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RESEARCH ARTICLE

Seasonal Changes in Body Composition in Elite Male Handball Players

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Abstract
Having knowledge of an athlete's body composition values enables individuals to assess their physical condition and performance. It has become increasingly important in recent years to demonstrate the significant relationship between body composition and athletes' physical performance. The aim of this study is to examine the changes in body composition of elite male handball players during preparation and competition periods (42 weeks). Twenty-three elite male handball players volunteered for this study The Tanita brand body analysis device was used to evaluate body composition and eight measurements were taken. Athletes were divided according to their playing positions (playmakers n=8 and goalkeepers n=4, wings n=7 and pivots n=4). 7 measurements were evaluated, which were weight (W), body fat percentage (BF%), fat mass (FM), muscle mass (MM), total body water (TBW), body mass index (BMI), and basal metabolic rate (BMR). Wing players had lower body fat percentage and body fat mass than all other playing positions and regardless of position, all athletes' body fat percentage and body fat mass significantly decreased at T2 ($p<0.05$). As a result, increase in body fat percentage and fat mass was observed during the competition period, and this increase continued ($p<0.05$). The increase in fat mass during the competition period may be due to different training content and higher training intensity during the preparation period, changes in nutrition habits due to camps, long trips, and tournaments, as well as the ef-fects of fatigue and stress. Further studies are needed in these areas.

Keywords
Body Composition, Fat Mass, Handball, Male

INTRODUCTION

Body composition is only one of the many factors (physical, physiological, genetic, and psychological) that determine athletic performance. In addition to body size, the structure of body composition components is also important. Body weight can be divided into various components to achieve a more balanced and ap-propriate distribution of fat, muscle, and bone mass (Sundgot-Borgen et.al., 2013). Determining athletes' body composition (low fat and muscle ratios) is an important factor in increasing performance. Having knowledge of an individual's body composition values allows for interpretation of their physical condition and performance. In recent years, it has become increasingly important to show that there is a significant relationship between body composition and athletes' physical performance (Rybakova et. al., 2020). Human physique varies in many ways, and this diversity in physical characteristics in certain sports turns into specific advantages for athletes during the game. Each sport requires a specific body type. A body type unsuitable for a sport can be a significant obstacle to a player's progress. Also, knowing and understanding the effect of training and competition on body composition can help athletes control their weight and safely change their body composition. Additionally, tracking body composition trends in specific sports enables coaches to prepare their athletes correctly for specific competi-tions or positions (Singh et. al., 2011). Handball is an Olympic team sport

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characterized by defensive actions and fast-paced offensive actions to score goals (Martínez-Rodríguez et.al., 2021). It is difficult to determine the factors that affect performance in handball because it is complex and multifactorial, characterized by high-intensity explosive movements. Handball players must coordinate running, jumping, pushing, changing directions, passing, catching, throwing, and blocking movements well. The intensities during the game always vary between standing, walking, sprinting, running at a moderate pace, moving sideways and backward, so a high level of endurance is essential to maintain a high game tempo throughout the game (Póvoas et. al., 2012; Michalsik et. al., 2015). Due to the high physical demands of handball, players need highly devel-oped anthropometric and physical attributes (linear speed, change of direction speed, aerobic capacity, muscle strength, and power) to succeed (Bilge, 2012)

In handball, there are generally four playing positions: 1) goalkeeper: stops the ball in the goal and prevents the opposing team from scoring; 2) playmakers (right-left-center): they are the ones who indicate where the attacks should start, serving as an extension of the coach on the field, and command the team in both offense and defense. The right-left playmakers are effective in both offense and defense; 3) wings: they are the ones who stop closed defenses in the goal area and often assist in scoring; 4) pivot: responsible for creating space by entering the defense wall at possible openings (Karcher & Buchheit, 2014). Handball players need to possess well-developed physical characteristics, including linear and change of direction speed, aerobic capacity, muscular strength, and power, to be successful in the sport. These anthropometric and physical qualities are strongly associated with handball performance and play a crucial role in determining a player's success on the court. Evaluating the match between physical structure and composition, weight, and height is considered important factors in performance, even depending on the sport and player positions (Martínez-Rodríguez et.al., 2020).

