Clinical Research

ENT Updates 2019;9(3): 219-226
DOI: 10.32448/entupdates.638475

ENT updates
www.entupdates.org

# The association between subjective and objective masculine vocal quality in hormone-naïve trans-male individuals

**Seher Şirin[1,2], Aslıhan Polat[3,4]**

*1 Department of Otorhinolaryngology and Head Neck Surgery, Kocaeli University School of Medicine, Kocaeli, Turkey*
*2 Voice Clinic, Kocaeli University School of Medicine, Kocaeli, Turkey*
*3 Department of Psychiatry, Gender Dysphoria Clinic, Kocaeli University School of Medicine, Kocaeli, Turkey*
*4 Community Mental Health Center, Kocaeli University, Kocaeli, Turkey*
*Seher Sirin, ORCID: 0000-0002-2982-9379*
*Aslıhan Polat, ORCID: 0000-0001-9649-8701*

**Abstract**

**Objective:** The aim of this study is to investigate the association between subjective and objective masculine vocal quality in hormone-naïve trans-male individuals.

**Methods:** Twenty-seven hormone-naïve trans-male individuals were recruited for the study. All the study participants had applied to undergo the gender transition process and been referred to the Voice Clinic. The Self-Perception of Voice Masculinity (SPVM) scale and the mean fundamental frequency (F0) were used to assess any association between subjective and objective vocal masculinity.

**Results:** The mean age of study participants was 25.3 years. The median F0 lay within the normal limits for cisgender females. However, in 12 out of 27 cases, F0 lay within the gender-ambiguous frequency range. SPVM scores were higher in this ambiguous group, a result with a strong tendency toward statistical significance (p=0.053). A moderate negative correlation between SPVM and F0 scores was observed (r=-0.484, p=0.027). The smoking frequency was high, with 77.8% of individuals in the group as a whole being smokers. Not only were F0 values of smokers lower than those of non-smokers, but their SPVM scores were also higher.

**Conclusion:** The findings from this study indicate that diversity in objective and subjective voice parameters exists even within the hormone naïve period. There appear to be several factors which influence F0 to a significant extent. Accordingly, a more comprehensive approach is called for when assessing transgender voice at all stages of the gender-affirming medical treatment process. The high frequency of smoking amongst the trans-male population should also be noted as it constitutes a serious health hazard.

**Keywords:** Transgenders, voice, masculinity, smoking behaviour, voice quality.

**Correspondence:** Seher Şirin
Department of Otorhinolaryngology-Head and Neck Surgery, University of Kocaeli School of Medicine, 41380, Kocaeli, Turkey. **E-mail:** ugurseher@hotmail.com

**Received:** 25.10.2019; **Accepted:** 6.11.2019



Online available at:
www.entupdatesjournal.org

## Introduction

The term "transgender" is an umbrella term used to refer to individuals whose gender self-identity mismatches their sex as assigned at birth.[1] The term "cisgender" is used to denote persons whose gender identity corresponds to their sex as assigned at birth.[1] Discomfort arising from a discrepancy between the sex assigned at birth and gender self-identity results in an impairment of psychosocial and mental functioning, known as "gender dysphoria".[2,3] In this article, we will use the term "voice-related gender dysphoria" to denote the discomfort arising due to vocal features that are incongruent, in terms of masculinity and femininity, between the sex assigned at birth and gender self-identity.[4]

Cross-sex hormone therapy is the dominant treatment in the gender transition process as well as voice-related gender dysphoria in trans-male individuals. For the most part, individuals desire and expect their vocal pitch to be congruent with their lifestyle and physical appearance, particularly in terms of their gender identity. Therefore, the pitch-lowering effect of testosterone treatment allows trans-male individuals seeking treatment to achieve a voice that is more compatible with their gender identity and thus hormonal therapy is usually considered to be an effective method to alter vocal quality in the direction desired.[5] However, in spite of hormonal therapy remaining the most effective treatment to achieve masculinisation of the voice, recent studies have reported diversity in treatment response, which indicates that hormonal treatment may not always be satisfactory.[6-8] In a recent meta-analysis, an overall rate of 16% was reported for incomplete satisfaction with vocal quality in spite of hormonal treatment, and in particular subgroups, this dissatisfaction reached a rate approaching 30%.[9] Factors thought to affect treatment outcome include differing sizes of the laryngeal framework and androgen insensitivity, as well as marked variations in the testosterone regime followed.[9] The treatment regimens in use include various administrations and dosages and are not standardised.[10] In any case, it is still unclear to what extent treatment should be maintained and whether or not it should be administered to every individual in an identical manner.[11] To make the matter yet more complicated, even if the pitch-lowering effect is successfully achieved, it may not always be satisfactory from the point of view of how individuals perceive the masculine quality of their own voice.[12]

