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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Analysis of Pulmonary Function Test Distributions in Healthy Young Male and Female Individuals

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Abstract

Aim: This study aims to determine the distribution of lung volumes and capacities (expiratory and inspiratory vital capacity, inspiratory capacity, inspiratory and expiratory reserve volume, tidal volume) in healthy young men and women aged 18-24 years using spirometry.

Materials and Methods: Measurements were performed on participating volunteers between December and March 2019 using a handheld spirometer (MIR MiniSpir Spirometer). Spirometry data and input volunteer form information were analyzed using descriptive statistics, t-test for comparison of group means, paired-sample t-test for within-group comparisons, chi-square test for categorical data, and parametric (t-test) or non-parametric (Mann-Whitney U) test_for quantitative-continuous data using SPSS™ 24.0 Windows Evaluation Edition (2016 Inc.). A p-value less than 0.05 was considered statistically significant.

Results: In our study, the distribution of lung volumes and capacities in individuals was examined. According to the analysis of our spirometric distribution measurements, it was shown that anthropometric values and sociodemographic characteristics can affect respiratory parameters. Mean vital capacity and tidal volume results were found to be significantly higher in men than in women. $EVC_{Expected}$ ($p<0.001$), $IVC_{Expected}$ ($p<0.001$), $IC_{Expected}$ ($p<0.001$), $ERV_{Expected}$ ($p<0.001$), EVC_{Found} ($p<0.001$), IC_{Found} ($p=0.002$), ERV_{Found} ($p<0.001$), TV_{Found} ($p=0.066$), $IC_{\%Expected}$ ($p=0.835$), $ERV_{\%Expected}$ ($p=0.009$), and BMI ($p=0.007$) respiratory parameters were found to be higher in men than in women.

Conclusion: A database has been created regarding the distribution of lung volume and capacity in healthy individuals. The results obtained will contribute to the standardization of tests to be conducted in future clinical and research studies.

Keywords: *Lung, Lung Volume Measurements, Spirometry/Pneumotacography, Lung Function Tests, Vital Capacity*

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Sağlıklı Genç Erkek ve Kadın Bireylerde Solunum Fonksiyon Test Dağılımlarının Analizi

Özet

Amaç: Bu çalışmada, statik akciğer volümlerini belirleyen test sonuçlarının (ekspiratuvar ve inspiratuvar vital kapasite, inspiratuvar kapasite, inspiratuvar ve ekspiratuvar rezerv volüm, tidal volüm) 18-24 yaş grubu sağlıklı erkek ve kadın genç bireylerde spirometre yöntemi ile akciğer hacim ve kapasiteleri dağılım analizlerinin belirlenmesi amaçlanmaktadır.

Gereç ve Yöntem: Aralık-Mart 2019'de katılan gönüllü bireylere el spirometresi makinası ile (İtalyan Markası MIR MiniSpir Spirometre) uygulanarak ölçümler yapıldı. Spirometre veriler ile bireylerin tanıtıcı gönüllü form bilgileri SPSS™ 24.0 Windows Değerlendirme Sürümü (2016 Inc.) Bilgisayar İstatistik Paket Programı aracılığıyla tanımlayıcı istatistikler, grup-ortalamalarının karşılaştırmalarında t-testi, grup-içi karşılaştırmalarında Paired Samples t-testi, kategorik verilerde ki-kare testi, sayısal-sürekli verilerde parametrik (t-test) veya non-parametrik (Mann-Whitney U) testi kullanılarak değerlendirilmiştir. *p* değerinin 0,05'den küçük olması istatistiksel anlamlılık düzeyi olarak kabul edildi.

Bulgular: Çalışmamızda, bireylerde akciğer hacim ve kapasitelerinin dağılımı incelenmiştir. Spriometrik sinyal ölçüm analizlerimize göre antropometrik değerlerin, sosyodemografik özelliklerin solunum parametrelerini etkileyebileceği gösterilmiştir. Ortalama vital kapasite, tidal volüm sonuçları erkeklerde kadınlara göre anlamlı derecede yüksek bulunmuştur. $EVC_{Beklenen}$ (p=0,001), $IVC_{Beklenen}$ (p=0,001), $IC_{Beklenen}$ (p=0,001), $ERV_{Beklenen}$ (p=0,001), $EVC_{Bulunan}$ (p=0,001), $IC_{Bulunan}$ (p=0,002), $ERV_{Bulunan}$ (p=0,001), $TV_{Bulunan}$ (p=0,066), $IC_{\%Beklenen}$ (p=0,835), $ERV_{\%Beklenen}$ (p=0,009) BKİ (p=0,007) solunum parametrelerinin ortalama ± SD erkeklerde kadınlara göre daha yüksek saptandı.

Sonuç: Sağlıklı bireylerde akciğer hacmi ve kapasitesinin dağılımına ilişkin bir veri tabanı oluşturulmuştur. Elde edilen sonuçlar, gelecekteki klinik ve araştırma çalışmalarında yapılacak testlerin standardizasyonuna katkıda bulunacaktır.

Anahtar Kelimeler: *Akciğer, Akciğer Hacim Volüm Ölçümleri, Spirometre/Pnömotakograf, Solunum Fonksiyon Testleri, Vital Kapasite*

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INTRODUCTION

Respiratory physiology and the measurement of the functions of the lungs, a vital organ, have fascinated humanity since ancient times, and our current knowledge has been achieved step by step thanks to the dedicated work of many scientists. Today, as a result of advances in molecular biology and genetics, respiratory physiology has been relegated to the background, both in our country and worldwide. However, to better elucidate disease mechanisms, understand how data obtained through molecular biology affect lung function, and guide treatment appropriately, knowledge of respiratory physiology and biophysics also needs to be evaluated. To understand the current level of respiratory function testing and to interpret the results accurately, it is necessary to know how the parameters we use in our daily routines and take for granted were developed, what kind of efforts were made for this, and the logic behind their development. For young scientists, especially those wishing to work in the field of respiratory function, thoroughly researching the history of each parameter and getting to the root of the problem is extremely important.

A spirometer is the main piece of equipment used in basic respiratory function tests. It is commonly used to determine the cause of shortness of breath, assess the effect of pollutants on lung function, monitor the effectiveness of medications, and track progress in disease treatment. Spirometry has provided reliable quantitative data that can be used in the complex compensatory network of respiratory diseases in situations where new X-ray technology cannot be fully relied upon (1-4).

Spirometry suggesting that Black individuals have weaker lungs than white individuals. "Some individuals are more resistant to heat and less resistant to cold than whites" due to "differences in the structure of the lung system" (5-8). Researchers have found that Native Americans have lower vital capacity compared to Westerners (9).

Over the last 40-50 years, advancements in science and technology have significantly impacted pulmonary function tests, clinical diagnosis, and treatment practices. Over the last 30 years, it has evolved from being a tool primarily used in physiological studies to becoming a widely used objective laboratory method in the clinical evaluation of respiratory system diseases (10). Pulmonary function tests (PFTs) are known to have first become widely performed in the 17th century; these tests are an objective method used to examine the ventilation, diffusion, and mechanical properties of the respiratory system. In 1846, vital capacity was measured using a device like Hutchinson's aqueous spirometer. According to ATS and ERS reports, the MIR MiniSpir spirometer, commonly used in clinics and respiratory function laboratories, possesses the basic technical specifications of a device capable of measuring continuous volume variables such as FVC and FEV_1 (2, 11). The subject of this research project is to determine or project static lung volumes (expiratory vital capacity, inspiratory vital capacity, inspiratory capacity, inspiratory reserve volume, expiratory reserve volume, and tidal volume) in healthy young individuals using spirometry; to understand the measurements of lung volumes and capacities; to analyze the distribution of respiratory capacity and CO_2 diffusion capacity measurements; to examine and detect variations; and to assess the likelihood of developing several conditions, such as pathophysiological problems during testing, in terms of early diagnosis and treatment of suspected or known respiratory diseases. Vital Capacity (VC) is the change in lung volume after maximum inspiration and is the sum of tidal volume, inspiratory reserve volume, and expiratory reserve volume. The vital capacity of normal adult's ranges from 3 to 5 liters. Many physiological factors such as age, gender, height, weight or body mass index, and ethnicity affect lung volume. Reference values for lung volume and capacity will be calculated. Changes in vital capacity have been evaluated and examined in terms of age and gender; This is because the measured air volume capacities in an individual can vary greatly among healthy individuals of the same or different ages, genders, and heights, as well as among healthy individuals of different ethnic backgrounds, playing a significant role in determining the values.

The aim of the study was to investigate how factors such as age, gender, height, weight or body mass, hormones, parental characteristics, stress, nutrition, and ethnicity can affect the test results determining static lung volumes (expiratory vital capacity, inspiratory vital capacity, inspiratory capacity, inspiratory reserve volume, expiratory reserve volume, and tidal volume).

The goals of our study are to address the fact that previous studies analyzing respiratory parameter waveforms related to lung volume and capacity have mostly focused on humans, particularly vital capacity respiratory measurement. My research through literature review and studies on human trials aims to reveal a significant amount of data regarding the relationship between respiratory parameter waveforms and lung volume and capacity. There hasn't been a sufficiently comprehensive direct comparative spirometry (SFT) study in healthy adult individuals based on gender, age, and height. Therefore, our study aims to fill these gaps. A comparative study of direct spirometry (SFT) results in healthy adult individuals based on gender, age, and height is not sufficiently comprehensive in the literature. However, articles in the literature have not yet conducted a direct comparative SFT study in healthy adult individuals based on gender, age, and height, and our goal is to address this gap. Our research aims to create a database for comparison with other research studies by directly evaluating our data analyses and providing a general framework for our findings.

Spirometric tests, particularly hand spirometry, are one of the most used methods for evaluat-

ing respiratory function. Because it provides a fundamental assessment of lung respiratory function, it can be used in conjunction with clinical examination and chest X-rays for the early diagnosis, treatment, and monitoring of lung diseases.