In the sport of handball, player profiling can be an effective method of identifying talent, assessing strengths and weaknesses, determining optimal playing positions, and designing personalized strength and conditioning training programs (Karcher & Buchheit, 2014; Schwesig et al., 2017). Through the use of profiles, coaches and coaches can gain valuable information about each player's unique physical and physiological characteristics, which can be used to improve their overall performance and contribute to team success. Evaluation of body composition, with a focus on fat and skeletal muscle content, is particularly important in sports science and practice (Cavedon et. al., 2018). Previous research suggests that certain physical characteristics, including high body mass and stature, are associated with high-level handball performance (Lidor et. al., 2005). In addition, higher values of fatfree mass were associated with better performance, particularly due to increased muscular power and strength (Granados et. al., 2013) and physical characteristics can vary considerably across different player positions in the team (Karcher & Buchheit, 2014; Lidor et. al., 2005).

In talent selection, assessing players' body composition is important in determining their playing positions and developing training programs (Schwesig et al., 2017; Fieseler et. al., 2017). Studies on anthropometry and body composition in handball are available (Milanese et. al., 2011; Owen et. al., 2017). However, no study has been found that examines changes in body composition values in elite male handball players during a season. The aim of this study is to examine changes in body composition between different playing positions in elite male handball players during the preparation and competition periods (42 weeks). We have two hypotheses in this study. Especially in fat and muscle mass: 1- We expect a decrease in fat mass, an increase in muscle mass, at the end of the preparation periods and during the competition period, 2- A decrease in fat mass and an increase in muscle mass between positions.

MATERIALS AND METHODS

Study Design

Twenty-three elite male handball players participated in this study voluntarily (age: 25.41 ± 5.44 yr, height: 190.53 ± 5.79 cm, body weight: 93.71 ± 10.9 kg). After explaining the objectives of the study, written informed consent was obtained from each subject. This study followed ethical standards and received approval from the Zonguldak Bülen Ecevit University Non-invasive

Clinical Research Ethics Committee, reference number (no: 2023/01, date 11.01.2023). Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.This study was designed to examine the changes in body composition during the preparation and competition period (42 weeks) of a handball team competing in the super league in the 2021-2022 season in Turkey. Measurements were taken at 8 different times: preseason (T1), end of preparation period (T2), end of tournament and preparation match period (T3), end of first half (T4), end of second preparation period (T5), second half (T6), after Turkish cup at the end of second half (T7), and end of season (T8) (Table 1).

Table 1. Body composition testing timeline

Month	**August**				**September**					**October**					**November**				**December**				
Week	1	2	3	4	1	2	3	4	5	1	1	2	3	4	1	2	3	4	1	2	3	4	5
Monday	***T1***	TR	TR	TR	TR	TO	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR
Tuesday	C	TR	TR	TR	TO	R	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR
Wednesday	C	TR	TR	TR	TO	TO	TR	TR	TR	TR	TR	TR	TR	M	TR	TR	TR	TR	TR	TR	TR	TR	TR
Thursday	C	TR	TR	TR	TO	TO	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR
Friday	C	TR	TR	TR	TO	TO	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR
Saturday	C	TR	TR	***T2***	TO	TO	TR	M	M	M	M	M	EC	TR	***T4***	M	M	M	M	M	M	TR	TR
Sunday	R	R	R	R	TO	R	R	***T3***	TR	R	R	R	EC	R	TR	R	R	R	R	R	***T4***	R	R
Month	**January**				**February**				**March**					**April**				**May**				**June**	
Week	1	2	3	4	1	2	3	4	1	2	3	4	5	1	2	3	4	1	2	3	4	1	2
Monday	TR	TR	TR	TR	TR	TR	R	R	TR	R	R	R	***T7***	TR	TR	R	R	R	R	R	R	***T8***	R
Tuesday	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	R	R
Wednesday	TR	TR	TR	TO	M	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	R	R
Thursday	TR	TR	TO	TR	TR	TR	TR	TR	TR	TR	TR	TC	TC	TR	TR	TR	TR	TR	TR	TR	TR	R	R
Friday	TR	TR	TO	TO	TR	TR	TR	TR	TR	TR	TR	TC	TR	TR	TR	TR	TR	TR	TR	TR	TR	R	R
Saturday	TR	TR	TO	TR	TR	TR	TR	M	TR	TR	TR	TC	TR	M	TR	TR	TR	TR	TR	TR	TR	R	R
Sunday	R	***T5***	R	***T6***	R	M	M	R	M	M	M	TC	R	TR	M	M	M	M	M	M	M	R	R