Trans individuals cannot be considered a homogeneous group in terms of voice perception and expectation, a point we highlighted in a recent study, which highlighted the existence of variation among individuals from the very beginning of the process, even before treatment begins.[4]

Thus, considering the dearth of literature in this area, the aim of our study was to investigate the association between subjective and objective vocal masculinity in the pre-treatment period.

## Materials and Methods

### *Sample*

Since its inception in 2004, Kocaeli University's Gender Identity Clinic (KoUGIC) has provided services for trans individuals from an interdisciplinary perspective (a psychiatrist, endocrinologist, gynaecologist, urologist, plastic surgeon, and voice specialist) aiming to assess, protect and manage both the physical and mental health of patients during the gender transition process. The objective is to provide an equitable delivery of high-quality care reflecting the recommendations of the World Professional Association for Transgender Health.[3,4] The phoniatric evaluation protocol includes perceptual assessment of the voice, initial voice recordings, and the use of standardised subjective rating scales as well as videolaryngostroboscopic examination.

The medical records were evaluated from hormone naïve trans-male individuals referred to the Voice Clinic who had completed the perceptual assessment measures as well as having their voice recorded postmenstrually during the same visit. The exclusion criteria were as follows: aged under 18 years, incomplete scales and/or voice samples, individuals who were already under hormonal treatment, and individuals who had received previous voice therapy. The study protocol was approved by the Institutional Review Board of the University of Kocaeli Medical School (KU/GOAEK 2019/272). Written informed consent was obtained from all the participants included in the study.

### *Measures*

#### *Sociodemographic Questionnaire*

A sociodemographic questionnaire covering age, job, educational status, socio-economic status, employment status, relationship status, alcohol and/or smoking history, family and/or social support, outward appearance, and current so-

cial gender identity was administered to the participants.

Self-Perception of Voice Masculinity (SPVM)

The self-perception of voice masculinity scale (SPVM) is in use as a subjective voice measure to assess the perception of voice gender. Participants rated their SPVM on a five-point Likert scale. Each item offered the following possible choices, ranging from 1 to 5: 'very female', 'somewhat female', 'gender neutral', 'somewhat male' and 'very male'. The rating scale was based on equal interval scales with very female/feminine at one end and very male/masculine at the other.

### *Acoustic Analysis*

The Computerised Speech Lab software, Multi-Dimensional Voice Program (MDVP) model 5105 (Kay Elemetrics Corporation, Lincoln Park, New Jersey, USA) was used for the analysis of vocal samples. The average of two recorded voice samples of a sustained /a/ vowel was used, following a demonstration by the examiner in a quiet room with less than 50 dB of background noise and with a microphone placed at a distance of 10 cm from the speaker.

The mean fundamental frequency (F0) is a frequently employed major objective cross-gender measure of acoustic difference. [13] Therefore, we chose this measure as the acoustic analysis parameter of interest. Although there is no definitive absolute distinction between masculine and feminine F0, in a recent meta-analysis the following values were used to evaluate the response to testosterone in trans males: cisgender male normative frequencies are at or below 131 Hz, cisgender female normative frequencies are 185 Hz or above, and the gender ambiguous frequency range is 185 Hz or less.[9,13,14]

Statistical analysis was performed using the SPSS v22 (IBM Corp., Armonk, NY, USA) application. Descriptive statistics were generated for all the variables. The Shapiro-Wilk test and graphical examinations were used to test the normality of the data. Non-parametric tests were applied for non-parametric data or for when the sample size was small. Descriptive data are expressed as the mean (plus standard deviation) and the median (with corresponding range). The correlation coefficients analyses between the SPVM measure scores and F0 were performed by means of Spearman's correlation test. The Mann–Whitney U-test was used to compare independent groups. All differences where the p value was 0.05 or less were considered statistically significant.