In this study, the lung volume and capacity (expiratory and inspiratory vital capacity, inspiratory capacity, inspiratory and expiratory reserve volume, tidal volume) of healthy male and female individuals aged 18-24 years were determined using spirometry (flowmeter), and the aim of our study was to determine and evaluate the distribution of respiratory function tests.

Since the research was conducted during the pandemic, the number of volunteers participating in the study was not large. Therefore, the analysis results obtained from a sample size of 30-35, which we determined based on statistical parameters during the pandemic, were applied and implemented; because these concern any problem related to science, and all verified and known ideas and principles are based on attempts to model facts and realities revealed by experiments. A minimum value of 30 was taken because the study was conducted during the pandemic. To better understand the universe with directly observable, measurable facts or objects with strong economic and other transfer possibilities, to obtain accurate concrete information based on observation, to solve the existing problems in our study, and to explain events within a scientific framework, the scientific studies and methods mentioned in the article were used; these studies and methods were used to clarify and justify events without using existing laws that generally do not offer solutions in the literature, and events were explained within the framework of laws based on the necessary testable logic and mathematics. The findings obtained were also tested and analyzed with scientific methods to determine the relationships and differences between fundamental variables with the aim of creating a better and more livable world for individuals.

MATERIALS AND METODS

Experimental measurement method with mir minispir spirometer (measurement method with respiratory function tester)

The MIR MiniSpir spirometer is the most preferred device developed for pulmonary function tests (PFTs). The spirometer we used in this study is the Italian brand MiniSpir. MIR MiniSpir is a multi-tasking and versatile spirometer ideal for accurate and early diagnosis of respiratory diseases (such as COPD and Asthma), and easy to use for family physician screening or rapid drug testing. The new generation handheld spirometer, MIR MiniSpir, can be used on all computers thanks to its special computer software (Figure 1).

Figure 1. Spirometric lung breathing, a device that measures forced inhalation and forced expiration functions

- Heat Sensor (Semiconductor (0-45 °C))
- Current Sensor (Two Way Digital Turbine)
- Communication Port (USB)
- Power Unit (USB Line)
- Carrying Bag (With the System)
- Cardboard Mouthpiece
- Nose Clip
- Mini Spirometer Tester



The distribution of lung volumes and capacities was measured using a portable handheld mini spirometer. With its economical price and ergonomic design (adaptation of the physical environment to the human, harmony between the device and the human), the MIR MiniSpir fulfills all the functions expected of a spirometer. The MIR MiniSpir spirometer is designed for pulmonary function tests (AFT). In our study, the distribution of lung volumes and capacities was measured using a portable handheld mini spirometer. The MIR MiniSpir fulfills all the functions expected of a spirometer. The distributions of forced inspiration and forced expiration lung functions were analyzed for both men and women (Table 1 and Table 2).

Table 1. Distribution of forced inhalation and forced exhalation lung function in boys

	NUMBER	PERCENTAGE
TOTAL DISTRIBUTION (∑ Distribution)	65	65%
MEN	35	35%
GIRLS	30	30%
MEN	Expected – NHANES III Values	35%
EVC	18 age = 2 (5.73 L and 5.26 L)	%Expected
	Average = 5.495 L	18 age = 2 (142% and 85%)
	19 age = 17 (5.32 L, 5.36 L, 5.63 L, 6.00 L, 5.43 L, 5.45 L, 5.51 L, 5.02 L, 5.23 L, 5.63 L, 5.75 L, 5.81 L, 5.76 L, 5.14 L, 5.63 L, 5.32 L and 5.23 L)	Average = 113.5%
	Average = 5.483 L	19 age = 17 (106%,108%, 95%, 174%, 88%, 99%, 97%, 95%,
	20 age = 8 (5.75 L, 6.09 L, 5.29 L, 6.44 L, 5.62 L, 5.42 L, 5.89 L and 5.14 L)	96%, 98%,100%, 102%, 85%, 85%, 101%, 70% and 82%)
	Average = 5.705 L	Average = 98.882%
	21 age = 5 (6.06 L, 5.74 L, 5.94 L, 5.74 L and 5.32 L)	20 age = 8 (114%, 76%, 114%, 95%, 94%, 91%, 84% and 110%)
	Average = 5.760 L	Average = 97.25%
	22 age = 1 (5.63 L)	21 age = 5 (83%, 88%, 113%, 94% and 114%)
	23 age = 1 (5.02 L)	Average = 98.4%
	24 age = 1 (5.63 L)	22 age = 1 (116%)
	General Average = 5.569 L	23 age = 1 (76%)
	Toplam ∑= 35	24 age = 1 (105%)
	Pretest Expected – NHANES III Values (PRE)	General Average = 99.28%
	18 age = 2 (8.12 L↑ and 4.45 L↓)	
	Average = 6.285 L	
	19 age = 17 (5.65 L↑, 5.80 L↑ , 5.36	

	L ⬇, 10.41 L ⬆, 4.75 L ⬇, 5.40 L ⬇, 5.34 L ⬇, 4.77 L ⬇, 5.00 L ⬇, 5.49 L ⬆, 5.77 L ⬇, 5.95 L ⬆, 4.90 L ⬇, 4.38 L ⬇, 5.66 L ⬆, 3.74 L ⬇ and 4.29 L ⬇) Average = 5.450 L 20 age = 8 (6.54 L ⬆, 4.62 ⬇, 6.05 L ⬆, 6.11 L ⬇, 5.29 L ⬇, 4.94 L ⬇, 4.97 L ⬇ and 5.67 L ⬆) Average = 5.523 L 21 age = 5 (5.01 L ⬇, 5.03 L ⬇, 6.72 L ⬆, 5.41 L ⬇ and 6.08 L ⬆) Average = 5.65 L 22 age = 1 (6.51 L ⬆) 23 age = 1 (3.81 L ⬇) 24 age = 1 (5.91 L ⬆) General Average = 5.54 L Total ∑= 35	
IVC	Expected – NHANES III Values 18 age = 2 (5.73 L and 5.26 L) Average = 5.495 L 19 age = 17 (5.32 L, 5.36 L, 5.63 L, 6.00 L, 5.43 L, 5.45 L, 5.51 L, 5.02 L, 5.23 L, 5.63 L, 5.75 L, 5.81 L, 5.76 L, 5.14 L, 5.63 L, 5.32 L and 5.23 L) Average = 5.483 L 20 age = 8 (5.75 L, 6.09 L, 5.29 L, 6.44 L, 5.62 L, 5.42 L, 5.89 L ve 5.14 L) Average = 5.705 L 21 age = 5 (6.06 L, 5.74 L, 5.94 L, 5.74 L and 5.32 L) Average = 5.760 L 22 age = 1 (5.63 L) 23 age = 1 (5.02 L) 24 age = 1 (5.63 L) General Average = 5.569 L Total ∑= 35	35%

IC	Expected – NHANES III Values 18 age = 2 (3.28 L and 3.66 L) Average = 3.47 L 19 age = 17 (3.71 L, 3.10 L, 3.96 L, 4.27 L, 3.14 L, 3.81 L, 3.86 L, 3.46 L, 3.03 L, 3.96 L, 4.07 L, 4.12 L, 3.30 L, 3.56 L, 3.96 L, 3.71 L and 3.03 L) Average = 3.65 L 20 age = 8 (4.07 L, 3.45 L, 3.05 L, 3.62 L, 3.22 L, 3.12 L, 3.35 L and 3.56 L) Average = 3.43 L 21 age = 5 (4.32 L, 3.37 L, 4.22 L, 3.37 L and 3.71 L) Average = 3.798 L 22 age = 1 (3.96 L) 23 age = 1 (3.46 L) 24 age = 1 (3.96 L) General Average = 3.337 L Total ∑= 35 Pretest Expected – NHANES III Values (PRE) 18 age = 2 (0.00 L⬇ and 1.84 L⬇) Average = 0.92 L 19 age = 17 (2.99 L⬇, 3.10 L=, 3.15 L⬇, 7.05 L⬆, 4.13 L⬆, 2.12 L⬇, 4.52 L⬆ 2.82 L⬇, 2.80 L⬇, 2.72 L⬇, 2.70 L⬇, 2.76 L⬇, 2.72 L⬇, 2.17 L⬇, 3.01 L⬇, 2.06 L⬇ and 1.79 L⬇) Average = 3.094 L 20 age = 8 (3.52 L⬇, 3.64 L⬆, 3.48 L⬆, 5.06 L⬆, 2.33 L⬇, 0.00 L⬇, 4.32 L⬆ and 2.88 L⬇) Average = 3.153 L 21 age = 5 (0.00 L⬇, 2.29 L⬇, 5.35 L⬆, 3.77 L⬆ and 3.82 L⬆) Average = 3.046 L 22 age = 1 (2.57 L⬇) 23 age = 1 (2.17 L⬇)	35% %Expected 18 age = 2 (0% and 50%) Average = 25% 19 age = 17 (81%,100%, 79%, 165%, 132%, 56%, 117%, 82%, 92%, 69%, 66%, 67%, 82%, 61%, 76%, 56% and 59%) Average = 8.705% 20 age = 8 (87%, 105%, 114%, 140%, 72%, 0%,129% and 81%) Average = 91% 21 age = 5 (0%, 68%, 127%, 112% and 103%) Average = 82% 22 age = 1 (65%) 23 age = 1 (63%) 24 age = 1 (110%) General Average = 82.457%

