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Anthropometric Profile and Body Composition of the Mexican Olympic Beach Volleyball Team

Perfil Antropométrico y Composición Corporal de la Selección Olímpica Mexicana de Voleibol de Playa

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SUMMARY: The present research corresponds to a cross-sectional descriptive study in the anthropometric field, which allows coaches to develop standards to identify talent and optimize training in the discipline of beach volleyball. Its objective was to define the anthropometric profile and body composition of the Mexican Olympic beach volleyball teams in both sexes. The participants were couples one and two of Mexico in both sexes (defined by FIVB ranking), 4 women and 4 men with average age of 30.25±6.85 and 27.25±7.36 years. The technique used was Heath-Carter´s somatotype method and the anthropometric profile restricted ISAK protocol. Among the findings resulting from the research, unification can be observed in the male morphological characteristics (triceps skinfold, front thigh skinfold, calf skinfold, circumference of relaxed and contracted arm, waist, hip, femur diameter and BMI), as for the somatotype, both sexes of Mexican couples are positioned in mesomorphs-balanced. In relation to other studies consulted, balance in somatotype and muscular development is observed with high performance teams. Weight and height, as well as age, are important variables for the selection of talent and future optimal performance in world and professional volleyball.

KEY WORDS: Somatotypes; Body composition; Anthropometric; Beach volleyball.

INTRODUCTION

Beach volleyball is a sport of cooperation-opposition (Hernández Moreno & Ribas, 2004) whose variations in the internal logic of the game compared to indoor volleyball are notorious; it is practiced on a sand court (instability and deformity of the surface), a smaller number of specialized players (blocker and defender), court dimensions, with a good number of gestural codes, motion communication and counter-communication, as well as techniques and strategies (Fédération Internationale de Volleyball, 2021a). Physically it is demanding, with 50-minute matches and defensive and offensive actions with short and explosive execution times of 3 to 4 seconds (anaerobic) (Pérez, 2021). Therefore, technical gestures such as jumping take a relevant role (Bosco & Rusko, 1983; Billington, 2012; Pezoa Fuentes, 2018; Nasuka, 2019), blocking (Bardales, 2014) and serving and of the temporal variables of the game related to essential aspects such as biodynamics and tactics (Clavijo-Redondo *et al*., 2016; Pérez-Turpin *et al*., 2019; Petrovici & Kovacs, 2021); because of the above, athletes should be in optimal physical and technical-tactical conditions to cope with the demands required by the sport (Pérez, 2021).

Body analysis and control is essential for training and performance development (López *et al*., 2019), therefore, such controls should be developed from anthropometric and body composition analysis as fundamental elements to follow-up and adjust training (Lentini *et al*., 2006). Such analysis is important because it helps to define the morphological features of athletes (Barajas *et al*., 2021), providing information not only of the physical conditions but also of their potential performance in relation to the function they have during the game (Pérez-Turpin *et al*.,

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2019; Gualdi & Zaccagni, 2001), in this sense, a characteristic morphological feature of the beach and indoor volleyball player of high competition is the height (D´Anastasio *et al*., 2019), as well as the lengths of upper and lower limbs, i.e., a tall player with elongated limbs, has a greater chance of success due to its ease to perform serves, spikes and blocks (Nasuka, 2019), jumping and block jump reach is influenced by arms and legs length, so absolute height contributes significantly to the percentage of total variance associated with athletic success (De Farias *et al*., 2016). It should also be considered that anthropometric data allow coaches to create normative standards for sports level, identify talents and design to optimize sports performance (Sánchez Muñoz *et al*., 2020).

In view of the above, research has been carried out in Mexico on youth indoor volleyball teams, as well as on the senior national indoor volleyball team (Lentini *et al*., 2006), however, there are no data on the anthropometric profile and body composition of the national beach volleyball team, only an analysis of the competitive activity in the 2019 Pan American Games (Pérez-Turpin *et al*., 2019) was found, in which an average lower height than their competitors is reported, highlighting the importance of the technical gesture of the ball setting for the spike and the anaerobic and aerobic power to achieve the requirements of the Pan American competition.

