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# ***International Journal of Volleyball Research***

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## FROM THE EDITOR:

It is with great pleasure that I share with you the global excitement that surrounds this edition of the *International Journal of Volleyball Research*. The USA Volleyball Sports Medicine and Performance Commission (SMPC) selected a new editorial team for the continuation of the journal in December, 2008. As a result, the journal is again alive and well, now in electronic form. As editor, I wish to express my sincere appreciation to the USA Volleyball and its SMPC for their continued vigilance and dedication to advancing volleyball through sport science research globally. The *IJVR* Editorial and Review Boards encourage those in sport science and volleyball communities to collaborate on research projects that answer questions about athlete performance enhancement as well as injury prevention and rehabilitation. We encourage those in related sciences to seek answers to questions that will propel volleyball forward based upon scientific inquiry from a variety of perspectives. There are endless opportunities to conduct investigations in the areas of 6-player indoor (men and women), sand (men and women), and sitting (men and women) volleyball. There are age groups, varying abilities coaching, officiating, rules, and event aspects of the game to consider. We promulgate the submission of original research manuscripts to the *IJVR*, as the journal will be published twice annually, at the ends of January and July. Manuscripts may be submitted to the editor at any time. We also encourage book reviews that focus on volleyball-related topics. It is our hope that this journal will be the one of choice to publish volleyball research in the future.

Darlene A. Kluka, Ph. D., D Phil, Editor



# Movement analysis related to functional characteristics of upper extremities in female junior volleyball players

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## Summary

The aim of our research report was to demonstrate within a group of female volleyball players how the technique of the overhead pass depends on the functional state of the upper extremities of players. It was a matter of a case study of a descriptive character. The description has been carried out by means of a manual examination of upper extremities and kinematic analysis – 3D. The tested group consisted of 10 female players, all of them members of a youth (under 16) team of the club Olymp Praha. The results of manual examination proved that some functional derangements of joints of upper extremities with female volleyball players were relatively often.

It was supposed and the thesis, that the derangements would affect the kinematic of the movement specific to the overhead passing the ball, has been verified. The results of the research did not confirm this hypothesis.

**Key words:** volleyball, kinematic 3D analysis, manual examination of the upper extremities, overhead passing

本研究主要是以案例方式來探討排球托球是否會受到上肢的功能性狀況之影響，根據上肢關節肌肉和三度空間運動學來做分析。實驗對象為十位15-16歲奧林匹克布拉格俱樂部的國家級比賽女性排球選手。研究結果發現女性排球選手的上肢關節和肌肉經常有功能性障礙，有證據顯示十位取樣的運動選手中有八位出現上肢功能性異常的狀況。研究結果指出，特別是排球初始訓練期的選手要保持健康，配合有效的補償性運動和發展全動作的技術是必要的，且選手需要定期接受骨骼肌肉系統檢查。此外，研究結果並未證實研究假設。

關鍵字：排球、三度空間運動學分析、人工檢驗上肢、托球

Cílem příspěvku je ukázat na skupině hráček volejbalu, zda je technika provedení odbití míče obouruč vrchem závislá na funkčním stavu horních končetin. Jedná se o případovou studii popisného charakteru. Popis byl prováděn pomocí funkčního vyšetření kloubů a svalů horních končetin a kinematické analýzy – 3D. Výzkumný soubor, tvořilo 10 hráček volejbalového družstva Olympu Praha hrajícího Českou extraligu kadetek ve věku od 15 do 16 let. Výsledky manuálního vyšetření ukázaly, že funkční poruchy kloubů a svalů horních končetin jsou u hráček volejbalu poměrně časté. U našeho souboru se tyto poruchy vyskytly u osmi probandek z deseti. Pro praxi ze zjištěných výsledků vyplývá nutnost důsledněji se věnovat kompenzačním cvičením a rozvoji všech pohybových schopností a to zejména v počátečních fázích sportovní přípravy. Dále, pak na nutnost pravidelného lékařského sledování pohybového aparátu u mladých sportovců.

Předpokládali jsme, že zjištěné dysfunkce kloubů a svalů horních končetin ovlivní kinematiku pohybu při odbití míče obouruč vrchem. Výsledky naší práce však tuto hypotézu nepotvrdily.

**Klíčová slova:** volejbal, kinematická 3D analýza, manuální vyšetření horních končetin, odbití obouruč vrchem

Cette enquête, une étude de cas, a été conçue pour montrer si la technique de passe (passe en touche haute) était affectée par la condition fonctionnelle des extrémités supérieures. La recherche était basée sur un examen fonctionnel des articulations et des muscles des extrémités supérieures et sur une analyse cinématique en 3D. L'échantillon de la recherche comprenait 10 joueuses juniors de volley âgées de 15 à 16 ans, dont toutes étaient membres du Club Olympique de Prague, jouant dans la ligue nationale. Le résultat de l'examen a montré que des troubles fonctionnels des articulations des extrémités supérieures sont extrêmement fréquentes chez les joueuses de volley. Il y avait des signes d'un trouble sur 8 des 10 joueuses examinées. Les résultats ont aussi indiqué qu'inclure des exercices de compensation efficaces et développer toutes les techniques de mouvement sont nécessaires pour maintenir la santé du joueur, surtout au stade initial de l'entraînement. Des bilans de santé réguliers du système musculo-squelettique sont aussi recommandés. L'hypothèse, cependant, n'a pas été confirmée par les résultats trouvés.

**Mots clés :** volley, analyse cinématique en 3D, examen manuel des extrémités supérieures, passe.

O objetivo desta investigação, estudo de caso, foi concebido para mostrar se o passe é afectado pela condição funcional dos membros superiores. A pesquisa foi baseada numa análise funcional das articulações e músculos dos membros superiores e análise cinemática 3D. A amostra da pesquisa incluiu 10 jovens jogadoras de voleibol com idades entre 15 a 16 anos, sendo todos membros da Praha Olympic Club e jogadoras na liga nacional. Os resultados mostraram que os

distúrbios funcionais das articulações e músculos das extremidades superiores são bastante frequentes em jogadoras de voleibol. As evidências revelaram que 8 num total de 10 jogadoras da amostra sofriam de um distúrbio desses. Os resultados também indicaram que a inclusão de exercícios de compensação e de desenvolvimento das habilidades de todos os movimentos são necessários para manter a saúde do jogador, principalmente na fase inicial do treino. Recomenda-se que haja check-up médico regular do sistema músculo-esquelético. A hipótese, contudo, não foi confirmada pelos resultados encontrados.

**Palavras-chave:** voleibol, análise cinemática 3D, avaliação manual dos membros superiores, ajuste

El propósito de esta investigación por medio de un estudio de caso, fue el determinar si el pase a dos manos usado en la levantada o acomodo se afecta por el estado funcional de las extremidades superiores. La investigación se basa en un analisis funcional de las extremidades superiores y un análisis cinematográfico tri dimensional. La muestra en esta investigación fueron 10 adolescentes jugadoras de voleibol de 15 y 16 años integrantes del Club Praha Olympic en la liga nacional. Los resultados del examen reflejaron una frecuencia considerablemente mayor de problemas en las articulaciones y músculos de la extremidad superior de las jugadoras. Se encontró evidencia de algún desorden funcional en 8 de 10 jugadoras examinadas. Los resultados también indican la necesidad de incluir ejercicios de compensación y de destrezas de movimiento para mantener la salud de la jugadora, especialmente en la etapa inicial del entrenamiento. También se recomienda un examen del sistema musculo-esquelético. La hipótesis planteada en el estudio no se confirmó según los resultados del estudio.

**Palabras claves:** voleibol, análisis cinemático tri-dimencional, examen manual extremidades superiores, levantada/acomodo.

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## INTRODUCTION

One of the factors limiting sport performance in particular sports is a decreased range of motion in joints. Although game performance in volleyball does not exert extreme demands on flexibility, it is very important to develop optimal range of motion in joints and related functions of individual muscles and muscle groups. A better understanding of movement system functions is one of conditions for cultivation and development of game performance in volleyball.

Our aim is to find out, with aid of kinematic analysis, whether joint and muscle dysfunctions affect movement performance in overhead passing.

Kinematic analysis has become a commonly used method in sports which allows us to gain objective basis for a more effective training process. Results of kinematic analysis enable more objective models of optimal movement performance and determination of kinematic barriers of movement performance (Tůma, 2001, Janura a Zahálka, 2004).

By means of kinematic analysis some volleyball skills were tested. However, we have found any studies about kinematic analysis of overhead passing neither in Czech, nor in foreign professional literature. In Czech volleyball literature, the following authors deal with examination of movement kinematics of game skills with aid of kinematic analysis: Analysis of a spike serve in five top volleyball players by means of 3D video-graphic method at European Championship 2001 was carried by Lehnert, Stromšík, Janura and Háp (2001).

By means of 3D video-graphic method the movement of a volleyball player in blocks (Lehnert, Janura, Stromšík and Vaverka (2001) and spikes (Zahálka and Süß, 2002) was analyzed. In foreign professional literature Huang, Liu and Sheu (1997) deal with volleyball skills examined by kinematic analysis. They recorded a take-off with one leg in the spike. Testing of the spike service by means of 3D kinematic analysis was carried by Coleman (2003). Kinematic analysis of a back row attack was examined by Huang, Liu and Sheu (1999). Methods in these studies do not vary practically in Czech and foreign authors. However, the described methods have particular imperfections. Relatively slow recording frequency is appropriate for relatively slow movements, but it can not exactly assess fast movements which are in volleyball very often. The next weakness is that during recording players' movement in a match it is not possible, because of obvious reasons, to label particular segments with appropriate markers. This increases an error during a recording assessment, because an examiner has to estimate the chosen points according to one's experience.

The third general problem of kinematic analyses is that functional status of participants' movement system is not assessed. It is known that muscle and joint dysfunctions change ranges of motion and muscle tension (Tichý, 2005). This has to modify the size of observed parameters and

inter-individual comparison of players is rather problematic. Thus phenomena, whose cause is unknown, are observed.

In our study we attempt to eliminate these defects so that:

- we use high-frequency infrared cameras (240 Hz)
- we label body segments by markers
- we manually examine joints and muscles of upper extremities to assess their functional status

## METHODS AND PROCEDURES

The aim of our research was to investigate which joint and muscle dysfunctions occur in the upper extremities in young women volleyball players and to verify whether the ascertained joint and muscle dysfunctions of the upper extremities affect the technique of the overhead passing. The research sample consisted of 10 women players of the club Olymp Praha competing in the Czech Extraleague of the youth. At the time of measurements all women players actively played volleyball for 4 – 5 years and trained 4 times a week.

**Table 1 Sample Characteristics:**

	Height [cm]	Weight [kg]	Age [years]	Training period [years]
mean	173.8	63.1	15.5	4.5
SD	4.6	2.7	0.5	0.5

Assessment of functional status of joints and muscles of the upper extremities (the arm, elbow and wrist) rises from the concept of functional manual medicine described by Tichý (2005). An advantage of this concept, in contrast to other techniques, is that it enables three-dimensional conception of functions of joints and muscles moving with a joint. This allows us to compare the results of movement kinematics better.

The principle of assessment, which is considerably dependent on examiner's experience, was done in this way:

a) a passive examination of big joints of both upper extremities (the shoulder joint, elbow joint, wrist) in excessive positions of all basic movements (shoulder joint: flexion – extension, abduction – adduction, external rotation – internal rotation; elbow: flexion – extension, supination – pronation; wrist: palmar flexion – dorsal flexion, radial duction – ulnar duction) toward the first resistance (a physiologic barrier). After a physiologic barrier, joint motion toward an anatomic barrier was assessed in a qualitative way (present – absent).

b) palpatory examination of the main muscles which perform basic movements in particular joints stated in the paragraph a). Muscle tension was estimated by a touch according to the resistance of muscle tissue to the examining fingers. The result was evaluated relatively based on the comparison of identical muscles assessment in both upper extremities.

For observation of the determining motor skill we used an optoelectronic system QUALISYS and 8 infrared cameras Qualisys ProReflex240 for 3D analysis.

The data gained from manual examination of joints and muscles of the upper extremity and 3D analysis were processed and evaluated by means of descriptive statistics.

## Proceeding

After a warm-up, the techniques of manual medicine were performed. Consequently, we labeled the markers directly on the skin and on the points with good touchable bone shapes.

It was a matter of these points:

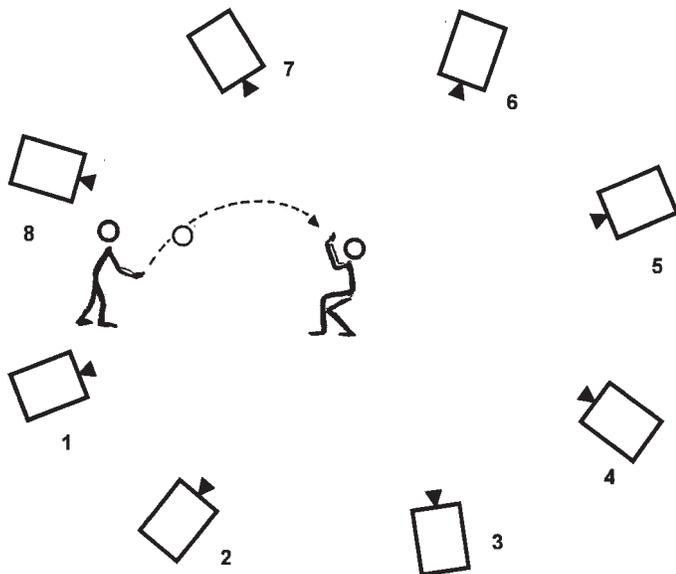
- Metacarpus I, III, V* – on the left and right limb
- Acromion* – on the left and right limb
- Epicondylus humeri medialis and lateralis* – on the left and right limb
- Olecranon* – on the left and right limb
- Distal ends of the ulna and radius* – on the left and right limb
- Spinous processes* - of the 1st and 3rd thoracic vertebrae

Then, the overhead passing was recorded for 30 seconds.

Cameras were set on tripods at the height of 2 meters and were placed in an ellipse shape around the limited area so that each marker would be recorded by two cameras every moment (Fig 1).

All women players had earlier experience with the examined manner of the passing. The passing was performed within a limited area at the distance of 5 m. A player standing in the circle was concentrated in the passing position and received a ball, which fell down above her forehead, so that the player did not need to take steps and then she passed

**Figure 1: Placement of the cameras during recording**



the ball. Totally there were recorded 6 cycles of the passing.

From the obtained data we used:

- in the shoulder: maximum and minimum ranges of *abduction* and *adduction*
- in the elbow: maximum and minimum ranges of *flexion* and *extension*
- in the wrist: maximal and minimal ranges of *flexion* and *extension*

## RESULTS

We found out a relatively high occurrence of functional joints and muscle derangements in the upper extremities in our participants (Table 2).

These derangements induce flexion or extension pathological chains in all participants. Concretely, from total 60 examined joints, there were functional derangements in 30, i.e. 50%. Functional impairments of joints were more often than structural impairments, in ratio 28 : 2. Derangements of the left upper extremity were more often than in the right one and it was in ratio 7 : 3. Extension pathological chains in the upper extremities were more often than flexion chains, in ratio 6 : 2. In this case, we have not included the result of participant 1 whose both elbow joints were structurally impaired. In eight participants out of a total of ten participants (80%) we found out functional derangements at least in one upper extremity; in two participants out of a total of ten (20%) we recorded functional impairment in both upper extremities and in two participants out of a total of ten (20%) we assessed both upper extremities healthy.

For transparency, we present the table which includes maximum and minimum angles in particular joints in one to three repetitions of the overhead passing in one participant out of a total ten participants obtained by means of 3D analysis.

## Statistics

The goal of the statistic evaluation was to find out whether there are differences in angles of maximum extension and flexion in particular joints between the left and the right upper extremity and whether the correlation between functional status of these joints and ranges of maximum and minimum angles exist.

For each participant, we assessed mean values of the differences in the examined parameter (maximum extension and flexion in joints) between the left and right upper extremity (UE), standard deviation, standard error mean for each point of the UE in extension and flexion. From these values, a table for each point (joint) and status (extension, flexion) was created where instead of differences there is an order according to the size of the difference between the left and right UE in absolute value from the lowest difference 1 toward to biggest difference 10 (Table 4).

**Table 2: Results of manual assessment of joints and muscles of the upper extremities**

No.	Name	Wrist		Elbow		Shoulder	
		Left	Right	Left	Right	Left	Right
1	M.S.	F	F	S	S	F	F
2	L. M.	F	0	F	0	F	0
3	M. K.	E	0	E	0	E	0
4	B. J.	E	0	E	0	E	0
5	V. D.	0	0	0	0	0	0
6	R. V.	E	E	E	E	E	E
7	I. H.	E	0	E	0	E	0
8	A. H.	E	0	E	0	E	0
9	K. H.	0	0	0	0	0	0
10	K. K.	0	F	0	F	0	F

**Legend:**

0 – Without a pathological finding (healthy joint)  
 F – Functional barrier - flexion  
 E – Functional barrier - extension  
 S – Structural barrier

**Table 3: Maximum angles in joints of the upper extremities in extension and flexion in one participant**

UE	Extension						Flexion					
	Left			Right			Left			Right		
Wrist	24.0	24.6	57.8	21.8	23.6	22.0	26.1	31.4	36.6	39.3	45.4	66.6
Elbow	32.8	32.9	27.6	40.5	43.3	38.9	98.7	99.5	102.3	112.7	114.7	111.4
Shoulder	87.9	97.4	94.8	71.1	82.3	47.2	71.2	74.3	68.6	53.5	51.5	46.8

**Table 4: Order from the lowest to the biggest difference according to absolute differences (left – right UE) in 3 points (wrist, elbow, shoulder) in extension and flexion**

No.	Name	Wrist		Elbow		Shoulder		Sum. Order	Final Order	finding UE
		Exte.	Flex.	Exte.	Flex.	Exte.	Flex.			
1	M. S.	4	7	9	2	3	1	26	3	LR
2	L. M.	6	6	8	10	5	4	39	8	L
3	M. K.	5	2	3	5	9	9	33	5	L
4	B. J.	7	4	2	4	8	2	27	4	L
5	V. D.	8	8	6	7	10	10	49	10	
6	R. V.	1	1	1	1	4	7	15	1	LR
7	I. H.	9	9	7	8	6	6	45	9	L
8	A. H.	3	10	5	6	7	5	36	6	L
9	K. H.	10	5	10	3	2	8	38	7	
10	K. K.	2	3	4	9	1	3	22	2	R

**Legend:**

Sum. Order - Sum of all 6 orders (3 points -wrist, elbow, shoulder- and 2 states – extension, flexion)

Final Order - Assigned order from the lowest sum. order toward the biggest one

Finding UE - blank – without any finding, L - finding on the left side of UE; R - finding on the right side of UE; LP - findings on both UE

The most significant differences between the left and right UE were in a healthy (without a finding) participant 5 (V.D.) and the lowest differences were in participant 6 (R.V) with findings on both UE (extension chain). Angle values on the right UE in healthy participants are higher in five cases out of a total of 6 (apart from wrist flexion). Angle values on the right UE in participants with findings at least on 1 UE are higher in 3 cases out of a total of 6.