## Results

Twenty-seven hormone naive individuals were enrolled in the study. The mean age was 25.3 years (range:18-43 years). Five of the twenty-seven individuals' social gender identity and outward appearance were still female due to working in a very conservative environment. The sociodemographic and gender transition-related characteristics of all participants are given in Table 1.

**Table 1.** Sociodemographic and gender transition characteristic data of the participants

| **Sociodemographic characteristics** | **n*** | **%** |
|---|---|---|
| Educational Status | | |
| College | 13 | 48.1 |
| High School | 13 | 48.1 |
| Middle School | 1 | 3.8 |
| Employment Status | | |
| Student | 7 | 25.9 |
| Employed | 17 | 63.0 |
| Unemployed | 3 | 11.1 |
| Socioeconomic Status | | |
| Low | - | |
| Moderate | 27 | 100 |
| High | | |
| Relationship Status | | |
| Partnered | 14 | 51.9 |
| Single | 13 | 48.1 |
| Married | - | |
| Smoking habit | 21 | 77.8 |
| **Gender transition-related characteristics** | | |
| Presence of family support | 14 | 51.9 |
| Presence of social support | 22 | 81.5 |
| Outward appearance and | | |
| Male | 22 | 81.5 |
| Female | 5 | 18.5 |
| Social gender identity | | |
| Male | 22 | 81.5 |
| Female | 5 | 18.5 |

* Total Number of patients

The median SPVM score was 3 (range: 1-4), indicating gender neutrality. The median F0 was 190 Hz (range:154-267 Hz), thus within the normal limits for a cisgender female (Table 2). However, 12 out of 27 individuals had an F0 lying within the gender ambiguous frequency range, i.e. less than 185 Hz. Median SPVM scores were higher in this group, a result showing a strong tendency toward statistical significance (p=0.053) when compared with individuals within the cisgender female normative range for F0. The median SPVM and F0 scores of the participants compared to normative F0 values are given in Table 3.

**Table 2.** Mean (SD) and median (range) SPVM and f0 scores of the participants

| | Mean (SD) | | Median (range) | |
|---|---|---|---|---|
| SPVM | 2.67 | (0.92) | 3 | (1-4) |
| f0 (Hz) | 196.11 | (31.15) | 190 | (154-267) |

f0: Mean Fundamental Frequency, Hz: Hertz, SD: standart deviation, SPVM: Self-perception of voice masculinity

The strength and direction of the correlation between the SPVM scores and F0 was examined using Spearman's correlation test. A moderate negative correlation between the SPVM and the F0 scores was observed (r= -0.484, p =0.027).

The median F0 scores were evaluated in detail depending on the SPVM scores of individuals, and these results are presented in Table 4. None of the individuals perceived their own voice to be very male. As the median F0 decreased, the SPVM scale scores moved towards to a greater perception of masculinity.

The subjective and objective vocal masculinity parameters were also investigated in relation to smoking habit.

**Table 4.** Median (range) f0 scores according to SPVM

| | n (27) | f0 (Hz) Median(range) |
|---|---|---|
| SPVM | | |
| 1 (very female) | 3 | 223.00 (190.00-262.00) |
| 2 (somewhat female) | 8 | 202.00 (162.00-248.00) |
| 3 (gender neutral) | 11 | 191.00 (167.00-267.00) |
| 4 (somewhat male) | 5 | 168.00 (154.00-190.00) |
| 5 (very male) | - | |

f0: Mean Fundamental Frequency,
Hz: Hertz, SPVM: Self-perception of voice masculinity

Although the result was not statistically significant, the F0 values of smokers were lower than those of non-smokers. Additionally, their median SPVM scores indicated a neutral gender perception, while for non-smokers the SPVM scores corresponded to somewhat female (p=0.195) (Table 5). Smoking habit was also compared with the normative F0 values for individuals. Ten out of 12 individuals whose F0 fell within the gender ambiguous frequency range plus

