VOICE CHANGES IN YOUNG FEMALES ASSOCIATED WITH POLYCYSTIC OVARY SYNDROME IN MADHYA PRADESH STATE: A COMPARATIVE STUDY

[1]Shivani Saxena, [2]Dr. Vini Abhijith Gupta
[1]Postgraduate Student, [2]Associate Professor
[1,2]Department of Speech-Language Pathology,
[1,2]Dr. M. V. Shetty College of Speech and Hearing, Mangalore, Karnataka, India

Abstract: Polycystic Ovary Syndrome (PCOS) is a heterogeneous endocrine disorder characterized by hyperandrogenism, oligo-anovulation, and polycystic ovarian morphology. As the larynx contains androgen receptors, elevated androgen levels may alter vocal characteristics. The current study compared acoustic and aerodynamic voice parameters between young females with PCOS and age-matched healthy controls. Forty females aged 18–30 years were divided into a PCOS group (n = 20) and a control group (n = 20). Acoustic measures included fundamental frequency (F0), jitter, shimmer, harmonic-to-noise ratio (HNR), speaking fundamental frequency (SFF), and pitch sigma. Maximum phonation time (MPT) for /a/, /i/, and /u/ assessed aerodynamic function. Independent-samples t tests and Mann–Whitney U tests ($\alpha = .05$) were employed for the statistical analysis. Compared with controls, the PCOS group showed significantly lower F0, SFF, pitch sigma, HNR, and MPT, along with higher jitter and shimmer (all $p \leq .001$), suggesting subclinical androgenic effects on the larynx warranting routine voice screening in PCOS care that may support early identification and referral to a Speech-Language Pathologist who plays a pivotal role in the assessment and management of voice.

Index Terms – Polycystic Ovary Syndrome, acoustic analysis, jitter, shimmer, maximum phonation time, hyperandrogenism.

I. INTRODUCTION

PCOS is among the most prevalent endocrine disorders in women of reproductive age, with global prevalence estimates of 6% to 20% depending on the diagnostic criteria applied [1] and a pooled prevalence of approximately 10% in India [2]. Diagnosis under the Rotterdam consensus requires at least two of three features: clinical or biochemical hyperandrogenism, oligo-anovulation, and polycystic ovarian morphology on ultrasonography [3], [1]. Beyond its reproductive and metabolic implications, PCOS is increasingly recognized as a multisystemic condition with cardiovascular, dermatologic, psychological, and phonatory consequences [4]. The larynx expresses androgen, estrogen, and progesterone receptors on vocal fold tissue [5], [6], and the chronically elevated androgen milieu in PCOS therefore provides a biologically plausible substrate for changes in voice quality.

Estrogens contribute to mucosal hydration and to the viscoelastic properties of the lamina propria, whereas androgens promote enlargement of laryngeal cartilages, thickening of the thyroarytenoid muscle, and lengthening of the vocal folds [7]. In adulthood, endogenous or exogenous androgen excess has been linked to virilization of the female voice, that is, the development of male-typical acoustic characteristics in a female speaker, including a lowering of fundamental frequency, loss of high frequencies, and a hoarse or rough vocal quality [8], with consistent acoustic signatures across iatrogenic, transmasculine, and tumor-related contexts even when perceptual change is subtle [7], [4]. PCOS, although typically associated with milder and more chronic androgen elevations than overtly virilizing conditions, warrants systematic acoustic and aerodynamic evaluation, particularly in young adult women where age-related laryngeal change is unlikely to act as a confounder.

Empirical work on voice in PCOS has, however, yielded inconsistent results. Gugatschka et al. [9] observed a non-significant trend toward lower fundamental frequency, an increase in the relative average perturbation, and a decrease in maximum phonation time in patients with PCOS, and Aydin et al. [10] found that abnormal muscle tension and impaired vocal fold vibration were more frequent in PCOS without corresponding acoustic deterioration, whereas Hannoun et al. [11] reported a higher prevalence of vocal symptoms with significant perturbation differences and reduced MPT between 17 patients and 21 controls.

More recently, El-hakeem et al. [12] reported statistically significant acoustic and laryngoscopic differences, whereas the systematic review and meta-analysis by Turetta et al. [13] found no pooled acoustic effect, attributing the

discrepancy to methodological heterogeneity and small sample sizes. Few studies have examined connected-speech parameters such as SFF and pitch sigma alongside sustained-vowel measures, and aerodynamic indices such as MPT remain underreported [4].

