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Voice analysis in women with polycystic ovary syndrome

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Abstract

Background Polycystic ovarian syndrome (PCOS) is a common endocrine disorder affecting one in five women of reproductive age. Polycystic appearance of the ovaries in ultrasonography is associated with oligomenorrhea, and clinical and or biochemical hyperandrogenism. PCOS has been associated with voice alterations for many years. However, there is insufficient research on voice analysis in PCOS patients.

Objectives This research aimed to examine the voice characteristics among women with PCOS.

Patients and methods Our study included 25 women confirmed with PCOS and 25 control. A complete voice assessment was performed for all participants using primary demographic data, vocal symptoms, auditory perceptual evaluation of the voice, Arabic version of the Voice Handicap Index, acoustic analysis, and video laryngoscopic examination of the larynx.

Results Our study revealed statistically significant differences between PCOS and control groups in phonasthenic symptoms, auditory perceptual assessment of the voice, acoustic parameters, and laryngoscopic examination.

Conclusion PCOS women with hirsutism are complaining of vocal symptoms, changes in vocal characters, and deterioration of the acoustic parameters of the voice. High serum levels of androgen can cause the deepening of the voice, which is essential for the early detection of vocal symptoms in PCOS patients to prevent virilization of their voice.

Trial registration NCT06085170. Registered 20 August 2023—retrospectively registered, <https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://classic.clinicaltrials.gov/ct2/show/NCT06085170&ved=2ahUKEwjEyLqUq6KGAXWxRPEDHb57DIQQFnoECBQQAQ&usq=AOvVaw1xTurnA6mJEZ9PK0vQS8VL>.

Keywords Polycystic ovary syndrome, Hyperandrogenism, Vocal symptoms, Dysphonia, Acoustic parameters

Background

One in five women of reproductive age suffers from the common endocrine condition known as polycystic ovarian syndrome (PCO) [1]. PCOS is a multidimensional

illness commonly marked by the appearance of tiny cysts on the ovaries, elevated androgen levels, inconsistent menstruation, failure in ovarian function, acne, hirsutism, alopecia, and glucose intolerance [2].

PCOS is typically diagnosed using the Rotterdam criteria, which states that it's more likely to affect women who have two of the three problems. These disorders include hyperandrogenism, oligo/anovulation, and polycystic ovaries in ultrasonography [3]. The human larynx is sensitive to hormones and has hormonal receptors embedded in the vocal folds. Vocal alterations correspond to sex hormone swings [4].

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Women who have PCOS often exhibit hyperandrogenism, which causes a deepening of their voices due to an excess of androgen. Voice changes have long been recognized as one of the defining characteristics of PCOS. Many researchers have reported an association between the voice of humans and the hormonal system in females at various stages of their lives [5].

PCOS patients appear to exhibit increased vocal symptoms compared to the control group. Physicians should examine alteration in voice in individuals with PCO complaining of hirsutism [6].

Anovulation and hyperandrogenism can cause significant virilization. In addition to hirsutism, greasy skin, and acne, androgens can also cause vocal alterations [7]. According to [8], high amounts of androgens may cause enlargement of the thyroarytenoid muscle, leading to a lower vocal pitch.

Our research aimed to examine the voice characteristics among women with PCOS.

Methods

The study comprised 25 participants with confirmed PCOS and 25 controls who did not have PCOS. All subjects signed consent to participate in the study. The phoniatrics unit at Minia University Hospital was the setting for this case–control study. The Research Ethics Committee at Minia University Faculty of Medicine approved this research (with Approval No. 901/10/2023). also, the clinical trials were registered publicly before any participants were enrolled in the study (Clinical Trials.gov identifier NCT06085170). Patients with hirsutism and infertility were recruited from the Minia Infertility Center at the Obstetric Gynaecology Department. PCOS was diagnosed based on three criteria: irregular menstrual cycles, oligo- or anovulation, signs of hyperandrogenemia (clinical and biochemical), and polycystic ovaries. Ultrasound detects polycystic ovaries with more than 12 follicles with diameters ranging from 3 to 9 mm. Our inclusion criteria for the study group included women with PCOS. Women in the control group have a regular menstrual cycle, no polycystic ovaries detected by ultrasonography, and no clinical or biochemical indications of hyperandrogenism. Subjects not having signs of hyperandrogenism, other causes of hyperandrogenism or anovulation, e.g., Cushing syndrome, androgen-secreting tumors, or other conditions, smoking, and professional voice users were excluded from the study. Demographic data was collected from our patients: age, Body Mass Index (BMI), smoking, symptoms of laryngopharyngeal reflux, and biochemical measurement of serum testosterone.

