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# Investigation of the Relationship Between Somatotype Structures and Respiratory Functions of Ski-mountaineering National Athletes

Burak KURAL[1]

## Abstract

**Aim**: The aim of this study was to determine the relationship between somatotype structures and respiratory functions of national ski-mountaineering athletes.
**Methods**: Nine male athletes (age 19.66±2.12 years, height 175.3±5.19 cm, body weight 68.55±2.69 kg) and four female athletes (age 17.25±0.95 years, height 164±8.58 cm, body weight 57±4,24 kg) participated in the study. Height, body weight, skinfold thickness, width and circumference measurements were taken. The somatotype structures of the athletes were determined by Heath-Carter method and pulmonary function measurements were determined by digital spirometer. Descriptive analysis, t-test, and Spearman correlation analysis were used to analyze the data.
**Results:** As a result of the analysis, the mean somatotype structure of male athletes was 3−5−2 (Endomorphic−Mesomorphic) and the mean somatotype structure of female athletes was 4−4−3 (Mesomorphic-Endomorphic). The pulmonary function test results of the athletes were within the normal range and showed higher performance than expected. It was determined that the FVC and $MEF_{25}$% values of the athletes whose somatotype structures were ectomorphic-mesomorphic were higher than the endomorph-ectomorphic ones and there was a significant difference between them. In addition, there was a negative correlation between FVC and endomorphic somatotype structures and body fat percentages of the athletes. No significant correlation was found in other variables.
**Conclusion**: The lung function of the athletes was healthy and strong, and somatotype structures especially affected their vital capacity and airways. The $FEV_1$/FVC values of the athletes were lower than expected, shows that the athletes in our study group had a narrowing and obstructive condition in the large airways.

**Keywords**
Ski-mountaineering,
Somatotype,
Pulmonary function test.

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# Dağ Kayağı Milli Sporcuların Somatatip Yapıları ve Solunum Fonksiyonları Arasındaki İlişkinin İncelenmesi

## Özet

**Amaç**: Bu araştırma, dağ kayağı milli sporcuların somatotip yapıları ile solunum fonksiyonları arasındaki ilişkiyi belirlemek amacıyla yapılmıştır.
**Yöntem**: Araştırmaya, Türkiye Dağ kayağı milli takımı hazırlık kampı'nda yer alan 9 erkek sporcu (yaş 19,66±2,12 yıl, boy 175,3±5,19 cm. vücut ağırlığı 68,55±2,69 kg) ile 4 kadın sporcu (yaş 17,25±0,95 yıl, boy 164±8,58cm, vücut ağırlığı 57±4,24 kg) gönüllü olarak katıldı. Araştırmaya katılan sporcuların boy uzunluğu, vücut ağırlığı, deri kıvrım kalınlığı, genişlik ve çevre ölçümleri alındı. Sporcuların somatotip yapıları Heath-Carter yöntemi ile, solunum fonksiyon ölçümleri ise dijital spirometre ile belirlendi. Elde edilen veriler SPSS 26.0 paket program kullanılarak analiz edildi. Verilerin analizinde betimsel analiz, t-Testi ve Spearman korelasyon analizleri yapıldı.
**Bulgular**: Analiz sonucunda erkek sporcuların ortalama somatotip yapıları 3−5−2 (Endomorfik−Mezomorf), kadın sporcuların ortalama somatotip yapıları ise 4−4−3 (Mezomorfi−Endomorfi) olarak tespit edildi. Sporcuların solunum fonksiyon testi sonuçları normal aralıkta ve beklenenden yüksek performans gösterdiği belirlendi. Sporcuların somatotip yapıları ektomorfik−mezomorfi olanların zorlu vital kapasite (FVC) ve zorlu ekspirasyon akımı %25 ($MEF_{25}$%) değerlerinin endomorf−ektomorf olanlara göre daha yüksek olduğu ve aralarında anlamlı farklılık olduğu belirlendi. Ayrıca sporcuların endomorf somatotip yapıları ve vücut yağ yüzdeleri ile zorlu vital kapasiteleri (FVC) arasında negatif korelasyon tespit edildi. Araştırmada diğer degişkenlerde anlamlı bir ilişki bulunmamıştır.
**Sonuç**: Sporcuların akciğer fonksiyonları sağlıklı ve güçlü olduğu ve somatotip yapıların özellikle vital kapasitelerini ve hava yollarını etkilediğini göstermiştir. Sporcuların obstrüktif ve restriktif akciğer ($FEV_1$/FVC) değerlerinin tahmin edilenden daha düşük olduğu bu durum araştırma grubumuzdaki sporcuların büyük hava yollarında daralma ve obstrüktif bir durum olduğunu göstermektedir.

