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SOMATOTYPE AND SOME PULMONARY FUNCTIONS OF PROFESSIONAL FEMALE SINGERS

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Abstract: *Understanding the somatotype and some of the essential pulmonary functions plays an important part at development of professional singers. With that knowledge professors can easily cooperate with the student. They know the type of body of their students and obtain important information about their breathing capabilities. Therefore the professors can more qualitatively follow their advancement. Since the art of singing is in close correlation with breathing technique the professors also encourage the specific technique, which is the most effective one for each individual.*
The purpose of our research was obtaining information about this specific group and thus with the results to enable a better understanding of physical characteristics and pulmonary functions of solo singers, which substantially contribute to a more quality work. We are reporting on a group of women, over the age of 20 years, who are actively involved in singing.
With the help of anthropometrical measurements we calculated their somatotypes (after Heath-Carter), and with the help of spirometrical measurements (Vitalograph) their lung functions. Statistically significant correlation of chest circumference indicates that singing and choir practice support a more intensive development of the muscular component. Average somatotype is represented in the central category with 3.6–2.9–2.9. The highest average forced expiratory vital capacity and forced expiratory volume 1 (FEVC and FEV1) was measured in a groups of singers with prevailing endomorphic and mesomorphic component.
Keywords: *Anthropometry; Spirometry; Somatotype; Female professional singers.*

For Professor Éva Bodzsár, for the friend and colleague
"Can we conceive what humanity would be if it did not know the flowers?"
(Maurice Maeterlinck)

Introduction

Somatotyping is a system of assigning subjects to a specific body type and knowing which kind of body type is most frequent in such groups is very important. Knowing basic pulmonary function is also important in improving the performance of singers.

In Slovenia there were some researches analyzing lung functions in groups of students.

Between the years 1954 and 1964 Brodar measured the vital capacity (VC) of students. The increment of VC during four years of studies in female group was 190 cm^3 and 280 cm^3 in male group. (Brodar 1960, 1974, 1981). VC was increasing in generation born between the years 1939 and 1942. The increases were, according to the opinion of the author, connected with increases in stature and common phenomenon secular trend (Rozman 1970). Zerbo presented the interdependence of anthropometric and spirometric parameters in healthy female students from the University of Ljubljana in her doctor thesis. She also determined Heath-Carter somatotype. A new prediction formula for FEVC and FEV1 was derived (Zerbo 1998, Zerbo-Šporin et al. 2002).

Somatotypes were also analyzed in a group of female students. Endomorphic-mesomorph types prevailed with 20.2%, followed by mesomorph-endomorph type with 19.5%. Mesomorphic-endomorph type was found in 15.7% cases and with 7% balanced ectomorph, endomorphic-ectomorph and central type. (Tomazo-Ravnik 1994, 2001). In the work of Zerbo (1998) female students were most frequently of mesomorph-endomorph somatotype.

There are no researches in the field of physical anthropology or pulmonary functions done in Slovenia for a group of professional singers.

Subjects and Methods

The participants were 36 professional female singers with age ranging from 20 to 44 years (Table 1). 27 of them attended Singing studio Bonaldi and Department for opera singing at Musical Academy in Ljubljana. Nine subjects sing in different choirs in Slovenia. They study singing or sing at least twice a week in a choir and attend courses of singing practice with vocal technique and technique of breathing. At the time of measurement all were in good health and with no known vocal, speech or lung ailments.

All subjects showed their cooperation by signing an informed consent form. Permission to conduct the study was also obtained from the Commission of medical ethics of the Ministry of Health of the Republic of Slovenia.

Table 1. Age distribution of singers.

Age (years)	20	21	22	23	24	25	26	27	28	29	30	33	38	43	44
N	5	6	5	3	4	2	3	2	0	1	1	1	1	1	1

Measurements were carried out by standard methods (Lohman et al. 1988, Carter and Heath 1990, Carter 2002). Standard anthropometrical instruments were used. All measurements were assessed by the same person in Bonaldi Studio in the period from June till December 2006. The condition in the place was stable and the place was warm and bright. All paired dimensions were measured according to Heath–Carter proposition on the right side. We measured stature, weight, biacromial, knee and elbow breadth, circumference of upper arm (relaxed and flexed), chest at maximal inspiration and expiration, waist, hip and calf. Skinfolds were measured three times with John/Bull caliper on triceps, subscapular, midaxillar, supraspinal and medial calf locality. All measurements were written down into a protocol.