Participants were asked if they experienced vocal symptoms such as frequent throat clearing, throat lump, deepening of their voice, and vocal fatigue during the

PCOS development stage. After recording the patient's voice for sustained vowel [a] vowel and connected speech, two experts graded it using the modified GRBAS scale. The recorded sample is scored using the modified GRBAS scale, which has four grades ranging from no to severe dysphonia, the grades are from 0 to 4. Voice Handicap Index (VHI) was created and validated initially by [9] for English-speaking people. VHI is a self-administered Arabic-language questionnaire (Additional file 1: Appendix 1). It asks patients to describe their voices and how much their quality of life is affected by a voice ailment on a functional, physical, and emotional level [10]. Then, each patient received a laryngeal examination utilizing a 70° rigid Telepack X LED, 8.5 (Karl Storz endoscope). The Multidimensional Voice Programme (MDVP) software evaluated the individuals' acoustic parameters in the same setting.

A sound-treated room was used for data collection. A microphone was positioned 10 cm before their mouths and continually phonated to record their vocal samples. After eliminating the irregularities in the first and last three seconds, the vocal features were examined using a continuous /a/vowel for nine seconds. Three vowel samples were taken, and the average was determined statistically. The measured acoustic variables were average fundamental frequency, shimmer, jitter, maximum phonation time, and harmonic-to-noise ratio. Data was input and analyzed using the Statistical Package for Social Science (SPSS) version 20 software from the University of Chicago. Quantitative data is presented as means and standard deviations, whereas qualitative data is presented as frequencies and percentages. A *P* value of less than 0.05 indicates statistical significance. A chi-squared test was utilized to compare categorical data, whereas independent quantitative data was compared using a student *t*-test. Our research aimed to examine the voice characteristics among women with PCOS.

Results

Demographic data

All patients fulfilled the diagnostic criteria for PCOS listed above (Table 1).

The study and control groups did not differ significantly ($P \geq 0.05$) regarding age and BMI (Table 1).

Significant nonstatistical differences regarding GERD were obtained between the research and control groups ($P \geq 0.05$) (Table 1).

Phonasthenic symptoms

Phone asthenic symptoms showed significant variations between patients and control ($P < 0.001$) (Table 2).

Table 1 Sociodemographic statistics

Variables	PCOs N (25)	Control N [25]	(P value)
Age: mean ±SD	25.96±2.86	26.00±3.27	0.964
BMI: mean ±SD	25.92±3.13	25.12±2.63	0.334
GERD: n (%)			0.333
Present	8(32%)	5(20%)	
Absent	17(68%)	20(80%)	
Oligo/ Anovulation:			<0.001*
Present	25(100%)	0(0%)	
Absent	0(0%)	25(100%)	
Clinical Hypergonadism:			<0.001*
Present	25(100%)	0(0%)	
Absent	0(0%)	25(100%)	
Polycystic Ovaries by US:			<0.001*
Present	25(100%)	0(0%)	
Absent	0(0%)	25(100%)	
Free testosterone levels (nmol/L)	3.19±0.53	0.007±0.006	<0.001***

*Variable is significant

Table 2 Phone asthenic symptoms

	PCOs N (25)	Controls N (25)	p-value
Frequent throat clearing: n (%)			0.039*
Positive	13(52%)	5(20%)	
Negative	12(48%)	20(80%)	
Deepening of the voice: n (%)			<0.001*
Positive	20(80%)	3(12%)	
Negative	5(20%)	22(88%)	
Throat lump: n (%)			0.186
Positive	8(32%)	4(16%)	
Negative	17(68%)	21(84%)	
Vocal fatigue: n (%)			0.039*
Positive	13(52%)	5(20%)	
Negative	12(48%)	20(80%)	

*Variable is significant

In the study group, 13 (52%) experienced frequent throat clearing, 20 (80%) had voice deepening, 8 (32%) had throat lumps, and 13 (52%) had vocal fatigue.

In the control group, 5 (20%) experienced frequent throat cleaning, 3 (12%) had voice deepening, 4 (16%) had throat lumps, and 5 (20%) had vocal fatigue.

Auditory perception of the voice (APA)

The study and control groups had substantial differences in APA of the voice ($P < 0.001$) (Table 3).

In the research group, 8 (32%) had grade I dysphonia with low pitch voice, 3(12%) had grade II dysphonia with strained character, and 14(56%) had no dysphonia.

