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Work and Environment Related Characteristics Associated with Voice Disorders among Primary School Teachers

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Abstract: The objective of this study is to assess work and environment related factors associated with voice disorders among primary school teachers in the Colombo district in Sri Lanka. Methods: An institution based cross sectional study was conducted among 790 primary school teachers, in the Colombo District in Sri Lanka. They were selected by a stratified random sampling method. The validated Voice Handicap Index (VHI-30) questionnaire and a self-administered questionnaire were used for data collection. Sound levels within 10 selected classrooms were measured objectively using CR:303 sound level meter (Cirrus). Data analysis was by bivariate method with chi squared and logistic regression. Results: Among the work related characteristics assessed teaching 5 or more subjects (OR=1.40, CI = 1.039, 2.90), staying after school hours (OR=1.69, CI = 1.19, 2.38) were significantly associated with voice disorders. Among the factors associated with work environment, teachers having a speech pattern in yelling and shouting category (OR=2.25, CI=1.68, 2.99), speaking in noisy environments (OR=1.09, CI= 1.15, 3.15), being exposed to smoky dusty environments (OR = 1.61, CI= 1.19, 2.16), having average or high dust levels in classrooms (OR=2.03, OR=1.50, 2.76), having a moderate to high noise level in classrooms (OR= 1.93, CI=1.45, 2.58) and having 'just adequate, inadequate and average' space in a classroom (OR=1.74, CI=1.29, 2.34) were significantly associated with voice disorders. The sound levels objectively measured in classrooms revealed that all classrooms had higher than acceptable noise levels during a teaching session. Conclusions and recommendations: The association of voice disorders with work related characteristics were similar to the findings in other studies. However, the high noise levels detected in the classrooms on objective measurement were high. It is recommended that these findings be addressed through a multidisciplinary approach and National standards for acceptable noise levels within classrooms be established.

Keywords: Voice Disorders, Primary School Teachers, Environmental Factors, Pattern of Speech, Noise Levels

1. Introduction

Voice is an important element of human communication and its importance is greater among occupational voice users. Teachers are among the largest group of occupational voice users in the world (Boltežar and Bahar, 2014) including Sri Lanka. In Sri Lanka among the formal occupational groups, teachers employed in public schools account for a large proportion and among them the highest number are employed in the Colombo District. Teachers are more prone to voice disorders as their work requires them to speak for long hours in noisy environments with children. This may lead to misuse of voice, leading to and aggravating voice disorders. Acoustics of the class rooms, cleanliness, humidity and heat are some of the risk factors associated with voice disorders (Alva et al., 2017), all of which are present in schools in the Sri Lankan context. Additionally, personal factors such as speech pattern described as yelling shouting, clenching teeth while speaking and holding breath while speaking (Devadas et al, 2016), teaching for longer than 20 hours per week (de Ceballos et al., 2011) and teaching for more than 15 years (Rossi-Barbosa et al., 2015) were all significant associations with voice disorder in teachers.

Therefore, unlike other teaching professionals such as lecturers and professors where the teaching environment is more favourable, schoolteachers have unique challenges and are at a higher risk of developing



voice disorders. Further, school type was also an important consideration for voice disorders as public schools were noisier and had a larger number of students, with a higher student to teacher ratio (Akinbode *et al.*, 2014). In Sri Lanka public schools, which are more popular are categorized accordingly into 4 types of schools. Type 1 AB being schools with advanced level subjects in the science stream, type 1C being schools with advanced level subjects in Arts or commerce streams only, type 2 being schools with classes up to grade 11 and type 3 being schools with classes up to grade 8 (Department of Census and Statistics, 2010). Among the 4 types of schools the 1AB and type 3 schools have larger primary schools. In Sri Lanka the composition of students in classes also vary according to male only, female only or mixed school, with most public schools in Colombo consisting of either male only or female only rather than mixed schools.