	24 age = 1 (4.37 L↑) General Average = 2.972 L Total ∑= 35	
ERV	Expected – NHANES III Values 18 age = 2 (2.08 L and 1.60 L) Average = 1.84 L 19 age = 17 (1.61 L, 1.86 L, 1.67 L, 1.73 L, 1.88 L, 1.63 L, 1.64 L, 1.56 L, 1.81 L, 1.67 L, 1.69 L, 1.70 L, 2.01 L, 1.58 L, 1.67 L, 1.61 L and 1.81 L) Average = 1.713 L 20 age = 8 (1.69 L, 2.05 L, 1.74 L, 2.18 L, 1.87 L, 1.80 L, 1.98 L and 1.58 L)	35% %Expected 18 age = 2 (0% and 163%) Average = 81.5% 19 age = 17 (165%, 145%, 133%, 195%, 33%, 201%, 50%, 125%, 122%, 166%, 182%,188%, 108%, 140%, 159%, 104% and 138%) Average = 67.257% 20 age = 8 (179%, 48%, 147%, 48%, 158%, 0%, 33% and 176%) Average = 98.625% 21 age = 5 (0%, 143%, 80%, 86 % and 14%) Average = 89.8% 22 age = 1 (237%) 23 age = 1 (105%) 24 age = 1 (92%) General Average = 119.685%
	Average = 1.861 L 21 age = 5 (1.74 L, 1.91 L, 1.72 L, 1.91 L and 1,61 L) Average = 1.778 L 22 age = 1 (1.67 L) 23 age = 1 (1.56 L) 24 age = 1 (1.67 L) General Average = 1.756 L Total ∑= 35 Pretest Expected – NHANES III Values (PRE) 18 age = 2 (0.00 L↓ and 2.61 L↑) Average = 1.305 L 19 age = 17 (2.66 L↑, 2.70 L↑, 2.21 L↑, 3.36 L↑, 0.62 L↓, 3.28 L↑, 0.82 L↓, 1.95 L↑, 2.20 L↑, 2.77 L↑, 3.07 L↑, 3.19 L↑, 2.18 L↑, 2.21 L↑, 2.65 L↑, 1.68 L↑ and 2.50 L↑) Average = 2.382 L 20 age = 8 (3.02 L↑, 0.98 L↓, 2.57 L↑, 1.05 L↓ or ↑, 2.96 L↑, 0.00 L↓, 0.65 L↓ and 2.79 L↑) Average = 1.7525 L	

	21 age = 5 (0.00 L↓, 2.74 L↑, 1.37 L↓ or ↑, 1.64 L↓ or ↑ and 2.26 L ↑)
	Average = 1.602 L
	22 age = 1 (3.94 L↑)
	23 age = 1 (1.64 L↑)
	24 age = 1 (1.54 L↓ or ↑)
	General Average = 2.051 L
	Total ∑= 35
TV	Pretest Expected – NHANES III Values (PRE)
	18 age = 2 (0.00 L↓ and 0.04 L↓)
	Average = 0.02 L
	19 age = 17 (1.00 L↑, 0.79 L↑ 1.29 L↑, 1.53 L↑, 0.63 L↑, 0.04 L↓, 0.71 L↑, 0.49 L↑, 1.31 L↑, 1.35 L ↓, 0.75 L↑ 1.54 L↑, 0.70 L↓, 1.48 L↑, 0.93 L↑, 0.86 L↑ and 0.03 L↑)
	Average = 0.907 L
	20 age = 8 (1.32 L↑, 0.84 L↑, 0.90 L ↑, 5.03 L↑ 1.47 L↑, 0.00 L↓, 1.09 L↑ and 1.61 L↑)
	Average = 1.5325 L
	21 age = 5 (0.00 L↓, 1.01 L↑, 1.03 L↑ , 1.79 L↑ and 2.26 L↑)
	Average = 1.218 L
	22 age = 1 (1.35 L↑)
	23 age = 1 (1.39 L↑)
	24 age = 1 (1.44 L↑)
	General Average = 1.085 L
	Total ∑= 35
FEV1	18 age = 2
	FEV1 = 4 lt and 6 lt
	FEV1 Total ∑= 10 lt
	FEV1 Average = 5 lt
	19 age= 17
	FEV1 = 1 lt, 1 lt, 3 lt, 4 lt, 2 lt, 4.9 lt, 10 lt, 5 lt, 2 lt, 1 lt, 2 lt, 3 lt, 3,5 lt, 5 lt, 2 lt, 3.5 lt and 2 lt

	FEV1 Total ∑= 54.9 lt
	FEV1 Average = 3.22 lt
	20 age = 8
	FEV1 = 0,5 lt, 4, lt, 1 lt, 1 lt, 4,9 lt, 4 lt, 2 lt and 6 lt
	FEV1 Total ∑ = 23.4 lt
	FEV1 Average = 2.925 lt
	21 age = 5
	FEV1 = 0.1 lt, 4 lt, 4.5 lt, 1 lt and 0.5 lt
	FEV1 Total ∑= 10.1 lt
	FEV1 Average = 2.02 lt
	22 age = 1
	FEV1 = 0.1 lt
	23 age = 1
	FEV1 = 0.1 lt
	24 age = 1
	FEV1 = 3 lt
	General Average = 2.902 lt
	Total ∑= 35

Table 2. Distribution of forced inhalation and forced exhalation lung function in girls

GIRLS	Expected – NHANES III Values	30%
EVC	18 age = 1 (4.14 L)	%Expected
	19 age = 15 (3.39 L, 3.99 L, 3.48 L, 4.13 L, 3.62 L, 3.71 L, 4.27 L, 4.32 L, 3.39 L, 3.80 L, 3.65 L, 4.30 L, 3.56 L, 3.62 L and 3.90 L)	18 age = 1 (90%)
	Average = 3.808 L	19 age = 15 (68%, 114%, 124%, 117%, 131%, 113%, 108%, 89%, 98%, 78%, 93%, 99%, 85%, 94% and 109%)
	20 age = 9 (3.67 L, 3.99 L, 3.39 L, 3.43 L, 3.43 L, 3.99 L, 4.00 L, 3.57 L and 3.80 L)	Average = 7.627%
	Average = 3.696 L	20 age = 9 (101%, 116%, 99%, 74%, 105%, 93%, 108%, 109% and 97%)
	21 age = 2 (4.32 L and 3.90 L)	Average = 100.222%
	Average = 4.11 L	21 age = 2 (107% and 87%)
	22 age = 1 (3.39 L)	Average = 97%
	23 age = 1 (3.43 L)	22 age = 1 (82%)
	24 age = 1 (4.36 L)	23 age = 1 (102%)
	General Average = 3.798 L	24 age = 1 (89%)
	Total ∑= 30	General Average = 3.862%
	Pretest Expected – NHANES III Values (PRE)	

	18 age = 1 (3.74 L↓)	
	19 age = 15 (2.30 L↓, 4.54 L↑, 4.30 L↑, 4.83 L↑, 4.74 L↑, 4.20 L↑, 4.63 L↑, 3.86 L↓, 3.31 L↓, 2.95 L↓, 3.41 L↓, 4.26 L↓, 3.01 L↓, 3.41 L↓ and 4.26 L↑)	
	Average = 3.867 L	
	20 age = 9 (3.69 L↑, 4.65 L↑, 3.34 L↓, 2.53 L↓, 3.62 L↑, 3.71 L↓, 4.32 L↑, 3.91 L↑ and 3.69 L↓)	
	Average = 3.717 L	
	21 age = 2 (4.64 L↑ and 3.38 L↓)	
	Average = 4.01 L	
	22 age = 1 (2.76 L↓)	
	23 age = 1 (3.51 L↑)	
	24 age = 1 (3.90 L↓)	
	General Average = 3.655 L	
	Total ∑= 30	
IVC	Expected – NHANES III Values	30%
	18 age = 1 (4.14 L)	
	19 age = 15 (3.39 L, 3.99 L, 3.48 L, 4.13 L, 3.62 L, 3.71 L, 4.27 L, 4.32 L, 3.39 L, 3.80 L, 3.65 L, 4.30 L, 3.56 L, 3.62 L and 3.90 L)	
	Average = 3.808 L	
	20 age = 9 (3.67 L, 3.99 L, 3.39 L, 3.43 L, 3.43 L, 3.99 L, 4.00 L, 3.57 L and 3.80 L)	
	Average = 3.696 L	
	21 age = 2 (4.32 L and 3.90 L)	
	Average = 4.11 L	
	22 age = 1 (3.39 L)	
	23 age = 1 (3.43 L)	
	24 age = 1 (4.36 L)	
	General Average = 3.798 L	
	Total ∑= 30	
IC	Expected – NHANES III Values	30%
	18 age = 1 (2.18 L)	%Expected
	19 age = 15 (2.09 L, 2.64 L, 2.17 L, 2.77 L, 2.30 L, 2.39 L, 2.89 L, 2.94 L, 2.09 L, 2.09 L, 2.01 L, 2.34 L, 1.96 L, 2.30 L and 2.55 L)	18 age = 1 (147%)
		19 age = 15 (0%, 0%, 108%, 0%, 0%, 86%, 151%, 68%, 0%, 134%, 93%, 169%, 154%, 89% and 96%)
	Average = 2.368 L	Average = 76.533%