The objective of this research was to define the anthropometric profile and body composition of the Mexican men's and women's beach senior volleyball team.

MATERIAL AND METHOD

The research was a cross-sectional descriptive study (Morales, 2012). The sample population consisted of 4 players from the Mexican Senior Men's and 4 players from the Mexican Senior Women's Beach Volleyball National Teams (Olympic cycle Tokyo 2021); with an average age of 30.25±6.85 years and 27.25±7.36 years for the second ones, to whom the Heath-Carter´s somatotype method was applied (Carter & Health, 1990), tri-compartmental morpho-structure was divided into muscle mass, bone mass and body fat. The skinfolds measurement technique was used under the restricted profile protocol and the Rosscrarf SRL anthropometric kit, validated by the International Society for the Advancement of Kinanthropometry (ISAK). The data were collected by ISAK Level I and II certified professionals under normal temperature conditions, in the morning and after urinary voiding. The above prior Helsinki´s Declaration agreement in which players and technical staff were informed about protocol's intakes, implications, and side effects (Manzini, 2000) and the Mexican Official Standard NOM-012-SSA3-2012, which establishes the criteria for the implementation of research projects for human health (DOF, 2017).

The values were obtained during the qualification phase for the Tokyo 2021 Olympic Games, organized by the North, Central America and Caribbean Volleyball Confederation (NORCECA) to grant the last ticket in the Continental Cup Finals Tokyo Beach Volleyball Qualification 2021 -held in Colima, Mexico- where 6 countries participated, in male and female, four couples per sex making a total of 24 teams; so, considering the time of intervention, the Mexican teams in both sexes were at their maximum performance. It is worth mentioning that couple number two of the Mexican men´s team qualified for the Olympics (the youngest and the one with the shortest time in the world tour). Data were recorded on the manual collection form and subsequently entered into specialized computer programs to use the statistical techniques of means and standard deviation to describe the population and the Mann-Whitney U test to identify differences between groups using the SPSS Statistics version 22 package.

RESULTS

The Mexican teams in the descriptive data have an average age of 28.75±6.77, with the male couples being the oldest. In terms of height, the overall average ranged between 182.44±8.36 cm, with the female having a lower height and BMI than the males (Table I).

In terms of skinfolds, circumferences and diameters, statistical differences were observed in 7 parameters between male and female couples (Table II). In the case of calf, thigh, relaxed and contracted arm, larger diameters, and circumferences were observed in males.

In the case of weight, % fat, % muscle mass and % bone mass descriptions, similarity was observed in the data of the two male couples in terms of overall composition. In the female case, percentage differences are observed between couple 1 and couple 2, derived from the time spent training in the Olympic cycle (Table III).

Regarding the description of the somatotype of the Mexican beach volleyball couples, in the nominal scale the female couples coincide in a mesomorph-balanced profile, the opposite case in the male couples, in which the presence of meso-endomorph and mesomorph-balanced profiles is observed (Table IV).

Table I. Descriptive data on weight, height and BMI (x±sd) of the Mexican men´s and women´s beach volleyball teams.

N=4		Men		
	Age	Weight (kg)	Height (cm)	BMI
OC*	24.50±0.70	95.80±12.58	187.25±10.25	27.25±0.60
C2	36.00±2.82	95.62±3.92	188.50±8.48	26.98±1.37
OA[a]	30.25±6.85	95.71±7.61	187.88±7.71	27.11±0.88
p value[a]	0.121	1.000	0.683	1.000
N=4		Women		
	Age	Weight (kg)	Height (cm)	BMI
C1	21.00±1.41	70.50±5.65	174.50±4.95	23.10±0.56
C2	33.50±2.12	74.15±2.05	179.50±4.95	23.05±1.90
OA[a]	27.25±7.36	72.32±4.06	177.00±4.96	23.07±1.15
p value[a]	0.121	0.439	0.439	1.000
OA[b]	28.75±6.77	84.01±13.71	182.44±8.36	25.09±2.35
p value[b]	0.386	0.021*	0.081	0.021*

OC*= Olympic Couple, C1= Couple one, C2= Couple two, N= Number of subjects, OAa= Overall Average intra-couple, OAb= Overall Average between sexes, p valuea = U de Mann-Whitney intra-couples, p valueb = U de Mann-Whitney between sexes.