## DISCUSSION

Results of the manual assessment proved that functional derangements of joints of the upper extremities are quite often in women volleyball players. In our sample, these derangements occurred in eight participants out of a total of ten participants. This high occurrence may be explained by the fact that volleyball is a physically demanding sport which includes very fast changes of body positions both in terms of space and mutual positions of body segments (jumping, techniques of going to the floor, fast changes of the direction).

The dominant upper extremity is usually loaded more; in our sample it was the right one in all participants (all players were right handed). However, higher load of the right upper extremities is not in accordance with our results which revealed more functional derangements in the left upper extremities. Therefore, it is possible that the left extremities are less muscularly developed in right handed people, i.e. they are weaker and worst coordinated.

Ferretti 1994, Ferretti, De Carli, Calderaro and Conteduca (1998) and Parkanová (2001) analyzed number of occurrences of individual body segments injuries in volleyball players and found out that one of the most injured joints was the shoulder. The shoulder is a crucial joint for the whole upper extremity and its injury consequently affects functional status of all joints of the upper extremity.

In our sample, functional joint derangements were more often than structural impairments. It can be explained by a few arguments. Our participants were 15 – 16 years old; it is the age when abrasion of structures of the movement system is rather rare. Functional impairments tend to be secondary, i.e. applied. It means that the primary cause may be completely different and distant and it may be transferred to the upper extremity as a consequence of nerve and mechanic chains, especially by means of skeletal muscles. These relationships are described in Czech physiotherapeutic literature by Janda (1984), Lewit (2003). Foreign professional literature does not deal very much with this theme. We have found only two variants of pathological chains in the upper extremities in our sample and it was either flexion or extension chain. Flexion chains were characterized by a higher range of hypertonic flexors and all flexion movements in joints. The situation was different in extension chains. These are in consonance with description by Tichý (2005) who has found them in his patients during their rehabilitation. From his conclusions and our results we may suggest that their occurrence is not characteristic only for volleyball players, but it is a matter of

a general phenomenon. Primary cause of the found chains could have been located out of the upper extremity, in area of the neck or trunk.

Extension chains were more often in our participants than flexion chains. The reason could be the fact that extensors of the upper extremities are more loaded in the overhead passing than flexors.

An overloaded muscle is anatomically shortened and induces the functional barrier in the joint where it performs the movement (Horáčková et al. 2003, Tichý 2003, Tichý et al. 2003).

One of the goals of our research was to examine, whether the functional status of joints and muscles of the upper extremities demonstrates in kinematics of the movement of the upper extremities. In other words, if, e.g. the flexion chain in one upper extremity leads to an increased range of flexion movements of particular joints in comparison to the other healthy upper extremity. Hypothetically, we supposed that it should be like that on the basis of the available literature. However, our results showed that this hypothesis can not be verified.

The slightest differences in joint angles between the left and right upper extremity were recorded in participant 6, who had pathological chains in both upper extremities. On the contrary, two healthy participants 5 and 9 without any pathological chains had one of the worst results when comparing kinematics of the left and right upper extremity and they were on the 7th and 10th place out of a total of ten participants, while the results of their assessment should be hypothetically the best.

The reason may be the fact that performance of a visible movement is dependent on more factors: The elementary precondition for success of such experiment is that all participants have mastered techniques of the selected skills, in our case it was the overhead passing in volleyball. Our participants have trained volleyball under expertise supervision for 4 – 5 years and some of them were the representatives of the Czech Republic; therefore we may consider them the players who mastered the volleyball technique on the top level.

The next factor was an accuracy of a tossed ball. The ball was tossed by the participants' coach, but despite his big effort, he did not always manage to toss the ball exactly to the identical place. Unfortunately, we are not aware of any device which would be used for similar reasons in the Czech Republic or abroad. For analysis of the overhead passing we selected only these cases, where the ball was correctly tossed. Inaccurate ball toss would obviously lead to the situation when participants had to move to a totally new position of the trunk before the passing the ball, so that the ball would fall over their forehead just as it results from the right methodology of the overhead passing (Císař 2005, Buchtel 2005).

It resulted into many cases when the left and right upper extremities were in a different position (abduction angle) to the trunk. A different abduction angle in shoulder naturally influenced initial and final positions in other joints of the upper extremities (elbows, wrists).

From this asymmetric mutual position of the upper extremities and the trunk it follows that one upper extremity had to develop more muscle strength in the passing than the other one. A different muscle activity set particular joints to the different position.

It is inevitable to realize that the next factor significantly influencing position of the joints of the upper extremities is symmetry, or asymmetry of the falling ball on the both hands. In asymmetrically falling ball, more loaded wrist is more bent than the other one; it activates a chain reaction in the whole upper extremity and asymmetric angle position of elbows and shoulders.

We may conclude that for other studies of this problem it is necessary to ensure that the ball is tossed always in the same way into the same point in order to minimize risks of eventual errors stated above. However, it means to develop an appropriate device.

## CONCLUSION

Our study may be regarded as a pilot study in this area because it attempts to compare a clinical, functional status of joints and muscles with movement stereotypes performance. We suppose that this procedure is unique in examination of the game skills and it was used firstly in our republic. A common practice is that in physiotherapeutic literature, only clinical status of the movement system is evaluated by means of mainly manual methods, or in biomechanic literature only movement kinematics is assessed without examination of functional status of the movement system.

It seems that for better understanding of fundamentals of movement as a visible phenomenon it will be essential to perform studies similar to our research when during one experiment results of manual and device assessment would be compared.

Despite the fact that our study has not definitely answered this question, it suggested the way which a science should take in this area.

## IMPLICATIONS FOR COACHING

Results indicated necessity of regular involvement of compensation exercises in training sessions and consistent control over its performance from youth categories. It is advised to insert compensation exercises at the beginning and end of a training session. The beginning of the training session (within preparation of an organism for a concrete performance) should include both intentional stretching and strengthening exercises. The purpose of strengthening exercises is improving efficiency of impaired muscles or

muscles with tendency for impairments. At the end of the training session there should be stretching and relaxing exercises.

Results pointed out a requirement for regular controls of players' movement systems and close cooperation between the coach, doctors and physiotherapists, and need for appropriate load regarding age categories and individual differences of particular players.

For future of assessment of motor skills in volleyball it is essential to examine next factors affecting player's performance and performance of game skills. One of possible ways is a triangulation of scientific methods as kinematic analysis and assessment methods from area of rehabilitation and physical medicine.

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## Body composition profile of elite women volleyball players

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### **Abstract:**

The contribution deals with body composition profile of elite women volleyball players, participants in Europe Champions League 2008. Body composition was examined by means of multifrequency bioelectrical impedance BIA 2000 M (Datainput, 2004). The elite volleyball players showed a high proportion of lean body mass and low proportion of fat mass when compared to both common population and elite women volleyball players in available literature. Commonly used lean body mass and fat mass are accompanied by other parameters which may head to individual assessment of eventual changes in player's body composition caused by training periodicity (ratio between extra cellular mass and intra cellular mass, percentage of proportion of body cell mass, intracellular and extracellular fluid and others). The authors emphasize the importance of continual observation of changes in body composition in top level volleyball.

**Keywords:** bioelectric impedance, body composition, volleyball

本研究主要以多頻率生物電組抗 BIA 2000 M 來檢驗 2008 年歐洲排球冠軍聯盟頂尖女性排球選手的身體組成 (Datainput, 2004)。本研究中的頂尖女性排球員擁有比一般大眾甚至比文獻探討中的頂尖女性排球員更高比例的淨體重和更低的脂肪比。普遍使用的淨體重和脂肪比，以及其他常見的測驗項目會導向經由週期性訓練所產生的球員身體組成改變之個人測量結果(細胞外和細胞內組成的比例，身體細胞組成的比例、細胞內液和細胞外液以及其他項目)。結論是作者強調要持續觀察頂尖排球選手身體組成的重要性。

關鍵字：頂尖女性排球選手、身體組成、多頻率生物電組抗、

La contribution traite du profil de composition du corps des joueuses d'élite de volley, participant à la Ligue des Champions d'Europe 2008. La composition du corps a été examinée au moyen de multifréquence bioélectrique impédance BIA 200 M (données d'entrée, 2004). Les joueuses d'élite de volley ont montré une haute proportion de masse corporelle maigre et une basse proportion de masse grasseuse quand on les a comparées à la population normale et aux joueuses d'élite de volley dans la documentation disponible. La masse maigre et la masse grasseuse, habituellement utilisées comme paramètres, sont accompagnées par d'autres paramètres qui pourraient mener à une estimation individuelle des changements éventuels dans la composition du corps de la joueuse causés par la périodicité de l'entraînement (rapport entre la masse extra-cellulaire et la masse intra-cellulaire, pourcentage de la proportion de la masse des cellules du corps, fluide intra-cellulaire et extra-cellulaire et autres). Les auteurs mettent l'accent sur l'importance de l'observation continue des changements dans la composition du corps dans le volley de haut niveau.

**Mots clés:** Impédance bioélectrique; composition du corps; volley des femmes.

Este estudo examinou o perfil de composição corporal de jogadoras de voleibol de elite, que participaram na Liga dos Campeões Europeus de 2008. A composição corporal foi examinada por meio de impedância bioelétrica e multi frequencial BIA 2000 M (dados de 2004). As jogadoras de voleibol de elite mostraram uma alta proporção de massa magra e baixa proporção de massa gorda quando comparadas com a população comum e outras jogadoras de elite de voleibol feminino na literatura disponível. A massa magra e massa gorda são comumente acompanhadas por outros parâmetros que podem levar a mudanças na avaliação individual de eventuais mudanças na composição corporal dos jogadores, causada pela periodicidade do treino (razão entre massa extra celular e massa intracelular, o percentual de proporção de massa celular corporal, fluído intracelular e extra celular, entre outros). Os autores enfatizam a importância da observação contínua de mudanças na composição corporal no voleibol de alto nível.

**Palavras-chave:** impedância bioelétrica, composição corporal, voleibol feminino

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## INTRODUCTION

Along with progress in the field of sport performance enhancement in volleyball, there is information dealing not only with volleyball player's somatotype, his body height or actual or appropriate body weight, but often the total quality of a player's body composition is evaluated in the scientific literature involving sport practice.

## REVIEW OF LITERATURE

Body composition is certainly a predisposition for sport performance. It points to a volleyball player's physiological profile (Melrose et al., 2007). On this basis we may estimate the said appropriate body weight and somatotype as important factors of sport performance (Bandyopadhyay, 2007, Gualdi-Russo & Zaccani 2001, Malosouris et al. 2008), or eventually it may be one of the predictors in talent selection. Information about body composition indicates an athlete's nutritional condition and provides information about actual homeostasis in the organism (Andreoli, 2003), what may be motivation for dietary adjustment (Hassapidou, 2001), or for appropriate supplementation of creatine, as women volleyball players' sport performances related to fitness preparation (Jon YeanSub Lim, 2003). The importance of nutrition in women volleyball players has been emphasized by Wang & Arendt (2003) who stated that low nutrition status may lead to anemia, osteoporosis and fatigue, thereby inhibiting motion.

Body composition of top-performance athletes differs from body composition of the common population, even when compared with recreational or performance athletes. Elite athletes have a higher percentage of active mass and lower percentage of inactive mass; hence, organized and regular activity positively influences the quality of body composition. Researchers have found that elite volleyball players show significantly higher values on chosen parameters in body composition (lean body mass and fat free mass) as non-athletes (Bandyopadhyay, 2007). Very important also is the recording of another parameter indicating body composition, body cell mass, which is one of the best predictors of muscle work and sport performance (Andreoli et al., 2003).

The problem of body composition in volleyball has been examined in scientific studies. Researchers have discussed lean body mass and fat mass dependent upon the method used. Because of the importance of this predisposition for sport performance, we decided to come out with an actual body composition profile of elite women volleyball players extended by more parameters of body composition quality.

## METHODS AND PROCEDURES

The group was composed of a women's volleyball team (N = 12, average age =  $24.40 \pm 2.87$  years). In that time they took part in Europe Champions League 2008. Mean body height in the group was  $184.00 \pm 4.25$  cm, mean body weight was  $73.00 \pm 5.90$  kg, mean value of BMI was  $21.58 \pm 1.56$  kg.m<sup>-2</sup>. Average period of volleyball playing experience was  $10.9 \pm$

$3.6$  years. The players trained on average  $24.4 \pm 1.8$  hours per week (10 – 11 training sessions / week).

Data indicating participants' body composition were gained in stable conditions in the morning at the beginning of the competitive period which included extra league matches and Champions League matches, after a 12-week preparatory period. Participants did not take any medications before measurements. At first we examined actual participants' weight by means of electronic scales with accuracy of 0.01 kg and participants' body height in standing position with accuracy on mm. To assess whole body bioimpedance we used the device BIA 2000 M (Datainput, 2004) which works on four frequencies (1, 5, 50 a 100 kHz) and cooperates with the program NUTRI 4. Validity and reliability of BIA measurements were handled in more studies (Jackson et al., 1988). One measurement took approximately 45 s. Contact resistance between surface electrode and skin was not higher than 250 Ohms.

On the basis of the data gained, we deduced actual participants' body composition. We examined Lean Body Mass (LBM), percentage of Fat Mass (%FM), value of Body Cell Mass (BCM) and Extra Cellular Mass (ECM) and their mutual ratio (ECM/BCM), proportion of Body Cell Mass in Lean Body Mass (CQ), Phase Angle (A) differing and identifying resistance and reactance (2 components of bioimpedance), Basal Metabolic Rate (BMR), Total Body Water (TBW) separating Extra Cellular Fluid (ECW) and Intra Cellular Fluid (ICW). In calculation of indirect measurable parameters identifying quality of body composition we considered particular prediction equations of software (Datainput, 2004).

Evaluation was done in absolute values and in percentage; we used basic statistic characteristics (arithmetic mean, standard deviation, standard error of mean, range).

## RESULTS

Mean value of TBW in the group was  $40.68 \pm 2.46$  l ( $55.73 \pm 3.37$  % of mean BW).

Value of ICW was  $23.35 \pm 0.62$  l, so  $57.40 \pm 1.52$  % TBW and  $31.99 \pm 0.85$  % mean body weight (Table 1). Mean value of extracellular fluid was  $17.06 \pm 1.82$  l ( $41.94 \pm 4.47$  % total body water).

Mean value of lean body mass in women volleyball players was  $55.78 \pm 3.64$  kg. After differing of extracellular and intracellular mass we registered greater part of body cell mass ( $30.44 \pm 2.08$  kg) –  $54.57 \pm 3.73$  % from lean body mass. Extracellular mass was  $25.35 \pm 2.31$  kg.

In ratio ECM/BCM we measured value  $0.84 \pm 0.08$  which is in harmony with value of phase angle which was on average  $6.61 \pm 0.52^\circ$ . Proportion of body cell mass in lean body mass (CQ) came up to  $54,78 \pm 2.32$  %. Fat mass was represented by  $15.90 \pm 1.83$  % in the observed group. Mean value of basal metabolic rate was  $1571.82 \pm 66.69$  kcal.

## DISCUSSION

Mean body weight of the group ( $73.00 \pm 5.90$  kg) and registered mean value of BMI, commonly used in practice, ( $21.58 \pm 1.56$  kg.m<sup>-2</sup>) did not show underweight or overweight. Although some authors present correlation between BMI and amount of fat tissue in the body ( $21.58 \pm 1.56$  kg.m<sup>-2</sup>), proper body weight and value of BMI does not provide accurate information about body composition.

By means of the bioimpedance method we registered all water stored in lean body mass, except for that unabsorbed in the gastrointestinal tract. The registered value of TBW ( $40.68 \pm 2.46$  l) matches with recommended 50 – 60 % of players' total body weight (on average  $55.73 \pm 3.37$  % of mean weight of the observed sample). The amount of measured water is determined at first by value of body cell mass along with amount of muscle mass whose eventual increase, by means of adaptation on load during good and planned training process, increases amount of total body water. In the case of high musculature, water volume in tissues may rise in 70 – 80% of total body weight (Dorhofer & Pirlich, 2007). Not only the portion of water in tissues is important, but also its distribution in particular elements, intracellular fluid and extracellular fluid. In our sample intracellular fluid was on average  $23.35 \pm 0.62$  l what made up  $57.40 \pm 1.52$  % of total body water and  $31.99 \pm 0.85$  % of mean body

weight. The value of extracellular fluid (lymph, plasma) was  $41.94 \pm 4.47$  % of mean total body water. These values correspond with desired distribution of total body water on particular components in a healthy population (Dorhofer & Pirlich, 2007); however, mean hydration of an organism related to body weight eliminates eventual dehydration or players' insufficient drinking regimes.

To detect water it is important to evaluate simultaneously other parameters. Eventual increased ratio ECM/BCM and decreased proportion of body cell mass in lean body mass (CQ) would indicate unwanted transfer of particular water components. What is equally important is lean body mass which represents non-fat body mass consisting of muscles, bones, CNS and organs including both intracellular and extracellular mass. Its indirect assessment is done when constant hydration ( $LBM = TBW/0.73$ ) is assumed; however, this assumption does not have to be fulfilled in senior and healthy elite volleyball players (insufficient drinking regime after sport performance). Therefore, when observing parameters indicating players' body composition, it is necessary to observe at first changes of water amount and eventual possible influence on values of other parameters.

Volleyball players show significantly higher values of lean body mass than the non-sporting population (Bandyopadhyay, 2007). Nichols et al. (1995) in a study of university volleyball

**Table 1 - Parameters of body composition**

	Mean	St. Deviation	Min	Max
TBW (l)	40.68	2.46	35.60	44.60
ICW (l)	23,35	0,62	22,10	24,60
ECW (l)	17,06	1,82	13,50	19,90
LBM (kg)	55,78	3,64	48,70	62,10
BCM (kg)	30,44	2,08	27,50	34,80
ECM (kg)	25,35	2,31	21,20	29,30
ECM/BCM	0,84	0,08	0,74	1,00
A (°)	6,61	0,52	5,60	7,30
CQ (%)	54,78	2,32	50,00	57,60
FM (%)	15,9	1,83	13,40	18,40
BMR (kcal)	1571,82	66,69	1460	1630

*TBW – Total Body Water*

*ICW – Intra Cellular Fluid*

*ECW – Extra Cellular Fluid*

*LBM – Lean Body Mass*

*BCM – Body Cell Mass*

*ECM – Extra Cellular Mass*

*ECM/BCM – Ratio of Extra Cellular Mass and Intra Cellular Mass*

*CQ - Proportion of Body Cell Mass in Lean Body Mass*

*A – Phase Angle*

*FM – Fat Mass*

*BMR – Basal Metabolic Rate*

players (n = 13, age 19.4±1 years, mean body height 175.8±5.6 cm, mean body weight 69,5 ± 6,2 kg) found significantly higher values of lean body mass in upper and lower limbs (p<0,01) compared to non-sporting population and even to other sport disciplines (gymnastics, basketball, tennis). Lean body mass in lower limbs was 18.8 ± 2.1 kg and in upper limbs 4.9 ± 0.6 kg. Melrose et al. (2007) noticed that women volleyball players (n=15, average age 15.5 ± 0.64 years, mean body height 170 ± 7 cm, mean body weight 62.8 ± 6.61 kg) had a high value of lean body mass which made up 46.7 ± 4.9 kg.