**Anahtar Kelimeler**
Dağ Kayağı,
Somatotip,
Solunum fonksiyon testi.

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[1] ***Sorumlu Yazar:*** Trabzon Üniversitesi Spor Bilimleri Fakültesi, Türkiye, burakkural@trabzon.edu.tr

## INTRODUCTION

Ski-mountaineering (skimo) is an outdoor sport in which you can freely ski off-piste in hard, loose, and powdery snow and make long climbs if desired (Volken ve ark., 2007). Skimo differs from regular alpine skiing in that the bindings in ski mountaineering can be movable and fixed at will for walking and ascending snow slopes (Branigan and Jenns 2006). Skimo is like classic cross-country skiing, but it is also different from cross-country skiing. The ascending and descent slopes in skimo are steeper than those in cross-country skiing. Therefore, they are equipped with adhesive coatings (ski skins) to prevent the skis from sliding backwards during the ascent (Fasel et al., 2016). Skimo, which has become increasingly popular in the Alps, has been practiced as a leisure and recreational activity, but recently it has also been practiced competitively. Therefore, skimo races have gained popularity in recent years. Many regional, national and international competitions are now organized in skimo, including European and World Championships. These races are organized in three basic disciplines. These are "individual", "vertical" and "sprint" races (House et al.,2019.

Skimo is one of the most strenuous, energy-demanding, and demanding endurance sports. This has also been demonstrated in research (Duc et al., 2011; Schenk et al., 2011; Praz et al., 2014; Gaston et al., 2019). This is because skimo races are usually organized at altitudes of about 2000 m above sea level, and the races last between 1.5 and 2.5 hours. Racers spend most of the time (more than 80% of the total race time) climbing (Volken et al., 2007). Therefore, skimo physical fitness, anthropometric, and somatotype characteristics are very important for race performance in alpine skiing. The idea that anthropometric, body composition, and somatotypic characteristics affect athletic performance has been the subject of numerous studies and is worthy of investigation for each sport, age, and gender (Psotta et al., 2009). For instance, it has been found that elite wrestlers (Sterkowicz et al., 2011), elite karate athletes (Katic et al., 2005), and elite volleyball players are taller and have less body fat than elite basketball and handball players (Bayios et al., 2006). Additionally, the somatotype structure of male and female gymnastics athletes is ectomorphic mesomorphic (Massidda et al., 2013). In this sense, the physical and physiological characteristics demanded by skimosport should be analyzed in detail by using scientific methods for each age and category. In this way, performance and physical characteristic norms can be established in accordance with the characteristics required by the sport, correct training programs can be prepared, and practical solutions can be developed for sports performance problems caused by physical characteristics.

When exercising or competing, skimo athletes achieve extremely high ventilation levels (up to 200 L/min), and they even attempt to keep this level even in freezing weather (Durand et al., 2005). Especially in individual competitions, athletes can reach altitudes of more than 3000 meters above sea level, sometimes even more than 4000 meters. This situation (physiological zone of the atmosphere; low, moderate, and extreme) significantly affects the vital capacity of athletes. Although vital capacity is an important indicator, forced vital capacity (FVC) measurements have been more accepted in recent years (Uzun, Akyüz, Taş, and Aydos., 2010). FVC is close to VC in healthy individuals. FEV1 has the advantage of being the most reproducible lung function parameter, and its normal value is 75-80%. Its decrease indicates major airway obstruction. Lung capacity of athletes is important for optimal function of the respiratory system (Kaminsky and Irvin, 2018). It is possible to determine the functional status of the respiratory system (lung volumes and capacities) using various breathing maneuvers. Spirometric measurements are one of the physiological tests that measure the volume of air inhaled or exhaled by athletes temporally (in minutes or seconds), qualitatively (size or capacity) and quantitatively (liters) (Singh et al., 2019).

