



Comparison of the Effects of Integrated Training (NASM OPT Model) and Traditional Strength Training on Some Physical Fitness Variables

“Entegre Antrenmanın (NASM OPT Modeli) ve Geleneksel Kuvvet Antrenmanının Bazı Fiziksel Uygunluk Değişkenleri Üzerindeki Etkilerinin Karşılaştırılması”

Gülcan TOHUMCU¹ & Türker BIYIKLI²

ORIGINAL ARTICLE

History

Received: 29 December 2025

Accepted: 26 April 2026

Published: 30 April 2026

DOI: <http://dx.doi.org/10.29228/anatoliars.111>

Authors Communications

1- Istanbul Nişantaşı University, School of Physical Education and Sports, Istanbul, TÜRKİYE

e-mail: gulcan.tohumcu@gmail.com

<https://orcid.org/0000-0002-8421-5361>

2-(Corresponding Author) Marmara University,

Faculty of Sport Sciences, Istanbul, TÜRKİYE

e-mail: turker.biyikli@marmara.edu.tr

<https://orcid.org/0000-0003-2953-7576>

Author Contributions

All authors contributed to the conception and design of the study.

Funding

This study received no specific financial support.

Competing Interests

The authors declare that they have no conflicts of interest.

Transparency

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study being reported; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained.

Ethical

This study follows all ethical practices during writing.

Citation

Tohumcu, G., & Biyikli, T. (2026). Comparison of the Effects of Integrated Training (NASM OPT Model) and Traditional Strength Training on Some Physical Fitness Variables. *Anatolia Sport Research*. 7(1):13-29.

Copyright © 2026 by Anatolia Sport Research

ABSTRACT

Aim: This study aimed to compare the effects of a NASM Optimum Performance Training (OPT)-based integrated exercise model and traditional strength training on selected physical fitness parameters.

Materials and Methods: Twenty-two individuals aged 20–35 years who had been exercising regularly for at least two years participated in the study. Participants were allocated into the traditional strength training group (TRAD; n = 10; 5 women and 5 men) and the NASM OPT-based integrated training group (INT; n = 12; 5 women and 7 men). Both groups completed an 8-week training program. Anthropometric variables, grip strength, push-up, sit-up, squat endurance, flexibility, maximal oxygen consumption (VO₂max), and postural alignment were assessed before and after the intervention. Within-group changes were analyzed using paired-samples t-tests, whereas between-group differences were examined using independent-samples t-tests. Statistical significance was set at $p < 0.05$.

Results: Significant within-group improvements were observed in several parameters. In the traditional strength training group, waist circumference in women and body fat percentage in men improved significantly. In the integrated training group, sit-up performance in women and push-up, sit-up, and flexibility performance in men showed significant improvements ($p < 0.05$). No statistically significant differences were found between the groups after 8 weeks ($p > 0.05$).

Conclusions: Both traditional strength training and integrated training effectively improved physical fitness parameters. Integrated training may provide broader functional benefits, although neither approach was superior overall.

Keywords: Integrated Training, NASM OPT Model, Physical Fitness, Traditional Strength Training, VO₂max

ÖZET

Amaç: Bu çalışmanın amacı, National Academy of Sports Medicine (NASM) Optimum Performance Training (OPT) modeline dayalı entegre antrenman ile geleneksel kuvvet antrenmanının seçilmiş fiziksel uygunluk parametreleri üzerindeki etkilerini karşılaştırmaktır.

Materyal ve Metod: Çalışmaya en az iki yıldır düzenli olarak egzersiz yapan, 20–35 yaş aralığında kadın ve erkek toplam 22 birey katılmıştır (geleneksel kuvvet antrenmanı: n = 10; entegre antrenman: n = 12). Her iki grup da 8 haftalık bir antrenman programını tamamlamıştır. Ön test ve son test ölçümleri; antropometrik değişkenler, el kavrama kuvveti, şınav, mekik, squat dayanıklılığı, esneklik, maksimal oksijen tüketimi (VO₂maks) ve postür analizini kapsamaktadır. Verilerin analizinde **eşleştirilmiş örneklem t-testi** ve **bağımsız örneklem t-testi** kullanılmıştır ($p < 0,05$).

Bulgular: Her iki grup içinde çeşitli parametrelerde istatistiksel olarak anlamlı gelişmeler gözlenmiştir. Geleneksel kuvvet antrenmanı grubunda kadınlarda bel çevresi, erkeklerde ise vücut yağ oranında anlamlı iyileşmeler tespit edilmiştir. Entegre antrenman grubunda kadınlarda mekik performansında; erkeklerde ise şınav, mekik ve esneklik performanslarında anlamlı gelişmeler belirlenmiştir ($p < 0,05$). Sekiz haftalık uygulama sonunda gruplar arasında istatistiksel olarak anlamlı bir fark bulunmamıştır ($p > 0,05$).

Sonuç: Hem geleneksel kuvvet antrenmanı hem de entegre antrenman yaklaşımı, fiziksel uygunluk parametrelerinin geliştirilmesinde etkili bulunmuştur. Entegre antrenman modeli daha geniş fonksiyonel kazanımlar sağlamasına rağmen, genel değerlendirmede iki antrenman yaklaşımı arasında belirgin bir üstünlük saptanmamıştır.

Anahtar Kelimeler: Entegre Antrenman, Fiziksel Uygunluk, Geleneksel Kuvvet Antrenmanı, NASM OPT Modeli, VO₂maks.

INTRODUCTION

The COVID-19 pandemic resulted in prolonged periods of physical inactivity worldwide due to lockdowns and home confinement, leading to noticeable declines in physical fitness and health-related parameters. Studies conducted during the pandemic demonstrated that structured physical activity programs implemented among individuals confined at home significantly reduced negative outcomes such as stress, anxiety, health deterioration, and unfavorable changes in physical appearance, while also promoting positive physical and psychological effects (Ciddi & Yazgan, 2020). Consequently, the importance of regular exercise for maintaining a healthy and active lifestyle became more evident during this period.

Although the terms *physical activity* and *exercise* are often used interchangeably, they differ conceptually. Physical activity refers to all bodily movements produced by skeletal muscle contractions that result in energy expenditure, whereas exercise is a planned, structured, and repetitive form of physical activity designed to improve or maintain specific components of physical fitness. Exercise is characterized by predefined goals, frequency, intensity, and duration, while physical activity encompasses unstructured daily movements without a systematic program (Bıyıklı, 2019).

The widespread global popularity of sport has transformed it from a recreational activity into a domain associated with competitive success, financial rewards, and professional performance optimization. Achieving and sustaining high performance levels requires careful athlete selection, systematic training planning, and the implementation of appropriate performance-enhancement methods (Bayraktar & Kurtoğlu, 2004). Consequently, scientific interest in training methodologies that enhance physical capacity and sport-specific performance has increased (Albay et al., 2008).

Daily functional movements such as grasping, throwing, lifting, and carrying require well-developed motor abilities including coordination, flexibility, strength, and endurance (Boyle, 2004; Cook, 2010). In addition, biomotor and physiological characteristics such as strength, endurance, flexibility, and aerobic capacity are important determinants of performance-related outcomes in both individual and team-sport contexts (Özer, 2011). Postural alignment reflects the anatomical and kinesiological relationship between body segments and the musculoskeletal structures responsible for maintaining upright posture (Arıncı & Elhan, 2014; Floyd, 2018). Therefore, optimal postural control is an important component of movement efficiency, functional performance, and safe exercise execution.