Correlation of lean body mass with physiological parameters as oxygen consumption, minute heart volume, vital capacity (Pařízková, 1973), or according to Melrose et al. (2007) specifically in women volleyball players (n = 29, average age = 14.31 ± 1.37 years) with isometric strength of arm (r = 0.90), isometric strength of leg (r = 0.62) and with ball velocity after the service (r = 0.58), points to significance of this parameter for covering physiological requirements of play and individual play skills.

Body cell mass as a functionally defined element of lean body mass consists of muscle cells and organs. It is involved in every human movement. According to Andreoli et al. (2003) assessment of body cell mass belongs to predictors of muscle efficiency and may predict sport performance. Body cell mass is the central measure of nutrition condition and regulator of energetic consumption of the organism. Its amount is determined genetically (constitutes type), or by age, as well as the type of training load which an organism undertakes.

Almeida & Soares (2003) studied young brazil women volleyball players' body composition (n=25, average age 16 ± 3.55 years, mean body height 174 ± 6 cm, mean body weight 64.35 ± 6.12 kg) using a training load on average of 2.5 hours / 2 x day, 5x a week. (Frasson et al., 2009). In young brazil volleyball players (n = 22, average age 15.8 ± 2.3 years, mean body height 174.77 ± 5.6, mean body weight 66.42 ± 5.8 kg), there was a minimal load of 4 hours a day and 3 times a week. Week training time of these players was 10 ± 2.9 hours. The examined players trained on average 24 hours / week in 11 training sessions during the study. It is evident that top-performance volleyball players, whose sport preparation consists of good physiological training during a preparatory phase within periodicity of sport training, have higher values of body cell mass than recreational athletes or the common population.

In the screened group we noticed body cell mass value 30.44 ± 2.08 kg what makes up 54.78 ± 2.32 % of total lean body mass. According to available sources (Dorhofer & Pirlich, 2007) elite athletes may reach values of body cell mass up to 60 % of lean body mass. No player got under the recommended "ideal" value, 50 – 56 % body cell mass, in lean body mass. From this parameter we may indirectly deduce that all players play volleyball at the performance or top-performance level in the long term, as we would measure lower percentages of body cell mass in case of

sport inactivity or recreational sport. Activity at lower levels or activity initiated in adulthood does not appear positively to increase body cell mass in lean body mass.

From a practical perspective, not only is the amount of body cell mass important but also its ratio to extra cellular mass. In the group we measured a larger amount of body cell mass (30.44 ± 2.08 kg) than extra cellular mass (25.35 ± 2.31 kg). The ratio between ECM/BCM was 0.84 ± 0.08 in the observed group. T ratio between body cell mass and extra cellular mass was also one of the indicators of nutritional condition. It may vary along with weight sustainment and lean body mass sustainment. It only emphasizes the importance of continual observation of top athletes' body composition. In healthy people there are values usually under 1.00, the lowest values measured in a practice environment are in elite judo athletes (Malá et al., 2008) who are typical for their musculature. Decrease of the ratio between ECM/BCM means improvement of the predisposition for muscle work but it can also be caused by catabolic plots or by changes in the water amount in extracellular fluid in dehydration.

A low value of ECM/BCM closely relates to a value of directly measurable phase angle. This parameter informs us about the quality of the cells. Nourished cells and trained muscle cells have high membrane integrity and density, so we register a high phase angle; incorrectly nourished cells or untrained muscle cells have a lower membrane density and lose nutritive and cell mass; hence, they have a lower phase angle. The values measured in this study indicate high cell quality and is in harmony with values typical for top sport. To link a phase angle to BCM, a higher phase angle than a directly measurable parameter indicates a greater part of BCM (BCM = phase angle x constant) in a case when there is adequate intracellular water. Eventual changes of this parameter linked to changes in body composition in long term observation in elite volleyball would be very slow.

When examining the amount of fat mass in the group we found a mean value 15.9 ± 1.83 %. The examined players had lower values of fat mass than found in existing literature for women volleyball players (Table 2).

The exception is Fleck et al.' study (1985) who, by means of underwater weighing, measured USA representatives and found fat mass of 11.7 ± 3.7 %. That is a significantly lower percentage (p<0.01) than the authors measured in university players (18.3 ± 3.4 % fat). Similarly, Bandyopadhyay (2007) stated that elite volleyball players (n = 178, average age = 20 – 24 years) showed a significantly lower percentage of fat mass manifesting ectomorph mesomorphy than in the common population who manifested endomorph mesomorphy. Malosaris et al. (2008) mentioned a significant difference between percentage of fat mass and manifestation of the endomorph element in comparison of various women players relating to their level (players of 1st Greek national league, n = 79 and 2nd league, n = 84).

Comparing the available literature, we infer that the value of fat mass registered in this investigation relates to team'

insertion among elite teams playing in the highest Europe league. Fat mass may be considered as an empty source of energy without any close relation to parameters responsible for performance.

## CONCLUSION

Relatively high values of lean body mass, body cell mass and low values of ECM/BCM and percentages of fat mass in these women volleyball players indicate their good physical level and belong to values classified for top-performance volleyball.

In eventual long term observation with effort to improve top women volleyball players' body composition, it is necessary to focus on nutritional adjustment, choice of supplementation and slowly decreasing total body fat along with simultaneous sustainment of body cell mass. We would measure the decrease of phase angle, resistance or proportion of body cell mass in lean body mass (CQ) in long term observation

of body composition by bioimpedance. It would be an unwanted loss of body cell mass, not only fat mass. In volleyball players it seems ideal to elevate active mass LBM along with simultaneous sustainment of fat mass which is possible to achieve by appropriate physical training, correct nutrition and proper supplementation.

## IMPLICATIONS FOR COACHING

We recommend regular observation of body composition parameters in elite volleyball players, but not to be limited by atwo-component model (fat mass and fat free mass). The observed values are helpful indicators for manipulation with physical load, nutritional condition or eventual player's convalescence from a short-term point of view (TBW, ICW, ECW) as well as from a long-term point of view (FM, ECM, BCM, CQ, LBM).

In this way we may create the appropriate background for optimal player performance.

**Table 2 - Comparison of fat mass with other studies.**

Study	n	Age (years)	BH (cm)	BW (kg)	Level	Method	FM (%)
Present study	12	24.4 ± 2.9	184.0 ± 4.3	73.0 ± 5.9	National players - elite	BIA 2000 M	15.9 ± 1.8
Almeida, T.A & Soares, E.A. (2003)	25	16.0 ± 3.6	174.0 ± 6.0	64.4 ± 6.1	Skilled	Skinfolds	20.5 ± 2.4
Ferris et al. (1995)	13	19.5 ± 1.1	176.7 ± 4.6	69.7 ± 10.8	NCAA Divison I	HD	22.2 ± 5.0
Filaire et al., (1998)	7	24.6 ± 2.6	179.8 ± 5.5	69.2 ± 6.3	National players - elite	-	20.1 ± 2.2
Fleck et al. (1985)	26	23.5 ± 2.6 21.5 ± 0.7	179.3 ± 7.7	68.5 ± 7.6	National level + women's university team	HD	11.7 ± 3.7 18.3 ± 3.4
Frassone et al. (2009)	22	15.8 ± 2.3	174.8 ± 5.6	66.4 ± 5.8	-	BIA	24.93 ± 4.1
Kreger & Brown (2008)	8	19.1 ± 1.3	172.2 ± 11.1	65.4 ± 5.2	Collegiate players	HD	22.92 ± 3.53
Malousaris, G.G. et al. (2008)	79 84	25.7 ± 5.1 22.0 ± 4.4	179.6 ± 5.8 174.7 ± 6.2	71.0 ± 8.2 68.2 ± 6.3	I Greek National league II Greek National league	Skinfolds Skinfold	22.7 ± 2.9 24.1 ± 2.6
Melrose et al. (2007)	15	15.5 ± 0.6	170 ± 7	62.8 ± 6.6	Competitive volleyball club	BIA (Omron)	21.0 ± 5.5
Nichols et al. (1995)	13	19.4 ± 1.0	175.8 ± 5.6	69.5 ± 6.2	University players	DEXA	27.1 ± 3.9
Tsunawake et al. (2003)	12	17.4	168.7±5.89	59.7 ± 5.7	Inter-high school league	HD	18.4 ± 3.3

*BH – Body Height*

*BW – Body Weight*

*FM – Fat Mass*

*BIA – Bioimpedance Analysis*

*HD – Hydrodensitometry*

*DEXA – Dual X-ray Absorptionmetry*

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# Changes in physical parameters performance in starters and non-starters elite volleyball players: A short report

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## Abstract

The aim of this study was to investigate the changes in physical parameters produced during an in-season resistance training (RT) program in 35 elite volleyball players competing in the elite Portuguese league. Moreover, differences in the adaptive responses between players who played most of the times (starters: S) and players that were mainly used as substitutes (non starters: NS) were analysed. The RT program consisted of 2 sessions per week over 12 weeks (Tables 2a and 2b). The main RT exercises were, respectively, the bench press (BP) and parallel squat (PS), plus jumping and throwing. Subjects performed 3 sets of 3-6 reps with a load of 50-80% 4RM-BP; and 3 sets of 3-6 reps with a load of 30-75% of 4RM-PS. On completion, all athletes then performed three explosive strength exercises: (i) vertical jumps into a box; (ii) vertical jumps with additional weights (3 sets of 5 reps); (iii) throwing medicine ball (3 sets of 10 reps. with a 3kg medicine ball). Rests of 2 minutes were permitted between sets and between categories. Of greatest interest was the lack of any interactions for group (S or NS) by time effects for any of the tests ( $p > 0.05$ ), except for the bench press in the final test ( $p = 0.025$ ). This indicates that both groups responded similarly to the training program. There were, however, several main effects for time, showing significant improvements for the entire group of population. In fact, for all physical parameters both S and NS improved significantly ( $p < 0.001$ ). Finally, no relationship was found between any physical parameters and the changes in performance for all groups.

**Key words:** volleyball, maximal dynamic strength, jumping, ball-throwing distance

本研究主要探討來自葡萄牙精英排球聯盟中的35位頂尖選手在賽季中接受阻力訓練(RT)後所產生的生理指標變化, 另外也比較先發球員(S)和替補球員(NS)的適應性反應之不同。阻力訓練是每週兩次共十二週的課程(見表格2a和2b)。主要的阻力訓練項目為仰臥推舉(BP)、平行蹲舉(PS)、跳躍和拋球。受測者需要做50-80% 4RM的三組仰臥推舉(一組為3-6次); 30-75% 4RM的三組平行蹲舉(一組為3-6次)。在結束上述動作後, 所有的受測者繼續做三項爆發力訓練: (i) 垂直跳箱; (ii) 負重垂直跳(三組, 一組5次); (iii) 藥球拋擲(三組, 一組10次, 三公斤藥球)。每組訓練的休息間隔為兩分鐘。研究結果發現除了最後一次的仰臥推舉外( $p = 0.025$ ), 先發球員與替補球員在這些測驗項目上都沒有差異 ( $p > 0.05$ ), 這顯示兩組球員對訓練課程的反應是類似的。全部球員都在主要時間的反應訓練上有顯著的進步, 先發球員與替補球員在所有的生理指標上都有明顯的改進( $p < 0.001$ )。最後, 研究結果發現兩組球員在所有的生理指標和表現改變上沒有相關。

**關鍵字:** 排球、最大肌力、跳躍、拋球距離

Le but de cette étude était d'examiner les changements dans les paramètres physiques produits pendant le programme d'entraînement de résistance de saison (ER) chez 35 joueurs d'élite de volley participant à la ligue portugaise d'élite. Les différences dans les réponses adaptatives entre les joueurs qui jouaient la plupart du temps (joueurs de la formation initiale : J) et joueurs qui servaient principalement de remplaçants (non joueurs de la formation initiale : NJ) ont été analysées. Le programme ER consistait en 2 sessions par semaine de plus de 12 semaines (tableaux 2a et 2b). Les exercices principaux de ER étaient, respectivement, le développé-couché (DC) et le squat parallèle (SP), plus le saut et le lancer. Les sujets ont exécuté 3 séries de 3-6 répétitions avec une charge de 50-80% 4 répétition maximum (RM)-DC; et 3 séries de 3-6 répétitions avec une charge de 30-75% de 4 RM par série. A la fin, tous les athlètes ont accompli 3 exercices explosifs de force : (i) des sauts verticaux dans une boîte; (ii) des sauts verticaux en ajoutant des poids (3 séries de 5 répétitions); (iii) lancer le ballon lesté (3 séries de 10 répétitions avec un ballon lesté de 3kg). Des repos de 2 minutes étaient autorisés entre les séries et entre les catégories. Il y avait un manque d'interaction intéressant entre les groupes (J ou NJ) dans les effets de temps pour tous les tests ( $p > 0.05$ ), sauf pour le développé-couché dans le test final ( $p = 0.025$ ), indiquant que les deux groupes répondaient de façon similaire au programme d'entraînement. Il y avait, cependant, plusieurs effets principaux pour le temps, montrant des améliorations considérables pour le groupe entier. En fait, pour tous les paramètres physiques, les J et NJ se sont améliorés de façon significative ( $p < 0.001$ ). Finalement, aucune relation n'a été trouvée entre tous les paramètres physiques et les changements de performance de tous les groupes.

**Mots clés:** volley, force dynamique maximale, sauts, distance de lancer de ballon.

O objectivo deste estudo foi investigar as alterações nos parâmetros físicos produzidas ao longo de uma época de treino força (TF) em 35 jogadores de voleibol de elite que competem na liga portuguesa. Diferenças nas respostas adaptativas entre os jogadores que jogaram mais tempo (titulares: T) e os jogadores que foram utilizados preferencialmente como suplentes (não titulares : NT) foram analisadas. O programa de TF foi aplicado durante 12 semanas, com duas sessões semanais (Tabelas 2A e 2B). Os principais exercícios TF foram, respectivamente, o supino (SUP) e agachamento paralelo (AP); para além de saltos e levantamentos Olímpicos. Os jogadores realizaram 3 séries de 3-6 repetições com uma carga de 50-80% 4RM-SUP, e 3 séries de 3-6 repetições com uma carga de 30-75% de 4RM-AP. De seguida, todos os atletas realizaram três exercícios de força explosiva: (i) saltos verticais para cima de uma caixa, (ii) saltos verticais com pesos adicionais (3 séries de 5 repetições), (iii) lançamento de bolas medicinais (3 séries de 10 repetições, com uma bola medicinal de 3 kg). Foram autorizadas pausas de 2 minutos entre as séries e as exercícios. Não existiram diferenças significativas entre ambos os grupos (T ou NT) para qualquer um dos testes ( $p > 0,05$ ), excepto para o supino no teste final ( $p = 0,025$ ), indicando que ambos os grupos responderam de forma similar ao programa TF. Houve, no entanto, alterações significativas, quer de força máxima, quer de força explosiva para cada um dos grupos. De facto, para todos os parâmetros físicos os T e os NT melhoraram significativamente ( $p < 0,001$ ). Finalmente, não foi encontrada relação entre todos os parâmetros físicos e mudanças no desempenho em ambos os grupos.

**Palavras-chave:** voleibol, máxima força dinâmica, salto, distância do lançamento da bola.

El propósito de este estudio fue investigar los cambios producidos en parámetros físicos de 35 jugadores elite de voleibol compitiendo en la liga elite Portuguesa, como resultado de un programa de entrenamiento de resistencia (RT) durante la temporada. En el estudio se analizaron las diferencias en respuesta de adaptación de los jugadores que jugaban la mayor cantidad del tiempo (iniciadores S) y los jugadores primordialmente participando como sustitutos (no iniciadores NS). El programa RT consistió de 2 sesiones a la semana durante 12 semanas (tablas 2a y 2b). Los ejercicios principales fueron la extensión de brazos en banco (BP), y las sentadillas con pies paralelos (PS), junto a ejercicios de salto y lanzamientos. Los participantes realizaban 3 series de 3-6 repeticiones con una carga de 50-80% de 4RM-BP, y 3 series de 3-6 repeticiones con una carga de 30-75% de 4RM-PS. Al final los jugadores realizaban tres ejercicios de fuerza explosiva: (i) saltos verticales a un cajón, (ii) saltos verticales con peso adicional (3 series de 5 repeticiones); (iii) lanzamientos de balón medicinal (3 series de 10 repeticiones con balón de 3kg). Se permitían descansos de 2 minutos entre las series y entre categoría de ejercicio. De gran interés fue la ausencia de interacción de efectos por grupo (S o NS) y tiempo a través de todas las pruebas ( $p > 0,05$ ), excepto en la extensión de brazos en la prueba final ( $p = 0,025$ ), indicando una respuesta similar de ambos grupos al programa de entrenamiento. Sin embargo, se encontraron varios efectos significativos en cuanto al tiempo en todo el grupo. De hecho, se encontró una mejora significativa en todos los parámetros para S y NS ( $p < 0,001$ ). Finalmente, no se encontró una relación significativa entre los parámetros físicos y los cambios en la ejecutoria para ninguno de los grupos.

**Palabras Claves:** voleibol, fuerza dinámica máxima, salto, distancia en lanzamiento de balón

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## INTRODUCTION

Team Volleyball, as several other ball games, requires not only technical and tactical skills, but also a great deal of physical fitness (Marques, González-Badillo, & Kluka, 2006; Marques, van den Tillaar, Vescovi, & González-Badillo, 2008). During a long competitive season, typical of any European league, Team Volleyball coaches mainly concentrate on technical and tactical drills, reducing the volume of training devoted to strength and conditioning activities. Unfortunately, few studies have examined how these parameters change during a competitive season in a large data of elite Team Volleyball players (TVPs). Only one study (Fry et al., 1991) appears to have had similar goals; however, the research was conducted during the off season and using a limited data set of female collegiate players.

Usually, the potentially greater the competitive responsibilities placed on actual starters in a sport (Kraemer et al., 2004), and the differential physiological and performance effects related to starters (S) or non starters (NS) status, have not been clarified in prior Team Volleyball research. In fact, little information has so far been produced relative to the adaptive responses in strength and power over the course of competitive ball game sports to examine possible differences between S and NS of the same team.