T- Measurement, C-Camp, TR- Training, TO-Tournament, M-Match, EC-European cup, TC- Turkey cup

The bioelectrical impedance analysis (BIA) is a frequently used method for the evaluation of body composi-tions due to its safety, speed, non-invasiveness, and relatively low cost (Özçetin et. Al., 2017). The assessment of body composition by BIA is based on the passage of a lowintensity (800 μA) and fixedfrequency (50kHz) electrical current through the body. When the electrical current is applied to the body, there is a resistance that opposes the current, called impedance. The drop in voltage between the electrodes provides a measurement of impedance. This is a vector sum of the resistance and conductance properties of body tissues, as well as a reactance (response) that arises from the resistance of cell membranes. Body water is a good conductor of electricity, and muscle clusters, like other tissues, are filled with electrolytes and water. Water offers little re-sistance to the passage of electrical current. Since body fat has a low hydration index, it has a high bioimpedance. Therefore, muscle conducts electricity more easily than fat, and the fat content can be calculated based on the difference between total weight, fatfree body mass, and fat mass (Sampei & Sigulem, 2009).

The Tanita (BC418) body composition analyzer was used to evaluate body composition. The measurement was conducted by an expert, and all measurements were supervised and performed by the sports science and medical team of the club. Athletes were instructed to avoid alcohol and caffeine for 24 hours before the test and to avoid food and fluids for at least four to five hours before the test. They were also instructed not to engage in any physical activity 12 hours before the test. Each measurement was taken at 10:00 in the morning. Athletes were divided into groups according to their playing positions (8 setters and 4

goalkeepers, 7 wings and 4 pivots). Seven measurements were evaluated, including weight, body fat percentage, fat mass, muscle mass, total body water, body mass index, and basal metabolic rate.

Statistical Analysis

The mean and standard deviation values of the weight, body fat percentage, fat mass, muscle mass, total body water, body mass index, and basal metabolic rate.variables were given according to the positions and repetition numbers of all players. The normality assumptions of the variables were examined using the Kolmogorov-Smirnov test. As the variables did not come from a normal distribution, the nonparametric Two-Way Friedman Test for repeated measures was performed.

The Wilcoxon test was used to determine which measurement caused the difference between positions. Statistical significance was set at $p < 0.05$ in all cases. All analyses were performed using IBM-SPSS 21 software.

Table 2. Body composition in handball players according to four playing positions at eight different points across the season (mean ± SD, n = 23)

