

An Acoustic Examination of Pitch Variation in Soprano Singing

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Introduction

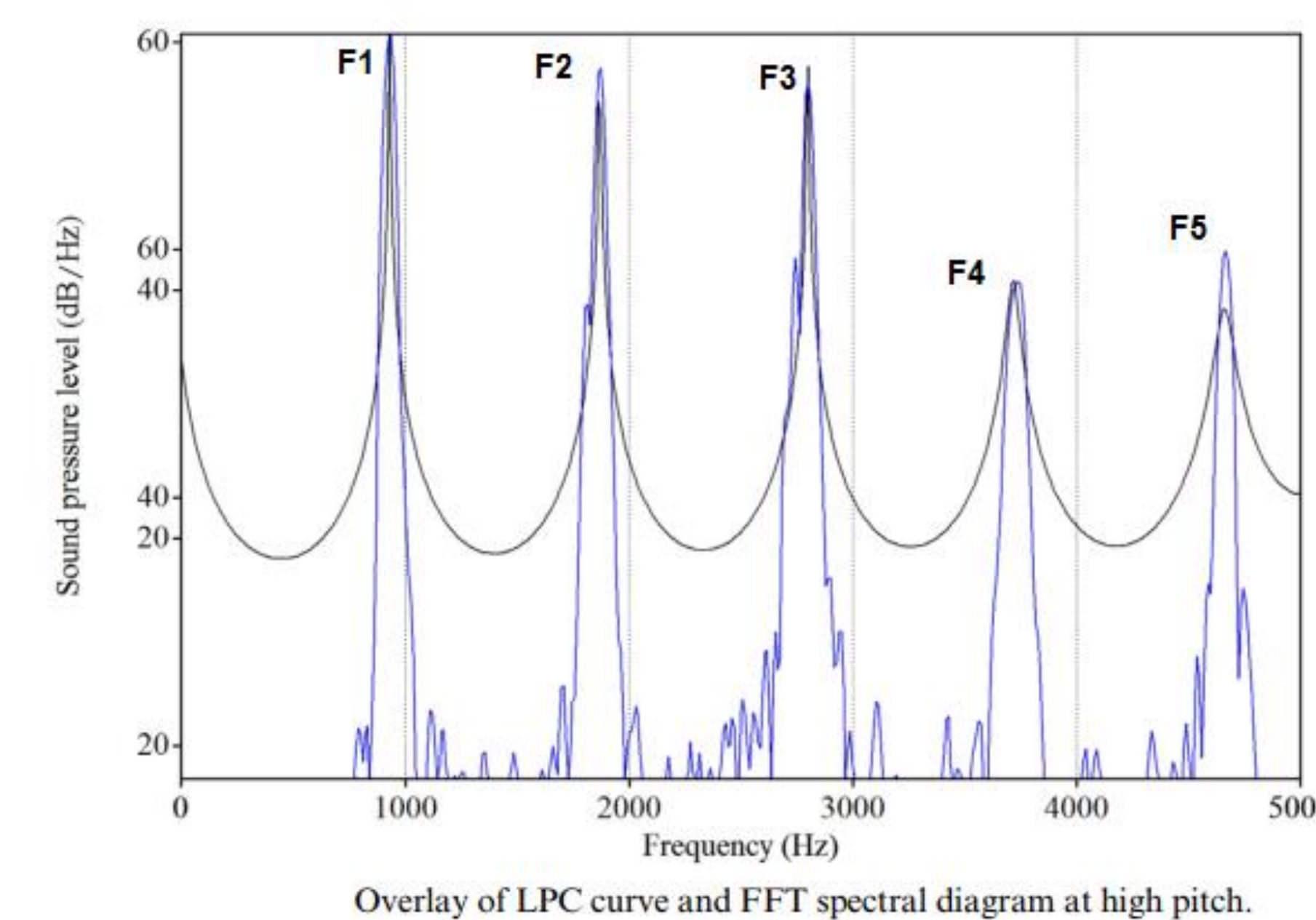
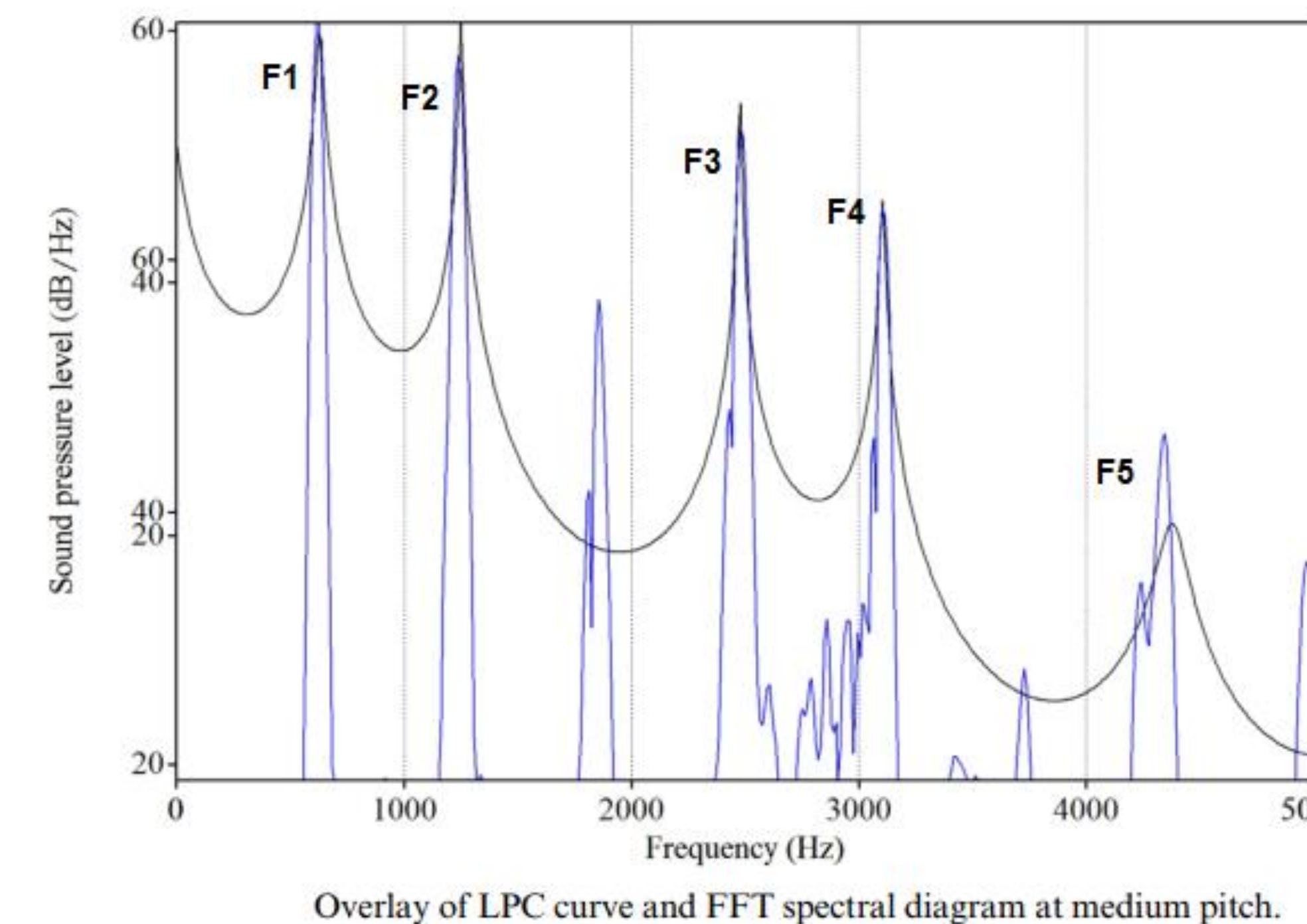
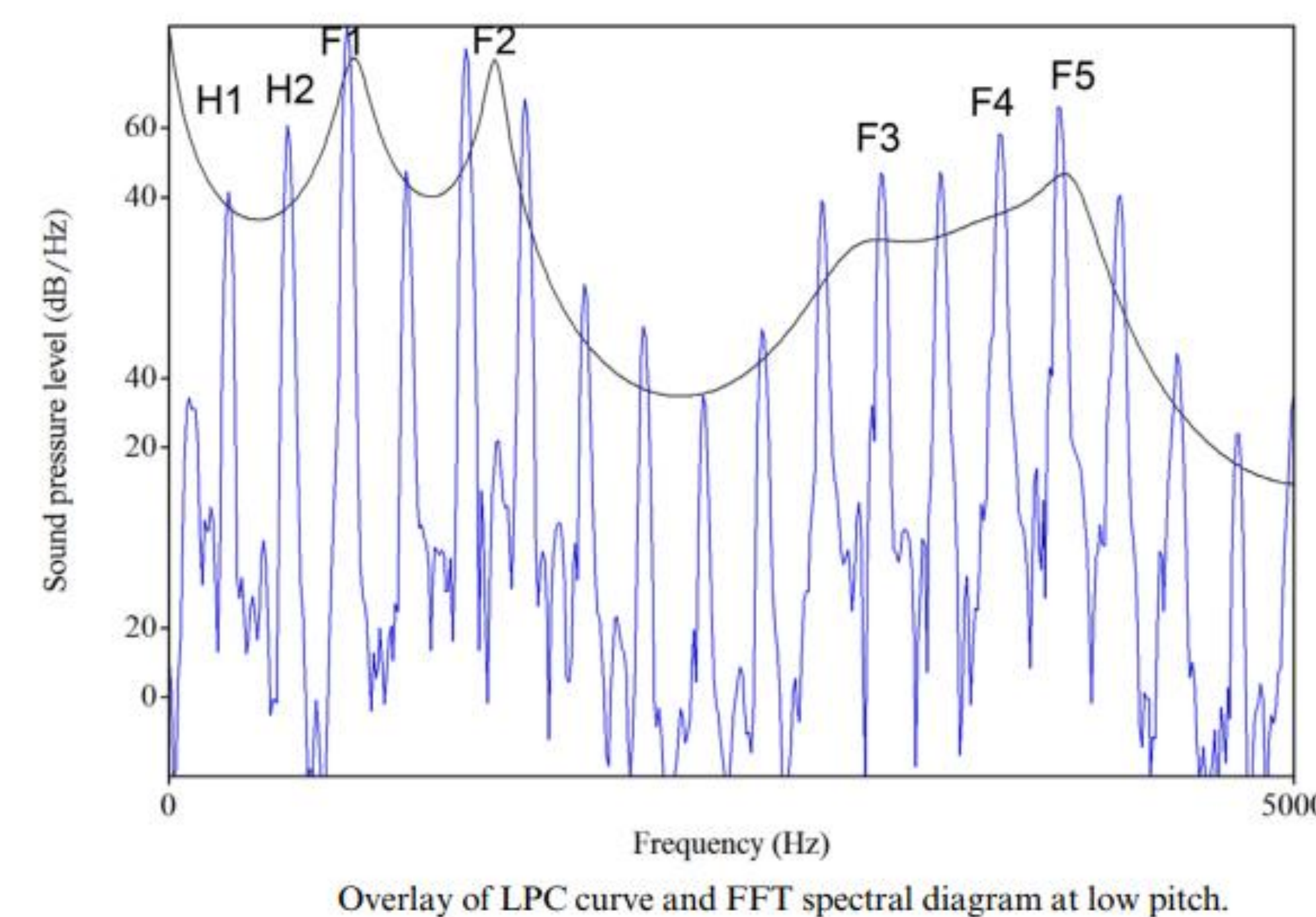
The singing voice has specific characteristics and parameters that are involved during the phonation mechanism, which may be analyzed acoustically.^{1,2} In this study, we aim observe the sopranos formants in pitch variation in the /a/ vowel.