In addition, body composition and physical structure play a crucial role in performance outcomes; for example, excess body weight negatively affects tasks such as running and jumping. Therefore, optimal physical characteristics are essential for maximizing physiological capacity, physical fitness, motor skill development, and athletic performance (Köklü et al., 2009; Vänttinen et al., 2010). As emphasized by Açıkkada and Ergen (1990), achieving high performance levels is unlikely unless an athlete's physical structure is compatible with the demands of the sport.

Training methodologies aim to maximize strength and power output to enhance performance. In this context, different neuromuscular training stimuli, including resistance training, plyometric exercises, and electrostimulation-based approaches, have been investigated for their potential effects on physical performance parameters (Brocherie et al., 2004). Effective training requires mastery of the technical, tactical, and theoretical principles of sport (Ossorio, 2001).

When appropriately planned and implemented, well-designed training programs can produce positive adaptations across different age groups and sport specializations (Watts, Joubert, & Lish, 2003).

Traditional strength training is one of the most widely used methods to improve muscular strength and hypertrophy. This approach is typically characterized by isolated muscle actions, performed predominantly in a single plane of motion using free weights or resistance machines (Bompa, 2000; Muratlı & Hidistan, 2018). Although traditional resistance training is effective in increasing muscular strength, functional performance is influenced by additional factors such as stability, movement quality, power, flexibility, speed, and agility. Most traditional resistance exercises emphasize concentric and eccentric contractions targeting a primary muscle group in a single plane, which may limit their transfer to multi-planar sport-specific movements.

In contrast, integrated and combined training approaches have gained popularity as alternatives to isolated resistance training. These models are based on the coordinated use of different training components within a systematic process and aim to develop physical, technical, and neuromuscular qualities together rather than in isolation (Conde & Delgado, 2000). Integrated training incorporates multiple exercise modalities, including resistance, balance, plyometric, and agility exercises, and emphasizes multi-planar, whole-body movements designed to enhance neuromuscular efficiency, strength, power, functional performance, and sport-related performance (Ateş & Ateşoğlu, 2007; Bakırcı, 2013; Hoffman et al., 2005; Rhea et al., 2008). These programs aim to replicate sport-specific movement demands and improve overall functional performance.

The National Academy of Sports Medicine (NASM) Optimum Performance Training (OPT) model represents a systematic and progressive integrated training framework grounded in the principles of human movement science. The OPT model consists of five phases—stabilization endurance, strength endurance, hypertrophy, maximal strength, and power—organized into three primary training levels: stabilization, strength, and power (Clark et al., 2017). Through a structured and individualized progression, this model aims to improve cardiorespiratory efficiency, metabolic function, body composition, neuromuscular coordination, and postural control. Previous research has also examined the effects of NASM-OPT-based training applications combined with traditional fitness training on selected physical parameters, supporting the practical relevance of this model in personal training settings (Bıyıklı, 2018).

Although both traditional strength training and integrated training models have been reported to improve physical fitness and performance-related outcomes, there is limited evidence directly comparing these two approaches within the same intervention design. In particular, studies examining the effects of a NASM Optimum Performance Training (OPT)-based integrated exercise model in comparison with traditional strength training on anthropometric, strength, muscular endurance, flexibility, cardiorespiratory, and postural parameters remain scarce. Therefore, addressing this gap may provide a clearer understanding of the relative effectiveness of these training paradigms in physically active adults. Accordingly, the aim of this study was to compare the effects of an 8-week NASM OPT-based integrated exercise model and traditional strength training on selected physical fitness and physiological parameters.

MATERIALS AND METHODS

Research Ethics

This study was approved by the Ethics Committee of Nişantaşı University (Approval Date: 15 March 2022; Decision No: 2022/12). All procedures were conducted in accordance with the ethical standards of the Declaration of Helsinki. Prior to participation, all participants were informed about the study procedures and provided written informed consent.

The human body typically adapts to strength training stimuli within approximately 4–6 weeks, after which the rate of strength development tends to plateau. Accordingly, periodized training programs should be systematically modified by manipulating training variables such as intensity, volume, rest intervals, and exercise selection in order to maintain training effectiveness and promote continued adaptation (Bompa & Haff, 2015; Suchomel et al., 2018; Del Vecchio et al., 2019). Training programs should also be structured according to the principles of progressive overload, specificity, recovery, and adaptation in order to optimize performance-related outcomes (Muratlı et al., 2011). Based on these principles, two different eight-week strength training programs were implemented in the present study.

A total of 22 participants, including 10 women and 12 men aged 20–35 years, who had been participating regularly in supervised exercise programs at health and fitness clubs for at least two years volunteered to participate in the study. Participants were allocated into two groups: the traditional strength training group (TRAD; $n = 10$; 5 women and 5 men) and the NASM Optimum Performance Training (OPT)-based integrated training group (INT; $n = 12$; 5 women and 7 men). Group allocation was performed using a randomized procedure after baseline assessments.

Sample size estimation was performed using G*Power 3.1 for a repeated-measures ANOVA (within–between interaction). Assuming an alpha level of 0.05, a power of 0.80, two groups, and two repeated measurements, the analysis indicated that the study was powered to detect a medium-sized effect.

A randomized pretest–posttest experimental design was used in the present study. All measurements were conducted at Nişantaşı The Red Fitness Center and Athletic House Fitness Center. Training sessions were performed three days per week over an eight-week period. Anthropometric and motor performance variables were assessed before and after the intervention.

Integrated Training Program (NASM OPT Model)

The NASM Optimum Performance Training (OPT) model was applied over an eight-week period in accordance with the NASM integrated training framework (Clark et al., 2017). This integrated training framework consists of five progressive phases: stabilization endurance, strength endurance, hypertrophy, maximal strength, and power development. The weekly progression of the integrated training program was structured as follows:

- ✓ Week 1: Stabilization endurance training
- ✓ Weeks 2–3: Strength endurance training (40–50% of 1RM)
- ✓ Weeks 4–5: Hypertrophy training (65–85% of 1RM)
- ✓ Weeks 6–7: Maximal strength training (90–100% of 1RM)
- ✓ Week 8: Power training (40–50% of 1RM performed with maximal explosive intent)

The integrated training program emphasized multi-planar, whole-body movements designed to enhance neuromuscular coordination, functional strength, and movement efficiency.

GOAL: TOTAL BODY		PHASE: 1 STABILIZATION ENDURANCE				
WARM-UP						
Exercise:	Sets	Duration	Coaching Tip			
SMR: Calves, IT-Band, Lats	1	30 s.	Hold each tender area for 30 sec			
Static Stretch: Calves, Hip Flexors, Lats	1	30 s.	Hold each stretch for 30 sec			
Treadmill	1	5–10 min	Brisk walk to slow jog			
CORE / BALANCE / PLYOMETRIC						
Exercise:	Sets	Reps	Tempo	Rest	Coaching Tip	
Floor Bridge	2	12	Slow	0		
Floor Prone Cobra	2	12	Slow	0		
Single-Leg Balance Reach	2	12	Slow	0		
Squat Jump w/Stabilization	2	5	Slow	90 s.	Hold landing 3–5 seconds	
SPEED, AGILITY, QUICKNESS						
Exercise:	Sets	Reps	Rest	Coaching Tip		
<i>Optional</i>						
<i>Optional</i>						
RESISTANCE						
Exercise:	Sets	Reps	Tempo	Rest	Coaching Tip	
Total Body	Ball Squat, Curl to Press	2	12	Slow	0	Vertical loading
Chest	Ball Dumbbell Chest Press	2	12	Slow	0	
Back	Standing Cable Row	2	12	Slow	0	
Shoulders	Single-Leg Dumbbell Scaption	2	12	Slow	0	
Biceps	Single-Leg Dumbbell Curl	2	12	Slow	0	
Triceps	Supine Ball Dumbbell Triceps Extensions	2	12	Slow	0	
Legs	Step-Up to Balance: Sagittal Plane	2	12	Slow	90 s.	
COOL-DOWN						
Exercise:	Sets	Duration	Coaching Tip			
Treadmill (optional)	1	5–10 min	Brisk walk; gradually reduce speed			
SMR: Calves, IT-Band, Lats	1	30 s.	Hold each tender area for 30 sec			
Static Stretch: Calves, Hip Flexors, Lats	1	30 s.	Hold each stretch for 30 sec			

Figure 1. NASM OPT Model (integrated training) Stabilization Endurance in Weeks 1 and 4.