	20 age = 9 (2.34 L, 2.64 L, 2.09 L, 2.13 L, 2.13 L, 2.64 L, 2.26 L, 2.26 L and 2.15 L) Average = 2.293 L 21 age = 2 (2.94 L and 2.55 L) Average = 2.745 L 22 age = 1 (2.09 L) 23 age = 1 (2.13 L) 24 age = 1 (2.45 L) General Average = 2.350 L Total ∑= 30 Pretest Expected – NHANES III Values (PRE) 18 age = 1 (3.20 L↑) 19 age = 15 (0.00 L↓, 0.00 L↓, 2.34 L↑, 0.00 L↓, 0.00 L↓, 2.05 L↓, 4.37 L↑, 2.01 L↓, 0.00 L↓, 2.79 L↑, 1.87 L↓, 3.95 L↑, 3.01 L↑, 2.05 L↓ and 2.45 L↓) Average = 1.792 L 20 age = 9 (1.83 L↓, 1.79 L↓, 1.73 L↓, 1.50 L↓, 1.28 L↓, 3.33 L↑ ,1.77 L↓,1.53 L↓ and 2.05 L↓) Average = 1.867 L 21 age = 2 (2.69 L↓ and 0.00 L↓) Average = 1.345 L 22 age = 1 (2.75 L↑) 23 age = 1 (0.00 L↓) 24 age = 1 (3.43 L↑) General Average= 1.859 L Total ∑= 30	20 age = 9 (78%, 68%, 83%, 70%, 60%, 126%, 78%, 68% and 96%) Average = 80.777% 21 age = 2 (92% and 0%) Average = 46% 22 age = 1 (132%) 23 age = 1 (0%) 24 age = 1 (140%) General Average = 79.533%
ERV	Expected – NHANES III Values 18 age = 1 (1.71 L) 19 age = 15 (1.30 L, 1.35 L, 1.31 L, 1.37 L, 1.32 L, 1.33 L, 1.38 L, 1.38 L, 1.30 L, 1.58 L, 1.53 L, 1.74 L, 1.49 L, 1.32 L, 1.34 L) Average = 1.402 L 20 age = 9 (1.32 L, 1.35 L, 1.30 L, 1.30 L, 1.30 L, 1.35 L, 1.62 L, 1.31 L and 1.56 L)	30% %Expected 18 age = 1 (32%) 19 age = 15 (0%, 0%, 150%, 0%, 0%, 162%, 19%, 134%, 0%, 10%, 101%, 18%, 0%, 103% and 135%) Average = 55.466% 20 age = 9 (141%, 211%, 124%, 79%, 180%, 28%, 157%, 181% and 105%)

	Average = 1.378 L 21 age = 2 (1,38 L and 1.34 L) Average = 1.36 L 22 age = 1 (1.30 L) 23 age = 1 (1.30 L) 24 age = 1 (1.67 L) General Average = 1.405 L Total ∑= 30 Pretest Expected – NHANES III Values (PRE) 18 age = 1 (0.54 L↓) 19 age = 15 (0.00 L↓, 0.00 L↓, 1.96 L↑, 0.00 L↓, 0.00 L↓, 2.15 L↑, 0.26 L↓, 1.85 L↑, 0.00 L↓, 0.16 L↓, 1.54 L↑, 0.31 L↓, 0.00 L↓, 1.36 L↑ and 1.81 L↑) Average = 0.76 L 20 age = 9 (1.86 L↑, 2.86 L↑, 1.61 L↑, 1.03 L↓ or ↑ , 2.34 L↑, 0.38 L↓, 2.55 L↑, 2.38 L↑ and 1.64 L↑) Average = 1.85 L 21 age = 2 (1.95 L↑ and 0.00 L↓) Average = 0.975 L 22 age = 1 (0.01 L↓) 23 age = 1 (0.00 L↓) 24 age = 1 (0.47 L↓) General Average = 1.034 L Total ∑= 30	Average = 134% 21 age = 2 (141% and 0%) Average = 70.5% 22 age = 1 (1%) 23 age = 1 (0%) 24 age = 1 (28%) General Average = 74.666%
TV	Pretest Expected – NHANES III Values (PRE) 18 age = 1 (1,42 L↑) 19 age = 15 (0.00 L↓, 0.00 L ↓ , 0.85L ↑, 0.00 L ↓ , 0.00 L↓ , 1.08 L ↑, 0.84 L ↑, 0.85 L ↑, 0.00 L ↓ , 1.47 L ↑, 0.72 L ↑, 0.59 L ↑, 1.89 L ↑, 0.50 L = and 1.15 L ↑) Average = 0.662 L 20 age = 9 (0.84 L , 1.00 L↑, 0.78 L ↑ , 0.43 L↓, 0.00 L↓, 0.36 L ↓ , 1.03 L↑ , 0.00 L ↓and 0.48 L↓)	30%

	Average = 0.546 L 21 age = 2 (0.75 L↑ and 0.00 L↓) Average = 0.375 L 22 age = 1 (2.17 L↑) 23 age = 1 (0.00 L↓) 24 age = 1 (1.68 L↑) General Average = 0.696 L Total ∑= 30
FEV_1	18 age = 1 FEV_1 = 4 lt 19 age = 15 FEV_1 = 2 lt, 2 lt, 2 lt, 5 lt, 2 lt, 0.5 lt, 15 lt, 2 lt, 4.9 lt, 4 lt, 0.5 lt, 14 lt, 3 lt, 2 lt and 6 lt FEV_1 Total ∑= 64.9 lt FEV_1 Average = 4.326 lt 20 age = 9 FEV_1 = 0.5 lt, 2 lt, 0,1 lt, 0.5 lt, 4 lt, 0.5 lt, 0,1 lt, 4 lt and 4.9 lt FEV_1 Total ∑= 16.6 lt FEV_1 Average = 1.844 lt 21 age = 2 FEV_1 = 4.9 lt and 0.1 lt FEV_1 Total ∑= 5 lt FEV_1 Average = 2.5 lt 22 age = 1 FEV_1 = 4 lt 23 age = 1 FEV_1 = 0.5 lt 24 age = 1 FEV_1 = 4 lt General Average = 3.3 lt Total ∑= 30

Eligibility criteria for participants in spirometric test measurement

Individuals aged 18-24 who do not have shortness of breath, wheezing, cough and sputum production, acute trauma affecting the lungs, alveoli, pleural space, or pleural tissue within the last 3 months, a diagnosed lung or heart condition, any abnormal sound or difficulty breathing with constant speed and depth, sleep apnea, central nervous system dysfunction controlling ventilation, a significant increase in respiratory workload in a short period, involuntary shortness of breath, air deficiency, and involuntary excessive weight loss or gain due to emotional states, stress, hunger, environmental or psychological factors; those who are not hungry or overeating; athletes; those who engage in sports, exercise, or training; those who do not engage in strenuous exercise for 30 minutes or more before the test; those who do not eat a heavy meal 2 hours before the test; those who do not wear clothing that restricts or narrows movement in the chest and abdominal area; those who rest sitting down before the test; and those who have not smoked for a long time are not eligible to take the exam. LFS scores of volunteers participating in the study were used under the following conditions: non-alcoholic, not having consumed alcohol for a long time, not having smoked at least 24 hours before the test (a substance affecting O_2 and CO_2 diffusion capacity), not having consumed alcohol at least 4 hours before the test (a distracting substance), being completely healthy physically, mentally and socially, not having undergone recent surgery, having normal breathing and exhalation rhythms, not having consumed caffeinated coffee, tea, energy drinks or carbonated drinks before the test, not having undergone any respiratory system surgery in the last year, and not having lung problems such as difficulty breathing. These criteria were considered and anticipated for inclusion in the study, and if deemed appropriate, it is important that volunteers inform the researcher before the test. Therefore, lung volume and capacity measurements were performed using hand spirometry to assess pulmonary function. Pulmonary function assessment of individuals was performed using a spirometer, in a seated position with shoulders relaxed in a chair with back support and no armrests, according to ATS/ERS recommended criteria. In the pulmonary function test, FVC, FEV1, FEV1/FVC, VC, IC, and MVV values were recorded as expected values and percentages according to age, height, BMI, and gender (Table 1, table 2, table 3, table 4, table 5 and table 6).

Working group and ethical statements

This research, titled "Analysis of Respiratory Function Test Signals in Healthy Young Male and Female Individuals," was conducted after obtaining the necessary approval from the Manisa Celal Bayar University Faculty of Medicine Human Research Local Ethics Committee (an independent, local, regional, and national review board for research in the field of management) with decision number 20.0478.486 dated 25/12/2019. The research was conducted after obtaining the necessary board approval. Prepared by an expert in the subject matter, the results and rationale of our measurements were presented based on precise and scientific data. The findings of the research related to our topic and event were determined and reported and presented in writing and orally to the competent authority and board. Thus, experimental preliminary application protocols, experiments, observational and non-interventionist research were prepared. In our research study, measurements were taken using hand spirometry from a randomly selected group of 35 men and 30 women (n=65) aged 18-24, with heights between 1.57-1.90 cm and weights between 38-95 kg, at Manisa Celal Bayar University Faculty of Medicine between December and March 2019. These volunteers were selected blindly from a mixed consent form and participated in a randomized controlled trial. In the study, individuals provided "Informed Consent" or signed a voluntary consent form acknowledging that animal rights were being protected. The study included healthy adults aged 18-24 years with heights ranging from 1.57-1.90 cm and weights ranging from 38-95 kg (gender, biology, identity, psychosocial, and cultural factors were reported).

Statistical analysis

In this study, volunteers were given handheld spirometers to take the necessary measure-

ments, and the spirometer data and information obtained from volunteer entry forms were evaluated using SPSS™ 24.0 for Windows Evaluation Version (2016 Inc.). An advanced digital computer statistical package analysis program was used (frequency was also used to determine the numerical distribution of the data). Descriptive statistics were used in the analysis of the data; The objectives of this study are: to determine whether the lung volumes and capacities of the population have a normal distribution using paired data for a single group, to calculate homogeneity values, to check spirometric distributions in group comparisons to show the presence of respiratory disorders, to test two different problems with parametric statistics, to test data and determine the numerical distribution according to sample size using the t-test, to determine the intergroup mean variation in comparisons between different groups using the independent t-test, to test the chi-square cross-tabulation test for all groups (for categorical data such as nominal variables) and the parametric (t-test) or Mann-Whitney U test (also known as the Wilcoxon rank sum test or Wilcoxon-Mann-Whitney test), a parametric technique used to test the statistical significance of the difference between two means, and to compare only two means in the t-test, or to determine whether two samples given quantitative scale observations come from the same distribution using the non-parametric (Mann-Whitney U) test, according to height, age and gender groups. The distributions were analyzed to compare them (for numerical-continuous data). A p-value <0.05 was considered statistically significant. The data for this study were collected at the University Human Research Application Center Laboratory located in the Physiology Department Dean's Office building of the Institute of Health Sciences, Faculty of Medicine, Manisa Celal Bayar University.