Speech-language pathologists are uniquely positioned within multidisciplinary PCOS care to perform instrumental acoustic, aerodynamic, and perceptual voice assessment and to differentiate hormonally mediated change from muscle tension dysphonia, benign mucosal lesions, or reflux-related dysphonia [10], [4].

Need of the Study

Despite the biological plausibility of androgen-induced laryngeal change in PCOS [5], [6], the existing literature is small, methodologically heterogeneous, and inconsistent, with most studies confined to sustained-vowel measures and rarely combining acoustic, prosodic, and aerodynamic indices in the same protocol [10], [12], [13]. Region-relevant data are particularly scarce in the Indian context, where PCOS affects roughly one in ten women of reproductive age [2]. The present study addresses this gap with a comprehensive voice-assessment protocol and standardized effect-size reporting of voice changes in healthy controls and females with PCOS in the Bhopal district of Madhya Pradesh.

II. METHOD

Aim

The current study aims to investigate and compare the acoustic and aerodynamic voice characteristics of young females diagnosed with PCOS versus age-matched healthy controls.

Participants

Forty females (aged 18–30 years) were divided equally into a clinical group (Group II; PCOS diagnosed via Rotterdam criteria by a specialist) and an age-matched healthy control group (Group I).

Inclusion Criteria: Females aged 18–30 years; confirmed PCOS diagnosis (Group II) or healthy status with no voice complaints (Group I).

Exclusion Criteria: Prior unrelated voice or laryngeal pathology for either group.

Study Design

The current study employed a cross-sectional, group-comparative design contrasting acoustic and aerodynamic voice parameters between young adult females with PCOS and age-matched healthy controls. Ethical approval was obtained from the institution prior to participant enrollment, and the study was conducted in accordance with the Declaration of Helsinki. Each participant provided written informed consent before participation.

Instrumentation

All voice samples were recorded in a quiet clinical environment using a Boat headphone microphone.

Acoustic analyses were carried out using Praat (Version 6.4) [14], following standardized analysis settings. Recordings were digitized at a sampling rate of 44.1 kHz with 16-bit quantization and stored as uncompressed waveform audio files. Acoustic parameters included Fundamental Frequency (F0), Jitter (%), Shimmer (%), and HNR during sustained vowel production between the clinical and control groups, and SFF and Pitch Sigma during connected speech between groups.

Aerodynamic measurement of MPT was performed for the vowels /a/, /i/, and /u/ in both groups with a calibrated digital stopwatch (accuracy ± 0.01 s). Ambient noise was monitored to remain below 50 dB SPL throughout each session, and all participants underwent a brief vocal warm-up before recording to standardize laryngeal conditions across the sample.

Procedure

Following case-history intake, participants completed a fixed-order voice protocol. First, F0, jitter, shimmer, and HNR were extracted from the most stable 3-second segment of a sustained /a/ (best of three trials). Next, SFF and pitch sigma were analyzed from a 30-second Rainbow Passage reading, excluding pauses. Finally, Maximum Phonation Time (MPT) for vowels /a/, /i/, and /u/ was recorded using the longest of three trials. A 30-second rest between trials minimized fatigue.

Analysis

Data were analyzed in jamovi 2.4.8 using descriptive statistics. Normality was assessed via the Shapiro–Wilk test. Group comparisons utilized independent-samples *t* tests (Cohen's *d*) for normal data and Mann–Whitney *U* tests ($r = |z|/\sqrt{N}$) for non-normal data. Significance was set at $\alpha = .05$ (two-tailed). Test statistics and *p* values were reported to three decimal places, with values below .001 reported as $p < .001$.

III. RESULTS AND DISCUSSION

The present study aimed to compare voice profiles of females with PCOS and age-matched healthy controls across six acoustic parameters (F0, jitter, shimmer, HNR, SFF, and pitch sigma) and three aerodynamic parameters (MPT /a/, MPT /i/, and MPT /u/). The acoustic voice characteristics of the two groups are summarized in Table 1 and illustrated

in Figure 1. Across all six parameters, the PCOS group differed from the control group and every difference reached the criterion for high statistical significance ($p < .001$).