GOAL: TOTAL BODY		PHASE: 2 STRENGTH ENDURANCE			
WARM-UP					
Exercise:	Sets	Duration	Coaching Tip		
SMR: Calves, IT-Band, Lats	1	30 s.	Hold each tender area for 30 sec		
Active Stretch: Calves, Hip Flexors, Lats	1	10 reps	Hold each stretch for 1-2 sec		
Treadmill	1	5-10 min	Brisk walk to slow jog		
CORE / BALANCE / PLYOMETRIC					
Exercise:	Sets	Reps	Tempo	Rest	Coaching Tip
Ball Crunch	2	10	Medium	0	
Reverse Crunch	2	10	Medium	0	
Single-Leg Squat	2	10	Medium	0	
Squat Jump	2	10	Medium	60 s.	
SPEED, AGILITY, QUICKNESS					
Exercise:	Sets	Reps	Rest	Coaching Tip	
<i>Optional</i>					
<i>Optional</i>					
RESISTANCE					
Exercise:	Sets	Reps	Tempo	Rest	Coaching Tip
Total Body	<i>Optional</i>				
Chest	2	12	Medium	0	Superset
Bench Press Push-Up		12	Slow	60 s.	
Back	2	12	Medium	0	Superset
Seated Cable Row Ball Dumbbell Row		12	Slow	60 s.	
Shoulders	2	12	Medium	0	Superset
Standing Dumbbell Should Press Single-Leg Scaption		12	Slow	60 s.	
Biceps	<i>Optional</i>				
Triceps	<i>Optional</i>				
Legs	2	12	Medium	0	Superset
Leg Press Step-Up to Balance		12	Slow	60 s.	
COOL-DOWN					
Exercise:	Sets	Duration	Coaching Tip		
Treadmill (optional)	1	5-10 min	Brisk walk		
SMR: Calves, IT-Band, Lats	1	30 s.	Hold each tender area for 30 sec		
Static Stretch: Calves, Hip Flexors, Lats	1	30 s.	Hold each stretch for 30 sec		
Coaching Tips: Resistance program can be split into 2, 3, or 4-day workout routine. Ex. 3-day routine: Day 1 (chest/back) Day 2 (legs) Day 3 (shoulders/biceps/triceps)					

Figure 2. NASM OPT Model (integrated training) Strength and Endurance in Weeks 5 and 8.

Traditional Strength Training Program

Participants in the traditional strength training group followed a conventional resistance training program for eight weeks, with training sessions conducted three times per week (Monday, Wednesday, and Friday). Exercise intensity was set at approximately 70% of one-repetition maximum (1RM), and each exercise was performed for 1-3 sets of 12 repetitions, in line with commonly applied resistance training and conditioning principles (Ratamess, 2012).

The training program primarily consisted of isolated resistance exercises using barbells and free weights, with a focus on major muscle groups. Exercise loads were individually adjusted and monitored throughout the intervention period in accordance with established strength training principles (Distefano et al., The training program primarily consisted of isolated resistance exercises using barbells and free weights, with a focus on major muscle groups. Free-weight exercises are commonly used in resistance training because they allow multi-joint loading patterns and require stabilization during movement

execution (Marsh, 2014). Exercise loads were individually adjusted and monitored throughout the intervention period in accordance with established strength training principles (Distefano et al., 2013).

Week 1	Week 2	Week 3	Week 4
Exercises performed during both training sessions of weeks 1–4			
Power clean (2 × 5, 60%)	Power clean (3 × 5, 60%)	Power clean (3 × 5, 75%)	Power clean (3 × 5, 80%)
Leg press (2 × 10, 60%)	Leg press (3 × 10, 60%)	Leg press (3 × 6, 75%)	Leg press (3 × 6, 80%)
Hamstring curl (2 × 15, 60%)	Hamstring curl (3 × 15, 60%)	Hamstring curl (3 × 10, 75%)	Hamstring curl (3 × 10, 80%)
Bench press (2 × 10, 60%)	Bench press (3 × 10, 60%)	Bench press (3 × 6, 75%)	Bench press (3 × 6, 80%)
Lat pulldown (2 × 15, 60%)	Lat pulldown (2 × 15, 60%)	Lat pulldown (2 × 10, 75%)	Lat pulldown (2 × 10, 80%)
Triceps ext (2 × 15, 60%)	Triceps ext (2 × 15, 60%)	Triceps ext (2 × 10, 75%)	Triceps ext (2 × 10, 80%)
Upright row (2 × 15, 60%)	Upright row (2 × 15, 60%)	Upright row (2 × 10, 75%)	Upright row (2 × 10, 80%)
Ab crunch (2 × 20)	Ab crunch (2 × 20)	Ab crunch (2 × 20)	Ab crunch (2 × 20)
Week 5	Week 6	Week 7	Week 8
Exercises performed during the first training session of weeks 5–8			
Hang snatch (3 × 5, 80%)	Hang snatch (3 × 5, 80%)	Hang snatch (4 × 5, 80%)	Hang snatch (4 × 5, 80%)
Back squat (3 × 10, 75%)	Back squat (4 × 10, 75%)	Back squat (3 × 6, 80%)	Back squat (3 × 6, 80%)
Hamstring curl (3 × 12, 75%)	Hamstring curl (3 × 12, 75%)	Hamstring curl (3 × 8, 80%)	Hamstring curl (3 × 8, 80%)
Lunge (3 × 12, 75%)	Lunge (3 × 12, 75%)	Lunge (3 × 8, 80%)	Lunge (3 × 8, 80%)
Calf raise (3 × 12, 75%)	Calf raise (3 × 12, 75%)	Calf raise (3 × 8, 80%)	Calf raise (3 × 8, 80%)
Exercises performed during the second training session of weeks 5–8			
Push jerk (3 × 5, 80%)	Push jerk (3 × 5, 80%)	Push jerk (4 × 5, 80%)	Push jerk (4 × 5, 85%)
Incline bench (3 × 10, 75%)	Incline bench (4 × 10, 75%)	Incline bench (3 × 6, 80%)	Incline bench (3 × 6, 80%)
Bentover row (3 × 12, 75%)	Bentover row (3 × 12, 75%)	Bentover row (3 × 18, 80%)	Bentover row (3 × 8, 80%)
Shoulder press (3 × 12, 75%)	Shoulder press (3 × 12, 75%)	Shoulder press (3 × 6, 85%)	Shoulder press (3 × 6, 85%)
Barbell curl (2 × 12, 75%)	Barbell curl (2 × 12, 75%)	Barbell curl (2 × 6, 80%)	Barbell curl (3 × 8, 80%)
Triceps push (2 × 12, 75%)	Triceps push (2 × 12, 75%)	Triceps push (2 × 8, 80%)	Triceps push (3 × 8, 80%)
Ab crunch (2 × 20)	Ab crunch (2 × 20)	Ab crunch (2 × 20)	Ab crunch (2 × 20)

Figure 3. Traditional Training Program.