7	T1	T2	T3	T4	T5	T6	T7	T8	Chi-Sq	*p* value
Weight (kg)										
All players	93.70 ± 10.92	93.71 ± 10.82	94.62 ± 10.66	94.68 ± 10.95	94.33 ± 10.74	94.92 ± 10.93	95.04 ± 10.45	95.04 ± 10.02	10.191	0.178
Goalkeeper	97.50 ± 11.88	97.05 ± 9.40	99.75 ± 5.30	97.95 ± 8.13	98.70 ± 8.20	101.15 ± 7.28	100.60 ± 7.50	100.20 ± 6.65	7.509	0.378
Playmaker	98.15 ± 7.55	97.58 ± 8.05	98.00 ± 8i31	99.10 ± 8.50	98.63 ± 8.90	98.60 ± 9.09	98.75 ± 9.23	98.53 ± 8.25	7.043	0.424
Wings	84.22 ± 7.81	84.58 ± 7.43	85.42 ± 8.82	85.24 ± 8.47	84.98 ± 8.13	85.06 ± 7.52	85.96 ± 7.87	86.48 ± 8.35	10.531	0.16
Pivot	104.70 ± 8.63	105.45 ± 11.24	105.70 ± 7.07	106.15 ± 7.71	104.75 ± 6.86	106.00 ± 6.65	104.75 ± 5.73	104.30 ± 6.08	4.939	0.667
Body fat Percentage (%)										
All players	14.95 ± 4.28	14.01 ± 4.16	14.78 ± 4.36	15.59 ± 3.8	15.38 ± 4.07	16.10 ± 4.14	16.01 ± 4.06	16.72 ± 3.75	27.53	**0.000***
Goalkeeper	19.20 ± 1.13	17.30 ± 0.14	19.60 ± 3.54	19.45 ± 1.06	19.80 ± 0.99	21.10 ± 1.41	21.50 ± 2.69	22.10 ± 3.25	11.275	0.127
Playmaker	14.53 ± 1.75	14.20 ± 1.91	14.08 ± 1.42	15.93 ± 1.07	15.58 ± 1.45	15.98 ± 1.20	15.43 ± 1.05	16.05 ± 1.00	8.413	0.298
Wings	11.98 ± 4.85	11.04 ± 5.07	11.70 ± 4.32	12.66 ± 4.33	12.12 ± 4.30	12.88 ± 4.26	12.86 ± 3.54	14.28 ± 3.74	13.95	**0.050***
Pivot	19.00 ± 1.13	17.75 ± 0.35	19.10 ± 1.27	18.40 ± 2.26	18.75 ± 1.48	19.40 ± 1.70	19.55 ± 0.64	18.80 ± 1.27	5.282	0.626
Body Fat Mass (kg)										
All players	14.28 ± 4.91	13.39 ± 4.65	14.24 ± 4.92	14.98 ± 4.33	14.79 ± 4.75	15.6 ± 4.96	15.47 ± 4.83	16.07 ± 4.36	30.04	**0.000***
Goalkeeper	18.65 ± 1.20	16.75 ± 1.48	19.45 ± 2.47	19.00 ± 0.57	19.50 ± 0.71	21.30 ± 0.14	21.55 ± 1.06	22.05 ± 1.77	11.048	0.137
Playmaker	14.30 ± 2.48	13.88 ± 2.39	13.80 ± 1.70	15.70 ± 0.86	15.45 ± 2.75	15.83 ± 2.41	15.30 ± 2.19	15.75 ± 0.73	9.839	0.198
Wings	10.26 ± 4.42	9.54 ± 4.57	10.14 ± 4.07	11.02 ± 4.16	10.46 ± 3.90	11.16 ± 4.02	11.18 ± 3.50	12.50 ± 3.75	15.737	**0.028***
Pivot	19.95 ± 2.76	18.70 ± 1.56	20.15 ± 0.07	19.45 ± 0.92	19.60 ± 0.28	20.55 ± 0.49	20.45 ± 0.49	19.65 ± 7.36	5.626	0.584
Muscle Mass (kg)										
All players	79.43 ± 7.53	80.33 ± 7.51	80.39 ± 7.75	79.71 ± 8	79.55 ± 7.3	79.34 ± 7.14	79.58 ± 7.22	78.98 ± 7.36	10.757	0.15
Goalkeeper	78.85 ± 10.68	80.30 ± 7.92	80.30 ± 7.78	78.95 ± 7.57	79.20 ± 7.50	79.85 ± 7.14	79.05 ± 8.56	78.15 ± 8.41	7.503	0.378