Despite the increasing popularity of skimo and the difficulty of the races, detailed analyses on the physical and physiological aspects of elite level athletes are still lacking. Thus, the purpose of this study was to identify the respiratory functions and somatotype structures of national skimo athletes and ascertain whether a correlation exists between them. In this research, the relationships between somatotype characteristics and respiratory parameters will be clearly revealed according to each age, gender, and category of skimo sport. It will be an important source in terms of its contribution to both the physical fitness of the skimosport, which is becoming increasingly popular in our country, and to the establishment of sportive performance norms according to each age and gender for the field of talent selection. Determining the relationship between body type and respiratory parameters demanded by skimo in national athletes will enable athletes and coaches to draw realistic goals in the short and long term and contribute to the formation of specific norms for the relevant age group and category. Considering that athletes are exposed to different intensities of exercise during training or competition, determining their lung capacity is very important in terms of preparing the intensity and frequency of exercise and the most appropriate training types to be applied. In this way, performance and physical feature norms suitable for the characteristics required by the sport branch can be established, correct training programs can be prepared and practical solutions can be developed for sportive performance problems caused by physical characteristics.

## METHOD

### *Model of the research*

This study was conducted with the survey design, one of the quantitative research methods. The survey method is a technique that seeks to characterize a situation as it is, either in the past or the present. What is important in this method is to observe the existing situation without changing it (Karasar, 2017).

### *Study group*

The sample group of our study consisted of 9 males (17.25±0.95 years old) and 4 females (17.25±0.95 years old) athletes in the skimo Turkis National Team Preparatory Camp. Prior to the study, the athletes and their parents gave their consent, and participation was entirely voluntary.

### *Data collection tools*

The study's athletes' somatotype structures were ascertained by measuring their height, BMI, and skinfold thickness in four distinct areas. Bone width was determined by measuring the diameter of the femur and humerus' bicondylar regions. Circumference measurements were made by utilizing a total of ten anthropometric characteristics including arm and calf region (Carter and Heath, 1990).

*Pulmonary function test:* The athletes' pulmonary function was assessed using a digital spirometer. Respiratory parameters were calculated, including forced expiratory flow (MEF) values of -25%, mid maximal expiratory flow rate ($FEF_{25–75}$), forced expiratory volume in 1 second ($FEV_1$), forced expiratory volume in 1 second ($FEV_1$), and forced vital capacity (FVC). These are maximal expiratory flows measured at certain points of the forced vital capacity maneuver. Frequently, values at the points where 25% ($FEF_{25\%)}$, 50% ($FEF_{50\%)}$, 75% ($FEF_{75\%}$) of FVC is exhaled are used (Özkurt et al., 2000). $FEF_{25\%-75\%}$ represents the region between 25% and 75% of the FVC maneuver (the middle part of the FVC) and is independent of effort and has been accepted as a parameter that reflects small airways better than $FEV_{1.}$ In the early stage of obstructive diseases, a decrease in $FEF_{25\%-75\%}$ can be detected while $FEV_1$ and FVC are normal. However, it has disadvantages such as being affected by age and smoking, having a wide normal range and low reproducibility. Therefore, parameters and methods that have been shown to better reflect small airways are preferred today (Quanjer et al., 2013).

The performance measurements of skimo athletes were carried out by the Turkish Mountaineering Federation in Trabzon Sports Performance Evaluation Center in a laboratory environment. For the acquisition and analysis of these measurements, written permission was first obtained from the Turkish Mountaineering Federation. Then, the necessary permissions were obtained for the athletes to participate in our study by signing voluntary consent forms due to their families and/or being over 18 years of age.