Table 1: *comparison of mean acoustic voice parameters between group I and II*

Parameter	Group I / Control (M)	Group II / PCOS (M)	Direction of change in PCOS	*p*	Significance
F0 (Hz)	233.45	203.55	Decreased	< .001	HS
Jitter (%)	0.20	0.29	Increased	.001	HS
Shimmer (%)	2.18	4.79	Increased	< .001	HS
HNR (dB)	22.39	17.91	Decreased	.001	HS
SFF (Hz)	243.60	215.25	Decreased	< .001	HS
Pitch Sigma (Hz)	38.97	28.01	Decreased	.001	HS

Note. HS = Highly Significant; S = Significant; NS = Not Significant.

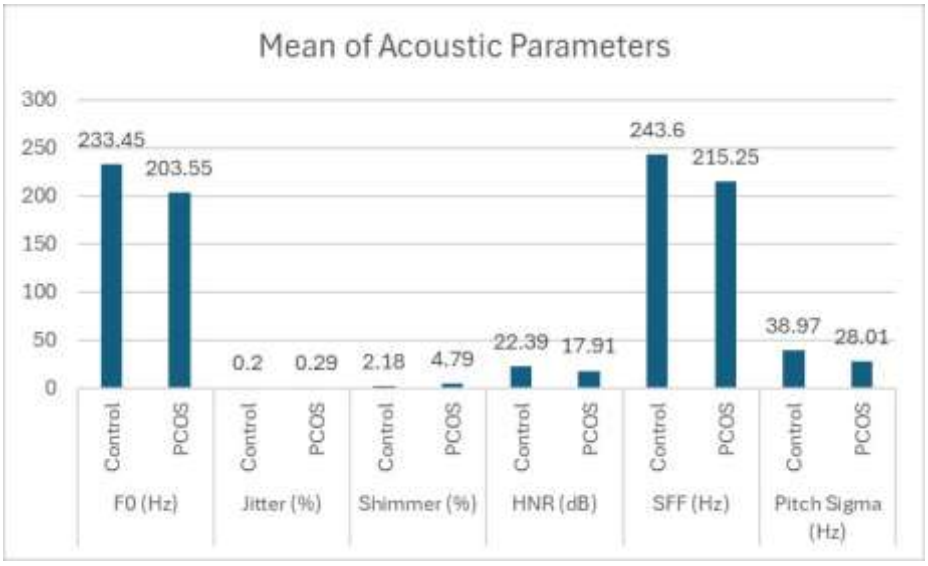

Figure 1: *comparison of mean acoustic voice parameters between group i and ii*

As shown in Table 1 and Figure 1, Group II (PCOS) demonstrated a lower habitual pitch than Group I (Controls) in both sustained phonation (F0) and connected speech (SFF), along with reduced pitch variability (Pitch Sigma), elevated jitter and shimmer, and reduced HNR. High statistical significance was observed for all six acoustic comparisons ($p \leq .001$). These findings stand in contrast to those of Aydin et al. [10] and Gugatschka et al. [9], who reported no significant acoustic differences in women with PCOS, and to the pooled null results of the meta-analysis by Turetta et al. [13]. The present acoustic results align with Hannoun et al. [11], who likewise found significant perturbation changes, and with El-hakeem et al. [12], who reported significant acoustic deviations. The pattern is biologically consistent with androgen-receptor–mediated laryngeal change [7], [5], [6], [4].

Table 2: *comparison of mean aerodynamic voice parameters between group I and II*

Parameter	Group I / Control (M)	Group II / PCOS (M)	Direction of change in PCOS	*p*	Significance
MPT /a/ (s)	15.15	11.05	Decreased	.001	HS
MPT /i/ (s)	17.30	11.70	Decreased	< .001	HS
MPT /u/ (s)	16.75	11.10	Decreased	< .001	HS

Note. HS = Highly Significant; S = Significant; NS = Not Significant.