Playmaker	83.85 ± 5.67	83.73 ± 6.90	84.20 ± 7.53	83.40 ± 8.01	83.20 ± 6.18	82.78 ± 6.82	83.45 ± 7.26	82.78 ± 7.77	4.896	0.673
Wings	73.98 ± 6.14	75.04 ± 5.22	75.30 ± 7.03	74.24 ± 5.88	74.52 ± 6.60	73.92 ± 4.99	74.80 ± 6.07	74.00 ± 5.89	3.759	0.807
Pivot	84.80 ± 5.80	86.80 ± 9.62	85.60 ± 7.07	86.75 ± 8.70	85.15 ± 7.14	85.50 ± 7.21	84.30 ± 5.23	84.65 ± 3.61	2.19	0.949
Total Body Water										
All players	58.15 ± 5.52	58.81 ± 5.49	58.85 ± 5.67	58.35 ± 5.84	58.23 ± 5.35	58.08 ± 5.22	58.26 ± 5.28	57.82 ± 5.39	10.673	0.154
Goalkeeper	57.70 ± 7.78	58.80 ± 5.80	58.80 ± 5.66	57.80 ± 5.52	58.00 ± 5.52	58.50 ± 5.23	57.85 ± 6.29	57.25 ± 6.15	7.503	0.378
Playmaker	61.40 ± 4.17	61.28 ± 5.04	61.65 ± 5.49	61.05 ± 5.86	60.90 ± 4.54	60.58 ± 4.98	61.10 ± 5.31	60.60 ± 5.69	4.803	0.684
Wings	54.14 ± 4.49	54.94 ± 3.83	55.12 ± 5.16	54.36 ± 4.28	54.56 ± 4.86	54.12 ± 3.67	54.78 ± 4.45	54.16 ± 4.30	3.693	0.814
Pivot	62.10 ± 4.24	63.55 ± 7.00	62.65 ± 5.16	63.50 ± 6.36	62.30 ± 5.23	62.60 ± 5.23	61.70 ± 3.82	61.95 ± 2.62	2.506	0.927
Body Mass Index (kg/m^2)										
All players	26.04 ± 2.04	25.98 ± 2.08	26.18 ± 1.99	26.14 ± 1.98	26.09 ± 1.89	26.27 ± 2.06	26.28 ± 1.87	26.28 ± 1.81	7.276	0.4
Goalkeeper	27.20 ± 1.70	26.95 ± 1.20	27.75 ± 0.07	27.10 ± 0.99	27.50 ± 0.85	28.10 ± 0.57	27.95 ± 0.64	28.05 ± 0.21	8.383	0.3
Playmaker	26.40 ± 1.05	26.13 ± 1.14	26.28 ± 1.22	26.50 ± 1.15	26.38 ± 1.33	26.43 ± 1.39	26.40 ± 1.37	26.28 ± 1.07	7.27	0.401
Wings	24.52 ± 1.99	24.62 ± 1.98	24.78 ± 1.99	24.74 ± 2.08	24.66 ± 1.81	24.70 ± 1.85	25.02 ± 1.98	25.16 ± 2.01	13.041	0.071
Pivot	27.95 ± 2.47	28.15 ± 3.18	27.95 ± 2.47	27.95 ± 2.47	27.70 ± 1.98	28.05 ± 2.33	27.55 ± 1.91	27.35 ± 2.19	7.286	0.4
Basal Metabolic Rate										
All players	2364.4±241.9	2389.1±245.77	2394.6±249.11	2376.3±259.68	2368.4±237.51	2363.6 ± 235.3	2370.6±233.73	2353.6±236.68	11.001	0.139
Goalkeeper	2342.0±39.41	2377.0±257.39	2387.0±239.00	2343.0±241.83	2352.0±240.42	2379.0±227.69	2356.0±267.29	2328.0±260.22	7.503	0.378
Playmaker	2477.2±191.13	2472.0±227.46	2487.7±246.34	2470.2±260.03	2460.2±210.85	2449.0±229.29	2469.0±243.39	2450.2±251.85	4.902	0.672
Wings	2197.2±197.42	2226.6±170.44	2238.4±227.98	2208.0±194.49	2212.8±212.66	2192.4±165.90	2221.2±197.74	2200.2±194.32	4.394	0.733
Pivot	2579.5±193.04	2642.0±315.37	2607.0±224.86	2642.5±275.06	2590.5±225.57	2605.5±226.98	2562.0± 61.22	2569.5±116.67	3.564	0.828