The aim of this study was to investigate the changes in physical parameters produced during an in-season resistance training (RT) program of 35 top TVPs. Moreover, differences in the adaptive responses between players who played most of the time (starters: S) and players that were mainly used as substitutes (non starters: NS) were analysed.

## METHODS

### Experimental Design and Approach to the Problem

This research was a longitudinal project completed over three professional competition in-seasons. All players competed in 2-3 matches per week, combined with volleyball practice sessions as well as the strength and conditioning regimen. The athletes were familiar with all of the testing and training exercises, as they had completed a pre-season training routine prior to the initiation of the current in-season study.

The RT program consisted of 2 sessions per week over 12 weeks (Tables 1a and 1b). The main RT exercises were, respectively, the bench press (BP) and parallel squat (PS), plus jumping and throwing. Subjects performed 3 sets of 3-6 reps with a load of 50-80% 4RM-BP; and 3 sets of 3-6 reps with a load of 30-75% of 4RM-PS. On completion, all athletes then performed three explosive strength exercises: (i) vertical jumps into a box; (ii) vertical jumps with additional weights (3 sets of 5 reps: loads varied between 10kg and 40kg); (iii) throwing medicine ball (3 sets of 10 reps. with a 3kg medicine ball). Rests of 2 minutes were permitted between sets and between categories.

## Subjects

A group of 35 professional male TVPs (mean  $\pm$  SD age:  $26.6 \pm 3.1$  years) participated in the study. Additionally, participant subjects were divided in 2 groups: starters (S;  $n = 22$ ), and non-starters (NS;  $n = 13$ ) based on the amount of game time each played during the season. Starters and Non Starters participated, respectively, in 81.7% and 18.3% of total game time. The physical characteristics (mean  $\pm$  SD) of the S and NS, respectively, were: age,  $26.9 \pm 3.0$  and  $24.6 \pm 3.49$  years; height,  $194.3 \pm 0.7$  and  $192 \pm 0.69$  cm; body mass,  $93.4 \pm 8.3$  and  $89.6 \pm 6.6$  kg. Seventy percent of the subjects were national first team players who played on European Champion, European league, World League, World Championship and Olympic Games winning teams. All players represented the same club, which has been rated as one of the best elite volleyball teams in Portugal. No players had taken exogenous anabolic-androgenic steroids or other drugs or substances expected to affect physical performance or hormonal balance during this study. All of the subjects gave their informed consent and volunteered to participate, which had the approval of the Academy's Ethical Advisory Commission.

### Testing Procedures

A detailed description of the muscular power testing procedures can be found elsewhere (Marques et al., 2008). These were tests that could be rapidly administered and were highly specific to Team Volleyball.

### Countermovement Jump

Countermovement jump (CMJ) height was measured using a trigonometric carpet (Ergo jump Digitime 1000, Digest Finland) by the methods previously described (Marques et al., 2008). Subjects began from a standing position, performed a crouching action followed immediately by a jump for maximal height. Each subject completed three attempts with two minutes of rest allowed between trials. The hands were on the hips throughout the entire jump. The average of the two best trials was used for analysis. The unloaded CMJ had an intraclass correlation coefficient (ICC) of 0.98 and a coefficient of variation (CV) of 3.4%.

### Medicine Ball Throw

An overhead medicine ball throw was used to evaluate the upper body muscular power. While standing, subjects held a 3kg medicine ball in both hands in front of the body with arms relaxed. The athletes were instructed to throw the ball over their heads as far as possible. A backward countermovement was allowed during the action. Five trials were performed with a one-minute rest between each trial. An average of the best four throws was subsequently used for analysis. The distance of the throw was recorded to the nearest 1cm. The ball throwing distance (BTd) showed an ICC of 0.93 and a CV of 6.4%.

## Maximal Dynamic Strength

Upper and lower body maximal strength tests were carried out using a 4-repetition maximum bench press (4RM-BP) and a 4RM parallel squat (4RM-PS). The 4RM-BP test was conducted on a standard bench and required the subject to perform an eccentric-concentric action. Beginning with the arms fully extended, the athletes lowered the bar towards the chest reaching 90° abduction of the shoulder joint and 90° flexion of the elbow before returning to the start position. Repetitions performed incorrectly were not included in the count. The protocol began with 50kg and increased 10, 5, and 2.5kg during subsequent sets until four complete repetitions could not be performed. All subjects performed 5-6 reps for each warm-up set. The rest time between sets was 3 minutes. In the 4RM-PS, the bar was placed across the trapezium at a self-chosen location and the starting position knee angle was set at 180° (full leg extension). The squat was performed to the parallel position, i.e. when the greater trochanter of the femur was lowered to the same level as the knee. Two researchers monitored the correct position. The subject then lifted the weight until his knees were fully extended. Each player started with identical weights of 90kg, performing on command a series of 4 complete parallel squats. Subsequently, the weight was increased by 10kg increments until the subject was unable to reach full leg extension. The last bearable load was determined as being 4RM. Five-minute rest intervals separated the 4RM-BP and 4RM-PS tests. The 4RM-BP showed an ICC of 0.96 and a CV of 5.6%. The 4RM-PS reported an ICC of 0.92 and a CV of 5.7%.

## Statistical Analyses

Mean and standard deviations were calculated for all variables. All data were checked for distribution normality

with the Shapiro-Wilkes test. A paired sample and independent student t tests were also applied to measures performance changes and to compare active game time in order to determine S and NS, which proved to be significantly different (i.e., again, S and NS participated in 81.8% and 18.2% of total game time, respectively). The Pearson correlation coefficient was calculated and the level accepted for statistical significance was  $p \leq 0.05$ .

## RESULTS

Of greatest interest was the lack of any interactions for group (S or NS) by time effects for any of the tests ( $p > 0.05$ ), except for bench press in the final test ( $p = 0.025$ ). This indicated that both groups responded similarly to the training program (Table 2). There were, however, several main effects for time, showing significant improvements for the entire group of population (Table 3). In fact, for all physical parameters both S and NS improved significantly ( $p < 0.001$ ). Finally, no relationship was found between all physical parameters and the changes in performance for all groups.

## Discussion

The primary aim of this study was to examine the changes in strength and power performance during a competitive season experienced group of elite male volleyball players. Results revealed that improvements in upper and lower body strength as well as jumping and throwing are possible during the competitive phase of the training cycle by using a combination of resistance exercises with moderate loads and explosive drills.

The potentially greater competitive stress placed on the S, and the differential physiological and performance effects related to S or NS status have not been clarified in prior

**Table 1a. Strength training programs between week 0 and week 6.**

Exercises	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6
Squat (1)	30: 3x6	30: 3x6	40: 3x6	40: 3x6	45: 3x6	45: 3x6
CMJ with additional load	3x5:10kg	3x5:10kg	3x5:10kg	3x5:10kg	3x5:20kg	3x5:20kg
CMJ into a box	5x6	5x6	5x6	5x6	5x6	5x6
Bench press (2)	50: 3x6	50: 3x6	50: 3x6	50: 3x6	60: 3x6	60: 3x6
Ball throwing	3x10:3kg	3x10:3kg	3x10:3kg	3x10:3kg	3x10:3kg	3x10:3kg
Exercises	Session 7	Session 8	Session 9	Session 10	Session 11	Session 12
Squat (1)	50: 3x6	50: 3x6	55: 3x6	55: 3x6	55: 3x6	60: 3x6
CMJ with additional load	3x5:30kg	3x5:30kg	3x5:30kg	3x5:30kg	3x5:30kg	3x5:35kg
CMJ into a box	5x6	5x6	5x6	5x6	5x6	5x6
Bench press (2)	60: 3x6	70: 3x6	70: 3x6	70: 3x6	75: 3x4	75: 3x4
Ball throwing	3x10:3kg	3x10:3kg	3x10:3kg	3x10:3kg	3x10:3kg	3x10:3kg

(1): Example: 50: 3x6: 3 sets of 6 reps with 50 percent of 4RM-PS; (2): Example: 60: 3x6: 3 sets of 6 reps with 60 percent of 4RM-BP.

**Table 1b.** Strength training programs between week 7 and week 12.

Exercises	Session 13	Session 14	Session 15	Session 16	Session 17	Session 18
Squat (1)	65: 3x6	65: 3x6	65: 3x6	70: 3x5	70: 3x5	70: 3x5
CMJ w/ additional load	3x5:35kg	3x5:35kg	3x4:40kg	3x4:40kg	3x4:40kg	3x4:40kg
CMJ into a box	5x6	5x6	5x6	5x6	5x6	5x6
Bench press (2)	75: 3x6	75: 3x6	75: 3x6	75: 3x6	80: 3x3	80: 3x3
Ball throwing	3x10:3kg	3x10:3kg	3x10:3kg	3x10:3kg	3x10:3kg	3x10:3kg
Exercises	Session 20	Session 21	Session 22	Session 23	Session 24	Session 25
½ Squat (1)	70: 3x5	70: 3x5	75: 3x4	75: 3x4	60: 3x6	Testing
CMJ w/ additional load	3x4:40kg	3x4:40kg	3x4:40kg	3x4:40kg	3x5:35kg	
CMJ into a box	5x6	5x6	5x6	5x6	5x6	
Bench press (2)	80: 3x3	80: 3x4	80: 3x4	80: 3x4	70: 3x6	
Ball throwing	3x10:3kg	3x10:3kg	3x10:3kg	3x10:3kg	3x10:3kg	

(1): Example: 50: 3x6: 3 sets of 6 reps with 50 percent of 4RM-PS; (2): Example: 60: 3x6: 3 sets of 6 reps with 60 percent of 4RM-BP.

sport research, especially with regard to volleyball players. The present study found opposite results compared by those observed by Fry et al. (1991). However, while differences appear to exist in physical characteristics between starters and non-starters, it was shown that most physical and performance variables for S and NS can be improved with a comprehensive strength and conditioning program for female collegiate volleyball players (Fry et al., 1991).

It is difficult to compare the results because they markedly differ in a number of factors, including gender, participant's experience, training regimen, and player's level. Another factor that could possibly contribute to the different outcomes between previous investigations (Fry et al., 1991) is related to the relationships between testing periods (off season versus in-season). Furthermore, only the present study and experiment published by Fry et al. (1991) investigated the differences in the adaptive responses between volleyball players who played most of the times and volleyball players that were mainly used as substitutes.

The present results showed that enhancements in upper and lower body strength as well as jumping and throwing are possible during the competitive phase of the training cycle by using a combination of resistance exercises with moderate loads and explosive drills. Therefore, designing a training regimen to simply maintain strength and power during the in-season may not be as advantageous for physical performance. However, a delicate balance must be achieved as practice and competition demands place great stress on athletes (Kraemer et al., 2002). It is difficult to compare results in the scientific literature when studies differ markedly in their design factors, including mode, frequency, intensity, frequency of training, and training history of subjects.

**Table 2.** Differences between starters and non starters in physical performance tests during the course of a 12-week competitive Team Volleyball training program.

Tests	Status	Mean	Std. Deviation
AGE	Starters	26.9	3.0
	Non Starters	24.6	4.0
HEIGHT	Starters	1.9	0.1
	Non Starters	1.9	0.1
WEIGHT	Starters	93.4	8.0
	Non Starters	89.6	6.7
1RM-BP 1	Starters	90.7	13.7
	Non Starters	83.8	15.8
1RM-BP 2 *	Starters	100.7	13.0
	Non Starters	91.2	14.3
1RM-PS 1	Starters	143.3	19.1
	Non Starters	129.2	21.8
1RM-PS 2	Starters	158.1	20.9
	Non Starters	150.8	18.9
BTd 1	Starters	11.9	1.2
	Non Starters	11.8	1.2
BTd 2	Starters	12.9	0.8
	Non Starters	12.3	1.1
CMJ 1	Starters	45.6	4.3
	Non Starters	44.7	3.5
CMJ 2	Starters	48.2	5.4
	Non Starters	47.3	2.4

1 - First evaluation, in the beginning of the program; 2 - Second evaluation, in the end of the 12-week program.

\*p=0.025.

**Table 3.** Changes in physical performance during the course of a 12-week competitive Team Volleyball training program in starters and non starters.

Status	Tests	Mean	Std. Deviation
Starters**	1RM-BP 1	90.7	13.7
	1RM-BP 2	100.7	13.0
Non Starters**	1RM-BP 1	83.8	15.8
	1RM-BP 2	91.2	14.3
Starters*	1RM-PS 1	143.3	19.1
	1RM-PS 2	158.1	20.9
Non Starters*	1RM-PS 1	129.2	21.8
	1RM-PS 2	150.8	18.9
Starters*	BTd 1	11.9	1.2
	BTd 2	12.9	0.8
Non Starters**	BTd 1	11.8	1.2
	BTd 2	12.3	1.1
Starters**	CMJ1	45.6	4.3
	CMJ2	48.2	5.4
Non Starters**	CMJ1	44.7	3.5
	CMJ2	47.3	2.4

1 - First evaluation, in the beginning of the program; 2 - Second evaluation, in the end of the 12-week program.  
 \*\*p<0.001; \*p<0.05

## CONCLUSION

Designing a training regimen to simply maintain strength and power during the in-season may not be as advantageous for physical performance. Moreover, while no differences appear to exist in performance between starters and non-starters, it was shown that most performance variables for ST and NS can be improved with a comprehensive strength and conditioning program for top Volleyball players.

## IMPLICATIONS FOR COACHING

Coaches, while devising training programs, would be well served to design training regimens to maintain strength and power during the in-season for ALL athletes. With no differences appearing between starters and non-starters in this study, it becomes evident that special considerations need not be given to starters above non-starters. Individual differences still need to be attended to, but not categorized by starters and non-starters.

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# Performance effectiveness in Complex II of Olympic-level male and female volleyball players

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## Abstract

The purpose of this study was to examine the dependence of performance effectiveness in Complex II (CII) and to investigate possible differences in performance effectiveness between Olympic-level volleyball male (M) and female (F) players. Performance of sequential actions of set-to-counter-attack (M = 644, F = 947) from 16 volleyball games (M=8, F=8) of teams competing in the final phase of the 2004 Olympic Games was assessed based on a 5-point numerical rating scale (Eom, 1989) by a 3-member group of expert coaches. Statistics included cross tabulation procedure to calculate performance percentages and frequencies, X<sup>2</sup> criterion to examine possible differences in the distribution of performance assessment in counter-attack for every performance assessment in set and Z criterion to compare performance effectiveness between genders (P<0.05). Results showed a significant (P<0.01) correlation between preceding and succeeding actions' overall performance in both genders. The higher the performance effectiveness of M and F setters was, the higher the performance effectiveness of M and F attackers, accordingly. Performance effectiveness in CII was found to be similar between genders. Based upon these findings, training should focus on making attackers able to counter-attack successfully against a solid team block under less favorable conditions, especially when they receive a low accuracy set.

**Key words:** Volleyball, Olympic-level, performance, set, counter-attack, gender

本研究是要探討 Complex II (CII) 的表現效率和男女奧運級排球選手的差異。研究樣本為2004年雅典奧運最後階段的16場排球比賽(8場男子組, 8場女子組), 研究的動作為從發球到面對對方攻擊的防守到組織進攻的連續動作(男子組=664, 女子組=947)。研究是根據Eom (1989)制定的五尺度數字評分表, 由三位受過專門訓練過的教練群進行樣本調查。研究者使用的統計分析包括交叉表來計算樣本的百分比和次數, 卡方考驗檢驗以舉球為基礎的攻擊組合成功率, 使用Z檢驗來比較男女球員的表現效率 (p<.05)。研究結果指出在男女組都發現先行和整體表現的成功率有高度的相關 (p<.01)。男女選手的舉球員的表現效率越高的話, 男女攻擊手的表現效率也提高, 然而男女選手在CII的表現效率是相近的。本研究的結論為排球訓練應該注意攻擊手在對方球隊擁有優秀封網能力而處於劣勢情況下的連續攻擊能力, 尤其是己方攻擊手得到較差的作球後的攻擊。

**關鍵字:** 排球、奧運等級、表現、舉球、後排攻擊、性別

Le but de cette étude était d'examiner la dépendance de l'efficacité de la performance dans le Complexe II (CII) et de déterminer des différences possibles de l'efficacité de la performance entre les joueurs de volley hommes au niveau olympique (H) et les femmes (F). La performance des actions séquentielles de passe à contre-attaque (H=644, F=947) de 16 matchs de volley (H=8, F=8) des équipes en compétition dans la phase finale des Jeux Olympiques de 2004 a été évaluée sur la base de 5 points de l'échelle numérique de classement (Eom, 1989) par un groupe de 3 membres d'entraîneurs experts. Les statistiques ont inclut la procédure de tabulation en croix pour calculer les pourcentages de performance et de fréquences, le critère X<sup>2</sup> pour examiner les différences possibles dans la distribution de l'évaluation de la performance en contre-attaque pour chaque évaluation de la performance en série et le critère Z pour comparer l'efficacité de la performance entre les sexes (P<0.05). Les résultats ont montré une corrélation importante (P<0.01) entre la performance générale des actions précédentes et suivantes chez les deux sexes. Plus l'efficacité de la performance des passeurs H et F était haute, plus l'efficacité des attaquants H et F, par conséquent, était haute. On a trouvé que l'efficacité de la performance en CII était similaire entre les sexes. L'entraînement devrait se concentrer sur la préparation des attaquants à contre-attaquer avec succès le contre d'une équipe solide dans des conditions moins favorables, surtout quand ils reçoivent une passe de basse précision.

**Mots clés:** Volley, niveau olympique, performance, passe, contre-attaque, sexe.

O objetivo deste estudo foi examinar a dependência da eficácia do desempenho no Complexo II (CII) e investigar possíveis diferenças na eficiência de desempenho entre jogadores de nível olímpico masculino (M) e feminino (F). A performance de ações sequenciais de contra-ataque (M = 644, F = 947), em 16 jogos de voleibol (M = 8, F = 8) de equipas a competir na fase final dos Jogos Olímpicos de 2004, foi avaliado com base numa escala de avaliação numérica em

5 pontos (Eom, 1989) por um grupo constituído por 3 treinadores especializados. Estatísticas, incluindo o processo de tabulação cruzada para calcular percentagens de desempenho e frequência, o critério X<sup>2</sup> para examinar eventuais diferenças na distribuição da avaliação de desempenho em contra-ataque para cada avaliação de desempenho em conjunto e critério Z para comparar a eficácia de desempenho entre os sexos ( $P < 0,05$ ). Os resultados mostraram uma correlação significativa ( $P < 0,01$ ) entre as ações precedentes e posteriores na performance geral em ambos os sexos. Quanto maior for a eficácia do desempenho dos passadores M e F, maior será a eficácia do desempenho dos atacantes M e F. Eficácia no desempenho na CII foi semelhante entre os sexos. O treino deve focar-se em fazer os atacantes capazes de contra-atacar com sucesso contra um bloco de uma equipa sólida, em condições menos favoráveis, especialmente quando eles recebem um set de baixa precisão.