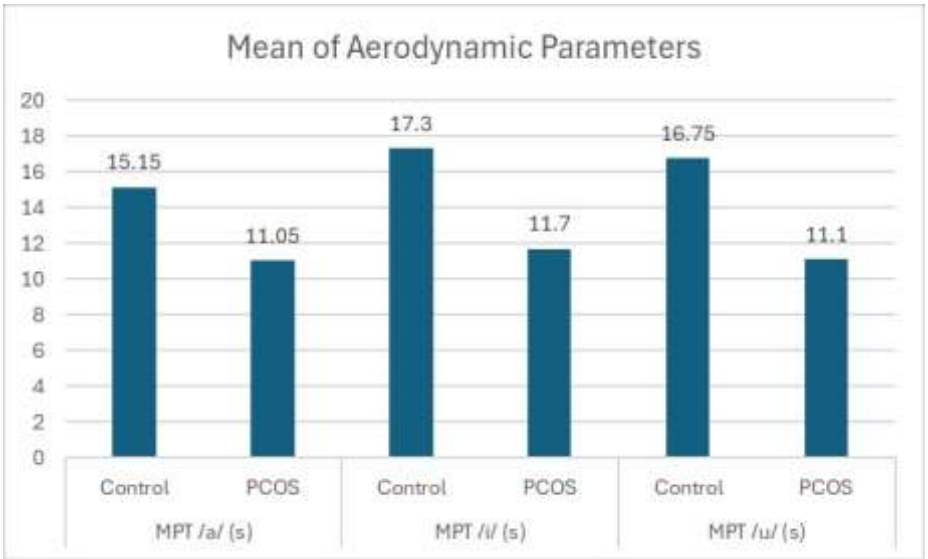

Figure 2: *comparison of mean aerodynamic voice parameters between group i and ii*

As shown in Table 2 and Figure 2, Group II (PCOS) sustained vowel phonation for substantially shorter durations than Group I (Controls), with reductions of approximately 4 to 6 seconds across /a/, /i/, and /u/. High statistical significance ($p \leq .001$) was observed for all three MPT comparisons. These findings align directly with Hannoun et al. [11], who similarly reported a significant reduction in MPT in women with PCOS. The pattern is also consistent with the stroboscopic findings of Aydin et al. [10], who documented incomplete glottal closure and abnormal vocal fold vibration in PCOS, both of which can shorten sustainable phonation. A contributing role of obesity-related and respiratory comorbidities described in the international PCOS guideline cannot be ruled out [1]. The uniform reduction across vowels suggests a source-level phonatory deficit.

IV. SUMMARY AND CONCLUSION

The current study aimed to investigate voice-related changes in females with PCOS as compared to those of age-matched healthy females. Findings suggest that young adult females with PCOS exhibited a consistent and statistically robust voice profile relative to age-matched controls, comprising lower F0 and SFF, reduced pitch variability, elevated jitter and shimmer, reduced HNR, and shorter MPT across /a/, /i/, and /u/. Effects were large across all nine parameters, suggesting that subclinical androgenic effects on the larynx are detectable with standard instrumentation well before overt virilization.

These findings extend earlier work reporting subjective complaints and laryngostroboscopic abnormalities without acoustic differences, and align with recent quantitative results. The pattern supports the integration of voice screening into multidisciplinary PCOS care as envisaged by current international guidelines and highlights the value of speech-language pathology expertise within endocrine and reproductive medicine. Larger samples, perceptual and laryngoscopic adjuncts, and longitudinal designs will further clarify mechanistic pathways linking endocrine status to phonatory function.

The findings carry clear clinical implications. Women presenting with vocal fatigue, hoarseness, or lowered pitch should be evaluated for endocrine conditions such as PCOS alongside common laryngeal disorders, particularly in India, where prevalence is substantial. Instrumental assessment using accessible software such as Praat and MPT screening offer low-cost adjuncts to routine PCOS care and hence may be included in current practices.

Limitations

Several limitations should be acknowledged: (a) the small sample size; (b) variables such as body mass index, biochemical androgen levels, menstrual-cycle phase, and hormonal medication use were not analyzed; (c) aerodynamic assessment did not include the s/z ratio; and (d) perceptual and laryngoscopic examination were not included.

Future Directions

Future research should adopt longitudinal designs with larger samples to track voice changes across PCOS progression and management. Combining voice measures with biochemical markers (testosterone, sex-hormone–binding globulin, anti-Müllerian hormone, insulin) and adopting standardized acoustic protocols would clarify endocrine–laryngeal links and enable reliable replication. Intervention-based research evaluating voice therapy outcomes in women with PCOS is also needed to translate these findings into clinical practice.

ACKNOWLEDGMENT

The authors thank all the participants for their willingness to contribute to this study. The authors also acknowledge the support of Dr. M. V. Shetty College of Speech and Hearing, Mangalore, for providing the academic and infrastructural support necessary to conduct this research.