### *Data analysis of the research*

The SPSS 26 package program was used to evaluate the data gathered from the athletes' somatotype structure. The Shapiro-Wilk test findings, skewness kurtosis scores, Q-Q plot, and histogram graphs were examined in order to ascertain the data's normalcy distribution. Parametric test techniques, the T-Test and Pearson Correlation tests, were employed to compare the groups since the data of the groups were determined to be normally distributed. For all statistical techniques, the allowed error level (α) was 0.05. Athletes' somatotype structures were ascertained using the Heath-Carter technique (Carter et al., 1990).

*Heath-Carter Somatotype Formula*

Endomorphism = - 0.7182 + 0.1451 * x - 0.00068 * x2 + 0.0000014 * x3

(x = "triceps" dkk + "suprailiac" dkk + "subscapula" dkk)

Height Correction Formula = x * 170.18 / height (cm) Mesomorphy = [0.858 + 0.601 * elbow width - "bicondylar humerus" (cm) + 0.601 * knee width - "bicondylar femur" (cm) + 0.188 * arm circumference (cm) + 0.161 * calf circumference (cm)] - [height (m) * 0.131] + 4.50

Ectomorphy = (Height-weight ratio) * 0.732 - 28.58

(Height-to-weight ratio = Height / 3√ Weight)

When placing X and Y coordinates on the somatocard, they are calculated according to the following formula.

X= Ectomorphy - Endomorphy

Y= 2 x Mesomorphy - (Endomorphy + Ectomorphy)

The X and Y coordinates on the somatocard were marked in order to ascertain the somatotype. There were three axes in each segment of the somatotype diagram. These axes intersect at the center of the triangle. This triangular shape was used to define endomorphism, mesomorphism and ectomorphism (Carter et al. 1990; Norton and Olds, 2004).

## RESULTS

In this part of the study, the findings and statistical analysis of the groups between the somatotype characteristics and pulmonary function test results of the athletes are given.

**Table 1.** Physical and somatotype characteristics of mountain skiing athletes

| Variables | Male Athletes (n=10) | | Female Athletes (n=4) | |
|---|---|---|---|---|
| | X± SD | Min-Max | X± SD | Min-Max |
| Age(years) | 19.6±2.12 | 16−22 | 17,2±0,95 | 16−18 |
| Body Weight(kg) | 68.5±2.69 | 65−73 | 57±4.24 | 51−60 |
| Height (cm) | 175.3±5.19 | 165−182 | 164.5±8.58 | 152−171 |
| BMI (kg/m2 | 22.3±1.27 | 21−25 | 21.1±1.16 | 19.5−21.1 |
| VYY% | 8.6±1.81 | 6.43−11.74 | 16.6±2.98 | 12.17−18.5 |
| Triceps DKK (mm) | 8.6±2.96 | 5.2−14 | 14.6±3.92 | 9.4−18.2 |
| Subscabula DKK (mm) | 10.1±1.98 | 6.4−12.4 | 12.3±0.93 | 11.2−13.2 |
| Supraspinal DKK (mm) | 10.4±3.10 | 6−16.20 | 12.7±3.57 | 9−17.6 |
| Calf DKK (mm) | 7.6±2.46 | 4.2−11.20 | 20.3±4.78 | 13.2−23 |
| Elbow diameter (cm) | 7.1±0.49 | 6.40−7.90 | 5.8±0.38 | 5.6−6.4 |
| Knee diameter (cm) | 9.8±0.32 | 9.40−10.5 | 9.3±0.61 | 8.6−10.1 |
| Flexor Biceps circumference (cm) | 30±1.88 | 27−33 | 25.5±1.22 | 24−27 |
| Calf circumference(cm) | 36.3±1.34 | 34−38 | 35.7±1.67 | 33.5−37.4 |
| Endomorph | 2.89±0.80 | 1.51−3.99 | 4.18±0.54 | 3.67−4.18 |
| Mesomorphy | 4.92±0.77 | 3.74−5.96 | 3.53±0.97 | 2.44−3.53 |
| Ectomorphy | 2.54±1.11 | 0.51−3.75 | 2.75±1.06 | 1.46−2.75 |