**Palavras-chave:** voleibol, nível Olímpico, set, desempenho, contra-ataque, género

El propósito de este estudio fue examinar la interdependencia de la efectividad del Complejo II (CII) e investigar posibles diferencias en la efectividad de la ejecutoria en jugadores masculinos (M) y femeninos (F) de voleibol de nivel Olimpico. La secuencia de ejecutoria de acciones desde el acomodo/levantada hasta el contra-ataque (M = 644, F = 947) de 16 partidos de voleibol (M = 8, F = 8) de equipos compitiendo en los Juegos Olímpicos del 2004 fueron analizados por un grupo de tres entrenadores expertos usando una escala numérica de 5 puntos (Eom, 1989). El análisis estadístico incluyó calculode tabulaciones cruzadas para determinar porcentajes y frecuencias, criterio X<sup>2</sup> para examinar diferencias en las distribuciones de la ejecutoria en el contra-ataque para cada valorización del acomodo; y criterio Z para calcular diferencias en la eficiencia entre sexo ( $P < 0.05$ ). Los resultados reflejaron una correlación significativa ( $P < 0.01$ ) entre la sucesión de acciones en la ejecutoria general de ambos sexos. Se encontró que mientras mas alta fuera la eficiencia de los colocadores/levantadores M y F, mas alta la eficiencia de los atacantes M y F. La eficiencia en la ejecutoria del CII fue similar en ambos sexos. El entrenamiento debe enfatizar en desarrollar atacantes capaces de contra-atacar exitosamente contra un buen bloqueo bajo condiciones poco favorables especialmente con una colocación poco precisa.

**Palabras Claves:** Voleibol, nivel Olímpico, ejecutoria, levantada, contra-ataque, género

## INTRODUCTION

Volleyball is an interactive game and can be divided into the two main phases of attack and defense, each having three or four sequential skill events that are expected to occur sequentially in a hierarchical order (Eom & Schutz, 1992; Fraser, 1988). It is, therefore, logical to expect that players' performances in one phase of the game will be dependent upon their performances in the previous phase. Prior studies have focused on assessing performance in isolated events of the game by identifying players' skill performances that could predict the team's final classification and/or success (Ejem & Horak, 1980; Eom & Schutz, 1992; Li, 2001; Marelić et al., 2004; Palao et al., 2004; Zetou et al., 2006; Zhang, 2000). More recent studies attempted to examine the dependence of performance effectiveness. Particularly, Bergeles and colleagues (2009) showed that Olympic-level male and female players were characterized by dependence of performance effectiveness in Complex I (the situation when the team that receives the serve performs in a sequential order the actions of reception, second set and attack). Specifically, they found that male and female attackers had a higher percentage of good, very good and excellent performance in attack when preceding performance of setters was assessed as good, very good and excellent, respectively (Bergeles et al., 2009). Furthermore, Barzouka et al. (2006) showed that Olympic-level female attackers had a higher percentage of excellent performance in both CI and Complex II (the situation when the opposing team will perform in a sequential order the actions of serve, block, floor defence, set and counter-attack) compared to setters, when the preceding actions' performance was assessed as either good or very good. Papadimitriou et al. (2004) found that the quality of reception of the opponents' serve differentiated significantly the offensive strategy in national-level male setters. Moreover, in national-level male teams, performance in the preceding action of set affected performance in the succeeding action of block and particularly the structure of the opponent's block (Paschali et al., 2004).

Bergeles et al. (2009) also reported that male attackers' average and very good performance effectiveness in CI was significantly lower than their female counterparts' respective performance effectiveness. Even though there has been previous research documenting differences between men and women in terms of upper and lower body absolute muscular strength (Bishop et al., 1987), jumping performance (Carter et al., 1994) and selected physical and performance characteristics (F.I.V.B., 2004 Olympic Games), which could relate to differences in volleyball performance between genders, there exists limited information on comparing performance effectiveness between male and female volleyball players.

The purpose of this study was twofold; first, to examine the performance effectiveness in CII (set-to-counter-attack) of Olympic-level male and female volleyball players; and second, to compare performance effectiveness in CII between genders. It was hypothesized that performance in the preceding action of set would affect performance in the

succeeding action of counter-attack, and that performance of male setters and attackers would be higher than performance of female setters and attackers.

## METHODS AND PROCEDURES

### *Sample*

The study's sample consisted of the evaluated actions of male (M) and female (F) setters and attackers (M = 644, F = 947) in CII from 16 volleyball games (M = 8, F = 8) of teams, who competed in the final phase of the Athens 2004 Olympic Games. The evaluated actions of male and female players, which constituted sets of 2 consecutive contacts with the ball (set-to-counter-attack) were defined as dependent variables.

### *Description of performance effectiveness rating scale*

Assessment of setters' and attackers' performance was based on the 5-point numerical rating scale proposed by Eom (1989), which quantifies the effectiveness of each skill performance in volleyball within a range of points from 0 to 4 (with a slight modification in the naming of the scores, thus in our study average corresponds to poor, good to fair and very good to good). The effectiveness of set performance, which refers to the accuracy of set, is evaluated in relation to: a) the attacker in terms of position, trajectory, distance from the net and timing of the set, and b) the condition of the opponent's block against that attacker. Specifically, a set that forced the attacker to give an easy or down ball or a free ball to the opposition regardless of the condition of the opponent blocking is assessed with performance score 1 and is evaluated as poor performance. A set that allowed the opponent's blockers to set up a solid block against the attacker who has been given the set, is assessed with performance score 2 and is evaluated as average performance. An accurate set resulting in incomplete two-man block<sup>1</sup> or a moderate set<sup>2</sup> resulting in one-man or incomplete two-man block is assessed with performance score 3 and is evaluated as good performance. An accurate set resulting in one or none opponent's blocker is assessed with performance score 4 and is evaluated as excellent performance (Eom, 1989). Data analysis did not include any actions of setters that were assessed with performance score 0 (situation when the setter made a mistake resulting in losing a point or side-out), since the action of counter-attack did not succeed.

The attack is evaluated by the degree of its effectiveness. Specifically, when the attacker made a mistake resulting in losing a point or side-out, this action is assessed with performance score 0 and is evaluated as an error. When the attacker attacked with a down ball or easy ball or free

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<sup>1</sup> Incomplete block refers to the situation where one of the blockers jumped in the wrong spot or was late to set up a solid two-man block against the attacker.

<sup>2</sup> Moderate set is defined as a high or medium or quick set in relation to the attacker in terms of height, trajectory, place along the net and distance from the net.

ball, this action is assessed with performance score 1 and is evaluated as poor performance. In the situation when the attacker attempted to kill but the attack was dug up by the opponent's digger regardless of the quality of the dig, performance of this action is assessed with score 2 and is evaluated as average performance. Furthermore, in the situation when the attacker attacked in such a way that his/her team could repeat the attack, performance of this action is assessed with performance score 3 and is evaluated as good performance. Finally, when the attacker gained a point or achieved a side-out, performance of this action is assessed with score 4 and is evaluated as excellent performance (Eom, 1989).

#### Reliability of assessment procedure

A three-member group of experienced coaches assessed the evaluated actions of set-to-counter-attack from 16 volleyball games, competing in the final phase of the 2004 Olympic Games, as afore-mentioned. Raters became familiarized with the assessment procedure by evaluating the actions of players in five games from the preliminary phase of the 2004 Olympic Games. In order to calculate intra-rater reliability, each rater evaluated the same actions of players on two separate occasions (day 1 and day 6), while inter-rater agreement was calculated on day 6 of the familiarization period. In the case of a discrepancy in assessment among raters, the median performance score was chosen, i.e. if performance of set was assessed with scores 2, 2, and 3 by raters, that action was assessed with performance score 2. Intra-rater and inter-rater reliability coefficients were found to be  $r=0.914$  and  $r=0.895$ , respectively, indicating high consistency in the assessment procedure.

#### Statistical Analysis

The calculation of frequencies and percentages derived from the pair of sequential actions set-to-counter-attack in every performance score was made with the crosstabulation method with levels 4 x 5 for performance assessment of male and female setters and attackers, respectively. In order to test whether performance assessment of counter-attack relates overall to performance assessment of set, the Spearman's correlation for ranked data was used, separately for male and female players. Subsequently, the X<sup>2</sup> criterion was used to examine possible differences in the distribution of percentages in performance assessment of counter-attack actions in every performance score for set, separately for male and female players (SPSS statistical software, v.12). Moreover, possible differences between male and female players' performance assessment (%) in each counter-attack performance score separately for every performance score of set were tested to significance with the Z criterion for independent samples (StatGraphics Plus statistical software, v.4). Level of significance for all tests was set at  $P < 0.05$ .

#### RESULTS

Correlation between performance in set and counter-attack Overall, performance assessment of counter-attack correlated significantly ( $p < 0.01$ ) with performance assessment of set, both in male (Spearman's  $\rho = 0.387$ ) and female volleyball players (Spearman's  $\rho = 0.535$ ).

**Table 1:** Performance assessment of male and female volleyball players in the preceding action of set in relation to performance in the succeeding action of counter-attack (Complex II).

		Performance score of counter-attack						
	Performance score of set	0 % (N)	1 % (N)	2 % (N)	3 % (N)	4 % (N)	X <sup>2</sup>	P<
Men Women	1	10.8 (8)	77 (57)	5.4 (4)	1.4 (1)	5.4 (4)	152.1	0.001
		10.1 (12)	83.2 (99)	4.2 (5)	-	2.5 (3)	216.4	0.001
Men Women	2	21.4 (79)	4.9 (18)	43.8(162)	3.2 (12)	26.8 (99)	207.8	0.001
		21.1 (104)	16.2 (80)	34.2 (169)	6.7 (33)	21.9 (108)	98.41	0.001
Men Women	3	21.1 (24)	0.9 (1)	33.3 (38)	4.4 (5)	40.4 (46)	68.54	0.001
		7.5 (16)	4.2 (9)	22.6 (48)	10.8 (23)	54.7 (116)	180.1	0.001
Men Women	4	7 (6)	-	10.5 (9)	11.6 (10)	70.9 (61)	97.16	0.001
		4.1 (5)	0.8 (1)	10.7(13)	2.5 (3)	81.8 (99)	292.4	0.001
Men Women	Total	18.2 (117)	11.8 (76)	33.1 (213)	4.3 (28)	32.6 (210)	209.7	0.001
		14.5 (137)	20 (189)	24.8 (235)	6.2 (59)	34.5 (326)	302.2	0.001

Note: Performance score rating 0: error, 1: average, 2: good, 3: very good, 4: excellent. X<sup>2</sup> refers to significance testing of the distribution of performance assessment scores for attack per every performance score of set, separately for men and women.

**Comparison in performance effectiveness between set and counter-attack**

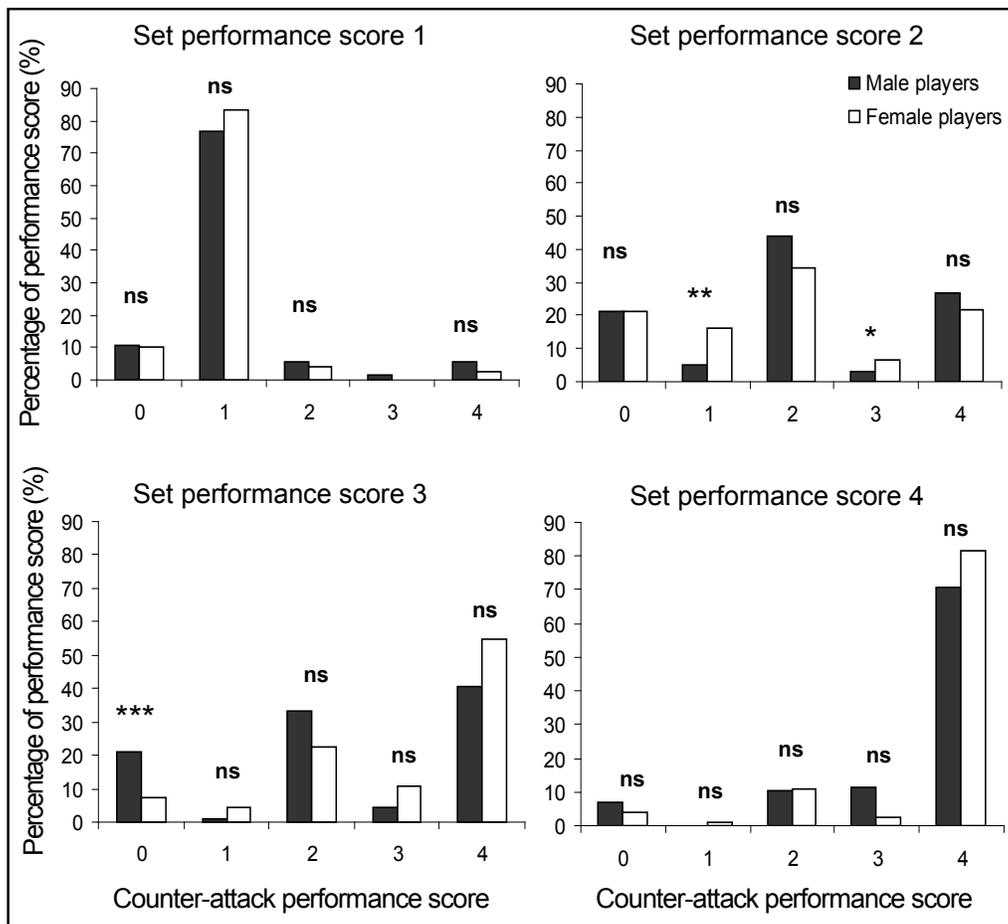
Examination of the distribution of percentages corresponding to all levels of performance assessment in counter-attack for performance scores corresponding to average, good, very good and excellent performance in set showed significant ( $p < 0.001$ ) differences both in male ( $X^2 : 68.5-207.8$ ) and female ( $X^2 : 98.4-292.4$ ) volleyball players (Table 1). Results on the comparison between preceding performance in set and succeeding performance in counter-attack showed that the majority of male attackers' counter-attack actions resulted either in good (33.1% (N = 213 actions)) or in excellent (32.6% (N = 210 actions)) performance, independently of the performance of setters. For female attackers, the majority of their counter-attack actions, independently of the preceding performance of setters, resulted in excellent (34.5% (N = 326 actions)) performance (Table 1). Furthermore, it can be seen that when performance of the preceding action of set was assessed as average (performance score 1), the highest percentage of the succeeding action of counter-attack resulted in average performance, both in male (77.0%) and female (83.2%) attackers. Accordingly, when performance of the preceding action of set was assessed as good (performance score 2), the highest percentage of the succeeding action of counter-attack resulted in good

performance (M = 43.8%; F = 34.2%), whereas, when preceding performance of male and female setters was assessed as either very good or excellent (performance scores 3 and 4), then the majority of actions in counter-attack resulted in excellent performance (M = 40.4% and 70.9%; F = 54.7% and 81.8%) (Table 1).

**Comparison in performance of set-to-counter-attack between genders**

Figure 1 presents results on the comparison in performance assessment of set in relationship with performance assessment in counter-attack between male and female players. Female attackers had a significantly higher percentage of counter-attack actions that were assessed as either average (16.2% vs 4.9%,  $Z = 3.02$ ,  $p < 0.01$ ) or very good (6.7% vs 3.2%,  $Z = -2.10$ ,  $p < 0.05$ ) compared to male attackers respective counter-attack actions, when the preceding action's performance was assessed as good (performance score 2) (Figure 1; Table 1). On the contrary, male attackers had a significantly higher percentage of erroneous counter-attack actions (assessed with performance score 0) than female attackers (21.1% vs 7.5%,  $Z = -3.38$ ,  $p < 0.001$ ) in the case when the preceding action's performance was assessed as very good (performance score 3) (Figure 1; Table 1).

**Figure 1:** Comparison between male and female volleyball players' performance assessment in the preceding action of set in relation to performance in the succeeding action of counter-attack (Complex II).



## DISCUSSION

The purpose of this investigation was twofold; first, to examine performance of Olympic-level male and female volleyball players in the sequential actions of set-to-counter-attack that constitute an important part of CII of the game; and second, to investigate possible differences in set performance in relation with counter-attack performance between genders.

### *Performance effectiveness in CII*

Volleyball is a game of interactive nature, where it is logical to expect that players' performances in one phase of the game will be dependent upon their performances in the previous phase. Results showed a significantly ( $P < 0.01$ ) high correlation between preceding and succeeding actions' overall performance, both in male and female players, thus providing ground to accept the first hypothesis. By applying a performance assessment rating scale (Eom, 1989) that uses adequate criteria to evaluate the effectiveness of the skills of set and counter-attack, it was possible to get an insight on the dependence of performance effectiveness between those two sequential skills. Specifically, present results showed that when male and female setters performed either average or good, then the effectiveness of succeeding performance of male and female attackers in counter-attack was average and good, accordingly (Table 1). Moreover, it was observed that when male and female setters' performance was either very good or excellent, then succeeding performance of attackers in counter-attack was excellent (Table 1). According to the rating scale applied to quantify effectiveness of skill performance (Eom, 1989), these results indicate that when counter-attack is performed after a transition of low accuracy by the setter, attackers will either have to counter-attack against a solid block, or will have to give an easy ball to the opposition, situations that will probably place their team in a disadvantageous position to score in case the rally continues. On the other hand, present results also indicate that when counter-attack is performed after a transition of high accuracy by the setter, attackers will be in the advantageous position to counter-attack either against an incomplete team block (in the case of a very good set) or a single block (in the case of an excellent set) and will probably ensure a point in favor of their team. Furthermore, the results of this study suggest that attackers were able to counter-attack against a single or incomplete team block successfully even in the case of receiving a moderate set (see Methods for definition). This finding could be related to the Olympic level of players, meaning that volleyball players who compete at an Olympic level would be more likely to perform effectively under less favorable conditions in comparison to volleyball players competing at a lower level, for example the national level.

Present findings agree with previous investigations that have shown the dependence of performance effectiveness between preceding and succeeding action in volleyball (Barzouka et al., 2005; Barzouka et al., 2006; Bergeles et al., 2009; Papadimitriou et al., 2004; Paschali et al., 2004). Particularly, Bergeles and colleagues (2009) recently

reported on the dependence of performance effectiveness in CI in Olympic-level male and female players. They found that male and female attackers had a higher percentage of good, very good and excellent performance in attack when preceding performance of setters was assessed as good, very good and excellent, respectively (Bergeles et al., 2009). Barzouka and colleagues (2005) have also shown that excellent performance of Olympic-level female setters and attackers was observed, when performance effectiveness of players in their preceding actions was either very good or excellent. In another study, they showed that Olympic-level female attackers had a higher percentage of excellent performance both in CI and II than setters, when the preceding actions' performance was assessed as either good or very good (Barzouka et al., 2006).