**Table 5.** Median (range) SPVM and f0 scores of the participants according to smoking habit

| | Non-smokers n (6) | Smokers n (21) | P-value* |
|---|---|---|---|
| SPVM Median (range) | 2 (1-4) | 3 (1-4) | 0.195 |
| f0 (Hz) Median (range) | 218.50 (168.00-262.00) | 190.00 (154-267) | 0.195 |

f0: Mean Fundamental Frequency,
Hz: Hertz, SPVM: Self-perception of voice masculinity
*Mann–Whitney *U*-test

**Table 3.** Median (range) SPVM and f0 scores of the participants according to normative f0 values

| | Gender ambiguous f0 range (≤ 185 Hz) n (12) | Female f0 range n (15) | P-value* |
|---|---|---|---|
| SPVM Median (range) | 3 (2-4) | 2 (1-4) | 0.053 |
| f0 (Hz) Median (range) | 168.50 (154.00-184.00) | 215.00 (190.00-267.00) | <0.001 |

f0: Mean Fundamental Frequency, Hz: Hertz, SPVM: Self-perception of voice masculinity
*Mann–Whitney *U*-test

11 of 15 individuals who were within the normal limits for cisgender females were current smokers.

With regard to outward appearance, no significant correlation was observed with either SPVM score or F0.

## Discussion

As the overall prevalence of trans individuals seeking treatment has increased globally, research has increased into the psychosocial and physical conditions and the specific expectations and needs of trans-gendered individuals.[15]

The human voice, like the face, contains important social clues about a person's mood, personality, age, and gender, and has even been described as an "auditory face" that facilitates social perception.[16] Therefore, voice is of particular importance for trans individuals. The literature investigating voice in transgender individuals has mostly so far concerned trans-females, and there is a paucity of research focusing on the voice in trans-males.[8] Furthermore, most of the studies involving trans-male vocal characteristics have been conducted with relatively small sample sizes, lack information about pre-treatment vocal status and have often focused on the outcomes of testosterone treatment.[8,9] Although androgen therapy is generally considered adequate to alter the voice in the desired direction for trans-males, recent studies have reported significant diversity in response to treatment.[9] A recent meta-analysis including the results of individuals who had been receiving treatment for at least 1 year, investigated the efficacy of testosterone therapy in masculinizing the voice in transgender individuals.[9] A failure ratio of 21% to achieve the cisgender male normative frequency range (i.e. ≤131 Hz) has been reported. The individuals concerned (21% of cases) were reported to have voices which fell in the gender ambiguous frequency range (i.e. ≤185 Hz).[9]

The findings of this study indicate that diversity in F0 is already present even in the pre-treatment period. This diversity in F0 is also associated with SPVM and, therefore, contributes to the variation in self-perception of voice gender among hormone naïve trans-male individuals. In our study sample, 44.4% of the participants had an F0 already within the gender ambiguous frequency range. This pre-treatment diversity implies that F0 has already been significantly influenced by other factors and thus it is likely that these same confounding factors would have an impact on testosterone treatment outcomes. When evaluating hormone treatment efficacy, therefore, these confounders need to be borne in mind.

As the main therapeutic target is to achieve the vocal quality that the trans individual desires and will be satisfied with, how they perceive their own voice should also be evaluated at the beginning of the gender affirming treatment process, together with F0. Watt et al [17] reported that a perception of their own voice as masculine in character lead to trans-males gaining a greater sense of psychosocial well-being. A decrease in F0 lead to a perception of the voice as more masculine in character, and, for most trans-males, it is important to be recognized as male by the community.[12] In a study by Sandmann et al [18] in both cisgender female and male subjects, the relation of F0 to how masculine or feminine-sounding individuals regarded their own voice was evaluated. While a lower F0 correlates significantly with self-assessment of a voice as masculine in cisgender males, no correlation was reported in cisgender females.[18] Nygren et al [6] reported a moderate to strong negative correlation between F0 and the self-perception of vocal masculinity in trans-male individuals who had undergone hormone therapy for at least 3 months. In our study group of hormone naïve trans-males, a moderately powerful negative correlation was observed between the SPVM and the F0 score. As F0 decreases, the SPVM scale moves towards to a greater perception of masculinity. This might well be related to the high number of individuals in the study sample whose F0 fell within a gender ambiguous range in the pretreatment period.

