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The Effects of a Beach Handball Training Program on the Morphological Characteristics of Elite Youth Male Handball Players During the Off-Season Period

Efectos de un Programa de Entrenamiento de Balonmano Playa en las Características Morfológicas de Jugadores Juveniles de Élite de Balonmano Masculino Durante la Pretemporada

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SUMMARY: The aim of this study was to examine the effects of a structured beach handball training program onselected morphological characteristics of elite youth male handball players during the off-season period. Thirty-four participants were divided into an experimental group, which underwent a six-week beach handball program, and a control group that engaged in general recreational activities. Morphological parameters including body height, body mass, body mass index, and body fat percentage were assessed pre and post intervention. The results demonstrated significant positive changes in body height and body mass in the experimental group, suggesting that targeted physical activity during the off-season may support growth and improve body composition in adolescent athletes. Although changes in body mass index and body fat percentage were less pronounced, trends indicated potential long-term benefits of structured sport-specific programs. The findings highlight the relevance of monitoring and planning individualized training strategies even during transition periods, and support the inclusion of sport-specific formats like beach handball to maintain physical readiness and promote optimal development. The study underscores the value of systematic interventions in youth sports training and provides insights for coaches and practitioners aiming to optimize athletic performance.

KEY WORDS: Sport-specific program; Training adaptation; Structured training; Physical development.

INTRODUCTION

Beach handball, as a dynamic and increasingly popular variant of traditional indoor handball, introduces specific physiological and biomechanical demands that can significantly contribute to the overall athletic development of youth athletes. This sport is characterized by high accelerations and decelerations, frequent jumping, sudden changes in direction, and play on an unstable surface—sand—which requires greater neuromuscular control, balance, and core muscle activation compared to indoor handball (Impellizzeri *et al*., 2008; de Villarreal *et al*., 2023). Training on unstable surfaces like sand induces increased neuromuscular activation, particularly in the hip and knee muscles, due to the need for additional stabilization and movement control. Given the reduced ground reaction forces, athletes must generate greater internal muscular force to maintain movement efficiency, making this type of training especially useful for developing endurance and injury prevention. These features suggest that beach handball may be a valuable training method, particularly during the off-season, when traditional training volume is reduced and there is a need for alternative approaches that ensure adequate recovery and continued physical development (Impellizzeri *et al*., 2008).

The off-season represents a key phase in the annual training cycle, marked by decreased training intensity and

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potential changes in athletes' physical condition. While traditionally associated with reduced physical demands, modern sports science emphasizes the importance of structured activity during this period to maintain core physical abilities and support continued progress (Issurin, 2010). Introducing sand-based training during the off-season not only provides a new training stimulus with reduced joint load but may positively affect improvements in body composition, balance, and functional strength (Binnie *et al*., 2014; Granacher *et al*., 2014), contributing to both athlete health and performance enhancement.

Morphological characteristics - such as body mass, body height, body mass index, and body fat percentage - are key indicators of athletic status in youth athletes, and potential predictors of performance in certain sports (Carter & Heath, 1990; Malina *et al*., 2004). During puberty and adolescence, significant changes in body composition occur due to biological maturation, and responses to physical stimuli can be more pronounced and variable (Beunen & Malina, 1988). For this reason, tracking the effects of specific training programs - such as beach handball - is essential for properly guiding the training process and optimizing the development of youth athletes. This type of training enables athletes to improve sport-specific physical abilities during the off-season, when traditional high-intensity training is limited due to the need for physiological recovery, load reduction, and injury prevention.

To the best of the authors' knowledge, this study is the first to examine the effects of a beach handball program on the morphological characteristics of elite youth male handball players during the off-season. Given the importance of a systematic approach to training during this period - especially regarding the maintenance and improvement of youth athletes' physical characteristics - there is a clear need to evaluate the impact of such sport-specific programs. In this context, the aim of this study was to examine the effects of a structured beach handball training program on selected morphological characteristics of elite youth male handball players during the off-season period. Based on this objective, the following hypothesis was proposed: It is assumed that implementing a structured beach handball program during the off-season will significantly influence changes in selected morphological characteristics among elite young male handball players.