Table II. Descriptive data of skinfolds, circumferences and diameters (x±sd) of the Mexican men´s and women´s beach volleyball teams.

	Averages		Men OC *vs* C2		Women C1 *vs* C2		Between sexes	
Parameter	Men	Women	*OA[a]*	P valor[a]	*OA[b]*	P value[b]	*OA[c]*	p value[c]
P. Triceps (mm)	6.37±1.70	11.25±4.33	6.37±1.70	0.439	11.25±4.33	0.121	8.81±4.00	0.059*
P. Subescapular (mm)	11.50±1.91	9.25±1.50	11.50±1.91	0.102	9.25±1.50	0.683	10.37±1.99	0.080
P. Biceps (mm)	3.75±0.64	6.00±3.39	3.75±0.64	0.121	6.00±3.39	0.439	4.87±2.56	0.144
P. Iliac crest (mm)	18.25±8.72	11.87±2.59	18.25±8.72	0.121	11.87±2.59	1.000	15.06±6.86	0.149
P. Suprailiac (mm)	8.50±1.47	9.62±4.47	8.50±1.47	0.439	9.62±4.47	0.683	9.06±3.14	1.000
P. Abdomen (mm)	18.25±8.25	12.62±2.65	18.25±8.25	0.439	12.62±2.65	1.000	15.43±6.42	0.245
P. Frontal thigh (mm)	8.50±1.91	15.75±5.04	8.50±1.91	0.102	15.75±5.04	1.000	12.12±5.24	0.020*
P. Medial calf (mm)	4.62±0.75	10.75±4.99	4.62±0.75	0.102	10.75±4.99	0.121	7.68±4.65	0.020*
C. Relaxed arm (cm)	36.62±0.86	30.80±1.40	36.62±0.86	0.221	30.80±1.40	0.221	33.71±3.29	0.019*
C. Contracted arm (cm)	38.82±1.31	32.65±3.13	38.82±1.31	0.439	32.65±3.13	0.121	35.73±3.98	0.029*
C. Waist (cm)	87.90±5.72	72.05±5.91	87.90±5.72	1.000	72.02±5.91	0.121	79.96±10.05	0.021*
C. Hip (cm)	107.67±3.78	100.52±2.52	107.67±3.78	1.000	100.52±2.52	0.439	104.10±4.84	0.029*
C. Calf (cm)	39.37±2.31	36.30±1.80	39.37±2.31	1.000	36.30±1.80	0.439	37.83±2.52	0.083
D. Humerus (cm)	7.55±0.59	7.17±1.55	7.55±0.59	0.439	7.17±1.55	0.221	7.36±1.10	0.245
D, Femur (cm)	10.62±0.76	9.12±0.12	10.62±0.76	0.667	9.12±0.12	1.000	9.87±0.94	0.020*

x±sd = Average and Standard Deviation, OAa= Intra-group men average, p valuea = Intra-group men (U de Mann-Whitney), OAb= Intra-group women average, p valueb = Intra-group women (U de Mann-Whitney), OAc= Average between men vs women groups, p valuec = Intra-groups men vs women (U de Mann-Whitney).

Table III. Descriptive data of kg and % of Body Fat, Muscle Mass and Bone Mass (x±sd) of the Mexican men´s and women´s beach volleyball teams.