Data Collection and Measurements

Anthropometric Measurements: Body height was measured using a Seca stadiometer with an accuracy of 0.1 cm. Participants stood barefoot in an upright position with heels together, arms relaxed at the sides, and head positioned in the Frankfort horizontal plane. Measurements were recorded during deep inspiration (Özer, 2009). Body weight was measured using an OMRON digital scale. Participants wore light clothing (shorts and a T-shirt) and were barefoot during the assessment. Body mass index (BMI) was calculated as body weight (kg) divided by height squared (m²).

Skinfold Thickness and Body Fat Percentage: Subcutaneous fat thickness was measured using a portable skinfold caliper on the right side of the body. Skinfold measurements were obtained at standardized anatomical sites according to established procedures. For male participants, thigh and subscapular skinfolds were used, while suprailiac and triceps skinfolds were measured in female participants. Body density and body fat percentage were subsequently calculated using the Sloan and Weir equations. Body composition assessment provides important information about fat mass and lean body mass distribution and is commonly used to evaluate exercise-related anthropometric changes (Koz, 2020).

Flexibility Assessment: Flexibility was assessed using the sit-and-reach test performed with a standardized sit-and-reach box. Participants completed two trials, and the best score was recorded in centimeters (Kamar, 2008).

Postural Assessment: Static postural alignment was evaluated using standardized postural assessment forms developed by Corbin et al. (2006). Participants were assessed in a standing position

from lateral and posterior views under standardized conditions. Postural deviations were scored based on severity using a four-point ordinal scale: 0 = none, 1 = mild, 2 = moderate, and 3 = severe. Total postural scores were calculated by summing the scores obtained from all assessed regions. The standardized structure of the form, the use of predefined scoring categories, and the application of the same assessment procedures before and after the intervention were used to support the methodological consistency of the evaluation, in accordance with basic principles of therapeutic movement assessment (Saadet et al., 2003). To enhance reliability, assessments were performed by experienced specialist physiotherapists and corrective exercise specialists who were trained in observational postural analysis. Prior to data collection, assessors reviewed the scoring criteria and assessment procedures to minimize inter-assessor variability.

Table 1. Postural Assessment

Lateral	Score	Posterior	Score
Forward head tilt	–	Lateral head tilt	–
Rounded shoulders	–	Scapular protrusion	–
Shoulder protraction	–	Scoliosis symptoms	–
Kyphosis	–	Shoulder length discrepancy	–
Lordosis	–	Leg length discrepancy	–
Abdominal sagging	–	Lateral curvature of the spine	–
Genu recurvatum	–	Gibbosity	–
Anterior balance	–	TOTAL	

Note. Postural deviations were scored based on severity (0 = none, 1 = mild, 2 = moderate, 3 = severe). Total score interpretation: excellent (0–2), very good (3–4), good (5–7), average (8–11), poor (≥ 12).

Handgrip Strength: Maximal handgrip strength was measured using a digital handgrip dynamometer (Takei T.K.K. 5401). Participants performed two maximal trials with each hand in a standardized anatomical position. The highest value obtained from both hands was recorded in kilograms (Günay et al., 2018).

Muscular Endurance Tests: Upper-body muscular endurance was assessed using the push-up test performed for 60 seconds. Participants were instructed to maintain proper body alignment throughout the test, and the total number of correctly performed repetitions was recorded. Lower-body muscular endurance was evaluated using the static wall squat test. Participants maintained a squat position with knees flexed at 90° while leaning against a wall. Time to exhaustion was recorded in seconds. Abdominal muscular endurance was assessed using the sit-up test, during which participants performed as many correctly performed repetitions as possible within 60 seconds.

Aerobic Capacity Assessment: Maximal oxygen uptake (VO_{2max}) was estimated using the Bruce treadmill protocol. Testing was conducted on a Technogym treadmill, and heart rate was monitored continuously using a Polar heart rate monitor. The test was terminated upon volitional exhaustion or signs of fatigue. VO_{2max} was calculated using the following equation: where T represents total running time in minutes (Mackenzie, 2005).

$$VO_2\max = (4.38 \times T) - 3.9$$

Stage	Minutes	% grade	MPH	dk/mile	km/h	dk/km	METS
1	3	10	1.7	25:18	2.7	22:13	3
2	3	12	2.5	24:00	4.0	15:00	4-5
3	3	14	3.4	17:39	5.5	10:55	7
4	3	16	4.2	14:17	6.8	8:49	10
5	3	18	5.0	12:00	8.0	7:30	14
6	3	20	5.5	10:55	8.9	6:44	17
7	3	22	6.0	10:00	9.7	6:11	21

Figure 4. Bruce Treadmill Test Protocol.

Statistical Analysis

All statistical analyses were performed using a statistical software package. Descriptive statistics were calculated for all variables and presented as mean ± standard deviation. Prior to inferential analyses, the normality of the data distribution was assessed using the Shapiro–Wilk test, which is appropriate for small sample sizes. Homogeneity of variances between groups was evaluated using Levene’s test. Since the assumptions for parametric testing were met, within-group pre-test and post-test differences were analyzed using paired-samples t-tests, whereas between-group comparisons were performed using independent-samples t-tests. The level of statistical significance was set at $p < 0.05$, corresponding to a 95% confidence level

RESULTS

This section presents within-group and between-group comparisons of pre-test and post-test measurements for the traditional strength training and NASM OPT model (integrated training) groups.

Table 2. Pre- and Post-Test Parameters of Male-Female Posture Analysis in the NASM OPT Model (Integrated) Training Group.

Variables	Gender	Pre Test (n=12)		Post Test (n=12)		t	P
		Av.	SD	Av.	SD		
Postural Assessment Score	M	6,57	2,50	1,14	1,21	7,22	,000
	F	4,60	1,51	,800	,836	7,75	,001

Note: Values are presented as mean ± standard deviation. The t and p values indicate within-group pre-test and post-test comparisons performed separately for male and female participants using paired-samples t-tests. INT: integrated training group.

Table 2 presents the within-group pre-test and post-test comparison of postural assessment scores separately for male and female participants in the integrated training group (INT). Paired-samples t-tests showed statistically significant improvements in postural assessment scores in both male participants ($t = 7.22, p < 0.001$) and female participants ($t = 7.75, p = 0.001$) after the eight-week intervention.

Table 3. Pre- and Post-Test Comparisons of Physical Parameters in Women's Groups Trained in Traditional Strength Training and NASM OPT Model (Integrated) Training.