Although studies on voice disorders among teachers have been conducted at the undergraduate level in Sri Lanka, the small sample sizes limit the ability to generalize the findings to the broader population. This study seeks to address this information gap and provide comprehensive insights. As the providers of education for the country's future generations, ensuring a comfortable work environment for primary school teachers is essential. The objective of this study was to assess work and environment related factors associated with voice disorders among primary school teachers in the Colombo district in Sri Lanka.

2. Methods

An institution based cross sectional study was conducted among primary schools with a minimum of 15 teachers in 2 education zones (Colombo and Sri Jayawardenapura), with the highest number of teachers in the Colombo District in Sri Lanka.

A primary school teacher being a permanent staff member with a minimum service of 1 year were included in the study while a primary school teacher on maternity leave or on long leave, diagnosed with mental illness or pregnant at the time of study or who were unable to read, write and/ or understand Sinhala or English language were excluded from the study.

A stratified random sampling method was used to select participants. The sample was first stratified by the type of school; type 1AB, type 1C, type 2 and type 3, into 4 strata. Once the number of teachers to be included in each stratum was decided it was further divided among the schools according to the sex composition of the students, into 3 categories as males only, females only and mixed. After deciding the number required from each category, the respective teachers were selected randomly.

The required sample size was calculated as 860. According to the sample size calculation to detect correlates by Schlesselman & Stolley in 1982, the required sample size was calculated as 570. However, this study was conducted as a part of a larger study where a sample size of 860 was required and the same sample was considered for this component of the study as well.

The validated and culturally adapted Voice Handicap Index (VHI-30) questionnaire and a self-administered questionnaire were used for data collection.

Sound levels were measured objectively with the CR:303 sound level meter (Cirrus) in 10 school that reported at least 5 teachers with voice disorders. The sound levels at 3 strategic positions in the classroom decided by the position of the teacher were measured. The sound level meter was placed 1 meter above ground level and at least 1 meter away from sound reflecting surfaces such as walls and held for 5 minutes in each position. A low reading for each position was obtained and averaged. These readings were compared with standard acceptable readings for a classroom during a teaching session.

Data analysis was by Statistical Package for Social Sciences (SPSS) software version 20 which was used for data entry, cleaning and analysis. Based on the cut off value of 14 developed for the VHI questionnaire as a part of the larger study, the teachers suffering from voice disorders were identified. For the analysis of work-related characteristics of voice disorders, each variable was analyzed in bivariate cross tabulations by logistic regression and chi squared test was used to assess the significance.



Table 1. Association between voice disorders and school type and teaching related characteristics

Selected correlate	Level of voice disorder				OR	Risk 95% CI	P
	With voice disorder (n = 436, 55.2%)		Without voice disorder (n = 354, 44.8%)				
	No	%	No	%			
Type of school (n = 787)							
Type 1 AB	177	51.0	170	49.0	0.733	0.419 – 1.281	0.275 (NS)
Type 1C	67	56.3	52	43.7	1.164	0.540 – 2.509	0.698 (NS)
Type 2	59	62.1	36	37.9	0.770	0.301 – 1.970	0.586 (NS)
Type 3	132	58.4	94	41.6	1.00		
Current grade taught							
1 ^a	72	58.1	52	41.9			
2 ^a	55	42.6	74	57.4			
3 ^a	70	51.9	65	48.1	1.025	0.634 – 1.657	0.919 (NS)
4 ^b	77	57.9	56	42.1	1.00		
5 ^b	77	57.0	58	43.0			
> 1 grade ^b	83	62.9	49	37.1			
Special class ^b	2	100	0	0			
Number of subjects taught							
1 ^a	51	66.2	26	33.8			
2 ^a	8	42.1	11	57.9			
3 ^a	8	34.8	15	65.2			
4 ^a	55	43.0	73	57.0	1.00		
5 ^b	157	57.9	114	42.1	1.405	1.039 – 2.900	0.027 (S)
>5 ^b	157	57.7	115	42.2			
Work experience in years							
1 – 5 ^a	51	54.8	42	45.2			
> 5 – 10 ^a	70	52.6	63	47.4			
> 10 – 15 ^a	72	54.1	61	45.9	1.00		
>15 – 20 ^b	34	48.6	36	51.4	1.112	0.839 – 1.473	0.461 (NS)
> 20 ^b	209	57.9	152	42.1			
Staying after school hours							
Yes	361	57.9	262	42/1	1.690	1.198 – 2.384	0.003(S)
No	75	44.9	92	55.1	1.00		

