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An Examination of the Performance Relationship Between Athletics Throwing Events and Anthropometric Characteristics Based on Branch-Specific Determinant Structural Factors

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ABSTRACT

The aim of this study is to examine the relationship between anthropometric characteristics and performance in throwing events (shot put, discus, javelin, and hammer throw) and to identify the specific structural factors determining performance in each event. Anthropometry includes measurements such as height, body mass, lean body mass, body fat percentage, limb lengths, and segment ratios, and is widely used in sports science for talent selection, performance prediction, and training planning. Literature findings show that the impact of anthropometric characteristics on performance is more pronounced in throwing events compared to many other sports. In shot put and discus throw, high body mass, upper extremity muscle mass, and shoulder width are prominent, while in javelin throw, arm length, trunk ratios, and velocity transfer are the determining factors. In hammer throw, lower extremity strength, balance, rotational velocity, and trunk circumference directly affect performance. Furthermore, increasing lean body mass and maintaining optimal body fat percentage have a positive effect on throwing speed and throwing distance. While anthropometric differences exist between genders, high technical efficiency can balance relative performance levels. Consequently, considering branch-specific anthropometric profiles, creating individualized training plans, and systematically using this data in long-term athlete development processes are crucial for maximizing performance in throwing events in athletics.

1. INTRODUCTION

Athletics is considered one of the oldest sports based on fundamental human motor skills such as running, jumping, and throwing. The origins of athletics are supported by archaeological findings and historical records to be as ancient as human history itself [1]. The evaluation of performance with objective criteria such as time, distance, and height has made athletics an important research area in sports sciences. Especially the shot put, discus, javelin, and hammer throw events are among the disciplines where the impact of physical and biological characteristics on performance is most clearly observed, as they are explosive movements requiring maximum force and speed production in a short time [2]. Among the factors determining sports performance, anthropometric characteristics hold a significant place. Anthropometry is a scientific field examining height, body mass, limb lengths, circumference and diameter measurements, and body proportions, and is widely used in evaluating athletes' suitability for their sport and in talent selection processes [3,4]. In sports sciences, anthropometric measurements are considered an important tool not only for determining an athlete's current performance level but also for predicting future performance potential [5,6]. The fundamental biomechanical factors determining performance in athletics throwing events are defined as the release velocity of the implement, the release angle, and the release height [2,7]. These factors are directly related to the athlete's anthropometric characteristics. For example, long arm segments and a wide shoulder structure contribute to increasing the throwing velocity by enhancing the moment generated during the throw [8]. Similarly,

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greater height can create an advantage on throwing distance by increasing the release height [2].

Throwing events have different anthropometric requirements within themselves. In shot put and discus throw events, high body mass, broad torso structure, and upper extremity muscle mass are among the determinant factors for performance [5,9]. In javelin throw, a relatively lighter body structure, long arm segments, and the efficiency of speed transfer come to the fore [6,10]. In the hammer throw event, lower extremity strength, balance, and rotational speed are reported as the fundamental elements determining performance [2,5]. These findings reveal that the ideal anthropometric profile differs for each throwing event.

Body composition is also an important variable affecting throwing performance. While an increase in lean body mass supports muscle strength and explosive power production, a high body fat percentage can negatively affect performance by reducing movement speed [2]. Elite throwers typically exhibit high lean mass and low-to-moderate body fat levels [5]. Furthermore, there are anthropometric differences between genders; although female athletes have lower absolute strength levels compared to males, it is reported that they can achieve similar relative performance levels due to their high technical efficiency [6,11].

Recent studies show that anthropometric analyses are an important tool not only for performance prediction but also for training planning, injury prevention, and long-term athlete development [12,13]. Determining event specific anthropometric characteristics contributes to creating individualized training programs and allows athletes to utilize their biological potential to the highest degree [5]. Therefore, a detailed investigation of the relationship between anthropometric characteristics and performance in athletics throwing events offers significant contributions to both the scientific literature and practicing coaches.