Variables	n	Pre Test	p	Post Test	P
Right Hand Strength	GA=5	43,96±13,47	,030	44,90±13,18	,009
	EA=5	26,36±6,58		23,66±3,86	
Left Hand Strength	GA=5	40,00±11,91	,032	41,34±11,55	,007
	EA=5	24,48±6,09		20,00±6,45	
Push-up	GA=5	6,60±3,64	,864	6,80±3,56	,091
	EA=5	6,00±6,63		12,60±5,72	

Crunches	GA=5	17,80±7,42	,811	19,80±9,60	,289
	EA=5	18,80±5,16		25,20±4,54	
Static Squat	GA=5	58,80±30,30	,738	62,20±34,14	,280
	EA=5	52,80±24,24		91,00±43,82	
VO ₂ max (ml/kg/min)	GA=5	30,13±6,28	,208	33,33±5,36	,485
	EA=5	37,10±9,47		37,92±12,95	
Flexibility	GA=5	17,60±5,45	,917	18,40±5,17	,422
	EA=5	16,90±13,46		23,20±11,58	

Between-group comparisons of physical performance parameters for female participants in the traditional strength training and integrated training groups are presented in Table 3. Significant differences were observed in right and left handgrip strength following the intervention ($p < 0.05$). No statistically significant differences were found in the remaining physical performance variables ($p > 0.05$).

Table 4. Pre- and Post-Test Comparison of Physical Parameters in Male Groups Undergoing Traditional Strength Training and NASM OPT Model (Integrated) Training.

Variables	n	Pre Test	p	Post Test	P
Right Hand Strength	GA=5	64,38±18,91	,005	66,86±13,18	,005
	EA=7	38,55±4,02		39,01±5,80	
Left Hand Strength	GA=5	60,70±5,82	,006	63,28±19,92	,010
	EA=7	34,57±6,63		37,70±7,42	
Push-up	GA=5	31,60±15,22	,036	31,40±15,33	,225
	EA=7	14,00±10,16		22,14±9,61	
Crunches	GA=5	37,40±15,93	,030	40,20±16,00	,220
	EA=7	21,57±4,61		31,57±6,34	
Static Squat	GA=5	79,20±22,39	,009	84,40±20,40	,162
	EA=7	43,00±16,89		63,57±25,44	
VO ₂ max (ml/kg/min)	GA=5	32,26±17,33	,888	44,01±8,44	,094
	EA=7	31,26±5,77		34,97±8,28	
Flexibility	GA=5	29,00±8,97	,259	25,00±4,84	,087
	EA=7	24,21±4,91		30,50±5,00	

Table 4 shows the between-group physical performance comparisons for male participants. After eight weeks of training, significant differences were detected between the groups in right and left handgrip strength ($p < 0.05$), while no significant differences were observed in other physical performance parameters ($p > 0.05$).

Table 5. Evaluation of Posture Analysis Test Results of Traditional Strength Training and NASM OPT Model (Integrated) Training Male-Female Groups.

Variables	Gender	N	Pre Test	P	Post Test	P
Postural Assesment	E	GA=5	8,00±1,73	,300	7,80±1,64	,000
		EA=7	6,57±1,51		1,14±1,21	
	K	GA=5	7,00±1,22	,025	6,80±1,30	,000
		EA=7	4,60±2,50		,800±,836	

Postural analysis comparisons between the traditional strength training and integrated training groups are presented in Table 5. Pre-test comparisons revealed a significant difference in postural scores among female participants ($p < 0.05$), whereas no significant difference was observed among male participants ($p > 0.05$). Post-test comparisons demonstrated statistically significant differences in postural alignment for both female and male participants ($p < 0.05$).

Table 6. Pre- and Post-test Comparisons of Anthropometric Characteristic Parameters in Traditional Strength Training and NASM OPT Model (Integrated) Training Female Groups.

Variables	n	Pre Test	P	Post Test	P
Height	GA=5	165,8±5,11	,302	165,8±5,11	,302
	EA=5	162,9±2,88		162,9±2,88	
Body Weight (kg)	GA=5	61,00±14,00	,986	60,14±13,66	,888
	EA=5	60,82±17,06		58,72±17,01	
Waist Circumference (cm)	GA=5	75,90±11,45	,623	75,10±11,29	,532
	EA=5	71,90±13,22		69,94±13,56	
Resting Heart Rate (bpm)	GA=5	74,80±2,77	,866	74,80±2,77	1,00
	EA=5	73,80±12,57		74,80±11,32	
Fat Mass (kg)	GA=5	34,73±,774	,011	34,29±,998	,002
	EA=5	24,01±7,19		23,28±5,41	
BMI (kg/m ²)	GA=5	22,00±3,80	,815	21,70±3,69	,891
	EA=5	22,71±5,41		22,12±5,53	

Anthropometric comparisons between female participants in the traditional strength training and integrated training groups are shown in Table 6. No significant differences were observed between groups at baseline. However, pre-test and post-test comparisons indicated a statistically significant difference in body fat percentage ($p < 0.05$).

Table 7. Pre- and Post-Test Comparisons of Anthropometric Characteristic Parameters in Traditional Strength Training and NASM OPT Model (Integrated) Training Male Groups.

Variables	n	Pre Test	P	Post Test	P
Height	GA=5	176,4±3,50	,426	176,4±3,50	,426
	EA=7	173,5±7,14		173,5±7,14	
Body Weight (kg)	GA=5	73,00±7,93	,108	72,90±7,68	,151
	EA=7	81,50±8,50		79,98±7,84	
Waist Circumference (cm)	GA=5	83,00±7,31	,021	82,48±7,22	,039
	EA=7	92,42±4,68		90,28±4,23	
Resting Heart Rate (bpm)	GA=5	78,20±7,39	,956	75,00±6,08	,870
	EA=7	78,57±13,11		75,85±10,13	
Fat Mass (kg)	GA=5	30,89±7,91	,262	30,41±7,94	,146
	EA=7	27,00±3,19		25,13±3,53	
BMI (kg/m ²)	GA=5	23,46±2,84	,049	23,46±2,84	,060
	EA=7	27,03±2,61		26,88±2,69	

Table 7. presents anthropometric comparisons between male participants in the traditional strength training and integrated training groups. Baseline comparisons revealed significant differences in waist circumference and body mass index (BMI) ($p < 0.05$). Following the intervention, a statistically significant difference remained only in waist circumference ($p < 0.05$).

DISCUSSION AND CONCLUSION

The present study compared the effects of two exercise paradigms—traditional strength training and the NASM Optimum Performance Training (OPT) model—on selected anthropometric, postural, and motor performance variables in sedentary adults following an eight-week intervention performed three times per week. Overall, both programs produced favorable adaptations; however, the pattern of change suggested that the integrated NASM OPT approach may provide broader movement-related benefits, particularly in postural alignment and selected neuromuscular outcomes.

In the traditional strength training group, the observed reductions in body fat percentage and selected skinfold measurements in men, together with the decrease in waist circumference in women, indicate that conventional resistance-based exercise can positively influence regional body composition. At the same time, the absence of significant changes in body weight and BMI is not unexpected. Recent evidence indicates that resistance training may improve body composition without necessarily producing large short-term changes in total body mass or BMI, particularly in relatively short interventions and when dietary intake is not strictly controlled (Kelley et al., 2023). Similarly, previous research comparing EMS and traditional training in sedentary women reported that different exercise-related stimuli may influence strength development and anthropometric characteristics (Öktem & Akın, 2022). This pattern suggests that improvements in adiposity-related indicators may occur even when global anthropometric markers remain relatively stable.