Spirometric tests were done on the spirometer Vitalograph 2120. We measured with this apparatus at the field. Before measurements, sex, age, stature and weight of each subject were input into the program. Among all the possible static and dynamic parameters we chose only the most frequently used ones for our analyses: Forced Expiratory Vital Capacity – FEVC and Forced Expiratory Volume 1 – FEV1 (Mc Ardle et al. 1996).

Girls and ladies were instructed how to breathe and tests were done in an upright position. For each test a new mouthpiece was placed into a mouth, clamping it with the teeth. Each test was done twice. Device automatically chose the best test result, which was later plotted on a graph with PC in the laboratory.

Components for the Heath–Carter anthropometrical somatotype were calculated by using regression formulas for endo-, meso- and ectomorphy. Coordinates x and y for each subject were calculated and plotted into somatographs. BMI was also calculated.

Basic statistics were done in program Excel for Windows and statistically analyzed by STATGRAPHIC Plus for Windows. Linear correlation and regression analyses between all anthropometrical and spirometrical parameters were calculated (Milton 1992).

Results and Discussion

Table 2 presents the average values of measured and calculated parameters. The difference in age of singers caused high differences in stature (SD=5.27), weight (SD=8.29) and all four circumferences.

We analyzed pulmonary function connected with the years of professional singing (Table 3).

The best mean value for FEVC and FEV1 is found in singers, who sing for two years followed by the group singing for one year.

In these groups the difference between the predicted and actually measured values was also the highest. The highest similarity between predicted and actual mean values of FEVC and FEV1 is found in the group, singing actively for four years. We expected such results. In the opinion of Bonaldi (2006) for the singers the first two years are very strenuous. They improve breathing technique and pulmonary functions. After this period they only maintain condition.

Anthropometric Heath–Carter somatotypes were calculated. At first we placed somatotypes of all subject into the proposed 13 somatotype categories. Because of the small number of participants we then condensed them to seven categories (Table 4).

Table 2. Average values of measured and calculated parameters.

	Min	Max	R	X	SD
Age (years)	20.0	44.0	24.0	25.2	5.98
Stature (cm)	157.0	179.0	22.5	167.3	5.27
Weight (kg)	47.0	79.5	32.5	60.5	8.29
Upper arm circ. relax. (cm)	22.5	34.5	12.0	27.3	3.02
Upper arm circ. flex. (cm)	23.5	35.5	12.0	27.9	3.02
Chest circ. in expiration (cm)	77.0	102.5	25.5	86.0	5.55
Chest circ. in inspiration (cm)	81.0	109.0	28.0	90.3	6.42
Waist circumference (cm)	65.0	91.0	26.0	76.3	6.78
Hip circumference (cm)	87.0	117.5	30.5	99.0	6.75
Calf circumference (cm)	31.0	42.0	11.0	36.5	2.82
Biacromial breadth (cm)	33.5	40.3	6.8	37.0	1.70
Elbow breadth (cm)	5.5	6.6	1.1	5.9	0.32
Knee breadth (cm)	6.4	9.8	3.4	8.1	0.93
Triceps skinfold (mm)	7.8	20.6	12.8	15.6	3.86
Subscapular skinfold (mm)	3.9	18.9	15.0	11.4	3.82
Midaxial skinfold (mm)	3.8	23.5	19.7	10.2	4.10
Soprailiacal skinfold (mm)	3.6	18.2	14.6	10.5	3.75
Calf skinfold (mm)	3.5	22.0	18.5	14.6	4.74
FEVCp (predicted)	3.2	4.4	1.16	3.8	0.28
FEVC (measured)	2.7	8.1	5.39	3.9	0.97
FEV1p (predicted)	2.8	3.8	1.07	3.3	0.25
FEV1 (measured)	1.6	6.9	5.26	3.2	0.84
BMI	17.5	30.5	13.0	21.4	2.95

Min: minimal value, Max: maximal value, R: range, X: mean value, SD: standard deviation;
FEVC: forced expiratory vital capacity; FEV1: forced expiratory volume in first second of expiration,
FEVCp and FEVp: predicted values; BMI: body mass index

Table 3. Pulmonary function and years of active singing (YAS).