2. MATERIALS AND METHODS

This review study was conducted through a systematic screening of scientific publications examining the relationship between anthropometric characteristics and performance in athletics throwing events (discus throw, shot put, and hammer throw). The literature review was performed using Web of Science, Scopus, PubMed, Google Scholar, and DergiPark databases. During the screening process, publications in Turkish and English were considered; keywords such as "anthropometry", "throwing events", "shot put", "discus throw", "hammer throw", "performance", "body composition", "atletizm" (athletics), "anthropometry", "throwing events", "performance" were used individually and in combined forms. The study included original research, review articles, and graduate theses investigating the relationship between anthropometric measurements and performance variables in athletics throwing events. In the selection of publications, relevance to the topic, methodological clarity, and scientific validity criteria were used as the basis; repetitive, methodologically insufficient, or off-topic studies were excluded from the evaluation.

3. ANTHROPOMETRIC MEASUREMENTS IN ATHLETICS THROWING EVENTS

3.1. Anthropometry

Anthropometry is the scientific field that studies the structural characteristics of the human body (height, weight, limb lengths, circumference measurements, proportions) [2].

3.1.1. Anthropometric Measurements

Anthropometric measurements are widely used to evaluate and predict performance in various sports [4]. Anthropometric measurements and morphological characteristics play a significant role in determining an athlete's success. An athlete's anthropometric and physical characteristics can be important prerequisites for successful participation in any sport [4].

3.1.2. Length Measurements

The lengths and proportions of body parts are used to determine various dimensions in human structures and differences in growth, to ensure the development of body parts for specific purposes, and for athletic achievements. Length measurements include lower extremities and upper extremities [14].

3.1.3. Diameter Measurements

Body diameter measurements are used clinically in many studies and for determining body structures. Diameter measurements include: Chest/Depth, biacromial diameter, femur bicondylar diameter, ankle, humerus bicondylar, wrist, biiliac diameter [14].

3.1.4. Circumference Measurements

These are commonly used in studies examining body composition. They are used to determine the circumferential parameters of body mass. Circumference Measurements include: Head,

neck, shoulder, chest (normal), chest (deep inspiration), abdomen, hip [14].

4. TRAINING AND ANTHROPOMETRY

Anthropometric characteristics encompass parameters such as athletes' body structure, segment lengths, and body composition and are used as a fundamental assessment tool in training planning [15]. Sport-specific anthropometric profiles contribute to the selection of training methods by determining the athlete's biomechanical and physiological advantages [16]. Especially in sports requiring strength, speed, and power, anthropometric variables such as height, body weight, muscle mass, and fat percentage have a direct impact on performance [17]. Anthropometric changes occurring with the training process provide important information for monitoring the athlete's development level and individualizing training loads [8]. Therefore, anthropometric measurements are considered an indispensable element in performance prediction, talent selection, and creating scientifically-based training programs [4]. Understanding the relationships between height, weight, body mass index, PPA, and the improvement trend in different activities can assist in talent identification, specialization age, goal setting, planning, injury prevention, and performance evaluation [12]. Garcia-Carrillo et al. [5] reported that performance increase reached up to 9% in athletes who underwent technical optimization in addition to power training. Zhao et al. [6] found that regular training led to a decrease in body fat percentage and a 4% increase in muscle mass ratio.

4.1. The Relationship Between Anthropometry and Performance

The strongest relationship between anthropometric characteristics and performance is seen in weightlifting and throwing sports, because the relationship between regional muscle mass and power is highest in these sports. Body proportion also differs significantly between genders in different sports. Female athletes' upper body musculoskeletal size is proportionally smaller compared to the lower body [9].

4.1.1. Table of Relationship Between Anthropometric Factors and Performance

Examining the table, it is seen that anthropometric factors are highly correlated with performance in all events [2].