Table 3 Auditory perceptual assessment of the voice (APA)

Variables	PCOs N= 25	Controls N= 25	p-value
APA of the voice: n (%)			0.001*
No dysphonia	14(56%)	21(84%)	
Dysphonia grade I, Low pitch	8(32%)	0(0%)	
Dysphonia grade II, Strained	3(12%)	0(0%)	
Dysphonia grade I, Leaky	0(0%)	4(16%)	

*Variable is significant

Table 4 Voice Handicap Index

	PCOS N (25)	Controls N (25)	P value
Functional VHI	0.68±1.34	0.56±1.26	0.746
Median and IQR	0(0–0.5)	0(0–0)	
Physical VHI: mean and ±SD	1.04±0.84	0.88±0.83	0.502
Median and IQR	1(0–2)	1(0–2)	
Emotional VHI: mean and ±SD	0.16±0.37	0.12±0.33	0.691
Median and IQR	0(0–0)	0(0–0)	
VHI total score: mean ±SD	1.16±1.02	1.48±1.04	0.281
Median (IQR)	1(0–2)	1(1–2)	

Table 5 Laryngoscopic examination

Variables	PCOs N= 25	Controls N= 25	p-value
Laryngoscopic findings:			0.036*
Normal	9(36%)	16(64%)	
vocal fold congestion and edema	10(40%)	6(24%)	
vocal fold nodules	0(0%)	2(8%)	
vocal fold hypertrophy	6(24%)	1(4%)	

*Variable is significant

In the control group, 4(16%) had grade I dysphonia with leaky character, 21(84%) had no dysphonia.

Voice Handicap Index There were no significant differences in physical, functional, emotional, or total VHI domains between the cases and control groups ($p > 0.01$). (Table 4).

Laryngeal examination

Laryngoscopic examination revealed substantial differences between patients and control groups ($P < 0.001$) (Table 5).

In the study group, 9(36%) had normal laryngoscopic findings, 10 (40%) had vocal fold congestion and edema, and 6 (24%) had vocal fold hypertrophy (Fig. 1).



Fig. 1 Laryngoscopic findings in PCOS



Fig. 2 Laryngoscopic findings in control

Table 6 Acoustic parameters

	PCOS N (25)	Controls N (25)	P value
Fundamental frequency (F0)	212.24±23.33	262.00±25.54	<0.001*
Jitter	0.35±0.07	0.33±0.06	0.522
Shimmer	3.01±0.61	2.95±0.69	0.747
HNR	19.64±2.51	21.08±2.32	0.041*
MPT	13.16±1.47	18.12±1.73	<0.001*

*Variable is significant

In the control group, 16 (64%) had normal laryngoscopic findings, 6 (24%) had vocal fold congestion and edema, 2 (8%) had vocal fold nodules, and 1(4%) had vocal fold hypertrophy (Fig. 2).

Acoustic analysis

Our investigation found a substantial difference ($P < 0.001$) between patients and controls for fundamental frequency, HNR, and MPT (Table 6).

In the study group, the mean of F0 was 212.24 ± 23.33 , HNR was 19.64 ± 2.51 and MPT was 13.16 ± 1.47 . while in the control group, the mean of F0 was 262.00 ± 25.54 , HNR was 21.08 ± 2.32 , and MPT was 18.12 ± 1.73 .

Discussion

Voice is a secondary sexual trait that reflects a person’s character and personality [4]. The most frequent endocrine condition among middle-aged women is polycystic ovary syndrome (PCOS) [11].

Many researchers have reported an apparent association between the hormonal system and the human voice in females at various stages of their lives [5]. Patients with PCOS exhibit more significant vocal symptoms than controls [6].

The current study showed statistically significant differences in phone asthenic symptoms like deepening voice, frequent throat clearing, and vocal fatigue. This finding may be explained by Ovarian hyperandrogenism, which is the primary endocrine component of PCOS. High androgen levels can cause hypertrophy in the thyroarytenoid muscle, leading to a lower vocal tone. Hyperandrogenism can cause instability in the voice and increase the muscle mass of the female’s VFs, resulting in the decreased fundamental frequency of the voice and deep voice. This finding aligns with [6], who reported that PCOS patients are more likely to have throat clearing, a deeper voice, and shorter maximum phonation times. Aydin et al. [12] conducted their study on 30 patients with PCOS and 22 subjects of a control group, revealing that the PCOS group had more voice complaints, although the difference was insignificant. Also, this was agreed with [13], who reported a substantial difference in subjective complaints between the PCOS and control groups, including throat clearing, throat lump, voice deepening, and difficulty hearing.