RESULTS

Of the participants, 35 (53.8%) were male and 30 (46.2%) were female, with an average age of 19.8 ± 1.28 years. 4.6% of participants were 18 years old (2 men, 1 woman = 3), 42.2% were 19 years old (7 men, 15 women = 22), and 26.2% were 20 years old (8 men, 9 women = 17). 10.8% were 21 years old (5 men, 2 women = 7), and 3.1% were 22, 23, and 24 years old (3 men, 3 women = 6). Descriptive distribution data and mean values of respiratory function parameters of the participants in the study are presented in Table 3 and Table 4.

Table 3. Mean distributions of the effects of forced inspiration and expiration functions of the lung on parameters of pulmonary function tests in healthy young men (mean values obtained for lung volumes, capacities and pulmonary functions for adults aged 18-24 years)

TOTAL DISTRIBUTION (∑Distribution (n=65) n%)	**EVC**	**IVC**	**IC**	**ERV**	**TV**	**FEV_1**
PARAMETERS **MEN**	EVC or IVC or VC / SIZE Ratio Overall Average Rate = 115.71 / 35 = 3.306 m^2 1. group 18 Age = Avg = 5.495 L = 6.11 / 2 = 3.055 m^2	EVC or IVC or VC / WEIGHT Ratio Overall Average Rate = 18.56 / 35 = 0.53 kg Expected – NHANES III Values 1. group	Expected – NHANES III Values 1. group 18 Age = Avg = 3.47 L 2. group 19 Age = Avg = 3.65 L 3. group 20 Age = Avg = 3.43 L	Expected – NHANES III Values 1. group 18 Age = Avg = 1.84 L 2. group 19 Age = Avg = 1.713 L 3. group 20 Age	Pre-Test Expected – NHANES III Values 1. group 18 Age = Avg = 0.02 L ⬇ 2. group 19 Age = Avg = 0.907 L ⬆ 3. group	FEV_1 Overall Average = 99 / 35 = 3.4 lt 1. group 18 Age = 2 FEV_1 Avg = 5 lt ⬆ 2. group 19 Age = 17

	2. group 19 Age = Avg = 5.483 L = 52.24 / 17 = 3.07 m^2 3. group 20 Age = Avg = 5.705 L = 25.32 / 8 = 3.165 m^2 4. group 21 Age = Avg = 5.760 L = 15,76 = 3.152 m^2 5. group 22 Age = 5.63 / 1.80 = 3.12 m^2 6. group 23 Age = 5.02 / 1.70 = 2.95 m^2 7. group 24 Age = 5.63 / 1.80 = 3.12 m^2 Overall Average = 5.569 L, Total ∑= 35 Pre-Test Expected – NHANES III Values (PRE) 18 Age = Avg = 6.285 L (Normal) 19 Age = Avg = 5.450 L ⬇ 20 Age = Avg = 5.523 L ⬇ 21 Age = Avg = 5.65 L ⬇	18 Age = Avg = 5.495 L = 0.13 / 2 = 0.065 kg 2. group 19 Age = Avg = 5.483 L = 1.22 / 17 = 0.07 kg 3. group 20 Age = Avg = 5.705 L = 0.58 / 8 = 0.07 kg 4. group 21 Age = Avg = 5.760 L = 0.35 / 5 = 0.07 kg 5. group 22 Age = 5.63 L = 5.63 / 60 = 0.09 kg 6. group 23 Age = 5.02 L = 5.02 / 65 = 0.07 kg 7. group 24 Age = 5.63 L = 5.63 / 86 = 0.06 kg Overall Average = 5.569 L, Total ∑= 35 Pre-Test Expected – NHANES III Values PRE) (IVC Values same as values of EVC)	4. group 21 Age = Avg = 3.798 L 5. group 22 Age = Avg = 3.96 L 6. group 23 Age = Avg = 3.46 L 7. group 24 Age = Avg = 3.96 L Overall Average = 3.337 L, Total ∑= 35 Pre-Test Expected – NHANES III Values 18 Age = Avg = 0.92 L ⬇ 19 Age = Avg = 3.094 L ⬇ 20 Age = Avg = 3.153 L (Normal) 21 Age = Avg = 3.046 L ⬆ 22 Age = 2.57 L ⬇ 23 Age = 2.17 L ⬇ 24 Age = 4.37 L ⬆ Overall Average = 2.972 L, Total ∑= 35	Avg = 1.861 L 4. group 21 Age = Avg = 1.778 L 5. group 22 Age = Avg = 1.67 L 6. group 23 Age = Avg = 1.56 L 7. group 24 Age = Avg = 1.67 L Overall Average = 1.756 L, Total ∑= 35 Pre-Test Expected – NHANES III Values 18 Age = Avg = 1.305 L ⬇ 19 Age = Avg = 2.382 L ⬆ 20 Age = Avg = 1.7525 L ⬆ 21 Age = Avg = 1.602 L ⬆ 22 Age = 3.94 L ⬆ 23 Age = 1.64 L ⬆ 24 Age = 1.54 L ⬆ Overall Average = 2.051 L, Total ∑= 35	20 Age = Avg = 1.5325 L ⬆ 4. group 21 Age = Avg = 1.218 L ⬆ 5. group 22 Age = 1.35 L ⬆ 6. group 23 Age = 1.39 L ⬆ 7. group 24 Age = 1.44 L ⬆ Overall Average = 1.085 L, Total ∑= 35	FEV_1 Avg = 3.22 lt ⬆ 3. group 20 Age = FEV_1 Avg = 2.925 lt ⬆ 4. group 21 Age= FEV_1 Avg = 2.02 lt ⬆ 5. group 22 Age= FEV_1 = 0.1 lt ⬇ 6. group 23 Age= FEV_1 = 0.1 lt ⬇ 7. group 24 Age= FEV_1 = 3 lt ⬆ Overall Average = 101.6 / 35 = 2.902 L, Total ∑= 35

22 Age = 6.51 L ⬆

23 Age = 3.81 L ⬇

24 Age = 5.91 L ⬆

Overall Average = 5.54

Table 4. Mean distributions of the effects of forced inspiration and expiration functions of the lung on parameters of pulmonary function tests in healthy young women (mean values obtained for lung volumes, capacities and pulmonary functions for adults aged 18-24 years)

TOTAL DISTRIBUTION (∑Distribution (n=65) n%)	**EVC**	**IVC**	**IC**	**ERV**	**TV**	**FEV_1**
RESPIRATORY PARAMETERS **WOMEN**	EVC or IVC or VC / SIZE Ratio Overall Average Rate = 74.35 / 30 = 2.47 m^2 Expected – NHANES III Values 1. group 18 Age = Avg = 4.14 / 1.70 = 2,43 m^2 2. group 19 Age = Avg = 3.808 L = 33.92 / 15 = 2.26 m^2 3. group 20 Age = Avg = 3.696 L = 20.35 / 9 = 2.26 m^2 4. group 21 Age = Avg = 4.11 L =	EVC or IVC or VC / WEIGHT Ratio Overall Average Rate = 16.91 / 30 = 0.56 kg Expected – NHANES III Values 1. group 18 Age = 4.14 / 56 = 0.07 kg 2. group 19 Age = Avg = 3.808 L = 0.9 / 15 = 0.06 kg 3. group 20 Age = Avg = 3.696 L = 0.56 / 9 = 0.06 kg 4. group 21 Age = Avg = 4.11 L =0.13 / 2 = 0.065 kg 5. group 22 Age = 3.39 / 38 = 0.08 kg	Expected – NHANES III Values 1. group 18 Age = 2.18 L 2. group 19 Age = Avg = 2.368 L 3. group 20 Age = Avg = 2.293 L 4. group 21 Age = Avg = 2.745 L 5. group 22 Age = 2.09 L 6. group 23 Age = 2.13 L 7. group 24 Age = 2.45 L Overall Average = 2.350 L, Total ∑= 30	Expected – NHANES III Values 1. group 18 Age = 1.71 L 2. group 19 Age = Avg = 1.402 L 3. group 20 Age = Avg = 1.378 L 4. group 21 Age = Avg = 1.36 L 5. group 22 Age = 1.30 L 6. group 23 Age = 1.30 L 7. group 24 Age = 1.67 L Overall Average = 1.405 L, Total ∑= 30	Pre-Test Expected – NHANES III Values 18 Age = 1.42 L ⬆ 19 Age = Avg = 0.662 L ⬆ 20 Age = Avg = 0.546 L ⬇ 21 Age = Avg = 0.375 L (Normal) 22 Age = 2.17 L ⬆ 23 Age = 0.00 L ⬇ 24 Age = 1.68 L ⬆ Overall Average = 0.696 L, Total ∑= 30	FEV_1 Overall Average = 99 / 30 = 3.3 lt ⬆ 1. group 18 Age = FEV_1 = 4 lt ⬆ 2. group 19 Age = FEV_1 Avg = 64.9 / 15 = 4.326 lt ⬆ 3. group 20 Age = FEV_1 Avg = 16.6 / 9 = 1.844 lt ⬆ 4. group 21 Age = FEV_1 Avg = 5 / 2 = 2.5 lt ⬆ 5. group 22 Age = FEV_1 = 4 lt ⬆ 6. group 23 Age =