Table 1. Anthropometry and performance relationship

Parameter	Throwing Branch	Correlation	Source
Arm Length - Throwing Distance	Javelin	0.62	Zhao et al. [6]
Body Length - Throwing Speed	Shot Put	0.54	Garcia-Carrillo et al. [5]
Lean Muscle Mass - Performance	Discus	0.69	Zhao et al. [6]
Leg Length - Rotational Balance	Hammer	0.59	Singh et al. [9]
Body Weight - Throwing Distance	Shot Put	0.71	Garcia-Carrillo et al. [5]

3.2. Application Areas of Anthropometric Data

Anthropometric data are widely used in sports sciences for determining the physical profiles of athletes and defining event-specific characteristics [16]. These data contribute to optimizing loading levels by allowing individual differences to be taken into account in training planning [18]. Anthropometric measurements provide objective and reliable indicators in the process of evaluating performance and monitoring development [15]. At the same time, anthropometric data are considered an important criterion for predicting an athlete's potential in talent selection and guidance studies [4]. In addition, data related to body composition and segment ratios are utilized in determining injury risk and creating preventive training programs [17]. Anthropometric measurements also provide a scientific basis for planning individual-specific exercise and equipment design in the fields of ergonomics and rehabilitation [16].

Table 2. Anthropometric application areas

Application Area	Purpose of Use	Example
Athlete selection	Branch suitability assessment	Long arm-body ratio → Javelin
Training plan	Strength and technical optimization	Angle of rotation relative to center of mass
Performance tracking	Monitoring of in-season anthropometric changes	Muscle mass tracking
Injury prevention	Asymmetry detection	Right-left arm difference analysis
Digital modeling	3D performance simulation	Biomechanical measurements

5. ATHLETICS

Athletics derives from the ancient Greek word ATHLOS, meaning 'achievement' and 'gift', and entered all world languages with this root. Athletics encompasses all of man's natural bodily actions such as running, jumping, and throwing. In athletics, time, distance, and height also form the basis for the different classifications of this sport [1].

Image 1. Athletics events

5.1. Throws

Athletics throwing events are shot put, discus throw, javelin throw, and hammer throw. Performance in these events requires a well-developed movement technique and high biological potential. In general, there are three main biomechanical factors that affect throwing technique and consequently throwing distance: release angle, release height, and release velocity [2]. In throws, the task of the movement is to send the implement as far as possible.

This distance is influenced by the following physical values:

Release velocity of the implement
Release height of the implement
Release angle of the implement
Air Resistance
Gravitational force [7].

5.1.1. Characteristics of Throwing Events

Throwing events (shot put, discus, hammer, javelin) are explosive movements requiring short-term maximum power production [2].

Each event involves different technical characteristics and anthropometric requirements: Shot put: High body mass, upper extremity strength, and torso rotation power [9]. Discus throw: Combination of long arm segment and wide shoulder span with rotation speed [6]. Javelin throw: Speed transfer advantage in slender but long-armed athletes [10]. Hammer throw: Combination of lower extremity strength, balance, and rotational speed [5].

5.1.2. Throws and Performance Relationship

Performance is determined by the interaction of technique, strength, coordination, and anthropometric structure factors [6]. When the necessary factors for an object to travel farther are examined with the help of motion laws and mechanics within physical science, it is clearly seen that human anthropometric characteristics affect this performance in a positive or negative way [8]. A greater shoulder width will allow more moments to be transferred to the thrown object, thus facilitating the overcoming of inertia moments [8]. Greater height may imply greater arm length. Greater arm length means a higher release height for a shot putter and a greater release velocity for a discus thrower. Abdel Fattah et al. [19] reported that the throwing height constitutes 82% of the thrower's height, while Abdel-Monsef Aly et al. [20] stated this ratio to be 86%. The importance of hand size emerges in the athlete applying force to the object more comfortably and more easily overcoming the external forces applied by the object in hand during the movement [8].

5.1.3. Gender and Event Differences

Although female throwers generally have lower absolute strength than males, they can achieve similar relative performance levels when their technical efficiency is high [2]. In female

javelin throwers, arm length and torso ratio show a stronger correlation with performance, while in male throwers, muscle mass and torso girth are more determinant [6]. Garcia-Carrillo et al. [5] stated that rates of anthropometric asymmetry (e.g., right-left arm difference) in different genders could affect performance.