*BMI: Body mass index, BMI: Body fat percentage*

The age, height, weight and BMI values of the athletes participating in the study were found to be 19.6±2.12 years, 175.3±5,19 cm, 68.5±2.69 kg and 22.3±1.27 kg/m for male athletes, respectively, and 17.2±.95 years, 164.5±8.58 cm, 57±4.24 kg and 21.1±1.16 kg/m for female athletes, respectively. The body fat percentage was found to be 8.6±1.81% in males and 16.6±2.98% in females. Tricep, Subscabula, Supraspinal, Calf, skinfold thickness values were 8.6±2.96 mm, 10.1±1.98 mm, 10.4±3.10 mm and 7.6±2.46 mm for male athletes, while 14.6±3.92 mm, 12.3±.93 mm, 12.7±3.57 mm and 20.3±4.78 mm for female athletes, respectively. Elbow and knee diameters, flexor biceps and calf circumferences were 7.1±.49 cm, 9.8±0.32 cm, 30±1,88 cm and 36.3±1.34 cm in male athletes, while these values were 5.85±0.38 cm, 9.3±0.61 cm, 25.5±1.22 cm and 35.7±1.67 cm in female athletes (see Table 1).

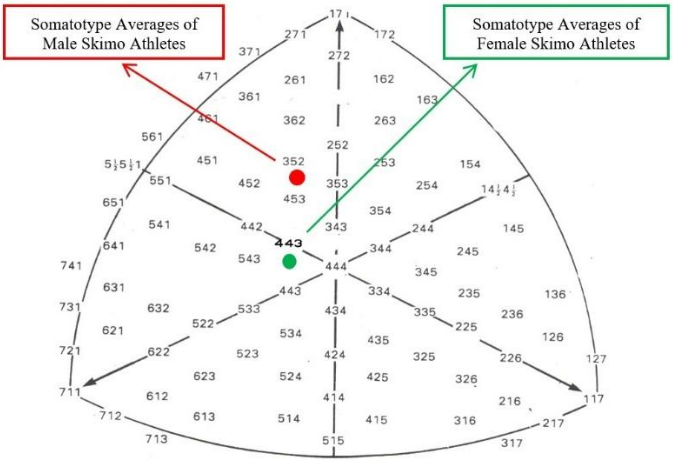


**Figure 1.** Distribution of somatotype averages of skimo athletes on somatocard

Somatotype values of male athletes were 2.89− 4.92− 2.54, while these values were 4.18− 3.53− 2.75 in female athletes. According to these results, it was determined that the somatotype structure of male athletes was Endomorphic-Mesomorphic, while female athletes were Mesomorphic-Edomorphic.

**Table 2**. Pulmonary function test results of skimo athletes

| Variables | Min | Max | X | SS |
|---|---|---|---|---|
| FVC (L) | 3.43 | 6.26 | 4.99 | 0.87 |
| $FEV_1$ (L) | 1.4 | 5.51 | 3.29 | 1.22 |
| $FEV_1$ /FVC (%) | 28.8 | 89.8 | 65.48 | 19.15 |
| $FEF_{25-75}$ % (L/s) | 1.12 | 6.4 | 3.15 | 1.70 |
| $MEF_{25}$ % (L/s) | 0.81 | 3.98 | 2.31 | 1.09 |
| PEF | 1.44 | 8.44 | 4.30 | 2.28 |

Respiratory parameters of skimo athletes were determined as FVC 5.38±0.71 L, $FEV_1$ 3.44±1.42 L, $FEV_1$/FVC 62.76±21.80 L, $FEF_{25-75}$ 3.31±1.97 L%, $MEF_{25}$ 2.45±1.26 L% and PEF 4.30±2.28 L.

