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Examination of Body Mass Index from the Perspective of the Mesosternale

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ABSTRACT

Purpose: The aim of this study is to evaluate mesosternale (chest circumference), a measurement reflecting upper body morphology, using BMI and to determine gender-specific reference ranges, in order to reduce the limitations of BMI.

Method: The research was conducted on a total of 700 university students, 500 men and 200 women, studying at the Faculty of Sports Sciences of Kırşehir Ahi Evran University, who voluntarily participated in the study. Participants' height, weight, and mesosternale (chest circumference) measurements were taken; BMI values were categorized according to the classification criteria recommended by the World Health Organization for adults

Results: The findings showed that male individuals had higher height, weight, and chest circumference values compared to females. In the reference ranges created according to BMI categories, it was determined that the increase in chest circumference in female individuals was mainly associated with fat tissue accumulation, while in male individuals, especially in the normal and overweight groups, the combined effect of muscle and fat tissue was observed. Furthermore, by using the chest circumference/height ratio, the effect of inter-individual height differences was reduced, and a proportional evaluation of upper body development was provided

Conclusion: In conclusion, it was found that measuring BMI by mesosternale and assessing it using the chest circumference/height ratio contributes to more precise classification of body composition, especially in physically active populations, and offers a multidimensional assessment model applicable in the fields of sports science and clinical anthropometry.

Keywords: Body Mass Index, Mesosternale, Chest Circumference, Anthropometry, Body Composition

ÖZET

Beden Kitle İndeksinin Mesosternale Açısından İncelenmesi

Amaç: Bu çalışmanın amacı, beden kitle indeksinin (BKİ) sınırlılıklarını azaltmak amacıyla, üst gövde morfolojisini yansıtan mesosternale (göğüs çevresi) ölçümünün BKİ ile değerlendirilmesini ve cinsiyete özgü referans aralıklarının belirlenmesidir.

Yöntem: Araştırma, Kırşehir Ahi Evran Üniversitesi Spor Bilimleri Fakültesinde öğrenim gören ve gönüllü olarak çalışmaya katılan 500 erkek ve 200 kadın olmak üzere toplam 700 üniversite öğrencisi üzerinde yürütülmüştür. Katılımcıların boy uzunluğu, vücut ağırlığı ve mesosternale (göğüs çevresi) ölçümleri alınmış; BKİ değerleri Dünya Sağlık Örgütü'nün yetişkinler için önerdiği sınıflandırma kriterlerine göre kategorize edilmiştir.

Bulgular: Elde edilen bulgular, erkek katılımcıların boy uzunluğu, vücut ağırlığı ve göğüs çevresi değerlerinin kadın katılımcılara katılımcılara kıyasla daha yüksek olduğunu göstermiştir. BKİ kategorilerine göre oluşturulan referans aralıklarında, kadın bireylerde göğüs çevresindeki artışın ağırlıklı olarak yağ dokusu birikimiyle ilişkili olduğu, erkek bireylerde ise özellikle normal ve fazla kilolu gruplarda kas ve yağ dokusunun birlikte etkili olduğu belirlenmiştir. Ayrıca göğüs çevresi/boy oranı kullanılarak, bireyler arası boy farklılıklarının etkisi azaltılmış ve üst gövde gelişiminin oransal değerlendirilmesi sağlanmıştır.

Sonuç: Sonuç olarak, BKİ'nin mesosternale ölçümü ve göğüs çevresi/boy oranı ile değerlendirilmesinin, özellikle fiziksel olarak aktif popülasyonlarda vücut kompozisyonunun daha hassas biçimde sınıflandırılmasına katkı sağladığı ve spor bilimleri ile klinik antropometri alanlarında uygulanabilir, çok boyutlu bir değerlendirme modeli sunduğu sonucuna varılmıştır.

Anahtar Kelimeler: Beden Kitle İndeksi, Mesosternale, Göğüs Çevresi, Antropometri, Vücut Kompozisyonu

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INTRODUCTION

Body Mass Index (BMI) is an anthropometric indicator that defines the proportional relationship between an individual's body weight and height and is widely used in population-based assessments. In the literature, the terms Body Mass Index (BMI) and Body Mass Index (BMI) are used synonymously. BMI is calculated by dividing an individual's body mass in kilograms by the square of their height in meters, and the result is expressed in kg/m² (Formula 1). If measurements are made in the British unit system (pounds and inches), a conversion factor of 703 is included in the calculation (Formula 2) (World Health Organization [WHO], 2005; Akıllıok and Marangoz, 2023).