Auditory perceptual assessment of voice showed highly statistically significant differences between cases and control groups. This observation can be interpreted as the anatomical changes caused by the hyperandrogenic state of the PCOS in the vocal folds; also, PCOS was mostly correlated to psychological distress. Women with

PCOS are more likely to experience sadness and mental stress due to hyperandrogenism's physical traits, such as obesity, hirsutism, infertility, and cystic acne, which may impact their feminine identity. This psychological stress may affect their voice. Zangeneh et al. reported that PCOS-related symptoms were most closely related to a psychiatric disturbance [14]. Psychological stressors can also have an impact on voice quality by causing dysphonia [15]. Depression and hirsutism symptoms are linked [14].

VHI showed no significant variance between cases and control. This finding may be explained by the grade of dysphonia in both groups being not severe enough to influence the patient's quality of life, which was clear from the result as the majority of patients had grade I dysphonia. This finding supports Gugatschka et al. [16], who reported that VHI had been investigated across all subsets, and there were no statistically significant differences in total or subgroup scores between groups. Also, this is in line with [12], who reported that the average VHI for the PCOS group was zero (0–27), and the results were identical to the controls' mean values ($P > 0.05$).

Our results demonstrated statistically significant variations between cases and control regarding laryngoscopy findings. These findings may be due to the effect of both estrogen and androgen levels in women with PCOS. PCOS has a hyperestrogenic effect. Estrogen is thought to stimulate mucosal hypertrophy and proliferation. Changes in estrogen levels produce water retention in the larynx, edema in the interstitial tissues, and venous dilatation, which leads to vocal fold congestion. Androgen induces muscle cell hypertrophy, which leads to vocal fold hypertrophy. These findings aligned with [6], who reported that three PCOS patients showed minor edema of the vocal fold, but one had vocal nodules. Aydin et al. found that abnormal laryngeal findings were more common in PCOS than control [12].

The acoustic characteristics differed significantly between the patients and controls. The mean of fundamental frequency in the research group was decreased more than the control group, leading to a deepening of their voice. These findings can be explained by hypertrophy of the vocal muscles due to high levels of androgen. These findings were agreed with Hannoun et al., who stated that patients with PCOS had a lower fundamental frequency than controls; however, the change was not statistically significant [6]. According to Nygren et al., high amounts of androgens may cause hypertrophy in the thyroarytenoid muscle, leading to a lower vocal tone [8]. Exogenous androgens can cause instability in the female voice and increase muscle mass in the vocal folds, resulting in decreased fundamental voice frequency and deepened voice [17]. Aydin et al.

found in their study about PCOS that the mean of MPT in the research group was decreased than in the control group, which was consistent with our findings [12].

Our study has some limitations, such as a small sample size and measuring the psychological state of the patients, which may contribute to the vocal problems.

Conclusion

PCOS women with hirsutism are complaining of vocal symptoms, changes in vocal characters, and deterioration of the acoustic parameters of the voice. High serum levels of androgen can cause the deepening of the voice, which is essential for the early detection of vocal symptoms in PCOS patients to prevent virilization of their voice.

Abbreviations

PCOS	Polycystic ovary syndrome
BMI	Body Mass Index
APA	Auditory Perceptual Assessment
VHI	Voice Handicap Index
FO	Fundamental frequency
GERD	Gastroesophageal reflux disease
HNR	Harmonic to noise ratio
MDVP software	Multidimensional Voice Program
SD	Standard deviation
MPT	Maximum phonation time
US	Ultrasonography

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s43163-024-00659-5>.

Additional file 1. Appendix 1. Voice Handicap Index (Original).

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None.

Authors' contributions

WA contributed significantly to the idea of the study. HE and HA was the key to the analysis, interpretation, and drafting of the manuscript. EA collected independently the study data from the selected individuals. HE and HA had a significant effect on data collection and analysis. WH made significant contributions to the data analysis, writing, and editing of the paper. All authors read and approved the final manuscript.

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Availability of data and materials

The materials are available from the corresponding author on request.

Declarations

Ethics approval and consent to participate

All Participants received their consent after the study was approved The Ethics Committee for Research in the Faculty of Medicine at Minia University gave its approval to this study (Approval No. 901/10/2023) also the clinical trials were registered publicly before any participants were enrolled in the study (Clinical Trials.gov Identifier NCT06085170).

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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