5.2. Shot Put

Shot put has taken its place in international competitions since the first Olympic Games in 1896. With developments in science and technology, throwing technique and the implement have undergone some changes. The shot, which was thrown using various different techniques in the past, is today thrown with two different techniques. These are; the glide and the rotational (spin) techniques [1]. In shot put competition, men compete with shots weighing 7.260 kg; women with 4 kg shots. The shot put competition is conducted from within a concrete circle with a diameter of 2.135m. In front of this circle, there must be a wooden stop board (toeboard) 12 cm wide, 122 cm long, and a throwing sector 40 degrees wide extending from the front of the circle into the landing area [21].

In Shot Put, throwing distance depends on the following variables:

Physical structure + body condition, Release velocity of the shot + release angle, Release height of the shot.

Depending on the above variables, the desired characteristics in terms of anthropometry and motor performance for this throwing event are:

Height, Body Weight, Arm Length, Shoulder Width, Hand Size [8].

Image 2. Shot put in athletics

5.2.1. Shot Put and Anthropometry Relationship

Throwing performance primarily depends on lower extremity explosive strength and upper body muscle mass [6]. The average height of elite shot putters ranges between 185-200 cm, and body weight between 110-130 kg [5]. Torso rotation speed, leg extension power, and arm length are the main determinants of throwing velocity [9]. Arm length and shoulder width provide a biomechanical advantage in directing the pushing force [10]. Zhao et al. [6] found that as the arm length--torso length ratio increased in shot putters, throwing distance increased. In Terzis's research [22], as the activation level of vastus lateralis and pectoralis major increased, shot put performance also increased.

Morrow et al. [23] showed that shot put performance over 17 meters requires more than 95 kg of lean mass. Calculation of the data obtained by Morrow et al. [23] revealed a body fat percentage of approximately 14.8% in shot putters. Therefore, the optimal anthropometric profile for shot putters can be summarized as: long arms, broad torso, and high muscle mass [2].

4.3. Discus Throw

The place of discus throw in athletics history goes back very far. For many years, discus throw existed as a display of power and a sport performed only by men. From 1896 to 1928, discus throw records showed continuous improvement [1]. For men, it is 2kg in weight, 219-221mm in diameter; for women, 1kg in weight and 180-182mm in diameter, and it is thrown from a circle 2.50m in diameter [19].

In Discus Throw, throwing distance depends on the following variables:

Release angle of the discus (37°-40°), release height of the discus, release velocity of the discus.

Depending on the above variables, the desired characteristics in terms of anthropometry and motor performance for the discus throw event are:

Height
Body Weight
Arm Length
Shoulder Width
Hand Size [8].

Image 3. Discus throw in athletics

5.3.1. Discus Throw and Anthropometry Relationship

Performance in discus throw is based on the harmony of rotation speed, arm length, and throwing angle [2]. It has been noted that discus throwers are generally 185-195 cm tall and weigh 100-120 kg [5]. Due to the 2 kg weight of the discus, technical coordination and balance are important factors [10]. Singh et al. [9] emphasized that lower extremity strength directly contributes to rotation speed. Zhao et al. [6] found that a shorter torso rotation time increases throwing velocity. Arm length is one of the parameters with the highest correlation with discus release velocity. Garcia-Carrillo et al. [5] found a strong relationship between shoulder width and performance in discus throwers. Zhao et al. [6] found that as the arm length--torso length ratio increased in discus throwers, throwing distance increased. Morrow et al., calculated that discus throw performance over 54 meters requires 93.9 kg of lean mass. Calculation of the data obtained by Morrow et al. [23] found a 13.1% fat percentage in discus throwers.

5.4. Hammer Throw

Hammer throw, like other throwing events, has shown development both technically and in terms of the implement throughout the historical process. Hammer throw was first thrown in the 1908 Olympics. The effort to resist the centrifugal force of the thrown implement occupies an important place in hammer throw technique [1]. The hammer consists of three parts; the hammer handle, the hammer wire, and the hammer head (ball). For men, the hammer's weight is 7.260 kg and its length can be between 1.175-1.215m. For women, the hammer's weight is 4kg, and its length is the same as the men's hammer [19].