YAS	N	FEVCp	FEVC	FEV1p	FEV1
1	9	3.86	4.22	3.37	3.41
2	5	3.69	4.37	3.22	3.83
3	5	4.00	3.46	3.50	2.77
4	6	3.86	3.82	3.37	3.22
5–8	4	3.81	3.64	3.32	3.05
10	6	3.76	3.49	3.29	2.87

FEVC: forced expiratory vital capacity; FEV1: forced expiratory volume in the first second of expiration, FEVCp and FEVp: predicted values

Table 4. Distribution of singers in condensed somatotype category.

Somatotype category	Number
Central	6
Endomorph	11
Endomorph-mesomorph	4
Mesomorph	2
Mesomorph-ectomorph	1
Ectomorph	10
Ectomorph-endomorph	2

Two groups prevail: endomorphs and ectomorphs. Mean somatotype is of the central type with the values for the three components 3.6–2.9–2.9. There is a small number of subjects with mesomorph component. The same case was also found in a sample of students (Zerbo 1998). The reasons of falling out of mesomorphic component after the opinions of Siegel (1996) and Claessens (1985) could be in the calculation of mesomorph component which does not include the dimensions of trunk. Mean somatotype in a sample of Zerbo (1998) was 4.1–3.6–2.7 and in a sample of Tomazo-Ravnik (1994) 3.9–3.8–2.5. Adult female groups very often show dominance of endomorphy over meso- and ectomorphy (Carter and Heath 1988, Gordon 1987).

All somatotypes of female singers with calculated x and y values was plotted into the somatograph with the programme at http://www.somatotype.org (Fig. 1).

The connections that exist between the somatotype categories and pulmonary functions are presented in Table 5. The highest correlation value of FEVC was in the group mesomorph-ectomorph but we must notice that in this group there is only one singer. Anyway, the best results of FEVC were found in singers with dominant endomorph and mesomorph components. Actually measured FEVC and FEV1 agree in most cases with predicted values. In her doctoral thesis Cowgill (2004) found very important correlations between three somatotype groups and breathing tendencies. The hypothesis for her research was that person's body type may influence breathing tendencies while singing. She described in detail three breathing technique: costal or intercostal, appogio which is closely related to diaphragmatic or abdominal and pancostal. Results reveal that endomorphs tend to breathe lower (appoggio breathing technique), mosomorphs in the rib cage area (costal breathing technique) and ectomorphs in the lateral chest area (pancostal breathing technique). Our sample shows higher values of ventilatory functions in cases with medium intensity of mesomorph component and Cowgill in such persons found costal type of breathing technique. They have also higher values of chest circumferences.

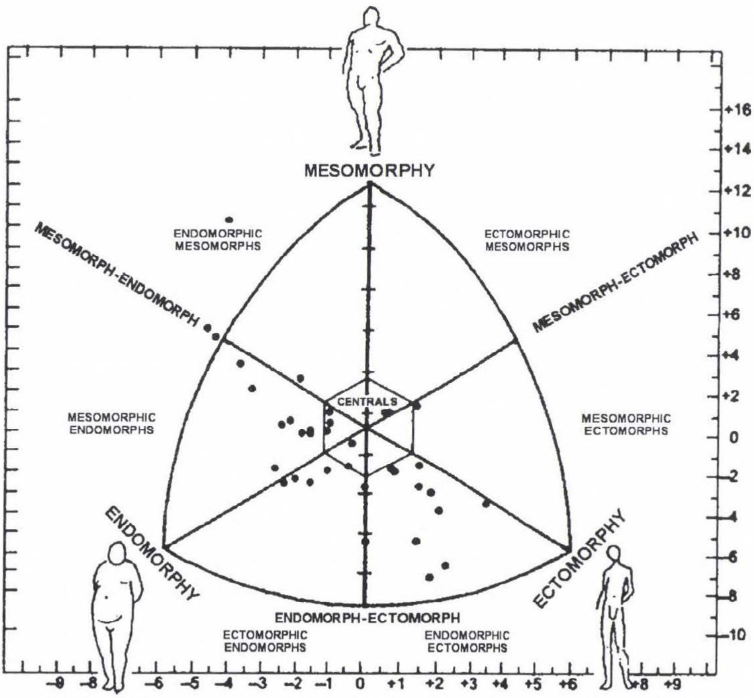

Figure 1: Somatograph with somatotypes of female professional singers.