Performance effectiveness in the sequential actions of set-to-counter attack was also found to be affected by the tempo of attack (Nikolaidou et al., 2008). Specifically, it was found that when counter-attack was performed with a 1st or 2nd tempo, average counter-attack performance, defined as the mean performance of actions assessed with scores from 1 to 4, was more effective compared to when counter-attack actions were performed with a 3rd attack tempo (Nikolaidou et al., 2008). There is also evidence that performance in the preceding action of set affected performance in the succeeding action of block in national-level male teams (Paschali et al., 2004). However, the reader should bear in mind that due to the complexity and interactive nature of volleyball, there are other variables that could affect performance of set and counter-attack, which have not been considered in the present study, like for example, type of attack.

### *Performance effectiveness in CII between genders*

The study's other purpose was the comparison of performance in set-to-counter-attack (CII) between male and female players. Results indicates that male attackers were significantly ( $P < 0.05$ ) less effective in their counter-attack actions compared to female attackers, when they received sets that allowed the opponent blockers to set up a complete team block against them (Figure 1; Table 1). Male attackers were also found to perform significantly ( $P < 0.01$ ) more erroneous counter-attack actions compared to female attackers, when setters' preceding performance ensured an accurate or a moderate set against an incomplete team block (Figure 1; Table 1). Considering both of these findings, the significant differences between male and female volleyball players in this study could probably be attributed to the fact that male attackers take more risks in their counter-attack actions as compared to female attackers, which could potentially result in a higher percentage of erroneous actions.

Similar significant differences between male and female players when their preceding and succeeding actions in CI were assessed as good and average, respectively, have been reported elsewhere (Bergeles et al., 2009). In agreement with previous findings in Complex I (Bergeles et al., 2009), present results on CII suggest that both male

and female attackers' percentages of excellent performance in counter-attack were similar, when both male and female setters produced very good or excellent quality sets (Figure 1; Table 1). Comparing the findings between CI (Bergeles et al., 2009) and CII of the present study, it is interesting to observe that male attackers' excellent performance in CII was lower compared to that of female attackers (M: 40.4% and 70.9%, F: 54.7% and 81.8%), when preceding performance effectiveness of setters was either very good or excellent (Table 1), whereas male and female attackers' excellent performance was similar in CI (M: 51.4% and 79.6%, F: 49.2% and 79.8%) (Bergeles et al., 2009). This finding delineates the need to take into account more variables to adequately examine performance effectiveness in volleyball. Overall, the few significant differences that were observed in performance in set-to-counter-attack between male and female volleyball players do not verify the second hypothesis and do not allow suggesting modifications to the game's rules or tactics. Previous work has shown that Chinese female attackers' excellent performance was 20% lower compared to male attackers' respective performance (Weimin, 1989). That difference was attributed to lower ball velocity in attack between male and female players (M = 33 m/sec, F = 18 m/sec), even though female attackers could attain a 5.77 cm height above the net with arms raised in comparison to the 2.97 cm respective height for male attackers (Weimin, 1989). Moreover, differences in anthropometric and physical skills have been reported between male and female players (Bishop et al., 1987; Carter et al., 1994). However, it appears that differences in the ball's velocity at serve and attack as well as the height at which attack is performed between genders are compensated with adjustments to players' reaction speed in reception and defense, as well as block height in such a way that male and female players' performance in a volleyball game appears similar.

## CONCLUSION

Olympic-level male and female volleyball players were characterized by dependence of performance effectiveness in CII, since it was shown that the higher the preceding action's performance effectiveness was, the higher the succeeding action's performance effectiveness became. Performance effectiveness in Complex II between male and female volleyball appears to be similar, despite few significant differences that could probably relate to male players taking more risks in their counter-attack actions than their female counterparts.

## IMPLICATIONS FOR COACHING

The practical applications of this study are that attackers should train under less favorable conditions, specifically in the situation when they receive a set of low accuracy. If one speculates that setters' performance is dependent upon performance on defense and that if the latter performance is assessed with performance score lower than 3 (average or good performance), then setters could only aim to deliver as an accurate set as possible, without being able to make choices in tactics, as to the condition of the opponent's block

against the attacker. Training should, therefore, focus on how to make attackers able to counter-attack successfully against a solid team block under less favorable conditions, especially when they receive a set of low accuracy.

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## Women volleyball officials: an historical review

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### Abstract

According to Kroll (1977) effective officials show concern for the welfare of each athlete, exhibit high standards of honesty and integrity, demonstrate knowledge of the rules, maintain objectivity, alertness and quickness to react to situations, and should exhibit consistency in interpretation and enforcement. Fratzke (1975) reported that other officials are dominant and self confident. Dominance varies according to whether the descriptors describe male or female officials according to Megargee (1972). Males are ambitious, forceful, optimistic, planning, resourceful, responsible, self confident, stable and stern. Women are aggressive, bossy, conceited, confident, demanding, forceful, quick, strong and talkative. Schurr and Phillip (1971) in a study of female basketball officials contend that women must be tough-minded, realistic, self-reliant, self-sufficient, responsible and able to make decisive decisions. The third trait described by the literature seems to reflect officials' ability to demonstrate emotional stability in the face of pressure and stress. Scheer and Ansoorge (1979) suggest that officials should also demonstrate an internal locus of control believing that their own behaviors influence the reinforcement that they receive. Lemaire, (1981) using the 18-trait California Personality Index (CPI), found that national volleyball officials were socially oriented with men more so than females were more sympathetic and sensitive than male volleyball officials. Lemaire also reported that both males and females are more dominant, assertive, sociable, ambitious and self-confident than the general population. Male officials were more self-accepting of themselves than were female officials or the general population. The best officials approach their responsibilities with a professional manner, make instantaneous decisions under pressure during the game without controversy and walk away "unremembered".

**Key words:** volleyball officiating, women

根據 Kroll (1977) 指出，有效率的運動裁判會關心每一位選手所擁有的權利，展現高標準的誠實性與公正性，熟悉競賽規則，維持競賽目的，對比賽過程有高度的警覺性及快速反應，並且也應該表現出執法的一致性和公正性。Fratzke (1975) 指出裁判擁有支配力和自信。Megargee 於 1972 年提到，支配性會依據敘述者對男性或女性裁判的描述而有所不同。男性是雄心勃勃、有說服力、有計畫性、樂觀、富於機智、負責任、有自信、可靠和嚴格的。女性裁判則是有進取心、喜好指揮他人、自負、有信心、高要求、有說服力、迅速、堅強和健談的。在一篇由 Schurr 和 Phillip (1971) 對女性籃球裁判的研究中發現女性必須具備有堅強的意志、實際、自立自強、自負、負責任和可以做果決的決定。文獻指出的第三個特徵表現在面對壓力下，裁判展現可穩定情緒的能力。Scheer 和 Ansoorge (1979: 53-58) 建議裁判應該表現內在控制，並相信他們自己的行為會影響他們收到的加強效果。

Lemaire (1981: 88) 使用有 18 種特徵組群的加州人格指數 (CPI) 為研究工具，發現國家級排球裁判比較善於與男性交際，女性裁判則是比男性裁判較富有同情心和較敏感。Lemaire 也發現男性與女性裁判都比一般大眾更有支配性、積極性、善於交際、有企圖心和有自信的。男性裁判比女性裁判和一般大眾更具自我認同感。最好的裁判會以專業態度去面對他們的工作責任，他們可以在比賽壓力下立即做出沒有爭議的決定，比賽結束後可從容退場，結束當場比賽的執法工作。

**關鍵字:** 排球裁判法、女性、裁判法

L'officiel, un partenaire essentiel dans le monde du sport, s'assure que les règles et les procédures du match sont suivies, créant dans une atmosphère impartiale pour tous les concurrents. Un officiel remplit plusieurs fonctions liées à la compétition. Les officiels commencent et arrêtent le jeu pendant une compétition athlétique, une course ou une performance athlétique. Les officiels jugent la qualité des techniques effectuées, l'adhérence de la performance pour spécifiquement établir un critère et renforcer les règles du jeu. Les officiels dans un sport d'équipe surveillent aussi l'interaction entre les athlètes concurrents. Une analyse historique des femmes qui ont arbitré au volley est fournie.

**Mots clés:** les femmes et le volley, l'arbitrage au volley.

O árbitro, um parceiro fundamental na Arena Desportiva, garante que as regras e procedimentos do jogo são seguidas, resultando num ambiente imparcial para todos os concorrentes. O árbitro cumpre várias funções relacionadas com a competição. Os árbitros iniciam e param o jogo durante a competição atlética, uma corrida ou um desempenho atlético. Julgam, também, a qualidade das habilidades realizadas, a aderência da performance para especificamente definir critérios e reforçar as regras do jogo. Os árbitros numa equipa desportiva também monitorizam a interação entre a equipa adversária. É fornecida uma análise histórica das mulheres que já foram árbitras de voleibol.

**Palavras-chave:** mulheres e voleibol, arbitragem no voleibol

The official, an essential partner in sports arena, ensures that the rules and procedures of the game are followed resulting in an impartial atmosphere for all competitors. An official fulfills several functions related to the competition. Officials start and stop the play during athletic competition, a race or an athletic performance. Officials judge the quality of the skills performed, the adherence of the performance to specifically set criterion and enforce the rules of play. Officials in a team sport also monitor the interaction between the opposing athletes.

Sports are recognized by the International Olympic Committee and are controlled by the governing body or International Federation. Federations formulate rules, conduct international competitions and certify officials. Nations through the power of their National Governing Body (NGB) have the right to modify specific rules or procedures for athletic events conducted within their own borders but must abide by the international rules during international competitions. The United States deviates from international rules by formulating variations on the rules of the game specific for play at the youth or scholastic levels. Rules may also vary between female and male sports. Officials in the United States are required to learn a set of rules for each level of play and modifications for each gender. International officials learn only one set of rules gaining experience with the international rule every time they work.

Officials work their way upward to the elite levels of the performance pyramid with each higher certification. Women and men are eligible to work at all levels of the competition for either gender, if they can demonstrate competency and obtain the required certification. For some women, the goal would be to reach the peak of the pyramid by becoming an international official, or for others, it would be to officiate

for a professional league. The United States, unlike most other countries in the world, maintains a separation between professional sports and amateur sports.

Professional sports teams are owned by rich and powerful individuals or groups of individuals who control a limited number of franchised teams. The elite or best athletes play professionally. Only recently have professional athletes been allowed to recross the amateur boundary and compete in the Olympic Games or World Championships after the International Olympic Committee and the representative of the professional sports reached agreement on the definition or amateurism. Now women officials have penetrated the ranks of officials working in these professional leagues in the United States. Although they exist around the world, womens' professional leagues have been slow to develop in some sports (basketball, softball, volleyball) in the United States. However, other sports such as tennis, golf or figure skating have historically experienced great success with professional competition. Women successfully work these leagues or events as an outgrowth of their experience with the women's collegiate game or national elite competition. Regardless of the nature of the sport, women have faced increasingly more difficult competition and obstacles as they attempt to obtain higher certification levels.

In actuality, the number of women officials has decreased with the increased popularity of women's sports, as more men want to officiate the women's game.

### Training and Certification

Women need not be elite athletes to become officials in particular sports; however, they must be willing to understand technique, strategy and rules as well as the techniques

**Table 1: USA National Governing Bodies of Sport referred to in this article**

Federation		
United States Olympic Committee		<a href="http://www.usoc.org">www.usoc.org</a>
Federation International Basketball Association	(FIBA) USA Basketball	<a href="http://www.usabasketball.org">www.usabasketball.org</a>
Federation International Volleyball Association	(FIVB) USA Volleyball	<a href="http://www.usavolleyball.org">www.usavolleyball.org</a>
International Softball Federation	(ISF) USA Softball	<a href="http://www.usasoftball.org">www.usasoftball.org</a>
Federation International Football Association	(FIFA) US Soccer Federation	<a href="http://www.usasoccer.org">www.usasoccer.org</a>
Federation International Gymnastics	(FIG) USA Gymnastics	<a href="http://www.usa-gymnastics.org">www.usa-gymnastics.org</a>
International Skating Union	(ISU) USA Figure Skating	<a href="http://www.usfsa.org">www.usfsa.org</a>
International Hockey Federation	(IHF) USA Ice Hockey	<a href="http://www.usahockey.org">www.usahockey.org</a>
International Amateur Athletic Federation	(IAAF) USA Track & Field	<a href="http://www.usatf.org">www.usatf.org</a>
International Amateur Swimming Federation	(FINA) USA Swimming	<a href="http://www.usaswimming.org">www.usaswimming.org</a>
International Tennis Federation	(ITF) USA Tennis	<a href="http://www.usatennis.org">www.usatennis.org</a>

of officiating. Officials are required to attend rules clinics, practical evaluation or rating sessions and critique sessions with clinicians. Officials generally begin working in entry level positions, such as lane judges, turn or stroke judges, linespersons or umpires, etc. As women learn the rules of the game, officiating techniques, to interact with coaches and other officials, they are rated by their supervisors earning assignments for more competitive competitions. Officials must learn to deal with pressure that comes with performance under stress and constant evaluation as they work in front of spectators whose emotions are at a fevered peak. Officials who can cope with stress and pressure while giving their best performance will progress quickly through the officiating ranks. Women must remain vigilant to the added pressure in a sports environment dominated by men. The male dominated system creates a political environment where women often work with male coaches, officiating partners, administrators and media personnel.

Once a woman obtains certification at the national level, she must be nominated by the national governing body to attend an international officials clinic. Nominations for international certification from each country must be approved by the International Federation before attending a clinic. Candidates for the international rating must meet age guidelines in addition to passing the written and practical exams. Finally, candidates work under the scrutiny of a jury leading to certification. A retirement age or fitness qualification may be imposed on officials by the International Federation to maintain their certification. Once certified, female officials must negotiate the obstacles of gender, cultural or political discrimination. Future assignments depend upon the evaluations of work in this biased environment, further complicated by the limited number of international competitions and the availability of the official for travel.

Female athletes who have completed their playing career and choose to concentrate on an officiating career, might earn their credentials qualifying her for nomination as an international official in an average of six to ten years. In some sports, however, the time required to move through the rating levels may be closer to fifteen years; others take even longer depending upon the total number of officials in the pool of each country and the need for international officials. An international competition requires only a small number of working officials. Countries that send athletes may send a competition referee for each team. As a second option the host country may provide several officials and then the Federation invites neutral officials to complete the officiating crew. Neutral officials insure that country bias does not interfere with the fairness of the competition. Officials from an athletes' country are not allowed to officiate any match that could have any impact on the status of that athletes' position in the competition results. Sports, where a panel of judges determine the final placement, select officials from a balanced mix of countries reflecting the demographics of the athletes or the competing countries. The old fashion concept that men are assigned men's events and women are assigned women's events is disappearing although it may occasionally influence the assignments.

The opportunities for women to officiate high profile sports have recently increased dramatically. Since the 1984 Los Angeles Olympic Games, women have received international certifications in many major sports. Despite this progress, in many sports female officials make up 1/4 to 1/3 of the total certified officials. Far fewer achieve their international certification. The United States has been a leader in the effort to certify women and nominate them to work major international competitions.

### **Women Pioneers and Groundbreakers**

In some sports, women have been accepted internationally for years and the assignment records are difficult to obtain. In other sports, women have been pioneers and groundbreakers earning international certification and assignments to major competitions.

Darlene May (USA, 1994-1996), the first woman to obtain the International Basketball Federation certification (FIBA), was the first to be assigned to work the Olympic Games in Los Angeles. In 1998, May was named to the inaugural class of inductees into the Women's Basketball Hall of Fame for her contributions as an official. Women have been assigned to officiate in every Olympic Games and World Championships since 1984. At the current time, there are eleven women internationally certified from the United States (Carla Fujimoto, Dee Kantner, Melissa Barlow, Sally Bell, Susan Blauch, Michelle Duncan, Lisa Pitts, Tanya Porter, Nan Sisk, Deb Summers, Kim Trautman). In 1997, Violet Palmer (USA) and Dee Kantner (USA) became the first women hired by the National Basketball League (NBA) as referees. Sandhi Ortiz-DelValle worked the first professional basketball game in 1991 for the United States Basketball League. She has a pending lawsuit against the NBA for \$2 million dollars and an officiating job. Kantner, Patty Broderick (USA) and June Courteau (USA) became the first females to work as the three woman crew for a men's National Collegiate Athletic Association (NCAA) Division I basketball game in 1990. (Barber. 1998)

In 1983, Sue Lemaire (USA) was certified by the International Volleyball Federation (FIVB) as the first woman international referee and was followed by Nancy Sommer (USA) within the year. However, women were not assigned to work either the Olympic Games or the World Championships until the 1996 Olympic Games in Atlanta when women were certified as International Beach referees. Four women, Sue Lemaire, Patty Salvatore (USA), Maria Villas-Boas (BRA), and Mireia Carreno Goma (ESP) were assigned to work the first beach volleyball event included in the 1996 Centennial Olympics. The other women certified as international beach volleyball officials are: Catriona Tweedie (AUS), Stefanie Bartram (GER), Martina Fezer (GER), Lucie Guillemette (CAN). Lemaire and Salvatore are internationally certified for indoor and beach volleyball. The FIVB established a second level of international certification, that requires officials who are assigned to major international indoor competitions to have the FIVB certification. No woman has been nominated to this level.

Women have officiated at the highest level of softball competition for many years. Since 1978, approximately forty women have been certified by the International Softball Federation (ISF) as officials for international competition. Eighteen of these female officials are from the United States. Softball was finally included as a medal event during the 1996 Olympic Games. Five of the twelve officials assigned to the 1996 Atlanta Olympic Games were women: Emily Alexander (USA), Julie Johnson (USA), Kathy Strahm (USA), Lisa Carmichael (CAN) and Gerry Lindburg (SWE). Four females have umpired in baseball's minor leagues. Bernice Gera (USA) worked a Class A league in 1997. Chris Wren (USA) umpired from 1975 to 1978. Pam Postema (USA) officiated from 1977 to 1983 in Class A baseball before moving up to Class AAA in 1993. She was "released in 1989 after working during the spring season in the major league. Postema filed a federal sexual discrimination suit against the American and National Leagues which was settled out of court in 1977". (Barber, 1998, 32) Theresa Cox (USA) worked the 1989-90 minor league season in Arizona.

Many women have achieved International Football Federation certification (FIFA) as international soccer referees. Soccer officials are classified as referees or assistant referees. There are sixty-six women referees and about the same number of certified assistant referees. Leanne Hepburn (USA) was the first woman assigned to referee at the 1995 Women's World Cup in Sweden. Jan Gettemeyer (USA) was the first woman assigned to work the Olympic Games in Atlanta in 1996 as a referee assistant. Nancy Lay (USA) and Sandra Hunt (USA) achieved the distinction of being the first women referees, while FIFA certified assistant referee, Susan Cicchinelli (USA), and Kari Seitz were the first assistant referees hired by professional division one Major League Soccer during the 1997 season. Lay, Hunt, and Seitz have been nominated to the FIFA for international certification as referees.