**Table 3.** Comparison of somatotype structures and respiratory function averages of skimo athletes

| Variables | Somatotype Structure | N | X± SS | t | p |
|---|---|---|---|---|---|
| FVC (L) | Endomorphic−Mesomorphy | 8 | 4.59±0.65 | -2.47 | 0.031 |
| | Ectomorphic−Mesomorphy | 5 | 5.62±85 | | |
| $FEV_1$ (L) | Endomorphic−Mesomorphy | 8 | 2.97±1.15 | -1.24 | 0.204 |
| | Ectomorphic−Mesomorphy | 5 | 3.81±1.27 | | |
| $FEV_1$ /FVC (%) | Endomorphic−Mesomorphy | 8 | 64.59±21.78 | -0.69 | 0.506 |
| | Ectomorphic−Mesomorphy | 5 | 72.73±11.41 | | |
| $FEF_{25-75}$ % (L/s) | Endomorphic−Mesomorphy | 8 | 3.02±1.76 | -0.33 | 0.749 |
| | Ectomorphic−Mesomorphy | 5 | 3.35±1.78 | | |
| $MEF_{25}$ % (L/s) | Endomorphic−Mesomorphy | 8 | 1.82±0.71 | -2.43 | 0.033* |
| | Ectomorphic−Mesomorphy | 5 | 3.09±1.21 | | |

*$p<0.05$; **$p<0.01$*

As a result of the comparison of respiratory function test results of skimo athletes according to somatotype structure; it was determined that FVC and $MEF_{25}$ % values of those with ectomorphic-mesomorphic somatotype structures were higher than those with endomorph-ectomorphic structures and there was a significant difference between them ($p<0.05$). There was no statistically significant difference in other test results.

**Table 4.** The relationship between respiratory functions and somatotype structures of skimo athletes

| Variables | FVC | $FEV_1$ | $FEV_1$/FVC | $FEF_{25-75\%}$ | $MEF_{25\%}$ |
|---|---|---|---|---|---|
| Age | 0.437 | 0.081 | -0.052 | 0.099 | -0.016 |
| Height (cm) | 0.816** | 0.489* | 0.237 | 0.574* | 0.345 |
| Body Weight (kg) | 0.765** | 0.393 | 0.056 | 0.365 | 0.319 |
| BMI (kg/m²) | -0.004 | -0.125 | -0.276 | -0.302 | -0.027 |
| BFP (%) | -0.548* | -0.013 | 0.283 | -0.154 | 0.196 |
| Endomorph | -0.737** | -0.178 | 0.132 | -0.445 | 0.112 |
| Mesomorph | 0.321 | 0.167 | 0.026 | 0.116 | 0.091 |
| Ectormorph | 0.432 | 0.152 | 0.035 | 0.419 | -0.027 |

*$p<0.05$; **$p<0.01$; SpearmanCorrelation*

In the comparison of respiratory functions and somatotype structures of skimo athletes, a strong positive correlation ($p<0.01$) was found between height and FVC (0.816), and a moderate positive correlation was found between $FEV_1$ (0.489) and $FEF_{25-75\%}$ (0.574). There was a strong and moderate negative correlation between FVC (-0.548-0.737) and body fat percentage and endomorph somatotype of the athletes. There was also a strong positive correlation between body weight and FVC (0.765) ($p<0.01$). In other parameters, no significant difference was observed between respiratory functions and somatotype structures (see Table 4).