By contrast, the NASM OPT group demonstrated a wider range of adaptations across body composition and performance-related variables. This may be explained by the integrated and progressive structure of the OPT model, which combines stabilization, strength endurance, hypertrophy, maximal strength, and power-oriented stimuli within a systematic framework. The inclusion of multi-planar tasks, instability-related demands, coordinated movement sequencing, and progressive neuromuscular loading may create a broader adaptive stimulus than traditional single-plane resistance exercise alone. Previous research has also shown that functional training performed under unstable conditions may improve selected anaerobic and performance-related capacities in trained athletic populations (Çağlayan & Özbar, 2017). In the current literature, integrative neuromuscular and functional training models have been associated with improvements in physical fitness, balance, postural control, movement quality, and body-composition-related outcomes (Cavaggioni et al., 2024).

One of the most notable findings of the present study was the improvement in postural alignment observed in the integrated training group, whereas no meaningful postural change was detected in the traditional strength training group. This finding is theoretically consistent with the foundational principles of the NASM OPT model, especially the early emphasis on stabilization endurance, sensorimotor control, alignment, and movement efficiency before progression toward higher-force production phases. Integrated training models are designed not only to increase force output, but also to optimize the quality and coordination of movement across kinetic chains. In this context, better postural outcomes may reflect improvements in neuromuscular control, trunk stability, proprioceptive function, and intermuscular coordination rather than merely gains in isolated muscular strength. Recent reviews and randomized controlled trials on integrative neuromuscular training similarly suggest that such approaches may be particularly effective for improving postural control, balance, physical performance, and movement competence when compared with more traditional training structures (Cavaggioni et al., 2024; Concha-Cisternas et al., 2024).

The handgrip strength findings also deserve attention. Although handgrip is not a direct measure of whole-body functional performance, it is widely accepted as a practical marker of general neuromuscular capacity and overall strength status. The more favorable pattern observed in the integrated training group may indicate that training methods requiring greater whole-body coordination, trunk involvement, and force transmission across multiple segments can contribute to broader neuromuscular adaptations. Previous research has shown that sport-specific resistance training may induce neural adaptations related to improved force production and movement coordination in trained athletes (Judge et al., 2003). This interpretation is aligned with studies showing that functional and

integrated resistance paradigms may produce equal or superior gains in selected performance variables, especially those linked to movement efficiency, force transfer, and muscular endurance.

At the same time, the lack of significant between-group differences in several other variables, such as VO_{2max} , flexibility, push-up, sit-up, or static squat performance, should be interpreted carefully rather than as evidence of no practical distinction between the models. Since cardiorespiratory adaptations are influenced by exercise intensity, duration, baseline fitness level, and cardiovascular responsiveness, changes in VO_{2max} may require more specific or longer-duration aerobic stimuli (Golbidi & Laher, 2012). First, the study duration was relatively short. Eight weeks may be sufficient to elicit early neuromuscular and coordination-related adaptations, but may be too brief to produce large and consistent divergences in broader physiological variables, especially in a small sample. Second, both interventions were performed regularly and supervised, which likely enhanced adherence and reduced the likelihood of a large contrast between programs. Third, some outcomes, particularly body composition and aerobic capacity, are strongly affected by baseline status, nutritional intake, recovery, sleep, and habitual physical activity outside the intervention, none of which appear to have been tightly controlled in the current design. Recent comparative studies in adult populations likewise report that combined exercise programs can improve health- and fitness-related markers, including body composition, energy expenditure, and metabolic outcomes, while between-group differences may remain small or inconsistent, particularly over short intervention periods (Grivas et al., 2025).

Another important issue concerns the practical meaning of the postural findings. In physically active adults, improvements in posture may have implications beyond aesthetics. Posture is closely related to movement efficiency, biomechanical alignment, and sport-related performance (Karakuş & Kılınç, 2006). More efficient alignment may contribute to improved movement economy, reduced compensatory patterns, and better exercise technique, all of which are relevant for long-term participation and injury-risk reduction. While the current study did not directly assess pain, balance confidence, or injury-related outcomes, the postural improvements seen in the integrated training group may represent an important foundation for future functional gains. This is especially relevant in physically active individuals, where movement quality, lumbopelvic control, and proprioceptive capacity may influence the quality of exercise performance. The broader literature increasingly supports the value of multi-component and neuromuscularly oriented exercise for improving movement quality and functional independence, particularly when training is progressive and individualized.

The present results are also broadly consistent with earlier studies comparing traditional resistance training with functional, suspension-based, sport-specific, or integrated models. In a direct comparison of functional and traditional resistance training, (Tomljanović et al., 2011). reported that both approaches may influence anthropometric and motor performance variables, supporting the relevance of comparing different resistance-training paradigms. Research comparing different training methods in sport-specific settings has shown that training modality may influence technical, biomotor, and physiological outcomes (Özcan, 2011). For example, previous research comparing TRX-based or suspension-based training with traditional resistance training has reported changes in selected muscular performance outcomes, supporting the relevance of alternative and functional resistance-training modalities (Janot et al., 2013; Özdamar, 2019). Similarly, studies examining different resistance-training modalities, including weightlifting, kettlebell training, and elastic-band-supported resistance exercises, have shown that various loading strategies may produce improvements in strength, power-related performance, jumping performance, and body-composition outcomes (Otto et al., 2012; Susam et al., 2022). Systematic review evidence also suggests that functional training can improve selected physical

function and performance-related outcomes, supporting its practical relevance as a multi-component training approach (Liu et al., 2024). Previous studies on functional, combined, and sport-specific training interventions have reported improvements in selected physical fitness and performance parameters in young populations and team-sport athletes, supporting the effectiveness of structured training programs for performance development (Çimen & Kılıç, 2017; Erken et al., 2020; Turğut et al., 2017). In that respect, the current findings reinforce the idea that the superiority of one training model over another may depend less on whether outcomes improve in general and more on which specific outcomes are prioritized.

Several limitations should be considered when interpreting these findings. The sample size was small, which may have limited statistical power and increased the influence of inter-individual variability. The intervention duration was restricted to eight weeks, and longer follow-up may have revealed more robust differences between the models. In addition, dietary intake and daily physical activity outside the structured sessions were not reported as controlled variables, which may have influenced anthropometric outcomes. Another limitation is that posture was evaluated using observational scoring rather than instrumented kinematic analysis; although the use of standardized forms and trained professionals strengthens methodological consistency, future studies should also report assessor blinding and inter-rater/intra-rater reliability whenever possible. These methodological refinements would improve confidence in postural outcomes and further strengthen the interpretation of integrated training effects.

Despite these limitations, the present study contributes to the growing evidence that integrated training models can be meaningfully applied in non-athletic adult populations. From an applied perspective, the findings suggest that both traditional strength training and NASM OPT-based integrated training can be used to improve physical fitness in sedentary adults, but that the OPT model may be especially useful when the practitioner's goals include postural alignment, movement quality, and broader neuromuscular development. This is important for exercise professionals working with sedentary clients, because early improvements in control, alignment, and functional competence may enhance adherence, exercise confidence, and the safety of later progression toward higher-intensity training phases.

In conclusion, both traditional strength training and NASM OPT-based integrated training were effective in improving selected physical fitness parameters in sedentary adults. However, the integrated training model demonstrated a broader pattern of adaptation, especially in postural alignment, handgrip strength, and selected body composition variables. Although major between-group differences were not observed across all outcomes, the findings suggest that an individualized and progressively structured OPT-based approach may provide additional value when the goal is not only to increase fitness, but also to improve movement quality and postural control. Future studies with larger samples, longer intervention periods, tighter control of dietary and lifestyle factors, and more advanced biomechanical assessments are needed to clarify the specific advantages of integrated training in sedentary and clinical populations.