The USA Hockey Association following the commitment of the International Hockey Federation (IHF) to promote women officials at their competitions sent 1 referee, Vicki Kale (USA), and 2 lineperson, Deb Pearce (USA) and Evonne Young (USA) to the 1996 Olympic Games and to the 1997 World Championships. In addition, Heather McDaniel (USA) and Vicki Kale also work men's professional minor league ice hockey. There are only eight women in the world internationally certified to officiate ice hockey.

Swimming requires many officials during a single event. There are turn and stroke judges as well as starter and the meet head referee. Carol Zalezski (USA), Jennine Dennis (USA) and Anne Liese Eggert (USA) are certified by the International Amateur Swimming Federation (FINA) as starters and head referees. Jennine Dennis was the first woman to be assigned internationally as a starter during the 1996 Atlanta Olympics.

Track and Field competition officials follow a similar classification format as swimming with the head meet official, starter, umpires and field judges. The number of women assigned to officiate during International Amateur

Athletic Federation (IAAF) track and field meets is increasing in a continued attempt to obtain gender equity within the officiating pool. Several women have been assigned to major competitions since the 1984 Olympic Games. Elizabeth Phillips (USA) was assigned as a marathon referee during the 1984 Los Angeles Olympic Games. Dee Jenson (a USA Track and Field Vice President) worked during the 1987 Pan American Games. Pat Rico (USA) worked the 1996 Olympic Trials and Doris Wahl (USA) was assigned as a starter during the 1996 Olympics and the 1997 Goodwill Games.

Women are now competing in the sport of wrestling at national and international levels. Wrestling officials are either mat officials or pairing officials. While most men have been mat officials and most women have been pairing officials, women have worked on the mat and women have been sent to the Olympic Games and the World Championships. Sue Siar (USA) currently serves as a leader in the United States as the National Pairing Director.

Other Olympic level sports have a history of female officials working at major international competitions. Since the early years of organized tennis, women have served as chair umpires and linespersons for the International Tennis Federation (ITF). Flo Blanchard, Anita Shukow, Mary Frances Glitz, Judy Popkin, Fran McDowell, Joan Vormann and Woody Walker are women who have achieved assignments at the United State Opens and have been invited to work at numerous international tennis tournaments.

Women have long served as officials during international figure skating competitions. Judges evaluate the competition, present the marks for each performance, then rank the winner chosen by the majority of judges. Referees control the competition environment and monitor that the judges scores fall within acceptable ranges of variation. The International Skating Union (ISU) restricted the number of international judges (12) and referees (6) allowed certification from each member country but this restriction has recently been lifted. The number of women eligible to obtain their international rating will increase according to the ability of each country to train and nominate new international officials. The women pioneers in figure skating are Claire Ferguson (also the first woman USA Figure Skating Association President), Janet Allen (USA), Lucy Brennan (USA) and Peg Faulkner (USA). The sport of gymnastics unofficially requires that women judge female competition. They must also have one female coach on the floor during competition. Jackie Fie (USA) and Audrey Shweyer (USA) have achieved International Gymnastic Federation (FIG) status as international judges.

Suzanne Jackson (USA, 1952-1998), director of tournament operations for Ladies Professional Golf Association (LPGA), served on the United States Golf Association (USGA) rules committee since 1985. In addition to officiating at the U.S. Women's Open Championship, Jackson was one of the first women to work the U.S. Men's Open Championship for the USGA. She was the first woman appointed in 1990 to rules committee of the Professional Golf Association (PGA) officiating both the PGA Championship and the Masters in

1990.

Many of these female pioneers and groundbreakers currently work as officials but are also involved in numerous administrative functions nationally and internationally. These women continue to help future female officials improve their skills and reach their dreams of becoming the internationally certified officials of tomorrow.

## IMPLICATIONS FOR COACHING

If you are interested in obtaining information regarding officiating opportunities in amateur sports, contact the specific sport National Governing Body Director of Officiating for information and local contacts. In the United States, for additional information concerning entry level officiating for Interscholastic sports contact the high school or college athletic director who works with the local officials association. There are two organizations in the United States with open membership for officials from all sports: the National Association of Sports Officials (NASO) and the National Federation Interscholastic Officials Association (NFIOA). Both associations publish a magazine containing articles targeting issues that concern officials.

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# The influence of Title IX on personal and professional biographies of early career female club volleyball coaches

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## **Abstract:**

Seeking to understand the relationship between Title IX and its impact on a select group of its contemporary beneficiaries, the purpose of this study was to determine the influence of Title IX on the personal and professional biographies of 8 early career female club volleyball coaches. This study utilized a modified case study design featuring constant comparison data analysis. Data were collected using a qualitative interview technique with each of the candidate's interviews subdivided into four distinct sections. Part I of the interview established a basic personal and professional biography of each individual coach. Part II provided data on the subject's athletic experiences. Part III addressed the life goals of the coaches. Part IV explored each individual participant's knowledge of Title IX. Findings revealed the existence of major themes common across all 8 coaches including (a) the shared belief that athletics provided opportunities for them to develop valuable life long personal and professional skills, (b) that opportunities for the acquisition of such skills were their implicit right (i.e., not directly attributable to Title IX, about which they knew little), and (c) the existence of an enduring commitment to the sport of volleyball as a source of personal identity and fulfillment. Once educated fully about Title IX, however, the coaches were unanimous in their belief that although progress in women's athletics -- related to the impact of Title IX -- had permitted them to succeed, inequity vis-à-vis opportunities accorded their male counterparts still existed. Correspondingly, the findings of this study suggest a post-gender society has not yet been attained and that efforts to ensure equal opportunity must continue.

為了要瞭解男女平權法(Title IX)及其對當代族群的貢獻之關係, 本研究的目的是探討男女平權法對女性排球俱樂部教練早期事業發展的個人與專業之影響。研究設計與工具使用改良式的案例設計, 其著重在持續性資料分析比較。在資料收集過程中, 八位研究對象均接受訪談, 訪談問題主要分做為四大部份: 第一部份為建立各研究對象的個人與專業基本資料, 第二部份為研究對象的運動背景, 第三部份為研究對象的生涯目標, 第四部份為探討其對男女平權法的瞭解。研究結果發現八位研究對象有主要數項特徵, 其包括: (a) 相信本身的運動經驗提供有價值的終生個人和專業技術, (b) 擁有這樣的排球技術是他們的隱性權利 (例如: 非直接歸為她們甚少瞭解的男女平權法), 以及(c) 為個人身份和滿足感的來源而對排球運動有長久的承諾。一旦受訪對象更加完整瞭解男女平權法後, 所有受訪的教練們都一致認為雖然男女平權法在對女性運動的影響讓他們有機會成功, 但是在與她們和男性同事之間的機會相比較之下, 不均等的現象依舊存在。所以研究結果建議我們不應該只是生活在男女平權後期而已, 我們得對公平男女權利的目標繼續努力。

**關鍵字:** 男女平權法、女性排球俱樂部教練、早期事業生涯

Cherchant à comprendre la relation entre le Titre IX et son impact sur un groupe privilégié de ses bénéficiaires contemporains, le but de cette étude était de déterminer l'influence du Titre IX sur les biographies personnelles et professionnelles de 8 femmes entraîneurs de club de volley en début de carrière. L'étude actuelle a utilisé un plan d'étude de cas modifié représentant une comparaison constante d'analyse de données. Les données étaient rassemblées en utilisant une technique d'entrevue qualitative, avec chacune des entrevues des candidats subdivisées en quatre sections distinctes. La première partie de l'entrevue a établi une biographie personnelle et professionnelle de base de chaque entraîneur individuel. La deuxième partie a fourni des données sur les expériences athlétiques du sujet. La troisième partie a abordé les buts de la vie des entraîneurs. La quatrième partie a exploré la connaissance du Titre IX de chaque participant individuel. Des conclusions ont révélé l'existence de thèmes majeurs, communs à chacune des 8 entraîneurs, comprenant (a) la croyance partagée que le sport leur a fourni des occasions de développer des compétences personnelles et professionnelles de toute une vie, (b) que les occasions d'acquérir de telles compétences étaient leur droit implicite (c'est-à-dire pas directement attribuables au Titre IX qu'elles connaissaient peu), et (c) l'existence d'un attachement durable au sport du volley comme source d'identité personnelle et dépanouissement. Cependant, une fois renseignées complètement sur le Titre IX, les entraîneurs étaient unanimes dans leurs convictions que, bien que le progrès dans le sport féminin -- lié à l'impact du Titre IX -- leur ait permis de réussir, l'injustice vis à vis des avantages accordés à leurs homologues masculins existait toujours. En accord, les conclusions de cette étude suggèrent que nous ne vivons pas encore dans une société égale pour les sexes et que les efforts pour assurer l'égalité des chances doit continuer.

**Mots clés:** Titre IX, les entraîneurs de joueuses de volley, analyse qualitative des expériences.

Tentando entender a relação entre o Título IX e seu impacto num grupo selecionado de beneficiários contemporâneos, o objectivo deste estudo foi determinar a influência do título IX nas biografias pessoais e profissionais de treinadoras de voleibol com menos de 8 anos de carreira. O presente estudo utilizou um caso de estudo introduzindo uma comparação de análise de dados constante. Os dados foram recolhidos por meio de uma técnica de entrevista qualitativa com cada uma das entrevistas do candidato subdividida em quatro secções distintas. Parte I da entrevista estabelece uma biografia básica, pessoal e profissional, de cada treinador. Parte II forneceu dados sobre as experiências atléticas do sujeito. Parte III abordou os objectivos de vida dos treinadores. Parte IV explorou individualmente o conhecimento de cada participante acerca do Título IX. Os resultados revelaram a existência de grandes temas comuns entre os 8 treinadores, incluindo (a) a crença comum de que atletas forneciam oportunidades para eles desenvolverem uma experiência pessoal e competências profissionais de valor, (b) as oportunidades para a aquisição de tais competências eram os seus direitos implícitos (ou seja, não directamente atribuíveis ao Título IX, sobre o qual pouco sabiam), e (c) a existência de um compromisso permanente para o desporto de voleibol, como fonte de identidade pessoal e realização. Contudo, uma vez educados plenamente sobre o Título IX, os treinadores foram unânimes na sua convicção de que embora o progresso das mulheres atletas - relacionados com o impacto do Título IX - permitiu que fossem sucedidas, a desigualdade e oportunidades concedidas aos seus homólogos masculinos ainda existia. Correspondentemente, os resultados deste estudo sugerem que ainda não vivemos numa sociedade onde existe igualdade entre os sexos e que os esforços para assegurar a igualdade de oportunidades têm de continuar.

**Palavras-chave:** Título IX, treinadoras de voleibol, análise qualitativa de experiências

## INTRODUCTION

### *Historical Background of Title IX*

Beginning in 1963, with the Equal Pay Act (EPA), Congress attempted to level the playing field in the area of gender equity. A year later, Congress passed Title VII of the Civil Rights Act of 1964 prohibiting a broader range of discrimination than did the Equal Pay Act. The EPA only prohibited sex discrimination, whereas Title VII prohibited sex discrimination as well as discrimination based on race, color, religion, and national origin. Moreover, Congress then took another step toward guaranteed equality by enacting Title IX of the Education Amendments of 1972 to bar sex discrimination in schools. This bill stated that “no person, on the basis of sex, shall be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving federal financial assistance.” Title IX’s use has cleared the way for female athletes and coaches to experience a myriad of benefits from athletic participation, as gender equity continues to progress toward advanced levels of available, and equal, gender neutral opportunities. Title IX has had a significant impact on young female coaches and athletes in contemporary society.

The body of literature describing the historical significance of Title IX is extensive. Cohen (1997), while recognizing the growth of women’s sports, particularly volleyball, contended that despite a surge in interest among males, gender balancing, funding shortfalls, and institutional conservatism have all kept volleyball largely a women’s game. She (1997) foretold that Title IX issues would be the premise for many legal battles over the following decade. From a legal perspective citing landmark cases in collegiate and high school athletics, Tatum (2002) delineated the genesis of Title IX and concluded that roadblocks still exist and that vigilance by parents, lawyers and administrators is important for continued progress toward full gender equity. Dougherty, Goldberger, and Carpenter (2002) interpreted landmark federal legislation intended to prevent discrimination, highlighting the different program areas that guide Title IX evaluations, its impacts on male athletes, four important cases, the involvement of athletic associations, and the concept of sexual harassment. Heckman (2003) evaluated the impact of Title IX from a 30-year retrospective. Heckman cited landmark court cases including *Harper v. Board of Regents, Illinois State University*, and *Weaver v. The Ohio State University* and also discussed successes and failures associated with the Title IX movement. Smith (2006) described recent lawsuits, trends and ideas regarding contemporary Title IX issues and applications of the law and identified the three prongs for Title IX testing compliance: (a) Substantial Proportionality, (b) History and Continuing Practice, and (c) Effectively Accommodating Interests and Abilities.

The Title IX debate has had a polarizing effect relative to equity in school-based sports. Covell (2003) described how progress in women’s sports has -- due to misapplication of

Title IX--unfortunately resulted in the loss of opportunities for men, an outcome, which was never intended by the authors of the act. Anderson (2006) described the significant gains women have realized since the passage of Title IX in 1972 and how new technologies and evaluation strategies allow the NCAA to gather more data to assist institutions with compliance issues. Anderson also found and that female athletes are still an underrepresented subset of the sport population.

Carpenter and Acosta (2006), whose national longitudinal study tracking women’s participation in intercollegiate sport spans 29 years, reported in 2006 data showing the highest ever participation by women in the United States’ intercollegiate athletic programs. However, the data revealed that a significantly smaller number of women are serving as head coaches and as lead administrators within their programs. In addition, the 2006 data show the lowest ever ratio of female coaches for women’s teams. Kiick (2007) described the growth of athletic opportunities for young females and women since the passage of Title IX in 1972, but also argued that complete gender equity has not yet been attained. Although almost four decades have passed since its passage, Kiick contended that contemporary society should not be satisfied with current levels of progress. Falduto (2006) described the process by which qualified coaches must be hired to pass the three-prong test, emphasizing that Title IX requires coaches for female athletes who are equally qualified to those of their male counterparts, whether those qualified coaches are men or women. He also asserted that Title IX can help assure that female athletes will receive the numerous life lessons as well as physical, psychological, and intellectual benefits by preventing unequal coaching.

Women’s personal perceptions of Title IX have also been examined. Based on her journal and correspondence, Walton (2003) provided an account of her experience as an athletic administrator and her fight for Title IX compliance.

Deboer’s (2004) case study is based on personal anecdotes which demonstrate how men and women approach the various aspects of their personal, professional, and competitive lives. Deboer, who is a former standout volleyball and basketball player, went on to coach volleyball at the University of Kentucky. She then moved into a position as an athletic director for the university, and is now currently serving as the executive director of the American Volleyball Coaches Association. The text highlights gender differences within the realm of sport, introduces the reader to the gender related reasoning behind various occurrences, then illustrates solutions on how one gender can intelligently interact with the other. Petit (2006), the former Head Women’s Volleyball Coach of the University of Nebraska, discussed his personal journey into the realm of coaching female athletes, the transformation of women in sports over the years, and how a coach can learn from the people one meets along his or her coaching journeys.

Hein and Hagger (2007) examined a theoretical model of global self-esteem that incorporated constructs from

achievement goal and self-determination theories. They hypothesized that self-determined motives mediate the influence of achievement goal orientation on global self-esteem. Findings suggest that participation in physical activity and athletics are likely to enhance young people's general self-esteem.

Heim (2008) described the experiences of executive females, working in Fortune 500 companies, relative to their needs to reshape the lessons they learn during childhood to produce a framework for success in the adult business world. Heim contended that boys learn how negative feedback is meant to improve performance at an early age and has no real significance of what other people may think of them. Because females are not involved in as many sports as males are in their traditional forms of play, they miss important experience to associate criticism with skill building. Furthermore, Heim also states that women, in an ironic sense, need to learn to deal better with accepting praise in order to cope in a business environment.

The Rimm Report of 1999 studied how 1,000 girls became successful women. Rimm found that (a) girls should be expected to learn that achieving the highest level of education possible is the greatest priority, (b) that high expectations and pressure are important learning devices for females, (c) that motivation is as critical as ability, (d) that girls need to learn to value and develop a work ethic (which is a component to motivation), (e) that assertiveness can be learned (assist girls to see themselves as smart and independent), and (f) that successful women all had quality educations and that parents need to strive to find the best educational opportunities available for their daughters.

Title IX has carved a new future for women's athlete in contemporary American society. Although significant progress has been made -- indeed, women have experienced extraordinary benefits from their participation in athletics since the passage of Title IX in 1972 -- efforts toward insuring gender equity in all areas of participation in sport must continue. Research on the success, or lack thereof, demonstrating institutional compliance and its related effects, must continue.

Seeking to understand the relationship between Title IX and its impact on a select group of its contemporary beneficiaries, the purpose of this study was to determine the influence Title IX on the personal and professional biographies of eight early career female club volleyball coaches.

## **RESEARCH METHODS AND PROCEDURES**

### *Research Design*

This investigation utilized a modified case study design featuring constant comparison data analysis. The data were collected using a qualitative interview technique. Each of the candidate's interviews were subdivided into four distinct sections (see Appendix for the actual questions). Part I of the interview established a basic personal and professional

biography of each individual coach. Part II provided data on the subject's athletic experiences. Part III addressed the life goals of the coaches. Part IV explored each individual participant's knowledge of Title IX.

### *Participants*

The participants in the study were 8 early career female club volleyball coaches averaging 3.5 years experience. Recruited via personal invitation from the lead investigators regional volleyball community, all were former members of the club, scholastic, and/or collegiate teams he had coached since 1998. For purposes of maintaining subjects' confidentiality, pseudonyms were used.

### *Data Collection*

Extended interviews -- which lasted approximately 90 minutes -- were conducted in person during the course of a 3- month period during the spring of 2007. Detailed notes of each interview were recorded manually and subsequently word -processed. Data were reviewed and constantly compared (Glaser & Straus, 1967) as gathered throughout the study. Similar to the data collection methods utilized by De Marco (1998), the process became "self-regenerating and ... assisted greatly in the identification and classification of recurring perspectives, themes, and categories" (p. 60). Constant comparison of the data from these interviews resulted in the identification of themes and categories describing the shared athletic coaching and playing experiences of the 8 coaches as related to the emerging case law surrounding Title IX.

## **RESULTS**

### *Data Analysis - Major Findings*

Explication of the data, in the form of 8 separate profiles of each participant, follows. Major findings were titled with each coach's pseudonym and divided into four separate sections: (a) Participants' Biographical Profiles, (b) Athletes' Experiences, (c) Athletes' Life Goals, and (d) Knowledge of Title IX.

### *Common Themes Based on the Analysis of the Subjects' Profiles*

Content analysis of the data revealed the existence of common themes across the subjects. They were (a) similarities in the subjects' biographical profiles, (b) life long lessons learned from their athletic participation, (c) the belief that the opportunities available to women in sport and athletics were unrelated to the implementation of Title IX, and (d) the belief that there were both positive and negative aspects of Title IX. An in-depth explication of each of these theme follows.

