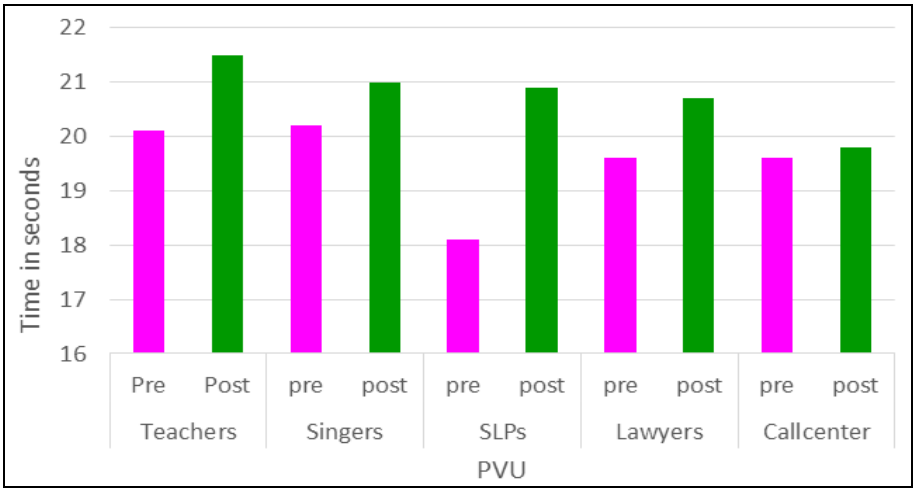

Fig 4: Mean score of s/z ratio in five professional users

Figure 4 explained the overall changes in s/z ratio among all groups of professional voice users, both males and females. The overall score reported that increased s/z ration in SLPs followed by teachers, singers, lawyers and call centers. Lawyers and call-centers show same changes in s/z ratio after the work. As seen in Table 11, ANOVA was conducted to determine the significance between pre and post s/z ratio between and within group of professional voice users.

Table 11: Analysis of variance was carried out to compare pre and post effects of S/Z ratio across all professionals

ANOVA						
		Sum of squares	**df**	**Mean square**	**F**	**Sig.**
S/Z pre	Between groups	.141	4	.035	1.405	.238
	Within groups	2.391	95	.025		
	Total	2.532	99			
S/Z post	Between groups	.077	4	.019	.274	.894
	Within groups	6.701	95	.071		
	Total	6.778	99			

Table 11 shows an analysis of variance showed the effect of Pre s/z ratio among professionals was not significant, F (4, 95) = 1.405, p = 0.238. However, the effect of Post s/z ratio among professionals was not significant, F (4, 95) = 0.274, p = 0.894

Table 12: Post hoc Tukey test was conducted to compare the s/z ratio across five professional voice users.

Multiple comparisons						
(I) Professional	**(J) Professional**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
Teacher	Singer	.0100	.05752	1.000	-.1501	.1701
	SLP	.0650	.05752	.790	-.0951	.2251
	Lawyer	.0325	.05752	.980	-.1276	.1926
	call centre	.0600	.05752	.835	-.1001	.2201
Singer	Teacher	-.0100	.05752	1.000	-.1701	.1501
	SLP	.0550	.05752	.874	-.1051	.2151
	Lawyer	.0225	.05752	.995	-.1376	.1826
	call centre	.0500	.05752	.907	-.1101	.2101
SLP	Teacher	-.0650	.05752	.790	-.2251	.0951
	Singer	-.0550	.05752	.874	-.2151	.1051
	Lawyer	-.0325	.05752	.980	-.1926	.1276
	call centre	-.0050	.05752	1.000	-.1651	.1551
Lawyer	Teacher	-.0325	.05752	.980	-.1926	.1276
	Singer	-.0225	.05752	.995	-.1826	.1376
	SLP	.0325	.05752	.980	-.1276	.1926
Call centre	call centre	.0275	.05752	.989	-.1326	.1876
	Teacher	-.0600	.05752	.835	-.2201	.1001
	Singer	-.0500	.05752	.907	-.2101	.1101
	SLP	.0050	.05752	1.000	-.1551	.1651

On Table 12 showed that there is no statistical difference in s/z ratio across all group of professional voice users such as Group I (Teachers), Group II (Singers), Group III (SLPs), Group IV (Lawyers), Group V (Call-centers)

Table 13: Pre and post values of mean and SD in male professional voice users

PVU'S		Teachers		Singers		SLPs		Lawyers		Call-Centers	
Condition		pre	post	pre	Post	pre	post	pre	post	Pre	Post
s/z	Mean (SD)	1	1.01	1.03	1.10	0.85	1.09	0.98	1	0.95	0.97
		0	0.16	0.31	0.43	0.26	0.08	0.07	0.12	0.09	0.31

