



VOICE CHARACTERISTICS OF SWIMMERS IN INDOOR SWIMMING POOLS

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ABSTRACT

Swimming is a physical fitness exercise done by individuals by propelling oneself through the waters. Swimming possesses many health benefits. At the same time, due to the exposure to chlorinated water and the byproducts of chlorine they are at risk for developing respiratory problems. This may have an effect on their voice characteristics. This purpose of the study was to check their acoustic characteristics. The study was conducted on thirty swimmers and compared it on age and gender matched normal controls. The phonation of the vowels /a/, /i/, /u/ was recorded, fed into CSL 4500 module (Kay Pentax, New Jersey) and further analysis was carried out using the MDVP (Multi Dimensional Voice Program). The fundamental frequency measures, short and long term frequency perturbation measures were compared across both the groups. Significant differences were found in mean fundamental frequency, Jitter %, RAP, PPQ in both the groups. The results suggest there is significant difference in the voice characteristics of normal and the swimmers. These results also suggest the need for counseling, awareness and vocal hygiene measures among swimmers regarding the better care of their voice which will in turn helps in improving their quality of life.

KEYWORDS : Swimmers, Chlorine, Acoustic analysis, MDVP

INTRODUCTION

A **voice disorder** is characterized by the abnormal production of vocal quality, pitch, loudness, resonance, and/or duration, which is inappropriate for an individual's age and/or gender. Swimming is an activity of propelling oneself through water using limbs. Swimming is either done in indoor swimming pools or outdoor pools. Swimming helps in improving the general physical fitness and possess a host of other benefits such as muscle strengthening, cardiovascular endurance, and meditative qualities. On the contrary, it also has its own adverse effects. The continuous rotation and usage of the shoulder muscles and neck muscles can lead to injury in swimmers. Injuries to the strap muscles can also cause voice related problems due to muscle tension dysphonia. Chlorine is mainly used as a disinfectant in indoor swimming pools. According to recent studies there is increasing evidence that irritant chlorination products in swimming pools can cause respiratory problems in competitive swimmers^[1]. Studies have also reported that acute exposure to chlorine may lead to severe manifestations of health consequences which include respiratory problems, laryngeal inflammation, asthma and chemical burns of the upper and lower airway mucosa and even chemical pneumonitis^[2]. It is also reported that children acutely exposed to chlorine in swimming pools had substantial lung function impairment associated with biochemical exhaled breath alteration^[3]. Studies have also reported that exposure to chlorine gas may initially cause problems such as eye and throat irritation which later may lead to acute airway obstruction including wheezing, cough, chest tightness, and dyspnea^[4]. Chlorine reacts with nitrogen-containing products in the water, such as urine or sweat, or synthetic products like cosmetics or soap. This reaction releases chloramines and nitrogen trichloride as well as other gases into the atmosphere. Chloramines are an irritant to the eyes, skin and the respiratory system and are responsible for most of the problems that swimmers complain of. Studies have also majority of elite swimmers suffered from airway hyper-responsiveness. The chlorinated water present in indoor swimming pools releases nitrogen trichloride, intake of this gas can cause severe damage to the lungs which could lead to respiratory distress or asthma^[5]. The most plausible explanation is that the exposure to chlorine based irritants in swimming pools causes defects in epithelial barriers predisposing individuals to allergic sensitization and airway inflammation. The thoracic and pulmonary disorders may serve also limit the vital capacity, which in turn will affect breath support which is necessary for efficient speaking. This respiratory distress in the swimmers may have an impact on their voice. However no studies have been done in the Indian context

investigating the voice characteristics in this population.

METHOD

Participants: The sample population included a total of 60 male adults. The experimental group consisted of thirty swimmers in the age range of 20-25 years. The control group consisted of thirty males, age and gender matched normal individuals who were neither swimmers nor were professional voice users. Both groups did not have any neurological or psychological symptoms neither did they have any history of smoking/ alcohol use also.

Procedure: The participants were seated comfortably in a quiet, noise free room. The task was demonstrated and the subjects were asked to phonate the vowel /a/, /i/ and /u/ at their comfortable pitch and loudness. This was recorded using a portable digital Sony recorder- ICD UX81F with a constant mouth-to-microphone distance of 10 cm and 45° off-axis positioning. Three trails were recorded and the best of three was selected for further analysis.

Instrumentation: The phonation sample was line-fed into the module of CSL 4500 (Kay Pentax, New Jersey) at 22 KHz sampling rate. The signal was displayed on the Multi

Dimensional Voice Program (MDVP) of the CSL 4500 module and a 3 seconds steady portion of the phonated vowel was identified and was subjected to acoustic analysis. MDVP provides a total of 33 parameters which can be classified under frequency measures, perturbation measures, noise measures, tremor measures and voice irregularity measures. In the present study fundamental frequency measures, Relative Average perturbations measures, Jitter%, Pitch Period Perturbation Quotient measures and Smoothed Pitch Perturbation quotient were compared. Independent t -test was used to find out significant difference between all parameters of two groups.

RESULTS & DISCUSSION

The results of independent t- test indicated a significant difference between participants in both the groups in all the five parameters. The mean fundamental frequency of the swimmers was 105 Hz, while that of normal controls (NC) was 130Hz ($p < 0.01$). The mean Jitter % values for Swimmers were 2.7 % while for NC it was 0.73 % ($p < 0.01$). The Relative Average Perturbation (RAP) values for swimmers was 1.68, while that of NC was 0.44 ($p < 0.01$). The Pitch Period Perturbation Quotient (PPQ) for Swimmers was 1.98 while that of NC was 0.44 ($p < 0.01$). The Smoothed Pitch Perturbation

quotient (sPPQ) for BKs was 3.29 while that of NC was 0.63 (p<0.01).

Table 1:Table showing the mean values and p values of Swimmers and Normal controls in terms Mean F0, Mean Jitter %, RAP,PPQ and SPPQ.

Parameters	Swimmers	Control group	p-value
Mean fundamental frequency	105 Hz	130 Hz	<0.01
Mean Jitter %	2.7%	0.73%	<0.01
Relative Average Perturbation	1.68	0.44	<0.01
Pitch Period Perturbation Quotient	1.98	0.44	<0.01
Smoothened Pitch Perturbation quotient	3.29	0.63	<0.01

Swimming in chlorinated water can lead to various voice problems. As the literature suggests, swimmers are subjected to more voice problems compared to normal due to frequent respiratory problems. According to the results obtained the voice characteristics of Swimmers are significantly deviant from the normal. The increase in the frequency perturbation measures in Swimmers can be due to the phonatory instability. These might be due to frequent asthma. A high degree of frequency perturbation measures results in a voice with roughness, which is usually perceived in the recordings of pathological voices. The above results are in consensus with previous studies.

CONCLUSION

The present study was an attempt to document voice characteristics in Swimmers in the age range 21-30 years and to compare them with normal controls of the same age group. The study throws light into the voice characteristics in terms of frequency perturbation measures in swimmers. The results revealed a significant difference of the mean values of the perturbation measures when compared with those of the normal adults. These results also suggest the need for counseling, awareness and vocal hygiene measures among swimmers regarding the better care of their voice which will in turn helps in improving their quality of life .The study may be replicated in a large population with larger sample size under each age group and by better controlling the factors that affect perturbation for better validation of the results

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