REFERENCES

[1] Teede, H. J., Tay, C. T., Laven, J. J. E., Dokras, A., Moran, L. J., Piltonen, T. T., Costello, M. F., Boivin, J., Redman, L. M., Boyle, J. A., Norman, R. J., Mousa, A., Joham, A. E., & the International PCOS Network. (2023). Recommendations from the 2023 international evidence-based guideline for the assessment and management of polycystic ovary syndrome. *European Journal of Endocrinology*, *189*(2), G43–G64. https://doi.org/10.1093/ejendo/lvad096

[2] Bharali, M. D., Rajendran, R., Goswami, J., Singal, K., & Rajendran, V. (2022). Prevalence of polycystic ovarian syndrome in India: A systematic review and meta-analysis. *Cureus*, *14*(12), Article e32351. https://doi.org/10.7759/cureus.32351

[3] The Rotterdam ESHRE/ASRM-Sponsored PCOS Consensus Workshop Group. (2004). Revised 2003 consensus on diagnostic criteria and long-term health risks related to polycystic ovary syndrome (PCOS). *Fertility and Sterility*, *81*(1), 19–25. https://doi.org/10.1016/j.fertnstert.2003.10.004

[4] Stogowska, E., Kamiński, K. A., Ziółko, B., & Kowalska, I. (2022). Voice changes in reproductive disorders, thyroid disorders and diabetes: A review. *Endocrine Connections*, *11*(3), Article e210505. https://doi.org/10.1530/EC-21-0505

[5] Kirgezen, T., Sunter, A. V., Yigit, O., & Huq, G. E. (2017). Sex hormone receptor expression in the human vocal fold subunits. *Journal of Voice*, *31*(4), 476–482. https://doi.org/10.1016/j.jvoice.2016.11.005

[6] Newman, S. R., Butler, J., Hammond, E. H., & Gray, S. D. (2000). Preliminary report on hormone receptors in the human vocal fold. *Journal of Voice*, *14*(1), 72–81. https://doi.org/10.1016/S0892-1997(00)80096-X

[7] Abitbol, J., Abitbol, P., & Abitbol, B. (1999). Sex hormones and the female voice. *Journal of Voice*, *13*(3), 424–446. https://doi.org/10.1016/S0892-1997(99)80048-4

[8] Nygren, U., Nyström, H. F., Falhammar, H., Hagenfeldt, K., Nordenskjöld, A., & Södersten, M. (2019). Voice dissatisfaction in individuals with a disorder of sex development. *Clinical Endocrinology*, *91*(1), 219–227. https://doi.org/10.1111/cen.14000

[9] Gugatschka, M., Lichtenwagner, S., Schwetz, V., Lerchbaum, E., Graupp, M., Gerstenberger, C., Kiesler, K., Obermayer-Pietsch, B., & Friedrich, G. (2013). Subjective and objective vocal parameters in women with polycystic ovary syndrome. *Journal of Voice*, *27*(1), 98–100. https://doi.org/10.1016/j.jvoice.2012.07.007

[10] Aydin, K., Akbulut, S., Demir, M. G., Demir, S., Ozderya, A., Temizkan, S., & Sargin, M. (2016). Voice characteristics associated with polycystic ovary syndrome. *The Laryngoscope*, *126*(9), 2067–2072. https://doi.org/10.1002/lary.25818

[11] Hannoun, A., Zreik, T., Husseini, S. T., Mahfoud, L., Sibai, A., & Hamdan, A. L. (2011). Vocal changes in patients with polycystic ovary syndrome. *Journal of Voice*, *25*(4), 501–504. https://doi.org/10.1016/j.jvoice.2009.12.005

[12] El-hakeem, W. H. A., Mohamed, H. M. A., Abdelmooty, E. A., & Essawy, H. G. (2024). Voice analysis in women with polycystic ovary syndrome. *The Egyptian Journal of Otolaryngology*, *40*(1), Article 117. https://doi.org/10.1186/s43163-024-00659-5

[13] Turetta, C., Colizza, A., Giannini, A., Ralli, M., Bogani, G., Laganà, A. S., Pecorini, F., Muzii, L., Paoli, A., Di Donato, V., & De Vincentiis, M. (2024). Polycystic ovary syndrome and alteration of vocal function: A systematic review and meta-analysis. *Gynecologic and Obstetric Investigation*, *89*(1), 22–30. https://doi.org/10.1159/000535819

[14] Boersma, P., & Weenink, D. (2024). *Praat: Doing phonetics by computer* (Version 6.4) [Computer software]. https://www.praat.org