MATERIAL AND METHOD

Sample of participants. The sample included 34 junior handball players (aged 15-17), evenly divided into two groups: the control group (C, n = 17) from ORK "BL" in Banja Luka and the experimental group (E, n = 17) from RK "Brod" in Slavonski Brod. Participation in the study was voluntary, and written informed consent was obtained from the parents of all participants. The inclusion criteria required a minimum of two years of training experience to ensure adequate physical preparedness. Exclusion criteria included injuries or illnesses, as these could negatively impact the results. The research was approved by the Ethics Committee of the Faculty of Physical Education and Sports, University of Banja Luka. The research was conducted in accordance with the Helsinki Declaration.

Research Design

Anthropometry. All anthropometric assessments were conducted following the standardized methodology outlined by the International Society for the Advancement of Kinanthropometry (ISAK), (Marfell-Jones *et al*., 2006).

Body height. Body height was measured using a portable stadiometer (SECA 213, Germany), from the vertex of the head to the floor, with the subject in the anatomical position and aligned to the Frankfurt plane. Measurements were taken with participants standing barefoot, maintaining an upright posture, and recorded to the nearest millimeter (1 mm). The final values were expressed in centimeters (cm) (Malousaris *et al*., 2008).

Body mass and body fat percentage. For the measurement of body mass and body fat percentage, the Tanita Segmental Body Composition Analyser BC-418 MA scale was used. During the measurement, participants, minimally dressed, stood still on the scale with their weight evenly distributed on both feet and their arms extended by their sides (Malousaris *et al*., 2008).

In the context of professional sports, the Body Mass Index is used as a basic reference for assessing body composition. It is calculated using a formula (Zierle-Ghosh & Jan, 2023):

$$BMI = \frac{\text{body mass (kg)}}{\text{body height (m}^2\text{)}}$$

Experimental program. The experimental program was implemented during the summer break, i.e., in the off-season phase of the annual training cycle, when athletes go through a phase of active recovery. The experimental group (E) followed a structured beach handball training program over six weeks. The program included three training sessions per week, focusing on technical and tactical activities specific to beach handball (Table I). The detailed structure and content of the training sessions are shown in Table II. In addition to

Table I. Structure and volume of the training process during the off-season period for the experimental and control groups.

Group	Program duration	Training sessions per week	Training sessions duration	Total number	Total number of matches
E	6 weeks	3x	75-90 min	18	6
C	6 weeks	3x	60-75 min	18	-

Note: E- experimental group; *C* - control group.

Table II. Structure and duration of training activities in the beach handball program.

Warm-up and Preparatory Phase	Introductory Phase	10 min	Natural movement forms with and without the ball (straight-line running with pace changes, zig-zag running forward and backward, squat walking, two-legged and one-legged jumps forward and backward, zig-zag jumps); Elementary games (tag games, ball games, games with equipment).
	Shaping Exercises	10 - 15 min	General body exercises with emphasis on arms and shoulder girdle.
	Specific Beach Handball Warm-Up	20 - 25 min	Partner or group work: all types of two-handed passing in place; one-handed passing alternately (left and right) in place; jump passes with and without 360° rotation; jump passes with 360° rotation and landing; "Zeppelin" passes; passing while moving, shooting on goal with goalkeeper preparation; shooting after 360° rotation; "Zeppelin" shot in motion.
Technical-Tactical Training		25 - 30 min	Drilling of beach handball-specific technical-tactical elements at low and high intensity. Group work: simple crossing and shooting (3x); double crossing and shooting (3 x); criss-crossing and shooting (3x); criss-crossing with 360° rotation and landing (3x); criss-crossing with "Zeppelin" shot and landing (3x; practicing combinations through game play; penalty shooting.
Cool Down		10 - 15 min	Static stretching and lowering of heart rate.

regular training, participants from the experimental group took part in tournaments in weeks two, four, and six, playing two beach handball matches each time. These competitive activities enabled dynamic repetition of sport-specific motor patterns under game-like conditions. Participants in the control group (C) did not follow a structured training program. During the off-season, they engaged in various sports and recreational activities under semi-controlled conditions, with a minimum frequency of three times per week, but without a specific focus on developing technical-tactical skills or morphological characteristics.