N=4			*Men*			
	Kg BF	% BF	Kg MM	% MM	Kg BM	% BM
OC*	15.05±3.60	15.60±1.69	40.90±2.82	42.90±2.68	16.85±3.18	17.50±0.98
C2	10.90±0.70	11.45±1.20	44.30±0.28	46.35±1.62	17.45±3.46	18.20±2.82
OA[a]	12.97±3.20	13.52±2.68	42.60±2.55	44.62±2.69	17.15±2.73	17.85±1.77
p value[a]	0.121	0.121	0.121	0.121	0.439	1.000
N=4			Women			
	Kg BF	% BF	Kg MM	% MM	Kg BM	% BM
C1	14.40±2.68	20.35±2.19	27.00±1.55	38.50±5.23	14.30±3.25	20.15±3.04
C2	13.65±0.91	18.40±0.70	32.25±0.77	43.55±0.21	12.65±0.07	17.10±0.42
OA[a]	14.02±1.69	19.37±1.74	29.62±3.19	41.02±4.20	13.47±2.10	18.62±2.49
p value[a]	1.000	0.439	0.121	0.121	1.000	0.121
OA[b]	13.50±2.43	16.45±3.76	36.11±7.43	42.82±3.79	15.31±2.99	18.23±2.04
p value[b]	*0.343*	*0.21**	*0.021**	*0.149*	*0.083*	*0.663*

OC* =Olympic Couple, C1= Couple one, C2= Couple two, N= Number of subjects, OAa= Overall Average intra-couples, OAb= Overall Average between sexes, p valuea = U de Mann-Whitney intra-couples, p valueb = U de Mann-Whitney between sexes.

Table IV. Descriptive data of Mesomorph, Endomorph and Ectomorph (x±sd) of the Mexican men´s and women´s beach volleyball teams.

			Men	
N=4	Endomorph	Mesomorph	Ectomorph	Nominal Scale
OC*	2.70±0.14	6.30±0.42	1.50±0.42	Meso-Endomorph
C2	2.05±0.21	6.00±0.56	1.75±0.91	Mesomorph-Balanced
OA[a]	2.37±0.40	6.15±0.44	1.62±0.60	Mesomorph-Balanced
p value[a]	**0.121**	**0.439**	**1.000**	
			Women	
N=4	Endomorph	Mesomorph	Ectomorph	Nominal Scale
C1	3.15±0.63	5.15±1.48	2.40±0.00	Mesomorph-Balanced
C2	2.70±0.84	3.95±0.77	2.75±1.20	Mesomorph-Balanced
OA[a]	2.92±0.66	4.55±1.19	2.57±0.72	Mesomorph-Balanced
p value[a]	**0.439**	**0.439**	**1.000**	
OA[b]	2.65±0.58	5.35±1.19	2.10±0.79	Mesomorph-Balanced
p value[b]	***0.149***	***0.386***	***0.767***	

OC*= Olympic Couple, C1= Couple one, C2= Couple two, N= Number of subjects, OAa= Overall Average intra-couples, OAb= Overall Average between sexes, p valuea = U de Mann-Whitney intra-couples, p valueb = U de Mann-Whitney between sexes.

DISCUSSION

The morphological characteristics between Mexican players (OC vs C2) participating in the 2016 and 2021 Olympic cycles do not register statistical differences, which allows inferring the standardization of a profile. The opposite occurred in the female couples 1 and 2. However, we found significant statistical differences between the sexes (Delgado-Martín *et al*., 2020), specifically in the parameters of weight (p-value < 0.05 = 0.021), BMI (p-value < 0.05 = 0.021), triceps skinfold (p-value < 0.05 = 0.059), front thigh skinfold (p-value < 0.05 = 0. 020), calf skinfold (p-value < 0.05 = 0.020), relaxed arm circumference (p-value < 0.05 = 0.019), contracted arm circumference (p-value < 0.05 = 0.029), waist circumference (p-value < 0.05 = 0.021), hip circumference (p-value < 0.05 = 0.029) and femur diameter (p-value < 0.05 = 0.020).

If we compare the Mexican men's team against the few sources of information found in references, we find that it presents higher levels of weight (kg), height (cm), BMI, % fat, kg in fat, kg in muscle mass, % and kg in bone and as a lower value % muscle mass in relation to the categories U19, U20 and Seniors of the Spanish Beach Volleyball team (Quiroga *et al*., 2014), these same results are repeated when comparing the variables of 79 beach volleyball players participating in the 2011 Spanish Championship (Quiroga *et al*., 2020), however, we must consider the age difference, which is higher in the Mexican team as a parameter that affects the modification of the values analyzed.