Practical Implications and Recommendations

- ✓ Both training models can be recommended for sedentary adults to improve health-related fitness.
- ✓ Traditional strength training appears effective for selected strength and body-composition outcomes.

- ✓ The NASM OPT model may provide additional benefits in postural alignment, neuromuscular control, and functional strength-related variables.
- ✓ For sedentary individuals with movement-quality limitations, poor posture, or low stabilization capacity, integrated training may be a more appropriate starting framework.
- ✓ Future research should examine OPT-based training using larger samples, longer interventions, and outcomes such as balance, functional movement quality, agility, pain, adherence, and injury-related risk markers.

REFERENCES

- Açıkada, C. & E. Ergen (1990). *Bilim ve Spor*. Ankara: Büro-Tek Ofset Matbaacılık.
- Albay, M.D., E. Tutkun., Y.S. Ağaoğlu., A. Canikli & F. Albay. (2008). Hentbol, Voleybol Ve Futbol Üniversite Takımlarının Bazı Motorik ve Antropometrik Özelliklerinin İncelenmesi. *Spor Metre Beden Eğitimi ve Spor Bilimleri Dergisi*, 6(1),13-20.
- Arıncı, K. & A. Elhan. (2014). *Anatomi*. 1. Cilt. 5. baskı. Ankara: Güneş Tıp Kitabevleri.
- Ateş, M. & U. Ateşoğlu. (2007). Pliometrik Antrenmanın 16-18 Yaş Grubu Erkek Futbolcuların Üst ve Alt Ekstremitte Kuvvet Parametreleri Üzerine Etkisi. *Spor Metre Beden Eğitimi ve Spor Bilimleri Dergisi*, 5(1), 21-28.
- Bakırcı, A. (2013). *Üniversite Basketbol Takımı Hazırlık Periyodu Performans Analizine Bağlı Uygulanan Kombine Antrenmanların Etkinliği*. Yüksek Lisans Tezi. Isparta: Süleyman Demirel Üniversitesi Sağlık Bilimleri Enstitüsü.
- Bayraktar, B. & M. Kurtoğlu. (2004). *Sporla Performans ve Performans Artırma Yöntemleri*. İstanbul: Form Reklam Hizmetleri.
- Bıyıklı, T. (2018). "Comparison of Physical Parameters of the Individuals Who Have Received NASM-OPT Model & EMS Training in Combination with Traditional Fitness Training Applications Regularly as Personal Training (PT) for 20 Weeks." *Journal of Education and Training Studies* 6(12), 158-171.
- Bıyıklı, T. (2019). *Uluslararası Fitness Eğitmenliği Ders Notları*. İstanbul: Athletic House Academy.
- Bompa, T. & G.G. Haff. (2015). *"Peridi Dönemleme Antrenman Kuramı ve Yönetimi"*. Ankara: Spor Yayınevi.
- Bompa, TO. (2000). *Total Training For Young Champions*. Champaign: Human Kinetics.
- Boyle, M. (2004). *Functional Training For Sports*. Champaign: Human Kinetics Publishers.
- Brocherie, F., N. Babault., G. Cometti., N. Maffiuletti., & J.C. Chatard. (2004). Elektro Stimulation Training Effects On The Physical Performance Of Ice Hockey Players. *Medicine & Science in Sports & Exercise*. 455-460.
- Cavagioni, L., L. Gilardini., M. Croci., D. Formenti., G. Merati. & S. Bertoli. (2024). The Usefulness Of Integrative Neuromuscular Training To Counteract Obesity: A Narrative Review. *International Journal of Obesity*, 48(1), 22-32. doi:10.1038/s41366-023-01392-4.
- Ciddi, P. K., & E. Yazgan. (2020). COVID-19 Salgınında Sosyal İzolasyon Sırasında Fiziksel Aktivite Durumunun Yaşam Kalitesi Üzerine Etkisi. *İstanbul Ticaret Üniversitesi Sosyal Bilimler Dergisi*. 19 (37), 262-279.
- Clark A.M., C.S. Lucett., E. McGill., I. Montel., B. & Sutton. (2017). *Sixth Edition NASM (National Academy of Sports Medicine) Essentials of Personal Fitness Training*. Burlington: Jones & Bartlett Learning.
- Concha-Cisternas, Y., J. Castro-Piñero., M. Vásquez-Muñoz., I. Molina-Márquez., J. Vásquez-Gómez., E. & Guzmán-Muñoz. (2024). Effects Of Neuromuscular Training On Postural Balance And Physical Performance In Older Women: Randomized Controlled Trial. *Journal of Functional Morphology and Kinesiology*, 9(4), 195. doi:10.3390/jfmk9040195.
- Conde, J., & M. Delgado. (2000). *Características Del Proceso De Entrenamiento*. En CÁRDENAS, D (Coord.). El Entrenamiento Integrado De Lashabilidades Visuales En La Iniciación Deportiva. Málaga: Ediciones Aljibe.
- Cook, G., L. Burton., K. Kiesel., M. Bryant., & J. Torine. (2010). *Movement: Functional Movement Systems: Screening, Assessment, And Corrective Strategies* (Vol. 24). Aptos, CA: on Target Publications.
- Corbin, C.B., G.J. Welk., W.R. Corbin & K. Welk. (2006). *Concepts Of Fitness And Wellness*. NY: The MacGraw-Hill.
- Çağlayan, A. & N. Özbar (2017). The examination Of The effects Of Functional Training Program Applied On İnstable ground On Anaerobic Capacities Of Elite Martial Arts Athletes. *European Journal of Education Studies*. 11. 812-824.
- Çimen, E. & F. Kılıç. (2017). 12-14 Yaş Hentbolculara Müsabaka Döneminde Uygulanan Kombine Antrenmanlarının Performansları Üzerine Etkilerinin Araştırılması. *Sportif Performans Araştırma Dergisi*. 1 (1), 35-50.