## DISCUSSION

This study was carried out to determine the relationship between somatotype structures and respiratory parameters (functional capacity) of national skimo athletes. Body types (structure types) and body composition often play an important role for potential competitive success in winter sports. Existing studies on body types in skiing are relatively few and also old. In our investigation, the physical structure and body composition, the mean heights of male and female skimo athletes were 175.3±5.19 cm and 164.5±8.58 cm, body weights were 68.5±2.69 kg and 57±4.24 kg, body mass index values were 22.3±1.27 kg/m and 21.1±1.16 kg/m, body fat percentages were 8.6% and 16.6%, respectively. Male skimo athletes were taller and heavier than female skiers, but female skimo athletes had a higher body fat percentage than male skimo athletes. These results are similar to Diaz, et al., (2010), Fornasiero et al., (2018) and Wagner et al., (2024) studies on skimo athletes. When compared with the studies conducted with different ski disciplines, it was seen that the body fat percentages of male cross-country skiers varied between 4.8-12.7%, female cross-country skiers between 10.6−22.7%, male alpine skiers between 9.7−15.8%, and women between 16.2−26.7% (Raschka and Ruf, 2022; Papadopoulou et al., 2012). According to these results, we can say that the fat percentage values of the skimo athletes in our research group are comparable to cross-country skiers' values. In the study, the mean somatotype values of male skimo athletes were endomorphic-mesomorphic (3−5−2), while the somatotype structures of female skimo athletes were mesomorphic−endomorphic (4−4−3). Diaz, et al. (2010) determined the somatotype values of male skimo athletes as endomorphic-mesomorphic (3−5−2). The result of this study is similar to our study. However, Taeymans et al. (2008) determined the somatotype structure of male alpine skiers as ectomorphic-mesomorphic and female alpine skiers as endomorphic-mesomorphic. Randáková (2005) determined the somatotype structure of male cross-country ski runners as ectomorphic-mesomorphic and female athletes as endomorphic-mesomorphic. According to the studies conducted by Toteva and Sumanov (1984), Chovanová (1976), Štěpnička (1977), Orvanová (1987), the mean somatotype values of ski jumpers were ectomorphic, while those of cross-country skiers were mesomorphic-endomorphic (Raschka, 2019). As can be seen, different disciplines in skiing reveal different body structures. An athlete is supposed to be muscular, have large hands, long legs, and somewhat broad shoulders and hips because skimo is a combined activity that combines both ski climbing and skiing down slopes, similar to cross-country skiing (Duc et al., 2011). Therefore, the somatotype structures of our research group (male and female skimo athletes) are aimed to be in the ectomorphic region with relatively high mesomorphy degrees. In other words, they should increase their muscle mass.

Traditionally, lung volumes and capacities have been used to assess the respiratory system's functioning state (Atan et al., 2013). Research from across the globe and in our nation has demonstrated that different sports have an impact on lung function. This study provided important data for future research by using pulmonary function tests and lung capacity measurements. The national skimo athletes' FVC 4.99±0.87 L, $FEV_1$ 3.29±.22 L, $FEV_1$/FVC 65.48±19.15 L, $FEF_{25-75\%}$3.15±.70%, and $MEF_{25\%}$2.31±.09 L/s were the values found in this study. When we look at the studies in the literature; Schenk et al. (2011) determined respiratory parameters as FVC 5.15 ± 0.71 L, $FEV_1$ 4.14 ± 0.49 L in a study examining the physiological characteristics of experienced skimo athletes. Dündar et al. (2023) found respiratory parameters as FVC 4.41 ± 0.84 L, $FEV_1$ 3.83 ± 0.78 L, $FEV_1$ /FVC 87.00 ± 7.80 L, PEF 8.07 ± 1.87 L/s in a study with 13 skimo athletes. When we look at different ski disciplines: Aktaş (2024) determined respiratory parameters for alpine skiing athletes as FVC 4.42 ± 1.02 L, $FEV_1$ 3.80 ± 0.81 L, $FEV_1$ /FVC 85.55 ± 6.06 L; while respiratory parameters for cross-country skiing athletes were FVC 4.45 ± 1.16 L, $FEV_1$ 3.83 ± 1 L, $FEV_1$ /FVC 86.22 ± 6.62. When our current study result was compared with the studies. We can say that FVC values are similar to our study. This value is in the normal range and shows a capacity above the expected performance of the skimo athletes' forced vital capacity. This might be explained by the fact that sports help to strengthen the respiratory muscles.

Forced expiratory volume in the first second ($FEV_1$) has the advantage of being the most reproducible lung function parameter and its normal value is 75-80% (Ulubay et al., 2018). Less than this value indicates narrowing of the large airway. In our research results, the mean value of $FEV_1$ of mountain skiers was found to be similar to the mean values in studies on skimo athletes and other ski disciplines (Schenk et al. 2011; Dündar et al., 2023; Aktaş, 2024), while the mean $FEV_1$ value was higher than in patients and lower than in those engaged in endurance sports (Cheng et al., 2003). We think that this is due to the narrowing of the large airways in skimo athletes. The low $FEV_1$ value can be expressed as an unexpected situation and offers a different perspective from the literature.