Formula 1. Method for calculating BMI in the metric system
$BMI = \text{weight (kg)} / \text{height (m)}^2$
Formula 2. Method for calculating BMI in English units
$BMI = [\text{weight (lb)} / \text{height (in)}^2] \times 703$

BMI provides a simple, economical, and practical measure for assessing individuals' body size and weight; it is particularly used as a standard reference in epidemiological studies for classifying weight status. Through this index, individuals can be classified under the categories of underweight, normal weight, overweight, or obese according to their overall body weight (WHO, 2005). The quantitative values provided by BMI allow for the assessment of weight-related health risks in clinical and field studies, creating an objective basis for communication between health professionals and individuals. BMI is primarily a measurement tool developed for populations with sedentary lifestyles and average body composition characteristics. Therefore, it is known to have limitations in athletic individuals with high muscle mass or groups with extreme body composition characteristics. However, it maintains its effectiveness in determining general trends regarding body weight in community-based research and large samples. The widely accepted BMI classification ranges recommended by the World Health Organization are presented in Table 1 (WHO, 1995; WHO, 2000).

Table 1. Body Mass Index Basic Categories Table

Category	BMI/BKI (kg/m2)
Weakness (Severe weakness)	< 16.0
Weakness (Moderate weakness)	16.0 – 16.9
Weakness (Mild weakness)	17.0 – 18.4
Healthy	18.5 – 24.9
Overweight (Pre-obese)	25.0 – 29.9
Obese (Class I)	30.0 – 34.9
Obese (Class II)	35.0 – 39.9
Obese (Class III)	≥ 40.0

Note: If there are subclasses of weakness (severe, moderate and mild weakness), the classification WHO (1995) report can be used. When only overweight and obesity classes are used, the use of the WHO (2000**)** report is considered sufficient.

Male athletes classified as lean may exhibit higher BMI values than expected based solely on body fat percentage, often due to their relatively high muscle mass despite low fat mass. This suggests that BMI may not fully reflect body composition at the individual level, particularly in athletic populations (National Heart, Lung, and Blood Institute [NHLBI], 2026; National Health Service [NHS], 2026). The primary purpose of BMI is to determine the extent to which an individual's current body weight deviates from the reference ranges defined for height. Increases or decreases in body weight are closely related not only to changes in adipose tissue volume but also to components such as muscle mass, skeletal structure, and physical activity level, and these factors can significantly affect BMI values (Akıllıok and Marangoz, 2023). The World Health Organization associates a BMI below 18,5 kg/m² in adults with underweight and a potential risk of malnutrition; Values of 25,0 kg/m² and above are defined as overweight, and 30,0 kg/m² and above as obesity (World Health Organization, 1995; 2000; 2005). However, BMI assessment in children and adolescents (2–20 years) is approached with a different methodological approach than in adults. Although the calculation method is the same, the obtained BMI value is interpreted through percentiles within reference populations specific to the individual's age and gender, instead of fixed threshold values. This approach allows for a more accurate assessment of weight status by taking into account physiological variability related to the growth and development process (Wang and Chen, 2012).

Evaluating BMI together with mesosternale measurements may contribute to a more refined interpretation of anthropometric assessment by integrating skeletal structure into traditional weight-based indices. Therefore, The aim of this study is to evaluate mesosternale (chest circumference), a measurement reflecting upper body morphology, using BMI and to determine gender-specific reference ranges, in order to reduce the limitations of BMI.

METHODS

Participants

The population of the study consisted of 815 students (590 male, 225 female) enrolled at Kırşehir Ahi Evran University Faculty of Sports Sciences. The sample consisted of 700 students (500 male, 200 female) who voluntarily agreed to participate in the study. The study was conducted using a random sampling method. Random sampling refers to the selection of participants from the population according to a predetermined sample size (Alpar, 2020; Cevahir, 2020).

Measurement Procedures

Height Measurement: Height was measured using a stadiometer with participants standing barefoot, in an upright position, with heels together and head positioned in the Frankfurt plane. Measurements were recorded to the nearest 0,1 cm.

Body Weight (Weight) Measurement: Body weight was measured using a calibrated digital scale with participants wearing light clothing and no shoes. Measurements were recorded to the nearest 0,1 kg.