Regarding the anthropometric values, we specify that Mexican players are positioned as mesomorphs-balanced in contrast to the Spanish ecto-mesomorph players in both studies (Quiroga *et al*., 2014, 2020). This means that the Mexican National team is characterized by greater muscle mass than the Spanish teams in their different categories. That is, mesomorph is dominant, while endomorph and ectomorph are equal, without differing by more than 0.5 in the somatotype graphic. In the world ranking, the Spanish National team is above the Mexican National team (Fédération Internationale de Volleyball, 2021b). In another study with U21 Spanish players categorized by playing position (Sebastia-Amat *et al*., 2020) we found that weight (kg) is higher in the Mexican team (95.71±7.62), in blockers (83.98±8.75) and defense (72.70±6.18), in reference to height, U21 Spanish players who play as blockers (190.82±6.22) are taller, but defenders are smaller (180.36±5.27) than Mexicans (187.88±7.71).

As for BMI, the measurement is higher in Mexicans (27.11±0.88), as well as in blockers (23.01±1.57) and defenses (22.38±1.90). The results of Kg muscle mass are similar to the blockers (42.50±5.47) and higher than the defenses (36.23±3.14) by (42.60±2.55) of the Mexicans, in kg of bone is higher in Mexicans (16.85±3. 18) than blockers (14.24±1.12) and defenses (12.71±0.61), in terms of kg body fat, Mexicans report significant higher numbers (12.97±3.20) by (6.96±0.92) of blockers and (5.93±1.37) of defenses.

It is worth mentioning that the somatotype of the Spanish blockers and defenses was ecto-mesomorphic (Quiroga *et al*., 2014, 2020), while the Mexican is mesomorphic-balanced. On the other hand, the Brazilian National team (Medeiros *et al*., 2010) reports lower average age of 28 years, upper height of 194cm, lower average body fat percentages in abdominal skinfold (12.5mm), iliac crest

(11.4mm), and overhead in frontal thigh (10.8mm), as well as average fat % of 8.7%, below the overall average. Therefore, it is recommended to reduce the overall average body fat percentage of the national team, considering as anthropometric reference the Brazilian team, world power in beach volleyball.

The Mexican women's National team, on the other hand, reports a height of 1.70cm lower than the top elite Iraqi players (178.70±18.11) (Lopes *et al*., 2013), however, has an average weight (kg), height (cm) and BMI higher than the Italian amateur level players (Gualdi & Zaccagni, 2001), while the anthropometric profile of the Italians is endomorphic-balanced, the Mexicans report to be mesomorphic-balanced, which implies a lower percentage of fat in the second ones.

Comparing the results with U19 and U21 Brazilian players, in terms of height, we report a similar average (176.5±3.53), however, a significantly higher lean body (49.3±9.61) in the Brazilians (Lopes *et al*., 2013). In comparison the results of the Mexican and Spanish players, we indicate that the height, average body weight and BMI are higher than 71 U19, U21and Senior Spanish players (Quiroga *et al*., 2014, 2020), according to the above, the average age of the Spanish players should be considered significantly lower in the two studies except for the Senior category (29.18±4.69) (Delgado-Martín *et al*., 2020), by 27.25±7.36 of the Mexican players. Regarding MM (kg), Mexican women report similar average numbers (29.62±3.19) to Spanish women (29.54±0.49 and 29.78±1.04) (Quiroga *et al*., 2014; Delgado-Martín *et al*., 2020). Lower percentages in average MM (41.02±4.20) by 44.40±0.95 and 45.43±0.81 (Quiroga *et al*., 2014; 2020). In terms of BF (kg), Mexican women reported 14.02±1.69 slightly higher than Spanish women (12.04±0.89) (Quiroga *et al*., 2014) and 13.92±4.13 (Quiroga *et al*., 2020); % BF slightly higher in Mexican women (19.37±1.74) by 18.28±1.15 (Quiroga *et al*., 2014) and 17.98±1.19 (Delgado-Martín *et al*., 2020). It should be noted that Spanish players on average are endomorphs-balanced (Quiroga *et al*., 2014, 2020), while Mexican players are mesomorphs-balanced, which implies greater muscle mass in the second ones. Comparing the data with the U19 and U21 central Europe players (De Farias *et al*., 2016) we found that the average age (18.5±0.70) is higher in the Mexican players (27.25±7.36), while the weight and height is lower in the European players. Body Fat % (15.15±1.90) and kg of body fat (10.10±1.84) are lower on average than Mexican women, the % of muscle mass (83.85±1.90) and kg of muscle mass (50.94±1.60) are significantly higher and have an ecto-mesomorphic somatotype while the Mexican women are mesomorphs-balanced.