	4.76 / 2 = 2.38 m^2 5. group 22 Age = 3.39 L = 3.39 / 1.57 = 2.15 m^2 6. group 23 Age = 3.43 L = 3,43 / 1.58 = 2.17 m^2 7. group 24 Age = 4.36 L = 4.36 / 1.74 = 2.50 m^2 Overall Average = 3.798 L, Toatal ∑= 30 Expected – NHANES III Values 18 Age = 3.74 L ↓ 19 Age = Avg = 3.867 L ↓ 20 Age = Avg = 3.717 L ↑ 21 Age = Avg = 4.01 L (Normal) 22 Age = 2.76 L ↓ 23 Age = 3.51 L 24 Age = 3.90 L ↓ Overall Average = 3.655 L, Total ∑= 30	6. group 23 Age = 3.43 / 65 = 0.05 kg 7. group 24 Age = 4.36 / 61 = 0.07 kg Overall Average = 3.798 L, Total ∑= 30 Expected – NHANES III Values (IVC Values same as values of EVC)	Pre-Test Expected – NHANES III Values 18 Age = Avg = 1.867 L 19 Age = Avg = 1.792 L ↓ 20 Age = Avg = 1.867 L ↓ 21 Age = Avg = 1.345 L (Normal) 22 Age = 2.75 L 23 Age = 0.00 L ↓ 24 Age = 3.43 L Overall Average = 1.859 L, Total ∑= 30	Pre-Test Expected – NHANES III Values 18 Age = 0.54 L ↓ 19 Age = Avg = 0.76 L ↓ 20 Age = Avg = 1.85 L 21 Age = Avg = 0.975 L (Normal) 22 Age = 0.01 L ↓ 23 Age = 0.00 L ↓ 24 Age = 0.47 L ↓ Overall Average = 1.034 L, Total ∑= 30	FEV_1 = 0.5 lt ↑ 7. group 24 Age = FEV_1 = 4 lt ↑ Overall Average = 3.3 L, Total ∑= 30

EVC: Expiratory Vital Capacity,
IVC: Inspiratory Vital Capacity,
IC: Inspiratory Capacity,
ERV: Expiratory Reserve Volume,
TV: Tidal Volume,
FEV1: Forced Expiratory Volume in One Second,
VC: Vital Capacity,
Mean: Average,
∑: Total,
NHANES III: 3rd National Health and Nutrition Survey,
L: Liter, lt, l

According to the data in Tables 5 and 6, in the total population examined to compare the entire group, only $EVC_{\%Expected}$ and Fahrenheit (°F) values were found to be generally lower in men (n=35) and higher in women (n=30). Other respiratory parameters, namely $EVC_{Expected}$, $IVC_{Expected}$, $IC_{Expected}$, $ERV_{Expected}$, EVC_{Found}, IC_{Found}, ERV_{Found}, TV_{Found}, $IC_{\%Expected}$, $ERV_{\%Expected}$, Temperature (°C), and BMI values, as well as sociodemographic values, were found to be higher in men (n=35) and lower in women (n=30) ($p<0.05$). All data showed a normal distribution. There was no statistically significant difference between the two sexes in terms of TV_{Found}, $EVC_{\%Expected}$, $IC_{\%Expected}$, Pressure, and Temperature values ($p>0.05$). According to the data in tables 5 and 6, the relationship between respiratory parameters and age was evaluated using parametric (t-test) or non-parametric (Mann-Whitney U) tests. No correlation was found between age and all respiratory parameters, including $EVC_{Expected}$, $IVC_{Expected}$, $IC_{Expected}$, $ERV_{Expected}$, EVC_{Found}, IC_{Found}, ERV_{Found}, TV_{Found}, $EVC_{\%Expected}$, $ERV_{\%Expected}$, $IC_{\%Expected}$, Celsius (°C), Fahrenheit (°F), and Pressure (P) ($p>0.05$) (Table 5 and table 6).

Table 5. Comparison of T-test group statistics of healthy young men and women = Descriptive statistical distribution of healthy young men and women according to respiratory function parameters = Distribution of the effects of forced inspiration and forced expiration lung functions on lung function test parameters

Feature	Number (n) and Total Number (∑n) = 65	Mean±SD and Total (∑) Mean±SD	*p***** value	Min – Max (Median)
$EVC_{Expected}$				
Man	35	5.56 ± 0.32	0.000***	3.39 – 6.44
Woman	30	3.79 ± 0.32, (∑) = 4.75 ± 0.94	(n.s.)	
$IVC_{Expected}$				
Man	35	5.56 ± 0.32	0.000***	3.39 – 6.44
Woman	30	3.79 ± 0,32, (∑) = 4,75 ± 0,94	(n.s.)	
$IC_{Expected}$				
Man	35	3.62 ± 0.38	0.000***	1.96 – 4.32
Woman	30	2.35 ± 0.28, (∑) = 3.03 ± 0.72	(n.s.)	
EVC_{Found}				
Man	35	2.97 ± 1.43	0.000***	2.30 – 10.41
Woman	30	1.85 ± 1.26, (∑) = 4.72 ± 1.32	(n.s.)	
IC_{Found}				
Man	35	2.97 ± 1.43	0.002*	0.00 – 7.05
Woman	30	1.85 ± 1.26, (∑) = 2.45 ± 1.45		

ERV_{Found}				
Man	35	2.05 ± 1.029	0.000***	0.00 – 3.94
Woman	30	1.03 ± 0.97, (∑) = 1.58 ± 1.12	(n.s.)	
TV_{Found}				
Man	35	1.05 ± 0.88	0.066**	0.00 – 5.03
Woman	30	0.69 ± 0.61, (∑) = 0.89 ± 0.79	(n.s.)	
$EVC_{\%Expected}$				
Man	35	99.2 ± 19.2	0.997**	68.00 –174.00
Woman	30	99.3 ± 14.6, (∑) = 99.2 ± 17.13	(n.s.)	
$IC_{\%Expected}$				
Man	35	81.8 ± 37.3	0.835**	0.00 – 169.00
Woman	30	79.5 ± 71.5, (∑) = 80.8 ± 44.9	(n.s.)	
$ERV_{\%Expected}$				
Man	35	119.6 ± 62.0	0.009*	0.00 – 237.00
Woman	30	74.6 ± 71.5, (∑) = 98.9 ± 69.8	(n.s.)	

$EVC_{Expected}$: Expected Expiratory Vital Capacity, $IVC_{Expected}$: Expected Inspiratory Vital Capacity, $IC_{Expected}$: Expected Inspiratory Capacity, $ERV_{Expected}$: Expected Expiratory Reserve Volume, EVC_{Found}: Found Expiratory Vital Capacity, IC_{Found}: Found Inspiratory Capacity, ERV_{Found}: Found Reserve Volume, TV_{Found}: Found Tidal Volume, $EVC_{\%Expected}$: Percentage of Expected Expiratory Vital Capacity, $IC_{\%Expected}$: Percentage of Expected Inspiratory Capacity, $ERV_{\%Expected}$: Percentage of Expected Expiratory Reserve Volume, m.s.s: Mean Standard Deviation, p**** value: According to parametric (t-test) or non-parametric (Mann-Whitney U) Test, min-max (median): Minimum and Maximum Median Value, BMI: Body Mass Index

* Statistical significance value <0.05, **>0.05 No statistical significance, *** 0 Lack of statistical significance (null hypothesis) or p<0.05, p<0.01 and p<0.001: Statistically significant difference, **** according to independent samples t-test, n.s.: Statistically insignificant difference

When the relationship between Body Mass Index (BMI) and respiratory parameters was examined, a moderately positive correlation was found only between BMI and $EVC_{Expected}$, $IVC_{Expected}$, $IC_{Expected}$, $ERV_{Expected}$, EVC_{Found}, IC_{Found}, and $EVC_{\%Expected}$, parametric (t-test) or non-parametric (Mann-Whitney U) test was used to determine that as BMI values increased, BMI values also increased, and this increase was statistically significant (p<0.05). These interpretations are as follows: r<0.2 indicates a very weak correlation or no correlation, 0.2-0.4 indicates a weak correlation, 0.4-0.6 indicates a weak correlation, 0.6-0.8 indicates a moderate correlation, and 0.8 and above indicates a very high correlation (Table 5, table 6 and table 7).

Table 6. Relationship between age, BMI, and respiratory parameters

Feature	t*	p*** value
Age-$EVC_{Expected}$	0.020	0.877** (n.s.)
Age –$IVC_{Expected}$	0.020	0.877** (n.s.)
Age –$IC_{Expected}$	0.044	0.728** (n.s.)
Age –$ERV_{Expected}$	-0.038	0.772** (n.s.)
Age –EVC_{Found}	-0.053	0.774** (n.s.)
Age –IC_{Found}	0.072	0.570** (n.s.)
Age –ERV_{Found}	-0.069	0.586** (n.s.)

Age –TV_{Found}	0.212	0.090** (n.s.)
Age -$EVC_{\%Expected}$	-0.108	0.394** (n.s.)
Age -$IC_{\%Expected}$	0.041	0.744** (n.s.)
Age –$ERV_{Expected}$	-0.074	0.556** (n.s.)
BMI-$EVC_{Expected}$	0.340	0.006** (n.s.)
BMI –$IVC_{Expected}$	0.340	0.006** (n.s.)
BMI –$IC_{Expected}$	0.332	0.007** (n.s.)
BMI –$ERV_{Expected}$	0.249	0.045**
BMI –EVC_{Found}	0.454	0.000****(n.s.)
BMI –IC_{Found}	0.252	0.043**
BMI –ERV_{Found}	0.242	0.052*** (n.s.)
BMI –TV_{Found}	0.115	0.362*** (n.s.)
BMI -$EVC_{\%Expected}$	0.355	0.004**
BMI -$IC_{\%Expected}$	0.065	0.606*** (n.s.)
BMI -$ERV_{\%Expected}$	0.228	0.068*** (n.s.)