Factors affecting the thrown distance (performance) in Hammer Throw:

Release height of the hammer. The release height depends primarily on the body position at that moment and the thrower's height.

Release angle of the hammer (44°)

Release velocity of the hammer

Air Resistance.

Release velocity is seen as the most important factor. For a 75m thrower; A 5% increase in velocity will increase the throw by 7m. A 5% change in release angle will change the distance by 61 cm [24].

Image 4. Hammer throw in athletics

5.4.1. Hammer Throw and Anthropometry Relationship

Hammer throw is an event combining rotational power, balance, and technical timing [9]. Uylaş [25] showed that athletes with high shoulder mobility achieved better centering during rotation. High torso rotation and foot balance of the athlete increase kinetic chain efficiency [2]. The average height of elite hammer throwers is 185-195 cm, and their body weight is around 105-125 kg. Zhao et al. [6] showed that lower extremity strength is determinant on rotational acceleration.

Garcia-Carrillo et al. [5] reported that torso girth and lower body muscle mass were the two most determinant factors for performance in hammer throwers. It has been calculated that for a performance over 75 m, a hammer thrower must have over 90 kg of total lean mass [2]. Calculation of the data obtained by Morrow et al. [23] found a 15.3% fat percentage in hammer throwers.

5.5. Javelin Throw

Javelin throw differs from other events due to its throwing area, acceleration method, and the difference of the thrown implement. Javelin throw requires rhythm, coordination, and special skill, as it involves acceleration by running and transferring that speed to the throw [1]. Towards the end of the 1800s, it took part in competitions, and it first took its place in the Olympic Games in 1908 [1]. Javelin is the only throwing event performed by running within a 30 - 36.50m runway. Women throw with implements weighing 600g, men with 800g [19].

Factors affecting the thrown distance (performance) in Javelin Throw:

Release height of the javelin

Release angle of the javelin

Release velocity of the javelin

Image 5. Javelin throw in athletics

4.5.1. Javelin Throw and Anthropometry Relationship

Javelin throw is a technical event combining speed and coordination with power [10]. The main factors determining throwing distance are; arm length, shoulder flexibility, and running acceleration [2]. Javelin throwers are generally reported to have a height of 180-190 cm and a weight of 80-95 kg [5]. Zhao et al. [6] found that torso length affected technical efficiency more in female javelin throwers. Zaras et al. [2] reported that elite javelin throwers generally have a low fat percentage (10-14%). Morrow et al. [23] although calculating that javelin throw performance over 65 meters in men requires 82.9 kg of lean body mass, could not reveal any relationship with javelin throw performance. Anthropometric parameters affecting performance in javelin throw are height, arm length, and shoulder width [19].

Table 3. Comparison table of anthropometric characteristics by branch

Branch	Average Height (cm)	Body Weight (kg)	Fat Percentage (%)	Key Characteristics
Shot Put	185–200	110–130	12–18	Upper body strength
Discus	185–195	100–120	10–15	Arm length and rotation
Javelin	180–190	80–95	10–14	Arm length, velocity transfer
Hammer	185–195	105–125	13–17	Lower body strength, balance

6. ANTHROPOMETRIC DATA OF ELITE ATHLETES

Elite performance in athletics throwing events (shot put, discus, hammer, javelin) is closely related to specific anthropometric characteristics. Research shows that these athletes have a distinct physical profile compared to the general population and even athletes in other athletics disciplines. Shot putters, due to maximal strength and explosive power requirements, typically have the highest body mass (110-150 kg) and body mass index; here, lean body mass and a strong skeletal structure are critical. Discus and hammer throwers exhibit a more balanced anthropometry, combining high body mass (95-130 kg) with long arms (biacromial and biiliac width) to maximize the centrifugal force generated during rotation. Javelin throwers have a more athletic profile, and since they require sprinting and throwing coordination, relatively lower body mass (85-105 kg) with upper extremity length and shoulder width are prominent features.

In all events, especially at the elite level, segmental measurements such as throwing arm length, shoulder width, and hand size provide biomechanical advantages affecting release angle and velocity. These anthropometric factors offer an innate potential, but transform into elite performance when supported by long-term specialized strength and technical training.