Vocal pitch and its acoustic correlate, F0, is known to be the most important indicator of voice gender.[13] Various factors other than biological sex can affect F0. Specifically, the ageing process, linguistic differences, and smoking are known to play a role in influencing the F0 of normal healthy individuals.[19]

In the two largest longitudinal series presenting voice data before and after treatment in trans-males, Bultynck et al [20] reported a mean age of 25.6 years (range:17-47) for 80 individuals and Nygren et al [6] reported a mean age of 27 years (range:18-64) for 50 individuals. Along with an increase in prevalence, the age at presentation is also reported to have become lower.[15] The demographic data in our study is comparable with previous studies, consisting as it did of 27 hormone naïve trans-males with a mean age of 25.3 years (range:18-43) seeking gender-affirming medical treatment.

Few studies have reported acoustic parameters across different language contexts before the beginning of hormonal treatment.[6,7,21-24] In the largest study evaluating

the effects of testosterone treatment on vocal F0, which was conducted in Sweden by Nygren et al [6], the mean F0 was reported to be 192 Hz, with a median value of 190 Hz (range:147-242 Hz) at baseline for 50 trans-male individuals. These values fit with the reported reference F0 of 188 Hz for cisgender vocally healthy Swedish females.[25] Deuster et al [7] reported a median speaking F0 of 192 Hz (range: 164-255Hz) at baseline for 11 trans-male individuals, which also fits in with the German cisfemale normative speaking F0 of 163.7 Hz (SD:27.5).[19] In our study, the median and mean F0 were 190 Hz (range:154-267) and 196.11 Hz (SD:31.15), respectively. As expected, at baseline, none of the reported F0 have been within the cisgender male normative limit, and this was the case with our series, too. However, in our series, it was observed that the median F0 was at, or even slightly below, the lower limits of the reported normative F0 value of 223.9 Hz (SD:23.4) for cisgender Turkish females of a similar age range during the postmenstrual interval.[26] In addition, 12 out of 27 individuals were already within a gender ambiguous frequency range (range:154-185 Hz). In fact, there have also been cases within the gender ambiguous frequency range at baseline in other studies.[6,7] In the study by Deuster et al [7], 6 out of 11 cases had an F0 within this ambiguous range, and Nygren et al [6] reported that in 10 out of their 50 cases, F0 was below 175 Hz at baseline, but they failed to comment further on this.

Smoking is another major factor affecting acoustic voice parameters. Studies in healthy cisgender female individuals have reported a significant decrease of 15-45 Hz in F0 due to smoking.[19,27] The effect of lowering F0 may cause cisgender female voices to be perceived as male by others. Indeed, a smoking cisgender woman being perceived as a man on the telephone is a classical clinical presentation of Reinke's oedema, a common laryngeal pathology. Thus, there are several studies reporting more frequent smoking in trans-male individuals seeking to benefit from this effect.[8,21] In a cross-sectional study by Cosyns et al [28] reporting long-term androgen treatment outcomes, only 34 % of 38 trans-males had never smoked. T'Sjoen et al [29], however, reported a non-smoker rate of 80% for 20 individuals, whereas Van Borsel et al [21] reported this rate as 50% based on a sample of 16 cases.[21,29]

An elevated smoking rate of 77.8% was observed in our study group. Although the majority of the sample were aware that smoking has a pitch lowering effect, no individual reported taking up smoking with this aim in mind. While age may not have significantly influenced F0 in our study, smoking frequency likely had a significant effect on lowering the overall median F0. Given that 10 out of 12 individuals who were within the gender ambiguous frequency range were current smokers, this might well be the reason why almost half of our study group had an F0 within the gender ambiguous frequency range even before hormone treatment could begin.