*t = parametric (t-test) or non-parametric (Mann-Whitney U) test, *** and ***** According to parametric (t-test) or non-parametric (Mann-Whitney U) test, ** Statistical significance <0.05, **>0.05 and ***>0.05 No statistical significance, **** 0 No statistical significance (null hypothesis) or p<0.05, p<0.01 and p<0.001, n.s.: Statistically insignificant difference

Table 7. Results of p-values in healthy young male and female individuals

Feature	p*** value
$EVC_{Expected}$	0.00***** (n.s.)
$IVC_{Expected}$	0.00***** (n.s.)
$IC_{Expected}$	0.00***** (n.s.)
$ERV_{Expected}$	0.00***** (n.s.)
EVC_{Found}	0.00***** (n.s.)
IC_{Found}	0.002** (n.s.)
ERV_{Found}	0.00***** (n.s.)
TV_{Found}	0.066** (n.s.)
$EVC_{\%Expected}$	0.997** (n.s.)
$IC_{\%Expected}$	0.835** (n.s.)
$ERV_{\%Expected}$	0.009** (n.s.)

Figure 2. Relationship between gender and EVCExpected, IVCExpected, ICExpected, and ERVExpected values in all healthy young male and female subjects. Comparison of EVCExpected, IVCExpected, ICExpected, and ERVExpected respiratory parameter values according to gender

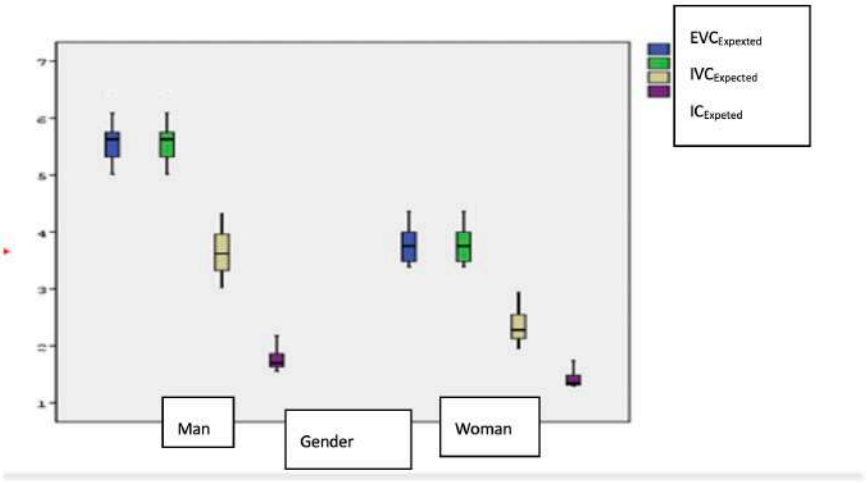


Figure 3. Relationship between gender and $EVC_{Expected}$, $IVC_{Expected}$, $IC_{Expected}$, and $ERV_{Expected}$ values in all healthy young male and female subjects. Comparison of $EVC_{Expected}$, $IVC_{Expected}$, $IC_{Expected}$, and $ERV_{Expected}$ respiratory parameter values according to gender. All healthy young male and female subjects. Relationship between gender and EVC_{Found}, IVC_{Found}, IC_{Found}, and ERV_{Found} values in female individuals. Comparison of respiratory parameter values (EVC_{Found}, IC_{Found}, ERV_{Found}, TV_{Found}) found according to gender

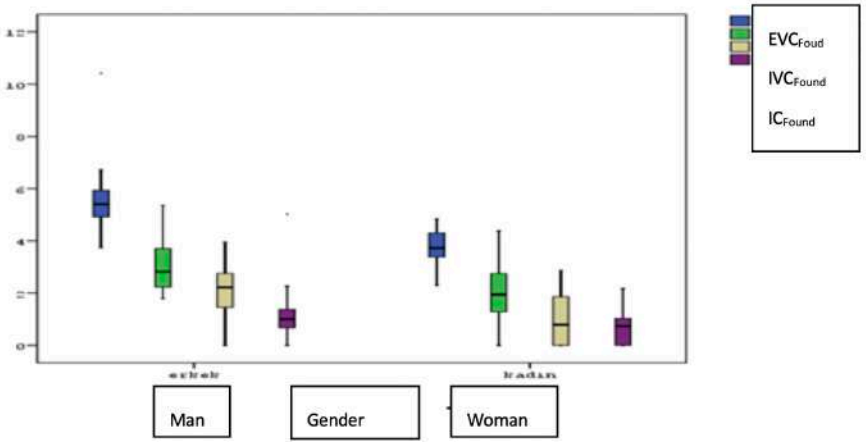


Figure 4. Relationship between gender and $EVC_{\%Expected}$, $IC_{\%Expected}$, and $ERV_{\%Expected}$ values in all healthy young male and female individuals. Relationship between expected values, $EVC_{\%Expected}$, $IC_{\%Expected}$, $ERV_{\%Expected}$ respiratory parameter values and gender, lung function, forced inspiration, and forced expiration function aspects

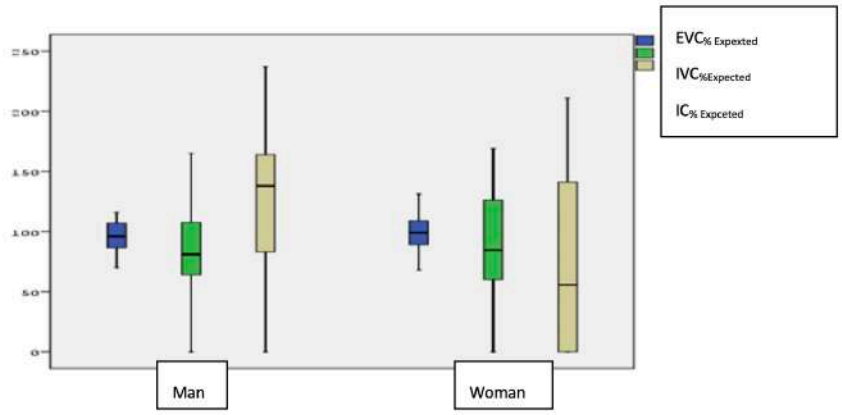
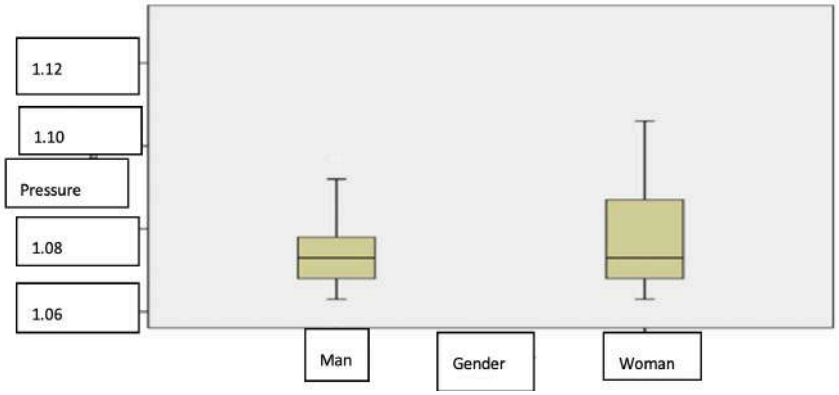


Figure 5. Relationship between blood pressure values in all healthy young men and women
Figures 2, 3, 4 and 5 show the box plot (histogram) representation of the $EVC_{Expected}$, $IVC_{Expected}$, $IC_{Expected}$, and $ERV_{Expected}$ variables, which are among the respiratory parameters that show statistically significant differences between the two sexes. Using biostatistical methods, Figures 2, 3, 4 and 5 were obtained via the SPSS™ 24.0 for Windows Evaluation Edition (2016 Inc.) Computer Statistics Package Program (the black lines in the middle of the graph are the median values) (Figures 2, 3, 4 and 5).



DISCUSSION

The aim of this study is to determine the tests reflecting static lung volumes (expiratory vital capacity, inspiratory vital capacity, inspiratory capacity, expiratory reserve volume, inspiratory reserve volume, tidal volume) in healthy young adult volunteers participating in our study, using an electronic portable handheld spirometer device in the laboratory or in the research experimental field. According to research, factors such as age, gender, height, weight, hormones, parental characteristics, stress, nutrition, and ethnicity can affect lung volume function in trace flow patterns in healthy individuals.

In the literature, the effects of lung volume and capacity on respiratory failure and disorders, depending on factors such as depression, exercise, family history, living conditions, gender, BMI, age, weight, and height, have been inves-

tigated through pulmonary function tests and spirometric measurements. There are not many adequate resources in the literature for studies on lung volumes and capacities and research reviews on human individuals (12,13). Our study found that lung function power was greater in humans (Lung Power Analysis = 3.051). According to our theory, which emerged from the results of our research, in our study, which is conducted using scientific methods that are important, innovative, and robust, relationships are established between events, designed to connect events to a cause, open to analytical methods, and where the clarity of the proposition considered valid in logic is tested for the solution of appropriate problems, the relevant data at hand has been used to explain the problem, and with these correct explanations, it has been possible to predict new facts regarding the solution of the research problem, and important new information that will contribute to the literature has been obtained.

In the literature, the accuracy and validity of equations obtained by using an "adjustment factor" in the variance in the equation group for predicting static lung volumes in a randomized sample of an ethnically heterogeneous population from Brazil have been established. The results should ideally be applied in clinical and research contexts to assess the normality of static lung volume values, ranging from 1.72-1.90 cm in men and 1.57-1.77 cm in women, in participants aged 18-24 years (14). It is believed that the distribution of lung volumes and capacities in adults can form the basis of sociodemographic and anthropometric measurements. The remarkably small lung volumes and capacities indicate that these can vary with age, changing height, and body structure (large or small). Studies comparing forced inspiration and expiration lung function to body weight have yielded varying results.

It has been verified, used to express the relationships between events and phenomena that need to be tested, and produced using the scientific article method. Thus, the true identities of the volunteers who were tested by us researchers in the field were discovered in a short time. This work has a scientific basis, presents possible solutions to a scientific research problem, and fills gaps in previous studies in the literature with findings not found in those studies. It has been deemed valid in various clinical and research studies in a short time, and is based on findings produced and clarified by researchers like ourselves, addressing previously unknown issues within a logical framework. The results of a hypothesis, a temporary solution proposed to address a specific scientific problem, are derived from a reasoning process that reaches a certain conclusion regarding the accuracy and reality of the data. The problems are solved through repeated experiments that consistently yield the same results. In this way, the laws, hypotheses, and realities of the natural world are directly proven, supported by new facts, in all their aspects.