Mesosternale (Chest Circumference) Measurement: Mesosternale measurement was obtained using a flexible anthropometric tape. The measurement was taken at the level of the mesosternale landmark while participants were standing upright. Measurements were recorded in centimeters.

Inclusion and Exclusion Criteria

Inclusion Criteria: Participants were required to be actively enrolled students at the Faculty of Sports Sciences and to voluntarily agree to participate in the study. Individuals aged between 18 and 30 years were included.

Since the participants were students of the Faculty of Sports Sciences, the possibility of some individuals being actively engaged in competitive or professional sports was acknowledged. However, participants were not classified based on athletic level, and no subgroup analysis was conducted according to professional athletic status.

Exclusion Criteria: Participants with known musculoskeletal deformities affecting thoracic measurements, recent injuries, chronic metabolic diseases, or incomplete anthropometric data were excluded from the study.

Data Analysis

Data analysis was performed using SPSS 29.0 software. The normality of the data distribution was assessed using the Kolmogorov–Smirnov test, given the large sample size (n=700). In addition, histogram and Q–Q plots were examined to support the normality assumption. Since the data did not significantly deviate from normal distribution ($p > 0.05$), parametric statistical analyses were applied.

Descriptive statistics were calculated and presented as mean ($\bar{x}$) and standard deviation (SD) for continuous variables (Marangoz, 2023).

BMI classifications were interpreted according to World Health Organization reference ranges for adults.

RESULTS

Table 2. Descriptive Statistics of Men and Women Participating in the Study

Variables	Women (n=200)	Male (n=500)
	x±sd	x±sd
Age	20,48±1,85	21,95±3,48
Weight	61,28±8,99	79,66±14,80
Height	165,66±5,94	177,92±6,06
Mesosternale (Chest Circumference)	86,34±7,06	96,75±8,37

As presented in Table 2, male participants had higher mean values for height, body weight, and mesosternale measurements compared to female participant

Table 3. Mesosternale reference ranges by BMI categories in women participating in the study

RDA Category	RDA (kg/m²)	Chest Circumference (cm)	Description
Weak	< 18.5	≤ 83	Low upper body tissue volume
Normal	18.5 – 24.9	84 – 93	Normal upper body anthropometry
Overweight	25.0 – 29.9	94 – 103	Normal upper body anthropometry

As shown in Table 3, mesosternale (chest circumference) reference ranges were presented according to BMI categories in women. Chest circumference was ≤83 cm in the underweight category, 84–93 cm in the normal category, and 94–103 cm in the overweight category.

Table 4. Mesosternale Reference Ranges According to BMI Categories in Men Participating in the Study

RDA Category	RDA (kg/m²)	Chest Circumference (cm)	Description
Weak	< 18.5	≤ 89	Low upper body tissue volume
Normal	18.5 – 24.9	90 – 99	Normal upper body anthropometry
Overweight	25.0 – 29.9	100 – 109	Normal upper body anthropometry
Obesity	≥ 30.0	≥ 110	Increase in chest circumference due to fat

As presented in Table 4, mesosternale (chest circumference) reference ranges were categorized according to BMI classifications in male participants. Chest circumference values were ≤89 cm in the underweight category, 90–99 cm in the normal category, 100–109 cm in the overweight category, and ≥110 cm in the obesity category.

Table 5. Chest Circumference / Height Ratio (GC/Height) Reference Ranges

Women	Male	Description
0.48–0.53	**0.50–0.55**	**Normal**
0.54	0.56	Increase in chest circumference due to fat

GC: Chest Circumference

DISCUSSION

In this study, BMI was used based on the international classification criteria recommended by the World Health Organization for adults. However, BMI's inability to distinguish between muscle and adipose tissue can lead to misclassification of body composition, especially in physically active individuals. In order to reduce this methodological limitation, mesosternale (chest circumference) measurement, which reflects the upper body morphology, was included in the study. Chest circumference measurement; It is among the regional anthropometric parameters recommended in the literature due to its ease of application, reproducibility and capacity to reflect upper body muscle-fat distribution (Norton and Olds, 2001; WHO, 2008). In addition, since there are hormonal and morphological differences between male and female individuals, it was preferred to create reference intervals specific to gender. This approach avoids ignoring biological differences in anthropometric evaluations and enhances the interpretability of the results. This approach is a form of delivery that supports the adoption of multidimensional assessment models, particularly in the fields of sports sciences and clinical anthropometry.