^{a, b} Rows were amalgamated to form one category

S = Significant, NS = Non significant

3. Results

The final sample size was 790 with a response rate of 91.8%. The age range of the sample was 24 to 60 years and the mean was 44.71 with standard deviation of 9.41. The highest number of teachers were in the 51-60 years (n=78, 36.2%) category followed by 41 – 50 years category. The least number of teachers were in the 20 - 30 years category (n=15, 7%). The majority were females (n=753, 95.3%).

The work-related characteristics were assessed by the type of school, characteristics related to teaching career and nature of activities conducted in school and factors contributing to voice load during the activities in school. These details are depicted in table 1.



Considering the type of school teaching in a type 2 school was associated with the highest percentage (62.1%) of teachers with voice disorders while the lowest percentage (51.0%) was found among teachers teaching in type 1AB schools. Teaching in type 1C (OR=1.164, CI =0.54, 2.50) was associated with voice disorders while teaching in other types of schools were protective for voice disorders although, these associations were not statistically significant.

Considering the grade taught, the highest percentage with voice disorders were from 'teaching more than 1 grade' category, which was 62.9%. It has also revealed that 57.4% of teachers teaching in grade 2 did not suffer from voice disorders. Teaching in a grade less than grade 3 was associated with voice disorders, however, this associations were not statistically significant.

Considering the number of subjects taught, a higher proportion of teachers were teaching more than 4 subjects and 57.9% and 57.7% of teachers teaching 5 subjects and more than 5 subjects suffered from voice disorders, respectively. This association was significantly associated with voice disorders (OR=1.40, CI = 1.039, 2.90). Work experience more than 15 years was associated with voice disorders but was not significant statistically. A higher number of teachers stayed after school hours and among them 57.9% suffered voice disorders and this association was statistically significant (OR=1.69, CI = 1.19, 2.38).

With regard to the factors associated with work environment in schools, voice load was considered here and the factors related to voice load were assessed by the pattern of speech during school hours, hours of teaching and by the composition of the students in a classroom. The findings are detailed in table 2.

A higher proportion of teachers were in the 'yelling and shouting' category (n=389) of them 65.2% suffered voice disorders, compared to the other categories of 'holding breath while speaking', 'speaking in usual volume/ tone' and 'other'. This association was found to be statistically significant (OR=2.25, CI=1.68, 2.99).

Considering the number of hours teaching, in the >3 -5 hours category 59% of the teachers suffered from voice disorders. However, a larger proportion of teachers were teaching in the >5 – 7 hours category with 54.6% of them suffering from voice disorders. This association was not statistically significant.

The composition of the school, by the sex of students, revealed that similar number of teachers teaching in a female only and male only schools with 56.3% and 56.2%, respectively suffering from voice disorders and 53.3% teachers in mixed schools suffering from it. These associations were not significant statistically.

Other work environment associated factors were assessed by working conditions in schools are also detailed in table 2.

A higher proportion of teachers had to speak in noisy environments and among them 56.6% suffered voice disorders and this association was statistically significant (OR=1.09, CI= 1.15, 3.15). Among teachers exposed to smoky or dusty environments 59.2% suffered voice disorders. These associations were found to be statistically significant (OR = 1.61, CI= 1.19, 2.16). Among teachers 'speaking to persons at a distance' 55.3% of them suffered from voice disorders while 44.7% of teachers not speaking to persons at a distance suffered voice disorders. This association was not statistically significant.

The classroom characteristics assessed are detailed in table 3.

Not having an open classroom was found to be associated with voice disorders as compared to an open classroom, with 53.6% of the teachers in open classrooms and 58.1% of teachers in closed classrooms suffering from voice disorders. This association was not statistically significant.

Having an average or high level of dust was associated with voice disorders with 58.7% and 64.9% teachers suffering from voice disorders in the respective categories. This association was statistically significant (OR=2.03, OR=1.50, 2.76).