T1: pre-season; T2: end of preparation period; T3: end of tournament and preparation match period; T4: end of first half; T5: end of second preparation period; T6: second half; T7: after Turkish cup at the end of second half; T8: end of season

RESULTS

The average values ± SD of the body composition (weight, body fat percentage, fat mass, muscle mass, total body water, body mass index, and basal metabolic rate) arranged according to all players and game positions for the eight applied measurements are shown in Table 2.

In the analysis, only differences were found in body fat percentage and body fat mass values between all athletes and wing players based on the eight measurements ($p<0.05$) (Figure 1, 2). Regardless of the positions, the body fat percentage and body fat mass of all athletes significantly decreased in T2 compared to T1. Compared to T2, an increase was observed in T4, T5, T6, T7, and T8. A decrease was observed in T5 compared to T4. In T6, an increase continued compared to T1, T2, T3, and T5, and in T7, it continued compared to T1 and T2. In T8, an

increase was observed again except for T6 and T7. Among the wing players, an increase was observed in T4 compared to T3, and a significant increase was observed in T2, T3, T5, and T7 compared to T8. Wing players had lower body fat percentage and body fat mass than all other game positions. Although it showed a decrease on average in T2 compared to T3, it was not significant. T4 showed an increase compared to T3. Similarly, in T8, it was significantly higher than T2, T3, T5, and T7. When evaluated both in all athletes and in positions, body fat percentage and body fat mass decreased significantly in the second measurement and increased significantly in the last measurement in wingers. However, in players playing in all positions, a decrease in body fat percentage, fat mass and body mass index was expected, and an increase in muscle mass, especially in the 2nd measurement and afterwards. Additionally, no significant changes were observed in weight, total body water, and basal metabolic rate measurements.

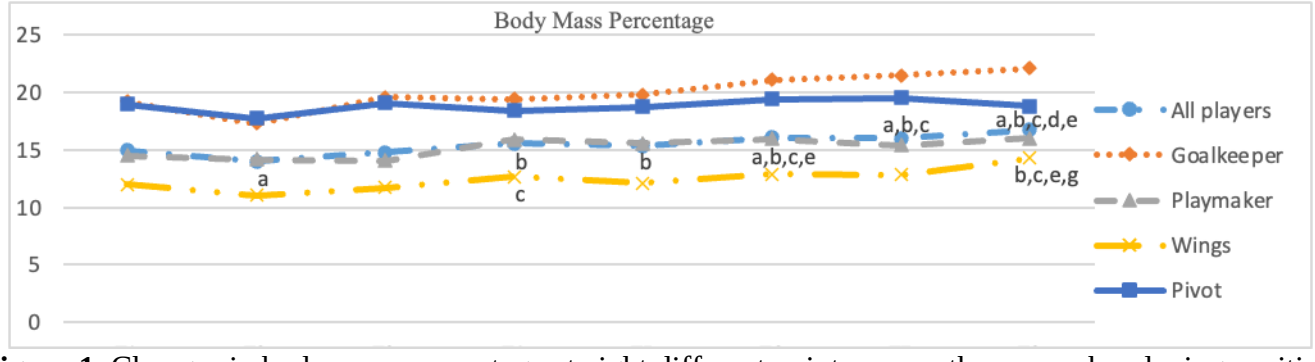

Figure 1. Changes in body mass percentage at eight different points across the season by playing position
[a] Significantly different from T1, [b] Significantly different from T2, [c] Significantly different from T3, [d] Significantly different from T4, [e] Significantly different from T5, [f] Significantly different from T6,[g] Significantly different from T7, [h] Significantly different from T8.