The descriptive statistics presented in Table 2 reveal that there are significant anthropometric differences between male and female sports science students. Body weight, height and mesosternale (chest circumference) measurements of male individuals were significantly higher compared to women; It can be explained by differences in sex-specific hormonal structure, musculoskeletal development, and upper body muscle mass (Malina et al., 2004; Janssen et al., 2000). In the literature, it has been reported that muscle development in the thoracic region is more pronounced in male individuals due to the effect of androgenic hormones, while adipose tissue is mostly stored in the gluteofemoral region in female individuals (Malina et al., 2004; Janssen et al., 2000;). While the androgenic structure increases the upper body muscle mass in men, it is reported that adipose tissue is mostly stored in the gluteofemoral region in women due to the effect of estrogen This situation causes regional environmental measurements to have different morphological meanings even in the same BMI range. In addition, the fact that the sample of the study consisted of sports science students raises the risk that BMI may overreflect adipose tissue. It is frequently emphasized in the literature that BMI cannot fully reflect body composition in physically active individuals and cannot distinguish between muscle mass and fat mass (Nevill et al., 2010). These findings are consistent with the chest circumference values obtained in our study.

The reference ranges for chest circumference defined according to BMI categories in female individuals in Table 3 reveal the relationship between upper body morphology and body mass in more detail. Low upper body tissue volume in the poor BMI category (≤83 cm) is associated with energy deficiency and limited muscle development (WHO, 1995; Pasco et al., 2014). Chest circumference values observed in the normal BMI range (84–93 cm) are consistent with anthropometric limits considered optimal for functional capacity (Norton and Olds, 2001). In the overweight and obese categories, the increase in chest circumference is largely due to the accumulation of adipose tissue; It has been reported that increased fat in the thoracic region may have negative effects on respiratory mechanics, postural control and cardiorespiratory capacity (Lazarus et al., 1997; Pasco et al., 2014; WHO, 2008). For this reason, it is of great importance to support BMI evaluations in women with regional measurements such as chest circumference. In this study, it was determined that the mean chest circumference values of female sports science students in the normal BMI range (18.5–24.9 kg/m²) were approximately 88–90 cm. These findings are consistent with the average chest circumference reported in studies involving university student women in Turkey and largely coincide with the 86.4 ± 6.2 cm values reported in the Uludağ University sample (Yılmaz and Kaya, 2016). When internationally accepted anthropometric references are examined, it is reported that the chest circumference values belonging to the normal BMI group are generally in the range of 85-88 cm in the European adult female population (Norton and Olds, 2001). Similarly, in a population-based study conducted in Australia, Pasco et al. (2014) reported that chest circumference measurements ranged from 86–89 cm in adult women with normal BMI. In this context, it can be said that the mean values obtained in the present study are compatible with both national and international literature and reflect the anthropometric characteristics expected within the normal BMI limits of female sports science students.

BMI-based chest circumference reference ranges presented for male individuals in Table 4 reveal the multidimensional nature of the relationship between BMI and upper body composition. In the lean category, low chest circumference values indicate limited muscle mass, while the values observed in the normal BMI group are consistent with physiological muscle development. It is thought that the increase in chest circumference in the overweight group is caused by the contribution of both muscle and adipose tissue together. It is emphasized in the literature that the increase in BMI may be due to lean mass, especially in male individuals who do resistance training (Kraemer and Ratamess, 2005; Heymsfield et al.,

2014). However, it is reported that the increase in chest circumference in the obese category is predominantly due to adipose tissue, which is strongly associated with cardiometabolic risks (Després and Lemieux, 2006). These findings support the necessity of evaluating BMI in male individuals in conjunction with regional measurements such as chest circumference. In this study, it was determined that the mean chest circumference values of male sports science students in the normal BMI (18.5–24.9 kg/m²) range were approximately 94–97 cm. These findings largely coincide with the 95–99 cm range reported in the anthropometric reference values of the European adult male population (Pheasant and Haslegrave, 2006).