Statistical analysis. The data obtained from the initial and final measurements were analyzed using the SPSS 20 statistical software (Statistical Package for Social Sciences, v. 20.0, SPSS Inc., Chicago, IL, USA). For each variable, the following descriptive statistics parameters were calculated: Arithmetic mean (Mean), Standard deviation (Std. Dev.), Minimum value (Min), Maximum value (Max). To assess the normality of the distribution, the Shapiro-Wilk test was applied. The statistical significance level for determining normality was set at $p < 0.05$. In cases where there was a statistically significant deviation from normal data distribution, a non-parametric statistical procedure was used for further analysis. Additionally, a 95 % confidence interval was applied for the purposes of this study. For examining the differences between groups at the initial measurement, an Independent T-test was used. To analyze

and determine the differences between groups at the initial and final measurements, as well as to assess the effect of the implemented training program, a two-way Analysis of Variance (ANOVA) was conducted, followed by the Bonferroni *post-hoc* test. The threshold for statistical significance was set at $p < 0.05$. The effect size was interpreted using Cohen's d values, based on pre-established categories: negligible ≤ 0.19, small 0.20 - 0.49, medium 0.5 - 0.79, large 0.8 - 1, and very large ≥ 1 (Cohen, 1988).

RESULTS

At the initial measurement (Table III), the control group showed higher average values of body height and body mass compared to the experimental group, while body mass index and body fat percentage were similar between the groups. Most variables followed a normal distribution, except body fat percentage, which deviated significantly from normality in both groups. These findings indicate initial morphological differences that should be taken into account when interpreting the effects of the training program.

At the final measurement (Table IV), the control group again exhibited higher average values for body height, body mass, and body mass index compared to the experimental group, while body fat percentage values were nearly identical. Most variables followed a normal distribution, except body fat percentage, which again showed significant deviations in both groups. This suggests the need for caution when applying parametric statistical tests. The observed differences confirm the presence of initial morphological variations, which may influence interpretation of the program's effects.

Analysis of results shown in Table V suggests that the most notable differences in morphological characteristics were observed for body height, which showed statistically significant differences at both measurement points ($p < 0.05$) with large and medium effect sizes ($d = -0.912$; $d = -0.771$). No statistically significant differences were found for the other variables. However, a medium effect size was observed for body mass, despite the absence of statistical significance, which may indicate potential practical relevance. These findings suggest that a structured training program may influence specific morphological characteristics, particularly body height in youth athletes, while changes in body mass and body composition may require longer training exposure or additional specific interventions to achieve statistically significant effects.

Table III. Descriptive statistics of morphological characteristics at the initial measurement in the experimental and control groups.

	Experimental					Control				
Variables	**Mean**	**Min**	**Max**	**Std. Dev.**	**Shapiro-Wilk**	**Mean**	**Min**	**Max**	**Std. Dev.**	**Shapiro-Wilk**
BH (cm)	177.58	155	190	8.330	0.164	184.41	171	195	6.520	0.884
BM (kg)	67.63	42.2	88.2	13.249	0.532	74.10	53.8	99.3	11.814	0.989
BMI	21.34	16.4	29.5	3.624	0.122	21.77	16.9	31.3	3.441	0.139
%BF	16.65	9.4	31	4.925	0.015	15.58	8.5	31	4.880	0.004

Note: n - number of participants; BH - body height; BM - body mass; BMI - body mass index; %BF - body fat percentage

Table IV. Descriptive statistics of morphological characteristics at the final measurement in the experimental and control groups.