In the literature, radiographic methods used for gas dilution, plethysmographic, and static left ventricular measurement in normal, healthy adults are quite comparable (14). A significant amount of data exists regarding the effects of race and ethnicity on left ventricular and pulmonary function tests (15,16). However, very little is known about the underlying physiological mechanisms. In our study, while no statistically significant change was detected in some values of the spirometer respiratory parameters, a statistically significant difference was detected in other parameter values.

This study presents a comprehensive description of static fluid ventilation (LV) values obtained from a randomly selected population of healthy adult men and women from a literature review. As expected of LV determinants in humans, sex, body size (height), and age explain 49–78% of the variation in observed values. Importantly, the use of a commonly recommended set of estimation equations led to double error, with lower LVs being overestimated and higher volumes underestimated. These results demonstrate that, as with most biological variables, reference values for LV should be considered, derived from a racially, ethnically, and geographically related population (11,17). Our study shows that the differences in forced inspiration and forced expiration functions of the lungs, compared with gender, age, height,

and body weight, range from 3.1% to 49.2%.

It is known in the literature that the effects of lung volume and capacity on respiratory failure and respiratory distress, depending on living conditions, gender, BMI, age, weight, and height, are investigated using pulmonary function tests and spirometric measurements. There is a lack of sufficient literature on research studies related to lung volume and capacity scores and the anthropometric and sociodemographic characteristics of human individuals (2,9,11). Our study found that lung function is higher in humans. IVC and EVC parameters showed clearly higher values in both male and female individuals. In our study, which was conducted by performing tests on the comprehensibility of the proposition designed to connect events, significant innovations and sound scientific methods arising from cause-and-effect relationships that are considered logically valid and open to analytical methods in solving the problems obtained from the research have been explained with appropriate data.

Looking at the results of our study, we found that some parameter values of the spirometer respiratory parameters did not show a statistically significant change or remained the same; the descriptive statistical distributions of respiratory function parameters of healthy young male and female individuals according to their respiratory function parameters/the distributions of the effect of forced inspiration and expiration functions of the lungs on the parameters of SFTs $EVC_{Expected}$ and $IVC_{Expected}$ mean standard deviation the p values were the same in the populations studied to compare the entire group, 4.75±0.94 (3.39-6.44), and were the same in both male and female groups. No statistically significant difference was found between the two sexes in terms of TV_{Found}, $EVC_{\%Expected}$ and $IC_{\%Expected}$ values. In the comparison of respiratory parameter values of $EVC_{\%Expected}$, $IC_{\%Expected}$ and $ERV_{\%Expected}$ according to sex, $EVC_{\%Expected}$ and $IC_{\%Expected}$ values were similar in both sexes ($p>0.05$). The change in respiratory P values according to sex was similar in the mean P values of E (1.07±0.016) to the mean P values of K (1.07±0.009) ($p=0.803$). The relationship between respiratory parameters and age was similar in terms of age and $EVC_{Expected}$, $IVC_{Expected}$, $IC_{Expected}$ and $ERV_{Expected}$, EVC_{Found}, IC_{Found}, ERV_{Found} and TV_{Found}, $EVC_{\%Expected}$, $ERV_{\%Expected}$ and when examining the relationship between BMI and respiratory parameters, no correlation was found between $IC_{\%Expected}$ respiratory parameters; there was no statistically significant relationship between age and respiratory parameters as $p<0.05$; there was no statistically significant correlation between BMI and $ERV_{\%Expected}$ and $IC_{\%Expected}$ values; there was no statistically significant correlation between BMI and respiratory parameters as 7 of them had $p>0.05$; when comparing $EVC_{Expected}$ and EVC_{Found}, $ERV_{Expected}$ and ERV_{Found} values, no statistically significant difference was observed between the mean values; when comparing a single group, the p-values of $EVC_{Expected}$-EVC_{Found} and $ERV_{Expected}$-ERV_{Found} were 0.827 and 0.928, respectively, and since $p>0.05$, there was no statistically significant difference between these four means; and statistically significant differences were found in some parameter values. A moderate positive correlation was found between $ERV_{Expected}$, $EVC_{Expected}$, IC_{Found} and $EVC_{\%Expected}$, indicating that these values increased as BMI values increased, and this increase was statistically significant. In the comparison of a single group, the p-value of $IC_{Expected}$-ERV_{Found} was found to be 0.001, and since it was <0.05, there was a statistically significant difference between the two means.

The accuracy and validity of the equations were determined using the equations obtained by correcting the variance in the set of equations for estimating static lung volumes in a random sample of an ethnically heterogeneous population from Brazil, as found in the literature; ideally, they should be applied in clinical and research contexts to assess the normality of static lung volume values in participants, ranging from 1.72-1.90 cm in men and 1.57-1.77 cm in women (16,18). It was concluded that the distribution of lung volumes and capacities in adults can form the basis of sociodemographic and anthropometric measurements. Studies comparing the strenuous breathing functions of the lungs to body weight have yielded varying results.

In this study, measures showing how far each data point in our group is from the mean or how widespread the distribution is that is, how wide a range (narrow or wide) the examined characteristic (specifically the relevant values or measurements) is distributed in this population variance and its derivatives, values that approximately show how far the participants in the group deviate to the right or left from the mean in terms of a particular characteristic, and measures of difference between individuals in the population, which are not found in the literature in previous studies, namely the participants' $EVC_{Expected}$ and $IVC_{Expected}$ mean standard deviation 4.75±0.94 (3.39-6.44) same, $EVC_{Expected}$ 4.75±0.94 (3.39-6.44), EVC_{Found} 4.72±1.32 (2.30-10.41), $IC_{Expected}$ 3.03±0.72 (1.96-4.32), IC_{Found} 2.45±1.45 (0.00-7.05), $ERV_{Expected}$ 1.59±0.23 (1.30-2.18), ERV_{Found} 1.58±1.12 (0.00-3.94), $EVC_{\%Expected}$ 99.2±17.13 (68.00-174.00), EVC_{Found} 4.72±1.32, $IC_{\%Expected}$ 80.8±44.9 (0.00-169.00), $IC_{Expected}$ 3.03±0.72, $ERV_{\%Expected}$ 98.9±69.8 (0.00-237.00), °F 82.4±5.24 (62.60-87.80), °C 28.03±2.91 (17.00-31.00), BMI 22.2±2.95 (15.42-29.67), ERV_{Found} 1.58±1.12, TV_{Found} 0.89±0.79 (0.00-5.03) higher than P 1.07±0.01 (1.06-1.13), EVC_{Found} 4.72±1.32, $EVC_{Expected}$ 4.75±0.94, IC_{Found} 2.45±1.45, $IC_{Expected}$ 3.03±0.72, EVR_{Found} 1.58±1.12, $ERV_{Expected}$ more than 1.59±0.23, VC 4.31±0.22, BMI more than 22.2±2.95, $EVC_{Expected}$ 4.75±0.94, $IVC_{Expected}$ 4.75±0.94, EVC_{Found} 4.72±1.32, $EVC_{\%Expected}$ 99.2±17.13, $ERV_{\%Expected}$ 98.9±69.8 this was found to be much lower than 82.4±5.24.

Previous studies on the analysis of respiratory parameter waves in relation to lung volume and capacity have mostly focused on humans, particularly vital capacity respiratory measurement. My literature review and research on human experiments have revealed a significant amount of data regarding the relationship between respiratory parameter waves and lung volume and capacity. However, a direct comparative study of SFTs (Spinal Function Tests) in healthy adult individuals, based on gender, age, and height, has not been sufficiently conducted before. Therefore, our study fills gaps in the literature. Since there hasn't been a sufficiently thorough comparative study of direct spirometry (SFT) results in healthy adult individuals based on gender, age, and height in the literature, our results cannot be compared with the results of studies in this section of some other articles. However, while some articles in the literature have not yet conducted a direct comparative study of SFTs in healthy adult individuals according to gender, age, and height, our research study, by directly evaluating our data analyses, has created a database for comparison with other research studies, as our values are based on a general outline of this lack of research.

CONCLUSION

In our study, an electronic handheld spirometer was used in a research laboratory to measure static lung volumes (expiratory, inspiratory vital capacity, inspiratory capacity, expiratory, inspiratory reserve volume, tidal volume) in healthy young adult vsolunteers. Many factors, such as age, gender, height, body weight, hormones, parental characteristics, stress, nutrition, temperature, race, ethnicity, and lung volume in healthy individuals, play a role in the normal or abnormal spontaneous blood flow movements that we observe as a result of the method determined by the device.

This study examined the distribution of lung volumes and capacities in individuals and observed that this distribution differed from the gas distribution seen in adult humans. Based on these results, it has been suggested that the spirometric measurement method, along with anthropometric measurements and sociodemographic characteristics, is effective in determining lung distribution and respiratory function parameters.

Our study validated the measurement of forced inspiration and forced expiration function of the lung, providing important information about the distribution of respiratory traces and static parameters in individuals. Normal lung volumes and capacities observed over time intervals can serve as an indicator and facilitator in analyzing emergencies involving more complex functional characteristics in individuals.

The spirometry devices used in studies to measure lung volume and capacity functions are

extremely sensitive and easily influenced because they provide highly detailed measurements. This research study provides crucial information for future clinical and research studies. This study examined the distribution of lung volume and capacity in individuals. Our analyses of spirometric distribution measurements have shown that anthropometric values and sociodemographic characteristics can influence respiratory parameters.

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Ethics approval: This study was conducted in accordance with the principles of the Helsinki Declaration. Approval Board: Manisa Celal Bayar University Faculty of Medicine, Institute of Health Sciences Ethics Committee (25/12/2019; 20.0478.486).

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