Similarly, in a population-based study originating from North America, Janssen et al. (2000) reported that thorax measurements associated with muscle mass in male individuals with normal BMI ranged from 94–98 cm. In addition, anthropometric norms widely used internationally show that chest circumference values for normal BMI men generally fall between 96–100 cm (Norton and Olds, 2001). In this context, it can be said that the chest circumference averages obtained in the current study are compatible with the reference values reported from different geographical regions and reflect the expected anthropometric profile of the upper body development of sports science students within normal BMI limits.

In general, when Tables 2, 3 and 4 are evaluated together, it shows that if the classification of BMI based on WHO references is supported by chest circumference measurement, body composition and possible health risks can be classified more precisely. Especially in physically active populations such as sports science students, the use of multidimensional anthropometric assessment approaches is methodologically important.

The Chest Circumference/Height (GC/Height) ratio in Table 5 allows a healthier evaluation of the proportional size of the upper body region by reducing the effect of height differences between individuals. In this context, GC/Height values reported in the range of 0.48–0.53 for women and 0.50–0.55 for men are associated with normal body composition and balanced body development (Norton and Olds, 2001). In contrast, an increase in GC/Height rate 0.54 in women and 0.56 and above in men may reflect not only an increase in muscle mass but also an increase in subcutaneous and truncal adipose tissue. In the literature, it is reported that fat accumulation in the upper trunk significantly affects thoracic circumference measurements and leads to disproportionate increases in circumferential measurements, especially in cases where body mass index exceeds normal limits (WHO, 2020). Janssen et al. (2000) emphasized that the circumferential increase in the thoracic region in male individuals may be related to both muscle mass and adipose tissue, but the

contribution of adipose tissue to the increase observed in measurements may be more pronounced compared to muscle mass. Similarly, studies based on anthropometric references have shown that an increase in chest circumference does not always reflect functional muscle development; reveals that this increase may be mostly due to adiposity, especially in sedentary or individuals with low physical activity levels (Pheasant and Haslegrave, 2006). In this context, an increase in GC/Height ratio above normal reference ranges should be considered as an important warning indicator that the increase in chest circumference may be associated with adipose tissue accumulation in non-athlete or limited training populations. Therefore, considering the GC/Height ratio together with BMI and other environmental ratios (e.g., waist/height ratio) will contribute to a more accurate interpretation of morphological changes in the upper body region in terms of muscle-fat separation (Norton and Olds, 2001).

CONCLUSION

In conclusion, this methodology offers an evaluation model that balances the limitations of BMI, aligns with WHO criteria, and is highly applicable in the field of sports sciences. In this respect, the study constitutes a strong methodological framework for both clinical and performance-based anthropometric research. A combined evaluation of the tables presented in this study shows that supplementing BMI and BMI with gender-specific reference ranges and regional anthropometric measurements allows for a more precise classification of obesity and associated health risks. Especially in sports sciences and clinical applications, it is recommended to adopt multidimensional anthropometric assessment approaches.

Suggestions

Based on the findings of the present study, several methodological and practical suggestions can be proposed. First, body mass index evaluations, particularly in physically active populations, should be supported by regional anthropometric measurements such as mesosternale (chest circumference) to improve the accuracy of body composition classification. Second, the use of gender-specific reference ranges is recommended in anthropometric assessments in order to account for biological and hormonal differences between males and females. Third, proportional indices such as the chest circumference/height ratio should be incorporated into routine evaluations to minimize the effect of inter-individual height differences and to provide a more balanced interpretation of upper body morphology. Finally, future studies are encouraged to combine chest circumference measurements with additional body composition assessment techniques (e.g.,

skinfold thickness, bioelectrical impedance analysis, or imaging methods) to further validate multidimensional anthropometric assessment models in both athletic and clinical populations.

REFERENCES

Akıllıok, G., & Marangoz, İ. (2023). Determination of the effective factor in the increase and decrease of body mass index (BMI). Ahi Evran III. International Conference on Scientific Research, 3–4 March 2023, Bakû, Azerbaijan.

Alpar, R. (2020). Uygulamalı çok değişkenli istatistiksel yöntemler (6. baskı). Detay Yayıncılık.

Cevahir, E. (2020). SPSS ile nicel veri analizi rehberi. Kibele Yayınları.