F0 is the principal acoustic difference between feminine and masculine-sounding voices. However, it should be noted that F0 is not the only acoustic parameter influencing the perception of voice gender. Other acoustic parameters such as voice range, sound pressure level and formant frequencies may also play a role.[25,30] Furthermore, the voice quality, resonance, and other aspects such as speech and communication properties differ between females and males.[21] Therefore, the femininity or masculinity of a voice is a very complex issue, about which relatively little is yet understood and this issue should also be taken into consideration when studying trans-voices.

Although these evaluations were performed in conjunction with a psychiatrist and voice specialist and these individuals were also participants in group psychotherapy, leading to a good therapeutic rapport, the relatively small sample size is the main limitation of the study. Second, the results reported may be subject to confounding. An age and smoking matched cisgender female control group was not used for our study, and other objective parameters such as vocal range, sound pressure level, formant frequencies, and speaking F0 were not investigated due to some data being missing from the records. These limitations might cause a degree of uncertainty about the conclusions. Lastly, being a single-institution study and including only individuals actively seeking treatment prevents immediate generalisation of our results to other institutions.

## Conclusion

On the basis of our findings, it could be argued that diversity in objective and subjective voice parameters exists not only in cross-sex hormone treatment response, but also within the pre-treatment period. The main aim of androgen treatment is to lower the vocal pitch in order to sound more masculine. However, there are other factors influencing F0 from an early stage, which may bear on treatment efficacy and patient satisfaction. Therefore, a more comprehensive approach should be implemented when assessing transgender voices throughout the gender af-

firming treatment process. Furthermore, smoking, a major confounder in the results, is yet another serious health hazard in an already neglected sexual minority group in terms of general medical health. The high frequency of smokers among the trans-male population should also be taken into account when considering public health.

**Acknowledgment:** The authors wish to thank Canan Baydemir for statistical support.

**Ethics Committee Approval:** Ethical approval was ob-tained from the Institutional Review Board of the Kocaeli University, School of Medicine (KOU/GOAEK- 2019/272).

**Informed Consent:** Informed consent was obtained from all the individual participants included in the study.

**Author Contributions:** Designing the study – S.Ş., A.P.; Collecting the data – S.Ş.; Analyzing the data – S.Ş., A.P.; Writing the manuscript – S.Ş., A.P.; Confirming the accuracy of the data and the analyses – S.Ş., A.P.