	Experimental					Control				
Variables	**Mean**	**Min**	**Max**	**Std. Dev.**	**Shapiro-Wilk**	**Mean**	**Min**	**Max**	**Std. Dev.**	**Shapiro-Wilk**
BH (cm)	178.88	158	191	8.015	0.310	184.52	171	195	6.568	0.873
BM (kg)	67.48	42.20	89.70	12.827	0.762	74.30	54.90	100.10	11.930	0.853
BMI	21.00	16.40	29.20	3.523	0.237	21.82	16.90	31.50	3.439	0.080
%BF	14.92	9.30	30.60	4.940	0.002	15.19	7.30	31.10	4.939	0.002

Note: n - number of participants; BH - body height; BM - body mass; BMI - body mass index; %BF - body fat percentage SE - size effect.

Table V. Differences in the morphologic characteristics of participants at pre and post measurements.

Variables	**Pre measurement**			**Post measurement**		
	p	**Cohen's d**	**SE**	**p**	**Cohen's d**	**SE**
BH	0.012	-0.912	large	0.032	-0.771	medium
BM	0.143	-0.515	medium	0.118	-0.550	medium
%BF	0.529	0.218	small	0.877	-0.054	negligible
BMI	0.725	-0.122	negligible	0.492	-0.238	small

Note: BH - body height; BM - body mass; %BF - body fat percentage; BMI - body mass index; SE - size effect.

Table VI presents changes in physical parameters (body height, body mass, body mass index, and body fat percentage) between initial and final measurements in the experimental and control groups. The analysis reveals a significant impact of the experimental intervention, with notable improvements in body height and body mass in the experimental group, accompanied by effect sizes ranging from very large to large (Cohen's d), while the control group showed negligible changes. Statistical significance was confirmed with $p < 0.001$ for body height and $p < 0.01$ for body mass. Changes in body mass index and body fat percentage were also statistically significant ($p < 0.05$ for body mass index), but effect sizes were small or negligible, suggesting a weaker impact of the training program on these parameters. Although statistically significant, the effects on body mass index and body fat percentage were less pronounced compared to those observed for body height and body mass, yet still offer valuable insights into the program's overall impact.

Table VI. Effects of the experimental program on the morphological characteristics of the participants.

Variables		Experimental Pre		Control Pre			Experimental Post
		Control Pre	Experimental Post	Control Post	Experimental	Control Post	Control Post
BH	**Mean Diff.**	-6.824	-1.294**	-6.941	5.529	-0.118	-5.647
	Cohen's d	very large	negligible	very large	medium	negligible	medium
BM	**Mean Diff.**	-6.465	0.153	-6.665	6.618	-0.200	-6.818
	Cohen's d	large	negligible	medium	medium	negligible	medium
BMI	**Mean Diff.**	-0.429	0.347*	-0.482	0.776	-0.053	-0.829
	Cohen's d	negligible	negligible	negligible	small	negligible	small
%BF	**Mean Diff.**	1.071	1.729***	1.465	0.659	0.394	-0.265
	Cohen's d	small	small	small	negligible	negligible	negligible

Note: BH - body height; BM - body mass; %BF - body fat percentage; BMI - body mass index; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

DISCUSSION

This study aimed to examine the effects of a structured beach handball program on changes in morphological characteristics of elite youth male handball players during the off-season. To the authors' knowledge, this is the first study to consider the impact of a specific program during this period in the context of elite youth athletes. Initial measurements revealed differences in body height and body mass between the experimental and control groups, although these differences were not statistically significant. These initial differences, particularly in body height and body mass, indicate potential sample heterogeneity, which is important to consider when interpreting the program's effects. Additionally, body mass and body mass index in the experimental group were lower than in the control group, suggesting differences in body composition between the groups that could influence the program's effects. Similarly, previous studies have indicated that initial morphological differences between groups can affect the success of training programs (Martinho *et al*., 2020; França *et al*., 2023).