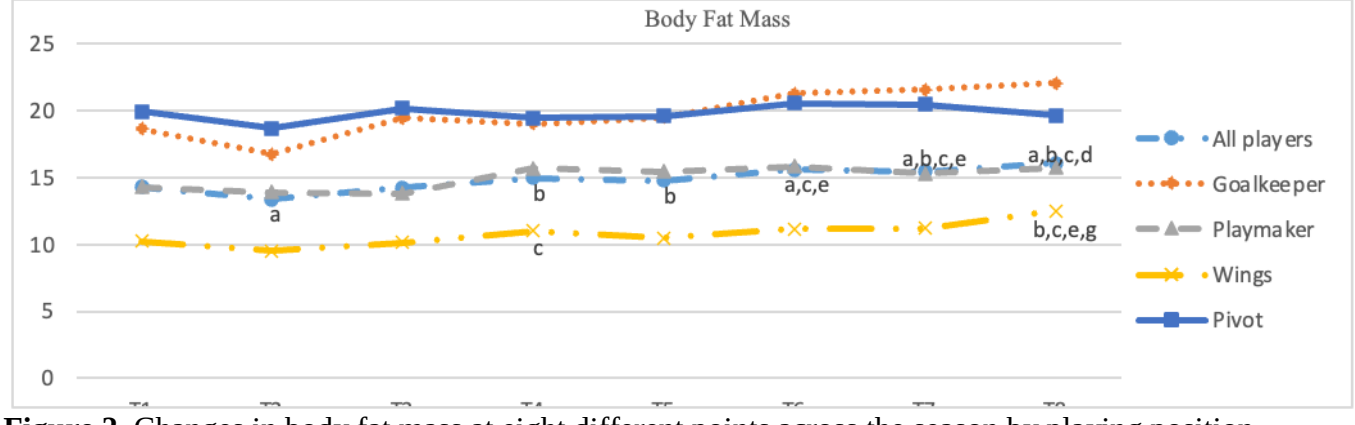

Figure 2. Changes in body fat mass at eight different points across the season by playing position
[a] Significantly different from T1, [b] Significantly different from T2, [c] Significantly different from T3, [d] Significantly different from T4, [e] Significantly different from T5, [f] Significantly different from T6,[g] Significantly different from T7, [h] Significantly different from T8.

DISCUSSION

The aim of this study was to examine changes in body composition of elite male handball players during preparation and competition periods (42 weeks). The main findings of these results are that during the preparation period before the season, all athletes experienced a significant decrease in body fat percentage and body fat mass. However, over the course of the season, a significant increase in body fat percentage and body fat mass was observed at several points, including T4, T5, T6, T7 y T8. It was also observed that wing players had lower body fat percentage and body fat mass than other playing positions. Finally, no significant changes were observed in weight, muscle mass, total body water, body mass index, and basal metabolic rate measurements.

As in the studies conducted by Owen et al. (2018), Lago Peñas et al. (2013) and Madic et al. (2018), it was found that there was a significant decrease in fat mass compared to preseason training start (T1) at T2 (Owen et.al., 2018; Lago-

Penas et. al., 2013; Madic et. al., 2018). The decrease in body fat percentage and fat mass at the end of the general preparation period indicates the result of the high level of aerobic, anaerobic and strength training applied during this period Reilly (1996). Although there was no significant difference in body fat percentage and fat mass at the end of the special preparation period for all players except for wing players playing in other positions, a decrease was observed in the averages. However, unlike the studies by Madic et al. (2018) and Ostojic (2003), in our study, the decrease in body mass percentage and fat mass did not continue after T2 with the competition period (Madic et. al., 2018; Ostojic, 2003). It was observed that there was an increase in body fat percentage and fat mass after T2, and this increase continued. This trend has been observed in other studies on team sport athletes Ostojic, (2003) and may be due to factors such as decreased training intensity and volume during the competitive season, increased travel, and changes in dietary habits.