- Del Vecchio, A., Casolo, A., Negro, F., Scorcelletti, M., Bazzucchi, I., Enoka, R., Felici, F., & Farina, D. (2019). The Increase in Muscle Force After 4 Weeks of Strength Training is Mediated by Adaptations in Motor Unit Recruitment and Rate Coding. *The Journal of Physiology*, 597(7), 1873–1887.
- Distefano, L.J., M.J. Distefano., B.S. Frank., M.A. Clark & D.A. Padua. (2013). *The Journal of Strength & Conditioning Research*. 27(4), 1083-1090.
- Erken, Y., Ö. Saygın & H.İ. Ceylan. (2020). Fonksiyonel Antrenman Adölesan Kız Ve Erkeklerin Seçilmiş Fiziksel Uygunluk Parametrelerini Geliştirir, *Atatürk Üniversitesi Beden Eğitimi ve Spor Bilimleri Dergisi*. 22(4).
- Floyd, RT (2018). *Yapısal Kinesiyoloji El Kitabı* (20.baskı) New York, NY: McGraw-Hill.
- Golbidi, S. & I. Laher. (2012). Exercise And The Cardiovascular System. *Cardiology Research and Practice*, 1-15.
- Grivas, G.V., et al. (2025). Comparative Analysis Of Combined Exercise Programs In Middle-Aged Obese Males: Impact On Energy Expenditure, Body Composition, And Metabolic Rate. *Frontiers in Sports and Active Living*, 7, 1533030. doi:10.3389/fspor.2025.1533030.
- Günay, M. (2018). *Antrenman Bilimi*. Ankara: Nobel Yayın Dağıtım.
- Hoffman, JR., N.A. Ratamess., J.J. Cooper., J. Kang., A. Chilakos & AD. Faigenbaum. (2005). Comparison Of Loaded And Unloaded Jump Squat Training On Strength/Power Performance İn College Football Players. *J Strength Cond Res* 19: 810–815.
- Janot J, Heltne T, Welles C, Riedl J, Anderson H, Howard A, & Myhre S L. (2013). Effects of TRX Versus Traditional Training Programs on Measures of Muscular Performance in Adults. *J Strength Cond Res*. 2: 23-38.
- Judge, LW., C. Moreau & J.R. Burke. (2003). Neural adaptations with sport- specific resistance training in highly skilled athletes. *J Sports Sci* 21, 419–427.
- Kamar, A. (2008). *Sporda Yetenek, Beceri ve Performans Testleri*. Ankara: Nobel Yayınları.
- Karakuş, S. & F. Kılınç. (2006). Postür ve Sportif Performans. *Kastamonu Eğitim Dergisi*, 14(1), 309-322.
- Kelley, G.A., K.S. Kelley. ve B.L. Stauffer. (2023). Effects Of Resistance Training On Body Weight And Body Composition In Older Adults: An Inter-Individual Response Difference Meta-Analysis Of Randomized Controlled Trials. *Science Progress*, 106, 1-17. doi:10.1177/00368504231179062.
- Koz, M. (2020). *Egzersiz fizyolojisi III, Vücut kompozisyonu*: https://acikders.ankara.edu.tr/pluginfile.php/2545/mod_resource/content/1/11.Hafta.pdf.
- Köklü, Y., A. Özkan., U. Alemdaroğlu. & G. Ersöz. (2009). Genç Futbolcuların Bazı Fiziksel Uygunluk ve Somatotip Özelliklerinin Oynadıkları Mevkilere Göre Karşılaştırılması. *Spor Metre Dergisi* 7, 61-8
- Liu, C.J., W.P. Chang., Y.C. Shin., Y.L. Hu. & J. Morgan-Daniel. (2024). Is Functional Training Functional? A Systematic Review Of Its Effects In Community-Dwelling Older Adults. *European Review of Aging and Physical Activity*, 21, 32. doi:10.1186/s11556-024-00366-3.
- Mackenzie, B. (2005). *101 Performance Evaluation Test*. London: Electric Word Plc.
- Marsh, G. (2014). *The Complete Guide To Training With Free Weights*. London: Bloomsbury Publishing.
- Muratlı, S. & I. Hindistan. (2018). *Sporda Kuvvet Antrenmanı*. Ankara: spor yayınevi ve kitabevi.
- Muratlı, S., O. Kalyoncu & G. Şahin. (2011). Antrenman ve Müsabaka. *Kalyoncu Spor Danışmanlık San. Tic. Ltd. Şti*. 3, 375-378.
- Ossorio, D. (2001). *La Influencia Motivadora Del Entrenamiento Integradosobre La Percepción Del Esfuerzo En El E Entrenamiento aeróbico*. Lecturas: Educación Física y Deportes. Buenos Aires. 7 - 41.
- Otto, W.H., Coburn, J.W., Brown, L.E. & Spiering, B.A. (2012). Effects of weightlifting vs. kettlebell training on vertical jump, strength and body composition. *Journal of Strength and Conditioning Research*, 26(5), 1199-1202.
- Öktem, U. & M. Akın. (2022). Sedanter Kadınlarda Elektriksel Kas Uyarımı (EMS) ve Geleneksel Antrenmanın Kuvvet Kazanımı ve Antropometrik Özellikler Üzerine Etkisinin İncelenmesi. *CBÜ Beden Eğitimi ve Spor Bilimleri Dergisi*, 17 (1), 70-79.
- Özcan, S. (2011). *Temel Tenis Teknik Öğretiminde İki Farklı Antrenman Metodunun Teknik Biyomotorik ve Fizyolojik Özellikler Üzerine Etkisinin Araştırılması*. Yüksek Lisans Tezi. Isparta: Süleyman Demirel Üniversitesi Sağlık Bilimleri Enstitüsü.
- Özdamar, S. (2019). *14 - 16 Yaş Erkek Voleybolcularda Uygulanan Sekiz Haftalık Asılı Egzersiz Sistemi ve Geleneksel Kuvvet Antrenmanlarının Karşılaştırılması*. Yüksek Lisans Tezi. İstanbul: Marmara Üniversitesi Sağlık Bilimleri Enstitüsü.
- Özer, K. (2009). *Kinantropometri Sporda Morfolojik Planlama*. Ankara: Nobel Yayınevi.
- Özer, Ö. (2011). *Elit Ferdi ve Takım Sporcuların Bazı Temel Biyomotorik Ve Fizyolojik Özelliklerinin Performans Boyutu İle Karşılaştırılması*. Yüksek Lisans Tezi. Isparta: Süleyman Demirel Üniversitesi Sağlık Enstitüsü.
- Ratamess, N. (2012). ACSM's Foundations Of Strength Training And Conditioning. Indianapolis. *American college of sports medicine*, 475.

- Rhea, MR., MD. Peterson., JR. Oliverson., FN. Ayllon. & BJ. Potenziano. (2008). An Examination Of Training On The Verti Max Resisted Jumping Device For Improvements In Lower Body Power In Highly Trained College Athletes. *J Strength CondRes*, 22, 735–740.
- Saadet, O., H. Demirel. & A. Sade. (2003). *Tedavi Hareketlerinde Temel Değerlendirme Prensipleri*. Ankara: HÜ Fizik Tedavi ve Rehabilitasyon Yüksekokulu Yayınları.
- Suchomel, T.J., S. Nimphius., C.R. Bellon. & M.H. Stone. (2018). The Importance of Muscular Strength, Training Considerations. *Sports Medicine*, 48(4), 765–78
- Susam, K., E. Harbili. & S. Harbili. (2022). Genç Voleybolcularda Elastik Bantla Yapılan Bench Press ve Squat Egzersizlerinin Kuvvet ve Sıçrama Performansına Etkisi. *Spor Bilimleri Dergisi*, 33 (2), 74-84.
- Tomljanović, M., M. Spasić., G. Gabrilo., O. Uljević., & Foretić, N. (2011). Effects Of Five Weeks Of Functional Vs. Traditional Resistance Training On Anthropometric And Motor Performance Variables. *Kinesiology. International Journal of Fundamental and Applied Kinesiology*. 43(2), 145-154.
- Turğut, M., R. Aydın. & A.O. Erkiş. (2017). Bartın Üniversitesi Badminton Takımında Yer Alan Kadın Sporculara Uygulanan 8 Haftalık Klasik Badminton Antrenmanlarının Bazı Fiziksel Performans Parametreleri Üzerine Etkileri. *Uluslararası Kültürel ve Sosyal Araştırmalar Dergisi (UKSAD)*. 2, 354-364.
- Vantinen, T., M. Blomqvist. & K. Hakkinen. (2010). ‘Development of body composition, Hormone Profile, Physical Fitness, General Perceptual Motor Skills, Soccer Skills and On- The- Ball Performance in Soccer-Specific Laboratory Test Among Adolescent Soccer Players’. *Journal of sports Science and Medicine*. 984, 547-556.
- Watts, P.B., L.M. Joubert. & A.K. Lish. (2003). Anthropometry Of Young Competitive Sport Rock Climbers. *Br J Sports Med*. 37(5), 420-4.