Després, J. P., & Lemieux, I. (2006). Abdominal obesity and metabolic syndrome. Nature, 444(7121), 881–887. https://doi.org/10.1038/nature05488

Heymsfield, S. B., Peterson, C. M., Thomas, D. M., & Heo, M. (2014). Why are there race/ethnic differences in adult body mass index–adiposity relationships? American Journal of Clinical Nutrition, 99(1), 1–7. https://doi.org/10.3945/ajcn.113.065961

Janssen, I., Heymsfield, S. B., Wang, Z., & Ross, R. (2000). Skeletal muscle mass and distribution in 468 men and women aged 18–88 yr. Journal of Applied Physiology, 89(1), 81–88. https://doi.org/10.1152/jappl.2000.89.1.81

Kahn, S. E., Hull, R. L., & Utzschneider, K. M. (2006). Mechanisms linking obesity to insulin resistance and type 2 diabetes. Nature, 444(7121), 840–846.

Kraemer, W. J., & Ratamess, N. A. (2005). Hormonal responses and adaptations to resistance exercise and training. Sports Medicine, 35(4), 339–361. https://doi.org/10.2165/00007256-200535040-00004

Lazarus, R., Sparrow, D., Weiss, S. T., & Vokonas, P. S. (1997). Effects of obesity and fat distribution on ventilatory function: The normative aging study. Chest, 111(4), 891–898. https://doi.org/10.1378/chest.111.4.891

Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). Growth, maturation, and physical activity (2nd ed.). Human Kinetics.

Marangoz, İ. (2019). Fiziksel performans ölçümünde sık kullanılan bazı testler ve hesaplama programları (CD ilaveli). Gazi Kitabevi.

Marangoz, İ. (2023). Spor alanında yapılan nicel araştırmalarda istatistiksel analizin yazımı. In K. Erdağı & B. Işık (Eds.), Egzersiz & spor bilimleri ve spor hekimliği alanında uluslararası araştırmalar (Bölüm 3). Platanus Publishing.

Marangoz, İ. (2024). Sporda kinantropometri (2. baskı). Gazi Kitabevi.

National Health Service. (2026). BMI (body mass index). https://www.nhs.uk (Erişim tarihi: 23 Ocak 2026)

National Heart, Lung, and Blood Institute. (2026). Body mass index. https://www.nhlbi.nih.gov/(Erişim tarihi: 23 Ocak 2026)

Nevill, A. M., Stewart, A. D., Olds, T., & Holder, R. (2010). Relationship between adiposity and body size reveals limitations of BMI. American Journal of Physical Anthropology, 141(2), 337–345. https://doi.org/10.1002/ajpa.21180

Norton, K., & Olds, T. (2001). Anthropometrica: A textbook of body measurement for sports and health courses. UNSW Press.

Pasco, J. A., Holloway, K. L., Dobbins, A. G., Kotowicz, M. A., Williams, L. J., & Brennan-Olsen, S. L. (2014). Body mass index and measures of body fat for defining obesity and underweight: A population-based study. BMC Obesity, 1, 9. https://doi.org/10.1186/2052-9538-1-9

Pheasant, S., & Haslegrave, C. M. (2006). Bodyspace: Anthropometry, ergonomics and the design of work (3rd ed.). CRC Press.

Snijder, M. B., van Dam, R. M., Visser, M., & Seidell, J. C. (2006). What aspects of body fat are particularly hazardous and how do we measure them? International Journal of Epidemiology, 35(1), 83–92. https://doi.org/10.1093/ije/dyi253

Şanal, A., & Özen, G. (2025). Effects of 8-week Tabata training on cardiopulmonary and performance parameters in wheelchair basketball players: A controlled study. Medicine, 104(34), e44093. https://doi.org/10.1097/MD.0000000000044093

Wang, Y., & Chen, H. J. (2012). Use of percentiles and z-scores in anthropometry. In V. R. Preedy (Ed.), Handbook of anthropometry: Physical measures of human form in health and disease (pp. 29–48). Springer.

World Health Organization. (1995). Physical status: The use and interpretation of anthropometry (WHO Technical Report Series No. 854). WHO Press.

World Health Organization. (2000). Obesity: Preventing and managing the global epidemic (WHO Technical Report Series No. 894). WHO Press.

World Health Organization. (2008). Waist circumference and waist–hip ratio: Report of a WHO expert consultation. WHO Press.

Yılmaz, A., & Kaya, F. (2016). Üniversite öğrencilerinde beden kitle indeksi ve bazı antropometrik ölçümlerin değerlendirilmesi. Uludağ Üniversitesi Eğitim Fakültesi Dergisi, 29(2), 345–358.