Table 4. Anthropometric characteristics and performance relationship in foreign athletes

Discipline	Gender	Athlete	Heightk	Weight	Time/Achievement
Javelin	Male	Arshad Nadeem	1.92 m	95 kg	92.97 m – Olympic Record
Javelin	Female	Haruka Kitaguchi	1.79 m	86 kg	65.80 m – Olympic Champion
Discus	Male	Rojé Stona	2.00 m	119 kg	70.00 m – Olympic Record
Discus	Female	Valarie Allman	1.83 m	70 kg	69.50 m – Olympic Champion
Hammer	Male	Ethan Katzberg	2.01 m	107 kg	84.12 m – Olympic Champion
Hammer	Female	Camryn Rogers	1.70 m	84 kg	76.97 m – Olympic Champion

Shot Put	Male	Ryan Crouser	2.01 m	145 kg	22.90 m – Olympic Champion
Shot Put	Female	Yemisi Ogunleye	1.83 m	90 kg	20.00 m – Olympic Champion

Table 5. Anthropometric characteristics and performance relationship in Turkish athletes

Discipline	Gender	Athlete	Height	Weight	Time/Achievement
Javelin	Male	Fatih Avan	1,83 m	90 kg	86.50m/Turkish record
Javelin	Female	Eda Tuğsuz	1,73 m	80 kg	67.21m/Turkish record
Discus	Male	Ercüment Olgundeniz	1,98 m	146 kg	67.50m/Turkish record
Discus	Female	Oksana Mert	1,85 m	95 kg	64.25m/Turkish record
Hammer	Male	Eşref Apak	1,85 m	105 kg	81.45m/Turkish record
Hammer	Female	Tuğçe Şahutoğlu	1,72 m	98 kg	74.17m/Turkish record
Shot Put	Male	Alperen Karahan	1,89 m	118 kg	20.81m/Turkish record
Shot Put	Female	Emel Dereli	1,79 m	95 kg	18.57m/Turkish record

Table 6. Summary of included studies related to throwing and anthropometry

Yazar	Job Title	Aim	Results
Alev [13]	Effects of post-activation potentiation applied at different loads in athletics throwing events	To examine the effects of PAP protocols on throwing performance.	It was found that moderate-to-high loads provided short-term performance enhancement.
Çarıkcı [10]	Javelin throwing technique and biomechanical evaluation	To evaluate javelin technique from a biomechanical perspective.	Optimal angle, speed, and segment coordination were found to be critical to performance.
Garcia-Carrillo, et al. [5]	Evaluation of physical fitness in track and field throwing athletes	To examine the physical fitness profiles of throwing athletes.	Elite shooters were observed to have high strength, power, and agility profiles.
Singh et al. [9]	Comparison of anthropometric characteristics and body composition between high and low performer hammer throwers	To compare the anthropometric differences of hammer throwers.	Top-level athletes were found to have greater lean mass and advantageous ratios.
Uylaş [25]	Are shoulder mobility test scores related to throwing performance in elite athletes?	To examine the relationship between shoulder mobility and performance.	Shoulder mobility was found to be significantly positively correlated with performance.
Zaras et al. [2]	Biological determinants of track and field throwing events performance	To examine the biological factors determining performance in throwing events.	Muscle strength, explosive power, and muscle architecture were shown to be key determinants.
Zhao et al. [6]	Anthropometric measurements, physical fitness, and specific throwing strength in adolescent throwers (14–18 yrs)	To examine the relationship between anthropometry, fitness, and strength in young throwers. To examine the relationship between anthropometric characteristics and performance.	Anthropometric measurements and strength tests were found to strongly predict performance.
Kale [21]	Relationship of performance with some anthropometric parameters in throwing events of athletics (Thesis)	To examine the effects of PAP protocols on throwing performance.	Arm and leg length, circumference measurements, and body proportions were found to be related to performance.