**Conflict of Interest:** The authors have no conflicts of in-terest to declare.

**Financial Disclosure:** The authors declared that no finan-cial support was received for this paper.

## References

1. Bouman WP, Schwend AS, Motmans J, et al. Language and trans health. Int J Transgend 2017;18:1-6.
2. Diagnostic and Statistical Manual of Mental Disorders. 5th edition. Arlington: American Psychiatric Association; 2015.p.156-60.
3. Coleman E, Bockting W, Botzer M, et al. Standards of care for the health of transsexual, transgender, and gender-nonconforming people, Version 7. Int J Transgend 2012;13:165-232.
4. Sirin S, Polat A, Alioğlu F. Voice-related gender dysphoria: quality of life in hormone naïve trans male individuals. Anadolu Psikiyatri Derg 2020;21:53-60.
5. Irwig MS. Testosterone therapy for transgender men. Lancet Diabetes Endocrinol 2017;5:301-11.
6. Nygren U, Nordenskjöld A, Arver S, Södersten M. Effects on voice fundamental frequency and satisfaction with voice in trans men during testosterone treatment-a longitudinal study. J Voice 2016;30:23-34.
7. Deuster D, Matulat P, Knief A, et al. Voice deepening under testosterone treatment in female-to-male gender dysphoric individuals. Eur Arch Otorhinolaryngol 2016;273:959-65.
8. Azul D, Nygren U, Södersten M, Neuschaefer-Rube C. Transmasculine people's voice function: A review of the currently available evidence. J Voice 2017;31:9-23.
9. Ziegler A, Henke T, Wiedrick J, Helou LB. Effectiveness of testosterone therapy for masculinizing voice in transgender patients: A meta-analytic review. Int J Transgender 2018;19:25-45.
10. Hembree WC, Cohen-Kettenis P, Delemarre-van de Waal HA, et al. Endocrine treatment of transsexual persons: an Endocrine Society clinical practice guideline. J Clin Endocrinol Metab 2009;94:3132-54.
11. Dekker MJ, Wierckx K, Van Caenegem E, et al. A European Network for the Investigation of Gender Incongruence: Endocrine Part. J Sex Med 2016;13:994-9.
12. Scheidt D, Kob M, Willmes K, Neuschaefer-Rube C. Do we need voice therapy for female-to-male transgenders? In: Murdoch BE, Gooze J, Whelan B-M, et al., editors. 2004 IALP-Congress-Proceedings. Brisbane, Australia: Speech Pathology Australia.
13. Gelfer MP, Mordaunt M. Pitch and intonation. In: Adler RK, Hirsch S, Mordaunt M, editors. Voice and Communication Therapy for The Transgender/Transsexual Client: A Comprehensive Clinical Guide. San Diego, CA: Plural Publishing; 2012. p. 187-224.
14. Azul D. Transmasculine people's vocal situations: a critical review of gender-related discourses and empirical data. Int J Lang Commun Disord 2015;50:31-47.
15. Arcelus J, Bouman WP, Van Den Noortgate W, Claes L, Witcomb G, Fernandez- Aranda F. Systematic review and meta-analysis of prevalence studies in transsexualism. Eur Psychiatry 2015;30:807-15.
16. Belin P, Bestelmeyer PE, Latinus M, Watson R. Understanding voice perception. Br J Psychol 2011;102:711-25.
17. Watt SO, Tskhay KO, Rule NO. Masculine voices predict well-being in female-to-male transgender individuals. Arch Sex Behav 2018;47:963-72.
18. Sandmann K, Am Zehnhoff-Dinnesen A, Schmidt CM, et al. Differences between self-assessment and external rating of voice with regard to sex characteristics, age, and attractiveness. J Voice 2014;28:11-8.
19. Berg M, Fuchs M, Wirkner K, et al. The speaking voice in the general population: normative data and associations to sociodemographic and lifestyle factors. J Voice 2017;31:13-24.
20. Bultynck C, Pas C, Defreyne J, Cosyns M, den Heijer M, T'Sjoen G. Self-perception of voice in transgender persons during cross-sex hormone therapy. Laryngoscope 2017; 127:2796-804.
21. Van Borsel J, De Cuypere G, Rubens R, Destaerke B. Voice problems in female-to-male transsexuals. Int J Lang Commun Disord 2000;35:427-42.
22. Damrose EJ. Quantifying the impact of androgen therapy on the female larynx. Auris Nasus Larynx 2009;36:110-2.
23. Deuster D, Di Vincenzo K, Szukaj M, Am Zehnhoff-Dinnesen A, Dobel C. Change of speech fundamental frequency explains the satisfaction with voice in response to testosterone therapy in female-to-male gender

dysphoric individuals. Eur Arch Otorhinolaryngol 2016;273:2127-31.
24. Irwig MS, Childs K, Hancock AB. Effects of testosterone on the transgender male voice. Andrology 2017;5:107-112.
25. Pegoraro Krook MI. Speaking fundamental frequency characteristics of normal Swedish subjects obtained by glottal frequency analysis. Folia Phoniatr (Basel) 1988;40:82-90.
26. Tatar EC, Sahin M, Demiral D, Bayir O, Saylam G, Ozdek A. Normative values of voice analysis parameters with respect to menstrual cycle in healthy adult Turkish women. J Voice 2016;30:322-8.
27. Vincent I, Gilbert HR. The effects of cigarette smoking on the female voice. Logoped Phoniatr Vocol 2012;37:22-32.
28. Cosyns M, Van Borsel J, Wierckx K, et al. Voice in female-to-male transsexual persons after long-term androgen therapy. Laryngoscope 2014;124:1409-14.
29. T'Sjoen G, Moerman M, Van Borsel J, et al. Impact of Voice in Transsexuals. Int J Transgender 2006;9:1-7.
30. Klatt DH, Klatt LC. Analysis, synthesis, and perception of voice quality variations among female and male talkers. J Acoust Soc Am 1990;87:820-57.



*Please cite this article as:* Şirin S, Polat A. The association between subjective and objective masculine vocal quality in hormone-naïve trans-male individuals. ENT Updates 2019;9(3): 219-226.