$FEV_1$/FVC value, a parameter used to detect the presence of obstruction, has a normal value of 70-80% in a healthy individual, but this ratio decreases with age (Ulubay et al., 2018). In our study, $FEV_1$/FVC ratio (65.48%) was below the expected value (89%). Uzun et al. (2010) found $FEV_1$/FVC as 91.89±4.93% and 83±0.07% in a study on wrestlers, Pastre et al. (2015). $FEV_1$/FVC ratios rise with sports participation but fall with disease; as a result, the value in our study falls between that of sportsmen and patients. This may indicate a severe narrowing or obstructive condition in the airways of skimo athletes.

Maximal expiratory flows measured at specific points of the forced vital capacity maneuver. Frequently, values at points where 25% ($FEF_{25\%}$), 50% ($FEF_{50\%}$), 75% ($FEF_{75\%}$) of FVC are exhaled are used. $FEF_{25-75}$ in individuals with allergic rhinitis was characterized by Marseglia et al. (2007) as being less than 80%. In our investigation, $FEF_{25-75}$ was almost 90%. This rate was higher than that of the patients, which is a result we anticipated to achieve.

It is evident that skimo athletes have different somatotypes, which may have an impact on the respiratory system. Researchers have noted that overweight causes a reduction in the functional function of the chest wall, resulting in smaller lung volumes and greater metabolic demands required for respiratory muscle contraction (Hyatt et al., 2009). In addition, lung volumes are known to be highly correlated with body size (Neogi et al., 2018). Looking at the literature, it was seen that different results were obtained between anthropometric characteristics and respiratory function parameters. This may be due to the fact that the athletes compared in the literature have different physical characteristics. Because the anthropometric characteristics and respiratory test values of the athletes in these groups may vary according to their sports branch. The current study's findings indicate that respiratory function values rose in direct proportion to increases in body weight and height. This result is similar to many findings in the literature. Lazovic et al. (2015) found a positive relationship between body weight and height and FVC, $FEV_1$ and $FEF_{25-75}$ parameters in their studies on 1630 athletes, Durmic et al. (2015) and Karaduman (2020) on athletes in different disciplines (basketball, handball, football, water polo), while Aktaş (2024) did not find a relationship in his study on alpine and cross-country skiing athletes. Considering this situation, we can say that overweight is a negative variable that has a primary effect on the pulmonary function of athletes. Furthermore, by examining the general population, we can conclude that the two anthropometric factors that have the most effects on respiratory performance in this study are height and body weight.

Athletes' respiratory functions vary and are strongly impacted by age, height, body weight, gender, race, and a variety of environmental variables (Neogi et al., 2018). An association between age and $FEV_1$ and FVC was found in a similar study on top athletes (Akınoğlu et al., 2019); however, in the current study, there was no relationship between age and respiratory parameters. Given that the athletes in the research were exceptional, this lack of discernible differences may be explained.

Body weight, body fat percentage and body types are known to have significant effects on pulmonary function. The relationship between body types (fat, muscle ratios) and pulmonary function has been previously investigated (Oke and Agwubike, 2015). The current study's findings indicate that the forced vital capacity of skimo athletes increases when their body fat percentage rises and their body shape approaches the endomorphic structure. In the literature; Durmic et al., 2015 found a negative relationship between body fat percentage and FVC in their study, which is similar to our research result.

## CONCLUSION

In conclusion, since it is thought that the respiratory parameters of skimo athletes according to body types are directly proportional to their lung capacities, some respiratory parameters were found to be correlated with somatotypes in our study. In addition, it was determined that skimo athletes were similar to cross-country skiers in terms of physical structure and body composition. While male athletes were endomorphic-mesomorphic, female athletes were mesomorphic-endomorphic somatotype. Apart from these, it was revealed that while the forced vital capacity of skimo athletes was above performance, $FEV_1$ /FVC values were lower than expected. This suggests that the athletes in our study had a narrowing or obstructive condition in the large airways.

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**Ethics Committee**: The Trabzon University Social and Human Sciences Scientific Research and Publication Ethics Committee at last granted clearance

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