In team sports, each game position has its own physiological characteristics due to different technical and tactical demands on the field. In handball, wing players have been measured to spend an average of 15 minutes more on the field than other players during the effective game time of 60 minutes. It has also been shown that wing players cover 1,200 meters more total distance than playmakers (2,882 m) or pivots (2,702 m), have two to three times more total sprint distance throughout the match, and have less body fat weight compared to players in other positions (Póvoas et. al., 2012; Büchel et. al., 2019; Mohoric et. al., 2022). Sibila et al. noted that goalkeepers and pivots generally have a higher height than wings, and pivots have more athleticism (more muscle mass) and a strong shot. Numerous studies have shown that wing players are fast, agile, and have a high jumping capacity with a low body mass index, and therefore generally have less weight and lower body fat percentage with the highest aerobic capacity (Schwesig et. al., 2017; Ghobadi et. al., 2013; Sporis et.al., 2010; Massuca et. al., 2015), while pivots are among the longest, heaviest, and slowest players Mohoric et. al., (2022), consisting of strong players constantly in contact and fighting with opponents (Sibila & Pori, 2009). These findings are in line with the results of our study, wing players had significantly lower body fat percentage and body fat mass compared to other positions, which is consistent with previous research on handball players (Martínez-Rodríguez et. al., 2020). This may be due to the specific physical demands of the wing position, which requires lighter and faster bodies to adcuire higher level of speed and capacity to change of movement rapidly (Bojić-Ćaćić et. al., 2018). Furthermore, no significant changes were observed in weight, muscle mass, total body water, body mass index, and basal metabolic rate measurements in all measurements. These findings are consistent with previous research on handball players after preseason training (Cichy et. al., 2020) and may indicate that changes in body composition during the season are primarily due to changes in body fat mass. However, there is limited distribution of body fat mass, there is not a sig-nificant change in most body composition parameters during the competition period (Milanese et. al., 2011).

It is important to note that the study was conducted on a single team and may not be representative of other teams or sports. Additionally, the study only measured body composition and did not take into account other factors that may have contributed to changes in performance, such as changes in strength, power, and sprint. Further research is needed to better understand the relationship between changes in body composition and changes in performance in handball.

As a result, unexpected results were obtained in our study, except for T2. An increase in body fat percentage and fat mass was observed during the competition period, and this increase continued. The increase in fat mass during the competition period could be attributed to the different training content and higher training intensity during the preparation period, changes in nutrition habits due to camps, long trips, and tournaments, as well as the effects of fatigue and stress. Further research is needed on these issues.

Examining body composition is important in sports such as handball, where body weight needs to be moved against gravity. In this study, norms were established for the body composition status of elite male handball players during the preparation and competition periods, and changes in specific periods were monitored. It was observed that handball players improved their body composition during the preparation period.

The increase in body fat percentage and fat mass during the competition process and at the end of the season showed that the transition period after the season should be well evaluated.

Conflict of interest

No conflict of interest is declared by the authors. In addition, no financial support wasreceived.

Ethics Statements

This study followed ethical standards and received approval from the Zonguldak Bülen Ecevit University Non-invasive Clinical Research Ethics Committee, reference number (no: 2023/01, date 11.01.2023).

Author Contributions

Study Design, Data Collection, Statistical Analysis, Data Interpretation, Article Preparation, Literature Review processes were carried out by the Author. The author has read and accepted the published version of the article.

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