7. DISCUSSION

In this review study, the relationship between anthropometric characteristics and performance in athletics throwing events has been comprehensively addressed. Literature findings reveal that anthropometric parameters play a determinant role on performance, especially in events requiring explosive power such as shot put, discus, hammer, and javelin throw. The obtained

results show that performance in throwing events is shaped not only by technical proficiency but also by the athlete's biological and structural characteristics [2,5].

It is observed that the fundamental biomechanical factors determining performance in throwing events - release velocity, release angle, and release height - are directly influenced by anthropometric characteristics such as height, arm segment length, shoulder width, and muscle mass. It is reported that athletes with long arm segments and a wide shoulder structure can generate a higher moment during the throw, and this situation positively contributes to throwing velocity [2,8]. These findings support that performance in throwing events is built not on chance, but on specific physical advantages.

When event-specific evaluations are examined, it is noteworthy that each throwing discipline has different anthropometric requirements. While high body mass, broad torso structure, and high lean body mass emerge as critical factors for performance in shot put and hammer throw; in discus and javelin throw, arm length, torso ratios, and speed transfer come more to the fore [6,9]. This situation reveals that there is no single ideal physical profile in athletics throwing events and that event-specific anthropometric assessments are mandatory.

Evaluating in terms of body composition, it is reported that an increase in lean body mass is positively related to performance, whereas a high body fat percentage negatively affects performance by limiting movement speed. The observation of generally moderate fat percentage and high muscle mass in elite throwers shows that this relationship is valid in practice as well [5]. Furthermore, it is stated that regular training processes provide positive adaptations on body composition and these adaptations contribute to performance increase [6].

Findings obtained in the context of gender differences show that the effect of anthropometric characteristics on performance can manifest in different ways in female and male athletes. It is reported that although female athletes have lower absolute strength values compared to males, they can achieve similar relative performance levels when their technical efficiency is high [11]. It is noteworthy that in the javelin throw event, arm length and torso ratios show stronger relationships with performance in female athletes, while muscle mass and torso girth show stronger relationships in male athletes [6].

In conclusion, anthropometric analyses are an indispensable tool in athletics throwing events not only for explaining performance but also for improving performance, reducing injury risk, and

Overall, the findings addressed within the scope of this study reveal that anthropometric characteristics are not only an explanatory component of performance but also an important component guiding performance development. This situation supports the necessity of using anthropometric analyses systematically in athlete selection, event guidance, training planning, and long-term athlete development processes.

8. CONCLUSION

The results of this review study clearly demonstrate that anthropometric characteristics are one of the fundamental factors determining performance in athletics throwing events. It is observed that anthropometric parameters such as height, body mass, lean body mass, arm length, shoulder width, and torso ratios create direct and indirect effects on the biomechanical variables determining throwing distance. In this context, it is concluded that high performance in throwing events requires not only technical skill but also possessing a suitable physical structure.

The obtained findings show that each throwing event has its own specific anthropometric requirements. While high muscle mass and torso volume come to the fore in shot put and hammer throw; arm length, segment ratios, and speed production capacity become more determinant in discus and javelin throw. This situation reveals that event-specific anthropometric profiles, rather than general criteria, should form the basis in athlete selection and event guidance processes.

The results also emphasize the importance of body composition on performance. Increasing lean body mass and maintaining body fat percentage at optimal levels supports explosive power production and throwing velocity, thereby contributing to performance increase. Therefore, it is of great importance that training programs are planned not only for technical and strength development but also for monitoring and optimizing body composition.

Considering inter-gender differences, it is observed that the relative importance of anthropometric parameters affecting performance can vary for female and male athletes. However, the joint evaluation of technical efficiency and anthropometric advantages in both genders allows for a more accurate analysis of performance. This situation necessitates coaches and sports scientists developing individualized approaches that consider individual differences.

planning long-term athlete development. Therefore, conducting anthropometric measurements at regular intervals, integrating the obtained data into training and talent selection processes, and establishing event-specific norm values will provide significant contributions both scientifically and practically.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Author Contributions: Study Design: EB, İY; Data Collection: EB, SG; Data Interpretation: EB, SG, ND; Article Preparation: EB, ND, SG, İY; Literature Review: ND, İY, SG, EB. All authors have read and approved the published version of the article.

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