Materials and methods

Sample: 30 professional sopranos between the ages of 20 to 45 years without vocal complaints. Recording in an acoustically controlled environment. We used a 64-GB iPad Air running the Apple IOS 9.3 using digital condenser microphone (Shure MOTIV MV88) at a distance of 50 cm placed directly in line with the mouth.³ The equipment was placed on a rigid music stand rack and adjusted according to the singer's height.

Results

Overlaying the LPC and FFT graphs revealed a similarity between F1 and F2 at the two pitches, with clustered harmonics in the F3, F4, and F5 region in the low pitch. At the medium pitch, there was similarity between F3 and F4, an F5 peak, and tuned harmonics.¹⁴ However, in the high-pitch vocalizations, there was an increase in the F2, F3, F4, and F5 values in relation to f0, and there was similarity between them along with synchrony between f0 and F1, H2 and F2, H3 and F3, H4 and F4, and H5 and F5.



Sung Pitches		f0	F1	F2	F3	F4	F5	Friedman test (P)	Comparative results
Low Middle C 261 Hz	Mean	260.5	800.2	1337.4	2976.1	3634.1	4250.3		
	Median	260.4	811.8	1314.1	2961.5	3629.9	4243.6	<0.001*	F0 < F1 < F2 < F3 < F4 < F5
	Standard deviation	1 semitone	28.1	121.3	265.5	323.6	232.1		
Medium Eb5 622 Hz	Mean	621.5	684.4	1301.8	2891.2	3564.0	4308.9		
	Median	622.4	664.4	1284.0	3024.0	3671.6	4251.6	<0.001*	F0 < F1 < F2 < F3 < F4 < F5
	Standard deviation	1 semitone	71.3	45.9	267.2	241.9	383.7		
High Bb5 932 Hz	Mean	935.8	929.3	1599.6	2778.4	3703.8	4675.4		
	Median	932.4	917.6	1732.1	2824.2	3759.0	4655.5	<0.001*	F0 = F1 < F2 < F3 < F4 < F5
	Standard deviation	3 semitones	38.3	321.7	184.0	237.9	173.3		

Note: * means "statistically significant".

Conclusions

Pitch changes indicate differences in the behavior of the fundamental frequency and sound formants in sopranos. The comparison of the sustained vowels sounds in f0 at the three pitches revealed specific vocal tract changes on the LPC curve and FFT harmonics, with an extra gain range at 261 Hz, synchrony between peaks of formants and harmonics at 622 Hz, and equivalence of f0 and F1 at 932 Hz.

For the next steps increase the reliability test for the extracted measures and their reproducibility. Additionally, perform the vocal tract charts for future comparative analyzes of the participants in conjunction with imaging exams.

Literature cited

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Further information

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