Table 5. Mean values for pulmonary function and somatotype.

	FEVCp	FEVC	FEV1p	FEV1
Central	3.8	3.8	3.3	3.3
Ectomorph-endomorph	3.9	3.8	3.4	3.2
Endomorph	3.9	3.8	3.4	2.9
Endomorph-mesomorph	3.7	4.0	3.2	3.3
Ectomorph	4.0	3.6	3.5	3.2
Mesomorph	3.7	3.9	3.2	3.2
Mesomorph-ectomorph	3.9	4.7	3.4	3.6

FEVC: forced expiratory vital capacity; FEV1: forced expiratory volume in the first second of expiration, FEVCp and FEVp: predicted values

Correlation between anthropometric and spirometric measurements show that the highest correlation exists between the chest circumference at inspiration, chest circumference at expiration, stature and weight (Table 6). The highest value is in chest circumference at inspiration and we assume that breathing courses for singers improve the development of muscle mass and this would affect positively lung functions which are very important for singers. Štefančič and Tomazo-Ravnik (1992) found higher chest circumferences in student groups which are active in sport. Mostly all other correlation correspond well to the results of female students in the work of Zerbo (1998).

Table 6. Correlation between anthropometric and spirometric parameters.

	FEVC	FEVCp	FEV1	FEV1p
Age (years)	0.05	–0.56	–0.09	–0.58
Stature	0.33	0.80	0.44	0.79
Weight	0.35	0.06	0.25	0.05
Upper arm circumference (relax)	0.05	–0.34	–0.05	–0.04
Upper arm circumference (flex)	0.06	–0.32	–0.03	–0.33
Chest circumference (expiration)	0.39	–0.03	0.35	–0.03
Chest circumference (inspiration)	0.50	0.00	0.49	0.00
Waist circumference	0.06	–0.15	–0.05	–0.15
Hip circumference	0.15	–0.05	0.11	–0.05
Calf circumference	0.04	–0.18	–0.15	–0.19
Biacromial breadth	0.43	0.33	0.35	0.32
Elbow breadth	0.28	0.38	0.36	0.50
Knee breadth	–0.21	–0.25	–0.10	–0.25
Triceps skinfold	–0.10	–0.30	–0.30	–0.30
Subscapular skinfold	–0.16	–0.11	–0.25	–0.10
Midaxillar skinfold	0.04	0.09	0.03	0.09
Suprailiacal skinfold	–0.09	–0.22	–0.19	–0.22
Calf skinfold	–0.16	–0.18	–0.33	–0.18
FEVC	1.00	0.27	0.69	0.26
FEVCp	0.27	1.00	0.41	1.00
FEV1	0.26	1.00	1.00	0.41
FEV1p	0.69	0.41	0.41	1.00

FEVC: forced expiratory vital capacity; FEV1: forced expiratory volume in first second of expiration, FEVCp and FEVp: predicted values

Conclusion

Our study presents the results obtained from anthropometric measurements, somatotype calculations and measured pulmonary functions and also determines some correlations among them.

We found some significant correlations among anthropometric and spirometric measurements. Significant correlation was found between height and both chest circumferences. Active singing and breathing practice improve the development of muscle mass components and this fact improves the progress of ventilatory parameters which is very important for progress of quality of singers.

Most of professional female singers belong to the central somatotype on the average. Central, mesomorphic-endomorph and balanced ectomorphs prevail.

The highest average FEVC and FEV1 were measured in the group of singers with prevailing endomorphic and mesomorphic component. This fact coincided with their diaphragmatic breathing (endomorphic component) and the use of costal breathing (mesomorphic component). The best results were found in the group singing for two years.

Since there is a lack of research regarding those themes, we hope that the present work inspires more of them. With that kind of research we could help teachers and singers to improve their results.

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