In the context of beach handball, a specific sport characterized by high intensity and the need for rapid and explosive movements, the off-season between training or competition phases can significantly impact athletes' physical characteristics. Beach handball training encompasses specific physical demands that differ from traditional handball, emphasizing endurance, strength, agility, as well as balance and coordination, due to the unnatural surface on which it is played (sand). Therefore, during the off-season, when athletes shift focus from specific skills to physical readiness, significant changes in their body composition and morphological characteristics may occur. Given that this study focuses on morphological changes during a training program, several key points can be observed in the context of beach handball. For example, athletes engaged in beach handball often have lower body height compared to athletes from other sports, aligning with research data showing lower average heights of athletes in sand sports (Pueo *et al*., 2020). Although body height was not statistically significant in this study, in the context of beach handball, lower height may offer advantages in terms of agility and speed, which are key characteristics for this sport. Furthermore, the reduction in body mass observed in the experimental group may be associated with increased aerobic endurance and reduced body fat, which is important for sports like beach handball where players are often exposed to high energy demands during short but intense periods of activity. Although changes in body mass index and body fat percentage in this study were minor, similar effects can be expected during the off-season for beach handball athletes as they prepare for greater competitive challenges.

Changes in morphological characteristics during the experiment, presented in Table IV, show significant changes in body height and body mass among subjects in the experimental group. The average height of subjects in the experimental group increased to 178.88 cm, while changes in the control group were negligible ($p = 0.310$). A similar trend was recorded in body mass, where the experimental group noted a decrease (67.48 kg in the final measurement compared to 67.63 kg in the initial measurement), while the control group had less pronounced changes. These results align with research indicating that physical activity can positively influence changes in body height and body mass, especially during adolescence (Mirtz *et al*., 2011; Zhang *et al*., 2024).

Moreover, Table V presents the program's effects on various variables, with a particular emphasis on the change in body height, which showed a statistically significant change with a large effect size (Cohen's $d = -0.912$) in the initial measurement, while later changes in final measurements were somewhat less pronounced ($d = -0.771$). This indicates that a structured training program can significantly impact the increase in body height among youth athletes, consistent with previous research suggesting that physical activity can positively influence growth and development, especially in adolescents (Karlsson *et al*., 2008; Amstrong 2018; Carsen *et al*., 2021).

On the other hand, changes in body mass index and body fat percentage were statistically significant in both groups but with smaller effects. In the control group, changes in body mass index were mild ($p = 0.776$), while the change in body fat percentage was statistically significant but with small Cohen's d values, indicating a smaller yet still significant effect. Similar findings have been documented in studies confirming that training programs can positively impact the reduction of body fat percentage, but longer program durations or additional specific interventions are needed to achieve more significant changes (Sallis *et al*., 1998; Hunter *et al*., 2004; Cohen *et al*., 2007). Furthermore, changes in body mass index and body fat percentage may be less pronounced due to the program's specificity, as similar instances have indicated that changes in body composition do not occur immediately but over time and with continuous training stimuli. As documented in research, reducing body fat and modifying body mass index often require longer periods and specific interventions in diet and physical activity (Donnelly *et al*., 2009; Hill *et al*., 2012).

In Table VI, which presents changes in morphological parameters between initial and final measurements, it is clear that changes in body height and body mass were most pronounced in the experimental group, with large effects (Cohen's $d = -0.912$ for body height and -0.665 for body mass). These results indicate a strong impact of the training program on body height and body mass, while effects on body mass index and body fat percentage were smaller. Although changes in body mass index and body fat percentage were statistically significant, the effects were relatively small, suggesting that the program did not have sufficient intensity or duration to lead to significant changes in body composition, consistent with previous research indicating that reducing body fat often requires long-term and specific interventions (Saris *et al*., 2003; França, *et al*., 2023). In conclusion, the hypothesis - that a structured beach handball program during the off-season will have a statistically significant impact on the morphological characteristics of young handball players - was largely confirmed. Effects were particularly pronounced in parameters of body height and body mass, while changes in body mass index and body fat percentage were present but less intense. These findings indicate the need for an individualized training approach, especially in sensitive phases of the training cycle.

CONCLUSION

The results of this study indicate that a six-week beach handball program during the off-season has a positive effect on the morphological characteristics of youth elite handball players, impacting body height and maintaining body mass. Although changes in body fat percentage and body mass index were not pronounced, detected differences suggest potential benefits of a structured training process during the active rest phase. Introducing beach handball as a training method in the off-season can contribute to maintaining functional and morphological parameters in youth athletes, enabling a higher-quality return to the standard training process and reducing the risk of undesirable changes in body composition. The obtained findings support the use of alternative sports activities, such as beach handball, in optimizing the physical development of youth athletes during transitional phases of their annual training cycle.