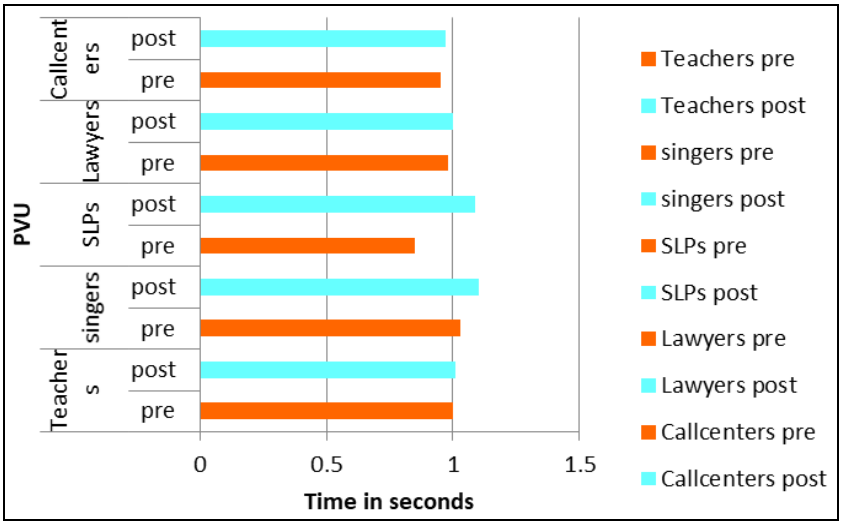

Fig 5: Pre and post values of mean and SD in male professional voice users

Figure 5 reported displays an increased s/z ratio in all professional voice users. The greatest difference of s/z ratio shows from pre to post in speech language pathologists. Singers' shows increased ratio, less than compared to SLPs. And other three groups such as lawyers, call-centers and teachers did not show much variation from pre to post condition.

Table 14: Pre and post values of Mean and SD in female professional voice users

PVU'S		Teachers		Singers		SLPs		Lawyers		Call-Centers	
Condition		pre	post	pre	post	pre	post	pre	post	pre	Post
S/z	Mean (SD)	1.01	1.14	1.03	1.10	0.85	1.09	0.98	1	0.95	0.97
		0.03	0.36	0.17	0.18	0.18	0.18	0.2	0.09	0.15	0.31

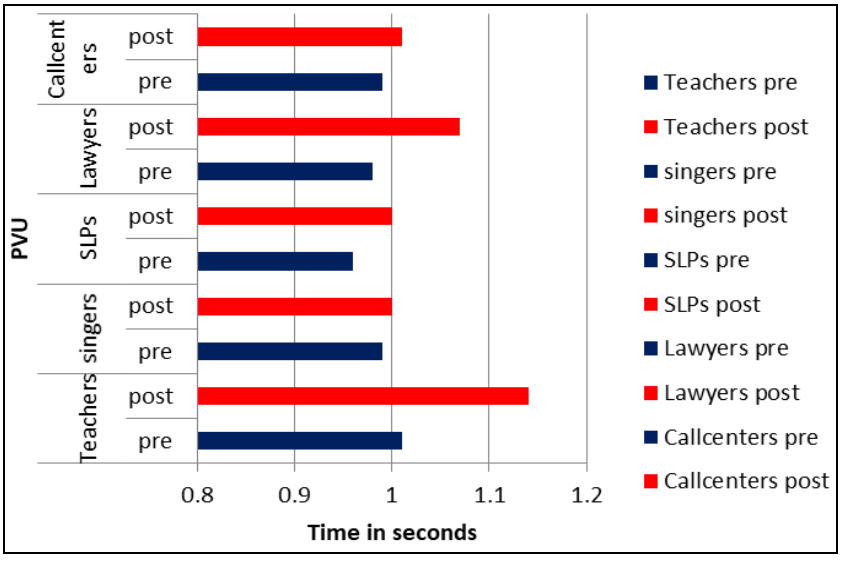

Fig 6: Pre and post values of s/z ratio in female professional voice users

Figure 6 showed the variation of s/z ratio in females in all the professional users. The results revealed that teachers have increase s/z ratio compared to other professionals. Lawyers have greater variation in ratio after the work but it less than teachers. Call-centers showed an increase in ratio after the work. SLPs and singers showed a least change in ratio after the vocal loading.

Table 15: Pairwise comparisons were made to compare across gender

Pairwise comparison						
(I) Gender	(J) Gender	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval for Difference	
					Lower Bound	Upper Bound
Male	Female	-.017	.036	.641	-.089	.055
Female	Male	.017	.036	.641	-.055	.089

Pairwise comparison results show that there is no significant difference (0.641) between male and female across professional voice users.

All inclusive results are co-related with study given by Elizebath *et al*. (2009). They found that s/z ratio is increased at the end of the semester compared to baseline and middle of the semester in female physical education teachers. Boominathan *et al*. (2012) have reported the same results in elderly college teachers.