In a comparative analysis with world elite couples, valuable aspects can be observed for decision making based on anthropometric variables of height and weight for beach volleyball (Bojanic *et al*., 2020). The Norwegian men´s Olympic couple (gold in Tokyo 2021 and first place in the World Circuit) averaged 89.5 (kg) in weight and 196 (cm) in height (Fédération Internationale de Volleyball, 2021b), these data show important differences with the Mexican OC 95.80±12.58 (kg) and 187.25±1025 (cm), in terms of age, the Mexican Olympic couple was younger with an average of 24.5 years against 25.5 years of the Norwegians. In the case of women, the United States of America team (gold in Tokyo 2021) has an average height of 189.5 (cm) and the Mexicans of 177±4.96 (cm) and in weight, USA registered in the time of the Olympic cycle 74.5 (kg), in turn, the two Mexican couples weighed 72.32 ±32 (kg), in terms of age, the Mexicans are younger 27.25±7.36 than the Olympic champions with 35.5 years (Sebastia-Amat *et al*., 2020).

Thus, studying or reviewing the anthropometric and somatotype trend will allow programming the training to establish a physical profile of the Mexican team. The study reveals the Mexican anthropometric and somatotype profile in both sexes of beach volleyball, in the comparative aspect with other teams classified in the first 20 of the world ranking, Mexico has the physical elements to be competitive. It should consider the design and management of a comprehensive program for the development of all areas of sporting, psychological, technical-tactical and administrative performance in order to maintain its presence in the Olympic Games and climbing the world ranking, as well as, to privilege in the preparation of high competition players, with younger age (younger), greater height and projections of the ecto-mesomorphic somatotype in accordance with the world tendency.

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RESUMEN: La presente investigación corresponde a un estudio descriptivo transversal en el campo antropométrico, que permite a los entrenadores desarrollar estándares para identificar talentos y optimizar el entrenamiento en la disciplina de voleibol de playa. Su objetivo fue definir el perfil antropométrico y la composición corporal de las selecciones olímpicas mexicanas de voleibol de playa en ambos géneros. Los participantes fueron las parejas uno y dos de México en ambos géneros (definidos por ranking Fédération Internationale de Volleyball), 4 mujeres y 4 hombres con edad promedio de 30.25±6.85 y 27.25±7.36 años. La técnica utilizada fue el método del somatotipo de Heath-Carter y el protoolo ISAK del perfil antropométrico restringido. Entre los hallazgos resultantes de la investigación, se puede ob-

servar una unificación en las carácteristicas morfológicas masculinas (pliegue cuatáneotricipital, pliegue cutáneo anterior del muslo, pliegue citáneo de la pantorrila, circunferencia del brazo relajado y contraído, cintura, cadera, diámetro del fémur e IMC), en cuanto al somatotipo, ambos sexos de las parejas mexicanas se posicionan en mesomorfos-equilibrados. En relación a otros estudios consultados, se observa equilibrio en somatotipo y desarrollo muscular con equipos de alto rendimiento. El peso y la altura, así como la edad, son variables importantes para la selección del talento y en el futuro desempeño óptimo en el voleibol mundial y profesional.

PALABRAS CLAVE: Somatotipo, Composición corporal, Antropometría, Voleibol de playa.

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