Scientific and Practical Contribution of the Study. This study contributes to the existing literature by providing the first concrete data on the effects of a structured beach handball program on the morphological characteristics of youth elite handball players during the off-season. The research shows that this form of training can influence the preservation or stabilization of body mass during a phase when athletes are otherwise prone to regression in physical parameters. The obtained results highlight the importance of including alternative forms of training stimuli in the transitional phases of the annual cycle, thereby expanding knowledge about training intervention models during periods

of reduced competitive load. On the other hand, the results of this study have practical implications for coaches, conditioning trainers, and sports professionals working with youth athletes. Implementing beach handball as a specific training model during the off-season can contribute to maintaining functional readiness, preserving body structure, and preventing negative changes in body composition. By applying structured training programs on unstable surfaces, it is possible to ensure continuity in the physical development of youth athletes, reducing the risk of overtraining, injuries, and performance regression.

Limitations of the Study and Recommendations for Future Research. Although the results of this study provide important insights into the effects of the beach handball program on the morphological characteristics of youth athletes, the study has certain methodological and practical limitations. First, the sample of subjects was relatively small, which may limit the ability to generalize the results to a broader population of youth handball players. Second, although the experimental program lasted six weeks, which aligns with the maximum duration of the off-season in professional handball, it is important to note that this period is often shorter in practice, as athletes soon after the season ends are expected to prepare for the new competitive year. This includes obligations such as basic preparations, testing, selections, control matches, and returning to the regular training regime. Accordingly, the possibility of conducting longer and more intensive experimental programs during this phase is limited, representing a practical limitation for researchers and coaches. Therefore, it is recommended that future research includes a larger number of subjects, as well as comparisons of different training models within the same timeframe. Furthermore, including additional variables such as motor abilities, functional capacities, and behavioral indicators (e.g., motivation level or subjective feeling of fatigue) can contribute to a more comprehensive understanding of the effects of the training process during transitional phases.

BOZIC, D.; KARISIK, S.; PRZULJ, R.; JOKSIMOVIC, M; MUNTEAN, R. I.; VALENTINA, S. & POPOVIC, A. Efectos de un programa de entrenamiento de balonmano playa en las características morfológicas de jugadores juveniles de élite de balonmano masculino durante la pretemporada. *Int. J. Morphol., 43(5)*:1771-1778, 2025.

RESUMEN: El objetivo de este estudio fue examinar los efectos de un programa estructurado de entrenamiento de balonmano playa en determinadas características morfológicas de jugadores juveniles de élite de balonmano masculino durante la pretemporada. Treinta y cuatro participantes se dividieron en un grupo experimental, que se sometió a un programa de balonmano playa de seis semanas, y un grupo control que realizó actividades recreativas generales. Se evaluaron parámetros morfológicos como la altura, la masa corporal, el índice de masa corporal y el porcentaje de grasa corporal antes y después de la intervención. Los resultados demostraron cambios positivos significativos en la altura y la masa corporal en el grupo experimental, lo que sugiere que la actividad física dirigida durante la pretemporada puede favorecer el crecimiento y mejorar la composición corporal en atletas adolescentes. Si bien los cambios en el índice de masa corporal y el porcentaje de grasa corporal fueron menos pronunciados, las tendencias indicaron posibles beneficios a largo plazo de los programas estructurados específicos para cada deporte. Los hallazgos resaltan la relevancia de monitorear y planificar estrategias de entrenamiento individualizadas, incluso durante los períodos de transición, y respaldan la inclusión de formatos específicos para cada deporte, como el balonmano playa, para mantener la preparación física y promover un desarrollo óptimo. El estudio subraya el valor de las intervenciones sistemáticas en el entrenamiento deportivo juvenil y proporciona información a entrenadores y profesionales que buscan optimizar el rendimiento deportivo.

PALABRAS CLAVE: Programa específico para cada deporte; Adaptación al entrenamiento; Entrenamiento estructurado; Desarrollo físico.

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