4. Summary and Conclusion

The results of aerodynamics measure (MPD) showed a greater reduction of MPD and increased s/z ratio in the post recording scores compared to pre-recording score were observed in Group V Call-centers and Group I Teachers followed by Group II Singers, Group III SLPs and Group IV Lawyers. It could be assumed that a teachers requires more respiratory and phonatory support to speak in a wider room set up allowing him/her to increase the vocal output and also need a greater respiratory and phonatory support to speak continuously through the telephone for a long period of time (Sliwinska-Kowalska *et al*., 2006, Boominathan *et al*., 2012). The comparison of MPD scores across gender, females showed a high reduction in post recording of MPD scores than males. This could be because of females having low respiratory and phonatory control compared to males (Tavares *et al*., 2012, Carrol *et al*., 1995, Mohseni *et al*., 2015). The statistical analysis results showed that there was a significant difference between pre and post MPD scores in all professional voice users, pre and post MPD scores between gender and overall results showed that significant difference within MPD scores, within professional voice users and within gender.

5. Acknowledgment

I would like to share my sincere thanks to Naseema Institute of Speech and Hearing for allowing me to carry out the research. My deepest thanks to Dr. Reeny Roy (Associate Professor, Naseema Institute of Speech and Hearing) for guiding me in this project with her immense knowledge and suggestions. I would also like to extend my gratitude to all the participants who cooperated in the research.

6. References

1. Rubin J, Korovin G, Epstein R. Special Considerations for the Professional Voice User. Diagnosis and Treatment of Voice Disorders. 3rd edition, 2003, 405-435.
2. Stemple JC, Glaze LE, Gerdeman BK. Clinical voice pathology: Theory and management (2nd ed.). Singular, San Diego, CA, 1995.
3. Tavares ELM, Brasolotto AG, Rodrigues SA, Pessin ABB, Martins, RHG. Maximum phonation time and s/z ratio in a large child cohort. Journal of Voice. 2012; 26(5):675-e1.
4. Maslan J, Leng X, Rees C, Blalock D, Butler S. Maximum Phonation Time in Healthy Older Adults. Journal of Voice. 2011; 25(6):709-713.
5. Gelfer MP, Pazera JF. Maximum duration of sustained /s/and/z/ and the s/z ratio with controlled intensity. Journal of Voice. 2006; 20(3):369-379.
6. Sliwinska-Kowalska M, Niebudek-Bogusz E, Fiszer M, Los-Spychalska T, Kotylo P, Sznurowska-Przygocka B, *et al*. The prevalence and risk factors for occupational voice disorders in teachers. Folia Phoniatrica et Logopaedica. 2006; 58(2):85-101.
7. Niebudek-Bogusz E, Kotyło P, Śliwińska-Kowalska M. Evaluation of voice acoustic parameters related to the vocal-loading test in professionally active teachers with dysphonia. International journal of occupational medicine and environmental health. 2007; 20(1):25-30.
8. Grillo EU, Fugowski J. Voice characteristics of female physical education student teachers. Journal of Voice. 2011; 25(3):e149-e157.
9. Aghadoost O, Amiri-Shavaki Y, Moradi N, Jalai S. A comparison of dysphonia severity index in female teachers with and without voice complaints in elementary schools of Tehran, Iran. Nurs Midwifery Stud. 2013; 1(3):133-8.
10. Remacle A, Morsomme D, Berrué E, Finck C. Vocal impact of a prolonged reading task in dysphonic versus normophonic female teachers. Journal of voice. 2012; 26(6):820-e1.
11. Boominathan P, Mahalingam S, Samuel J, Babu MVD, Nallamuthu A. Voice characteristics of elderly college teachers: A pilot study. Journal of Laryngology and Voice. 2012; 2(1):21.
12. Pereira ERBN, Tavares ELM, Martins RHG. Voice disorders in teachers: clinical, videolaryngoscopical, and vocal aspects. Journal of Voice. 2015; 29(5):564-571.
13. Mohseni R, Sandoughdar N. Survey of voice acoustic parameters in Iranian female teachers. Journal of voice. 2016; 30(4):507-e1.
14. Sabol JW, Lee L, Stemple JC. The value of vocal function exercises in the practice regimen of singers. Journal of Voice. 1995; 9(1):27-36.
15. Carroll LM, Sataloff RT, Heuer RJ, Spiegel JR, Radionoff SL, Cohn JR. Respiratory and glottal efficiency measures in normal classically trained singers from Journal of Voice. 1996; 10(2):139-145.
16. Lundy DS, Casiano RR, Sullivan PA, Roy S, Xue JW, Evans J. Incidence of abnormal laryngeal findings in asymptomatic singing students. Otolaryngology—Head and Neck Surgery. 1999; 121(1):69-77.
17. Van Wyk L, Cloete M, Hattingh D, van der Linde J, Geertsema S. The effect of hydration on the voice quality of future professional vocal performers. Journal of Voice. 2017; 31(1):111-e29.