A higher proportion of teachers were using chalk and among them 55.5% suffered from voice disorders and among those not using chalk 54.2% also suffered from voice disorders, and the association was not statistically significant.



A moderate to very high noise level in a classroom was associated with voice disorders with 59.9% and 69.7% teachers suffering from voice disorders in the respective category. This association was statistically significant (OR= 1.93, CI=1.45, 2.58). Most teachers were exposed to moderate noise levels (n=384).

Table 2. Distribution of association between voice disorders with voice load and selected working environmental characteristics

Selected correlate	Level of voice disorder				Risk		
	With voice disorder (n = 436, 55.2%)		Without voice disorder (n = 354, 44.8%)		OR	95% CI	P
	No	%	No	%			
Factors associated with voice load							
Pattern of speech							
Yelling and shouting ^a	255	65.2	136	34.8	2.250	1.688 – 2.998	<0.001(S)
Holding breath while speaking ^b	6	85.7	1	14.3	1.00		
Speaking in usual volume/ tone ^b	174	44.7	215	55.3			
Other ^b	1	33.3	2	66.7			
Hours of teaching/ day							
< 3 ^a	4	50.0	4	50.0			
> 3 – 5 ^a	79	59.0	55	41.0	1.00		
>5 -7 ^b	286	54.6	238	45.4	0.389	0.589 – 1.229	0.389 (NS)
> 7 ^b	67	54.0	57	46.0			
Composition of students in the classroom							
Male only	127	56.2	99	43.8	1.153	0.812 – 1.636	0.426 (NS)
Female only	156	56.3	121	43.7	1.143	0.819 – 1.595	0.431(NS)
Mixed	153	53.3	134	46.7	1.00		
Factors associated with selected working environmental characteristics							
Speaking in noisy environment							
Yes	408	56.6	313	43.4	1.090	1.155 – 3.155	0.012 (S)
No	28	40.6	41	59.4	1.00		
Speaking to persons at a distance							
Yes	353	55.3	285	44.7	1.030	0.722 – 1.469	0.872 (NS)
No	285	44.7	69	45.4	1.00		
Speaking in smoky/ dusty environment							
Yes	127	47.4	141	1.611		1.197 – 2.167	0.002 (S)
No				52.6			
				1.00			

^{a, b} Rows were amalgamated to form one category

S = Significant, NS = Non significant



Table 3. Association between voice disorders and classroom factors

Selected correlate	Level of voice disorder				OR	Risk		P
	With voice disorder (n = 436, 55.2%)		Without voice disorder (n = 354, 44.8%)			95% CI	-	
	No	%	No	%				
Nature of classroom								
Open classroom								
Yes	271	53.6	235	46.4	0.832	0.620 1.1104	-	0.218 (NS)
No	165	58.1	119	41.9	1.00			
Dust level								
No dust ^a	10	24.4	31	75.6				
Minimum ^a	95	46.8	108	53.2	1.00			
Average ^b	222	58.7	156	41.3	2.038	1.501 2.768	-	<0.001 (S)
High level ^b	109	64.9	59	35.1				
Chalk use								
Yes	339	55.5	272	44.5	1.054	0.754 1.472	-	0.760 (NS)
No	97	54.2	82	45.8	1.00			
Noise level within classroom								
Satisfactory ^a	71	41.5	100	58.5				
Low noise level ^a	73	50.0	73	50.0	1.00			
Moderate noise level ^b	230	59.9	154	40.1	1.938	1.452 2.586	-	<0.001 (S)
Very high noise level ^b	62	69.7	27	30.3				
Space and ventilation within the classroom								
Satisfactory ^a	124	46.1	145	53.9	1.00			
Average ^b	212	56.8	161	43.2	1.746	1.297 2.349	-	<0.001(S)
Just adequate ^b	57	68.7	26	31.3				
Inadequate ^b	43	66.2	22	33.8				

^{a, b} Rows were amalgamated to form one category

S = Significant, NS = Non significant

Considering the space within the classroom, among teachers having just adequate space, inadequate space and average space, 68.7%, 66.2% and 56.8% suffered from voice disorders respectively. This association was significant statistically (OR=1.74, CI=1.29, 2.34). A larger proportion (n=373) of teachers had average space and ventilation, in the classrooms.

Table 4 describes the sound levels measured by sound level meter.

The lowest sound levels recorded were from a male only school of type 1AB category (74.3 dB). While another female school in type 3 category recorded similar low values (76.6dB).

The highest sound levels were recorded from a type 1C, female only school, which was 85.5dB. All the other schools irrespective of the sex or type of school recorded sound levels between 74dB and 85.5dB. The acceptable noise levels in schools, have not been issued in Sri Lanka. According to the recommendations by the department of environment, housing and land development (Columbia), it recommends sound levels at a maximum of 65dB within school zones and a maximum of 55dB within class rooms (Cantor Cutiva & Burdorf, 2015). Accordingly, all the sound level measurements were higher than the acceptable levels.



Table 4. Description of the sound levels measured objectively (n=10)

Measurement of sound level			Remarks
Type of school	Sex of student	Value (dB)	
1AB	Female only	78	Higher than the acceptable range
1AB	Male only	74.3	Higher than the acceptable range
1AB	Male only	84.1	Higher than the acceptable range
1AB	Female only	76.6	Higher than the acceptable range
1C	Female only	85.5	Higher than the acceptable range
1C	Female only	79.4	Higher than the acceptable range
Type 2	Female only	84.1	Higher than the acceptable range
Type 2	Male only	83.6	Higher than the acceptable range
Type 3	Mixed	83.4	Higher than the acceptable range
Type 3	Female only	74.9	Higher than the acceptable range

4. Discussion

This article examines work and environment related characteristics associated with voice disorders among primary school teachers in the Colombo District. The work-related characteristics theoretically associated with voice disorders were assessed in this study and the significant associations are discussed.

The current study found that teaching more than 4 subjects was significantly associated with voice disorders. In a study by [Devadas et al., 2016](#) teaching in more than 5 classes was associated with voice disorders compared to teaching in less than 5 classes but the proportion of teachers not affected by voice disorders in these categories were higher, indicating that the number of classes taught had no association with voice disorders. The number of subjects taught has been studied less frequently in research. However, the available research does not explain the findings of the current study. These findings could be due to the increase in voice load as the number of subjects taught increased. Heavy workload with increasing number of subjects adding to stress may also contribute to voice disorders.

Staying after school maybe a common phenomenon in Sri Lanka and was a significant association with voice disorders but in other countries research has considered the total number of hours spent in school. This aligns with a study done in Brazil where teachers staying in school for 21 – 40 hours and more than 40 hours reported an OR greater than 1 ([de Ceballos et al., 2011](#)). In another study the number of hours spent in the school per day was categorized as less than 10 hours and more than 10 hours where teaching for more than 10 hours showed a higher proportion of voice disorders which was not significant statistically ([Menon et al., 2019](#)). Some studies have reported a larger proportion of teachers had 'overstretched work demands' but a smaller percentage suffered from voice disorders compared to those not having such demands ([Munier & Farrell, 2016](#)). Staying after school hours doesn't necessarily mean it is for teaching. However, it can be considered that staying after school hours would increase the voice load for most teachers as they stay to conduct additional classes or for other student activities most of the time.

Yelling and shouting, was associated with voice disorders compared to other patterns of speech. Yelling and shouting is an added strain on the vocal cords damaging it causing voice disorders. If the strain persists the damage could even be more permanent ([Akinbode et al., 2014](#); [Thibeault et al., 2005](#)).

Considering the environmental factors associated with voice disorders, noise levels within classrooms is an important contributor to voice disorders. Speaking in noisy classrooms may be a requirement in some schools. On measuring the sound levels objectively within selected classrooms, by the sound level meter, it was noted that



sound levels were higher than the acceptable international values suitable for teaching in all the schools irrespective of the composition of the students and the type of schools. There is no legislation for acceptable noise levels in a teaching environment in Sri Lanka and the measured values were compared with the standards recommended by the department of environment, housing and land development (Columbia).

Research also supports that having a high noise level within classrooms is an important associated factor for voice disorders. Voice symptoms were strongly associated with the noise levels within and outside the school, in a study done in the Netherlands (Cutiva & Burdorf, 2015). A high noise level within classroom is significantly associated with voice disorders, in primary schools in India (Devadas *et al.*, 2016). In one study however, noise has not been referred to as a predictor for vocal problems but it was mentioned that compromised classroom acoustics and the number of students and the peripheral noise levels affected teachers voice and that teachers have to speak at least 10dB louder than the surrounding noise levels (Hermes *et al.*, 2016). Poor acoustics in the classrooms were also attributing to high noise levels in the classrooms and has contributed to voice disorders (Cutiva & Burdorf, 2015; Thibeault *et al.*, 2004). The findings in the current study are compatible with the findings in literature.

Dust level within the classrooms, as perceived by the teachers was a significant association with voice disorders in the current study. Dust can be from environmental sources, due to poor maintenance of classrooms or from chalk dust used by most teachers. It is a known factor to irritate the mucosa and lead to upper respiratory infections as well. Many studies support the association between voice disorders and chalk dust and/ or dust and irritants (Sliwiska-Kowaska *et al.*, 2006; de Ceballos *et al.*, 2011). In another study although the environment was not an associated factor for voice disorders, separate factors in the environment; irritants, humidity were found to be significantly associated with voice disorders (Kooijman *et al.*, 2006). In addition air borne allergens also may contribute to irritants in the environment which has shown to be associated with voice disorders among teachers (Ohlsson *et al.*, 2012).

Reduced space and ventilation in classrooms were significantly associated with voice disorders in this study. Reduced space and poor ventilation can affect voice disorders in multiple ways; it could increase the humidity and temperature in the classrooms, it could have an effect on the reverberation time of sound depending on classroom conditions and these are associated with voice disorders if they are on the higher side (Cutiva *et al.*, 2015). On the other hand, it may be argued that a well-ventilated open classrooms would expose the teachers to a higher level of environmental background noise. Therefore, a classroom should have adequate ventilation and good acoustics and the need for standard to be developed in classrooms is mentioned in literature as well (Cutiva *et al.*, 2015; Munier & Farrel, 2016)

Although the study was carefully planned and conducted some limitations are acknowledged. The study was conducted in 2 out of the 4 education zones of the Colombo District, due to time constraint and other practical issues. If the study were conducted in all 4 zones the results may have been more complete. The assessment for selected associated factors was conducted as a cross-sectional analytical study therefore, the temporal association between them and voice disorders could not be assessed. A longitudinal study design would have been more informative. The sound level meter was used without a wind shield and the recorded readings can be slightly higher than the actual values.

5. Conclusions and Recommendations

In conclusion, several work related and environmental factors are significantly associated with voice disorders among primary school teachers in Sri Lanka. Almost all of these factors are modifiable and with timely corrective action voice disorders among teachers can be controlled and prevented.

Work related characteristics of teachers contributing to voice disorders; teaching more than 4 subjects, staying after school hours and yelling and shouting, pattern of speech, are all modifiable and the teachers should be made aware of these risk factors and how they can be controlled while teaching effectively.

The noise levels objectively assessed in selected classrooms proved that the sound levels were much higher than the comfortable speaking range within classrooms. This condition must be rectified. Standards for acceptable noise levels within classrooms for Sri Lanka should be developed, without delay.



Other environmental factors associated with voice disorders; dust including chalk dust and space and ventilation in classrooms are to be improved with the involvement of the school authorities to make the teaching environment more congenial for teachers. Standards for classroom settings are recommended to be developed through multidisciplinary involvement.

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Does this article screen for similarity?

Yes

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Data Availability Statement

Raw data sets are not publicly available to preserve the privacy of the participants.

Conflict of Interest

The author has no conflicts of interest to declare. There is also no financial interest to report. The author certifies that the submission is original work and is not under review at any other publication.

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