### *Profile Similarities*

Many similarities can be drawn from the biographical profiles

of these subjects relative to their involvement in sport as coaches. All of the coaches were introduced to the sport of volleyball sometime between the third and fifth grade, all had club volleyball playing experience, and all of the coaches, with only one exception, continued their playing careers while attending institutions of higher education.

Each coach also shared a very similar first coaching experience. All of the coaches, with only one exception, had their first introduction to coaching as a high school athlete who was working as an assistant camp coach for middle school athletes. Each took a great deal of enjoyment from this first experience. Jennifer, similar to the experiences of the coaches involved in the study, found her first experience to provide her with a new perspective of the game, as well as finding a sense of joy in helping to instruct and build confidence in younger players. All of these coaches would later become camp instructors during their collegiate careers at many volleyball camps and clinics. These coaches later went on to coach club volleyball teams, with some who were also coaching high school and / or collegiate teams as well.

#### *Lessons Learned from a Lifetime of Athletic Participation*

When evaluated, the skill sets learned from their participation in athletics, as it is applicable to their personal and professional lives, permitted these female coaches to unknowingly develop a solid consensus on the value of athletic participation to their lives. As Elizabeth noted, in a holistic sense, that “I would not be who I am today without sport in my life.” Carly expounded on this notion when she clearly stated that “athletics has taught me more than any class or book ever possibly could.” Athletics, she postulated, has permitted her to become a stronger person, and that concept is what should be most important in life.

Heather further believed that athletics involvement has pushed her to be efficient, quick and timely. Heather stated that, “I expect more out of myself today because of my involvement in athletics.” And, athletics has also taught her how to work in a variety of social settings with people from many different walks of life. Becky echoed these remarks as she contended that athletics has taught her how to build and maintain relationships, and, moreover, how a person can then apply these skills in order to converse and relate to people on different levels. Becky stated, “The relationships that I have built today, in general, or with people of different ages, are because of the skills I learned in athletics.”

Content analysis of lists of positive traits generated through these interviews led to the identification of the theme Lessons Learned, which strongly supports the notion that participation in athletics provided opportunities for these young women to develop life long skills, which deeply valued and evidenced in their personal profiles, have been made manifest in their personal and professional lives.

#### *Belief in the Opportunities Available Today to Women in Sport*

Data also revealed that, of the eight participants who took part in this research project, five of the eight felt that there were only a few, to almost no further opportunities available to women in sport today than there have been over the last twenty years. Only three of the participants felt that there now existed many more opportunities for women’s involvement in sport today. It also should be noted that the evidence provided by these participants is solely based on their life experiences and perception of today’s society.

Amy, Becky and Carly observed that opportunities for growth for females, through athletics, had been made available to them throughout the course of their playing and coaching careers. Amy believed that she has seen a great deal of expansion of opportunities for female athletes today outside of the normal scholastic team availability – particularly in the sport of volleyball. She stated that “these opportunities, outside of normal school teams, has expanded a lot; especially in volleyball.” She also felt that female athletics is both more “accepted and expected,” and that there also existed a great “physical attraction within society” a whole relative to female athletes. Becky concurred with the statements by Amy and further noted the dramatic increase in club volleyball over the last ten years. Becky stated that “the idea of club volleyball has taken off and the number of available recruiting services is increasing.” She also believed, beyond the opportunities for female athletes to attend camps and clinics, that there exists greater improvement in athletic budgets for female teams. Carly also made similar statements, relevant to Becky’s claim, of more monetary support going into school budgets for female athletes, and she feels that there is an emerging trend to hire more female coaches at the collegiate level. Carly stated, “I have seen more women being hired by own father, and it appears that female teams today get more support and more money in their budgets.”

The inverse of these observations are echoed by the other five participants in the study who have found little to no growth in greater opportunities for female athletes. Heather, on one end of the spectrum felt that there have been very few new sports, and little growth offered to female athletes over the last few years. Heather stated, “I have witnessed no significant change; nor have I seen anything new created.” Jennifer took this argument a step further when she stated that “what is missing from female sports today is the opportunity for girls and women to participate in recreational leagues.” Though Elizabeth, in her particular hometown, has seen an increased number of teams available to female athletes in the parks and recreations division, believed that the overall growth might be on a steady increase, but it has been particularly small.

#### *Knowledge of Title IX and Related Areas*

The intent of the United States Congress was to take a step forward, in regards to equality within the fabric of the American

society, by enacting Title IX of the Education Amendments of 1972 to bar sex discrimination in schools. Title IX's use, over the previous thirty-seven years, has cleared the way for female athletes and coaches to experience vast benefits from athletic participation, as gender equity continues to progress toward advanced levels of available, and equal, gender neutral opportunities. Title IX has had a remarkable impact on young female coaches and athletes in today's society, through its opportunities it has afforded them, and it will continue to do so into the future. Title IX's original intent was not concerned with establishing equity in sport relative to gender, but its interpretations by the court system, particularly over the last twenty years, has acted as a catalyst toward this notion of gender equity in athletics.

When the participants were asked to discuss their knowledge of Title IX in Part IV of their interviews, not a single participant of the eight in the study could accurately provide a definition or an understanding of the original passage of Title IX. Although, further analysis of the data revealed that three participants (Carly, Elizabeth, Becky) had some working idea of the status / use of Title IX in American society today, three participants (Amy, Heather, Jennifer) possessed some idea of its use and implications, and two participants (Dawn and Gabriel) admittedly had no conceptual knowledge of Title IX. Heather, when asked to discuss her knowledge of Title IX, provided a typical answer which surmised that Title IX was an attempt to promote women in sports and to halt "discrimination against women's athletics." She further assumed, by "looking at the trophies [in the university's athletics cases] that Title IX came about in the 1970s or 1980s." She furthered her discussion under the premise that "Title IX, I assume, is to prevent inequity between genders in athletics because sport is an important part of society, and it goes along with the equal rights movement of the time period."

Furthermore, in an acknowledgement of historical context, each of the coaches struggled to name important or famous female athletes during, or prior to, the 1970s (this does not include the one reference by a subject to the film *A League of their Own*). When asked to name female athletes within the last five years, they could easily provide examples, though any reference to an athlete of 10 or more years ago was virtually not possible by each participant.

This evidence might suggest that today's female coaches and athletes have very little information of the women's rights movement in sports over the last 100 years in the United States, and that important female athletes, to sport or women's rights in sport, have been greatly ignored by the public and within the sports community.

#### *Positive Aspects of Title IX*

Once each participant had received some information about Title IX by the investigator (via a brief explanation of its history and implications, lasting approximately 10 minutes), each of the participants were able to identify positive and negative aspects of the law and make connections as to how

it actually had impacted upon their lives. Examples of these perceptions follow.

Amy, in a protective stance, said that the interpretation of Title IX in favor of female athletes is necessary in order to protect other women's sports on campus that might not be doing as well as others. She also surmised that "since there are more opportunities to be involved in athletics there should also be an increased chance to coach; more opportunities for females to coach in female sports." Carly also observed that it was important to "offer more opportunities for women, but historically more males have been involved." Becky also saw a rise in the opportunities available for female coaches today, and it is her hope, that with increased grant money, more opportunities will be offered in the future. Gabriel further believed that there exists more opportunities for female athletes to play and coach sports today, though, like many of her fellow colleagues in the study, felt there exists few opportunities for women to coach male sports teams today.

#### *Negative Aspects of Title IX*

By referencing the remarks of the subjects, it can be determined there also exists some negative aspects of Title IX, but solutions exist on how to rectify gender inequity in sport. Amy stated, "The greatest amount of inequities today in female sports is due in part to societal perceptions." She felt that "from a business perspective if money is not put into a program then it cannot grow; though this is a systematic problem" at many levels. Heather also noted the compelling theme that in order to end any inequities that exist today "the money needs to be spent in promotion of female sports." She also believed that more high school teaching and coaching positions should be provided to women as well, in order to produce a greater equity at that particular level. Gabriel also contended that male teachers are more likely to receive teaching / coaching positions, and are more likely to receive promotions at the administrative level. Whereas Jennifer, extended Heather's thoughts by stating there "still exists a stigma with females coaching male athletes, but there exists no stigma to males coaching female athletes" (something also noted by Elizabeth as well).

Dawn echoed many of these similar comments, and Carly, took this a step further when she discussed how she personally finds the trend distasteful, in regards to many athletic departments today, that have cut opportunities for males, in order to produce an even ratio with female sports. Dawn contended that "there is far too much politics to work through today ... no matter what the [gender]." Elizabeth also noted the increase in number of male sports being cut by colleges today, in order to provide some equalization in numbers, as well as colleges attempting to provide athletic teams with similar scholarship availability. Becky also saw a growing sentiment, within the athletic realm, when she related how a close, and highly qualified, male friend, who is a collegiate coach for women's basketball, has found it increasingly more difficult to find a head coaching position due to his gender. She sadly stated, "I have witnessed

the pressure of watching a friend passed over for positions due to his male gender in coaching a female sport.” Carly felt that there exists “a lack of money in general for both genders in sports today – you cannot compensate for one by penalizing another.”

Three of the participants from the study observed that opportunities for growth for females through athletics had been made available to them throughout the course of playing and coaching careers. One participant believed that she has seen a great deal of expansion of opportunities for female athletes today outside of the normal scholastic team availability – particularly in the sport of volleyball. An unexpected finding was that the subjects did not know Title IX had produced more opportunities for them. Though, one must also view these same levels of participation through the perception of the other five participants in the study.

These five participants believed that there had been little to no change witnessed within the opportunities available to female athletes in today’s society. Lacking knowledge of the actual law itself, the participants in the study did not know Title IX had produced more opportunities for them over the years.

**DISCUSSION**

Reverberating in the responses of these eight participants regarding to gender based head coaching positions was their knowledge that there exists today very few females who regularly coach male teams and a perception that the majority of coaches for female teams are men. They were acutely aware that their positions as female coaches were the exceptions to this trend. Specifically, although compliance with Title IX has resulted in the opportunities for female

their participation in athletics.

athletes, the same cannot be said of female coaches. These beliefs are supported by Carpenter and Acosta (2006):

The representation of females among the ranks of head coaches for MEN’s [sic] teams remains at 2%; where it has been since before the passage of Title IX. Today, even though the number of women’s teams is at an all-time high, the representation of females among the coaching ranks of women’s intercollegiate athletics is at an all time low [42.4% for all divisions].

Upon learning of these discouraging data during their debriefing interviews, the participants made suggestions on how to further implement Title IX for greater effect. All believed that more human and financial resources should be directed to bring about true gender equity.

The current study revealed that participants exhibited a specific set of positive traits (see Table 1. Benefits of Athletic Participation) that common threads were woven from, through the constant comparative method. Content analysis of these lists of positive traits led to the identification of the theme Lessons Learned, which strongly supports the notion that participation in athletics provided opportunities for these young women to develop life long skills which deeply, valued and evidenced in their personal profiles, have been made manifest in their personal and professional lives.

This analysis additionally revealed three categories of skills sets that are highly prized in today’s workplace. Table 1 provides each skill set, a description of the skill that falls under that particular category, and how many of the participants stated that it was a skill directly derived from

Table 1. Employment Related Skills Developed through Athletic Participation

<b>Working Smart</b>	<b>Teamwork / Leadership</b>	<b>Understanding Roles</b>
Time management (5)	Teamwork (7)	Goal oriented (7)
Organization	Social skills (7)	Perseverance (6)
Responsibility	Networking skills (3)	Positive attitude (5)
Efficiency	Leadership skills (3)	Competitiveness (4)
Detail orientation	Leadership opportunities	Composure (3)
Consistency	Delegation of responsibility	Self-confidence (3)
Defining limits	Sportsmanship	Perspective
Verbal expression	Trust	Dedication
Critical thinking skills	Friendship	Maturity
		Solid work ethic
		Will to succeed
		Life Experience (3)
		Self-motivation
		Self-reliance

Note: Numbers note frequency of terms used by participants during interviews

The skills learned by the participants in this study, which they are now imparting to their own athletes, were thematic. Reported in the findings of the related literature reviewed herein, the acquisition of these skills are essential for success in the business world.

The category titles for Table 1: Employment Related Skills Developed through Athletic Participation represent the perceptions of the participants and are consistent with the findings of Heim (2008), DeBoer (2004), and Rimm (1999), endorsing the notion that sports provide women with essential life experiences.

## CONCLUSIONS

Seen through the lens of progress made since Title IX's passage in 1972, women's participation in sports, particularly in volleyball, had come a long way. Female athletes and coaches who were once type cast as "tom-boys," are now coming closer to being seen as empowered equals. Women, in today's society, have also found that it is alright to be both feminine and athletic at the same time. By barring sexual discrimination in educational settings, Title IX has paved the way for female athletes and coaches to experience vast benefits from athletic participation. As was demonstrated in the present study, participation in athletics has allowed women to develop many positive traits that have prepared them to lead successful lives. However, in the present study, the participants -- themselves direct beneficiaries of opportunities generated by Title IX -- were not cognizant of the efforts that were made to pave the way for them to begin to experience gender equity. In addition, as can be seen in the literature reviewed for the present study, women today are still all too often not provided the same opportunities as those offered to men. This is perhaps due to the fact that economics drives sport (e.g. some men's sports generate greater revenue). Consequently, women still have miles to go before they may rest within the full fabric of gender equity in sport and society.

## IMPLICATIONS FOR COACHING

The opportunities afforded to female athletes and coaches, through participation in athletics, has a profound impact on their lives. Results from this study suggest that the participants' early coaching experiences, even as volunteer assistants in a middle school camp, when they were high school students, made a major impact on their lives and fostered a sincere desire to continue their coaching careers. Participation opportunities for female athletes and coaches in sport, in childhood and later in life, are necessary to instill the positive traits needed to function properly in the adult world. Coaches, administrators, politicians, and others, need to make as many opportunities available to females, as they do for males, to participate in athletics. The positive traits developed, within athletic opportunities, provide young women the ability to develop life long skills, which they deeply value, and are made manifest in their personal and professional lives.

Women's athletics today, due to the enactment and further interpretations of Title IX, has witnessed many great leaps forward since 1972. It is important, though, that coaches and others note that women still have not received parity in athletics over 37 years later, and because of this discrepancy, many women are missing the opportunity to develop skill sets that they need in their professional lives. Subsequently, they are left at a serious disadvantage. A need, then, exists for coaches, and others to push for greater equity within athletics for women.

Finally, regardless of the competition level, as witnessed in this study, female athletes and coaches who are direct beneficiaries of the opportunities generated by Title IX, are still not cognizant of the efforts made by previous members of society. It should then be a portion of the task of today's coaches and athletic administrators to assist in instructing athletes concerning the people and efforts that were made to pave the road for opportunities they receive today.

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## Selected Volleyball Research Abstracts

Watkins, H. G., & Owen, N. (2008). Gender differences in lower limb frontal plane kinematics during landing, *Sports Biomechanics*, 3, 333-334.

The aim of this study was to investigate gender differences in knee valgus angle and inter-knee and inter-ankle distances in university volleyball players when performing opposed block jump landings. Six female and six male university volleyball players performed three dynamic trials each for which they were instructed to jump up and block a volleyball suspended above a net set at the height of a standard volleyball net as it was spiked against them by an opposing player. Knee valgus/varus, inter-knee distance, and inter-ankle distance (absolute and relative to height) were determined during landing using three-dimensional motion analysis. Females displayed significantly greater maximum valgus angle and range of motion than males. This may increase the risk of ligament strain in females compared with males. Minimum absolute inter-knee distance was significantly smaller, and absolute and relative inter-knee displacement during landing significantly greater, in females than males. Both absolute and relative inter-ankle displacement during landing was significantly greater in males than females. These findings suggest that the gender difference in the valgus angle of the knee during two-footed landing is influenced by gender differences in the linear movement of the ankles as well as the knees. Coaches should therefore develop training programs to focus on movement of both the knee and ankle joints in the frontal plane in order to reduce the knee valgus angle during landing, which in turn may reduce the risk of non-contact anterior cruciate ligament injury.

Salci, Y., Kentel, B. B., Heycan, C., Akin, S., Akin, S., & Korkusuz, F. (2004). Comparison of landing maneuvers between male and female college volleyball players, *Clinical Biomechanics*, 19(6), 622-628.

The aim of this investigation was to compare differences in kinematic and kinetic parameters of knee, hip and ankle joints between male and female college volleyball players. A cross-sectional study, landing injuries which usually involve anterior cruciate ligament injuries are common in volleyball with a higher incidence in females. Landing preferences of both male and female players may provide additional background about the mechanisms contributing to the anterior cruciate ligament injuries. Eight female and eight male college volleyball players performed spike and block landings from 40 and 60 cm height platforms. Lower extremity joint kinetics and kinematics, and leg muscle strengths were recorded. Females demonstrated significantly lower knee and hip flexion angles compared to their male counterparts in knee flexion at 40 cm spike and hip flexion at 40 cm block landings. Group comparison also revealed that male players' peak knee extensor moment at 60 cm block landing was significantly different than female players. Additionally, female players applied significantly higher normalized ground reaction forces and males knee flexion angles and

thigh muscle strength results positive and highly correlated but relation could not found in females. It is likely that females may not use their thigh muscles as effective as males in landing. Female volleyball players initiate different lower extremity mechanics during landings than that of males. Identifying the landing strategy differences between female and male college volleyball players may provide detailed perspective about the load distribution in lower extremity joints for determining major factors affecting the increased incidence of anterior cruciate ligament injuries in females.

Pereira, G., Almeida, A. G., Rodack, A. L., Ugrinowitsch, C., Fowler, N. G., & Kokubun, E. (2008). The influence of resting period length on jumping performance, *Journal of Strength and Conditioning Research*, 22(4), 1259 – 1264.

The purpose of this study was to determine a resting interval between countermovement jumps (i.e., volleyball spikes) that allows the maintenance of maximal jumping performance. Ten male volleyball players ( $1.85 \pm 0.05$  m,  $77.2 \pm 10.6$  kg,  $21.6 \pm 5.3$  years) performed 6 experimental jumping sessions. In the first and sixth sessions, maximal countermovement jump height was measured, followed by submaximal countermovement jumps to the point of volitional fatigue. The number of countermovement jumps was used as a reference to test the effect of rest period between volleyball spikes. From the second to fifth experimental sessions, 30 maximal volleyball spikes were performed with different resting periods (i.e., 8, 14, 17, and 20 seconds) followed by countermovement jumps. Between the 15th and 30th spikes, the blood lactate concentration and heart rate were measured. Because the performance on the first and sixth sessions was the same, no training effects were noticed. During the 8-second resting interval set, the lactate concentration increased significantly between the 15th and 30th spikes (i.e., from  $3.37 \pm 1.16$  mmol to  $4.94 \pm 1.49$  mmol); the number of countermovement jumps decreased significantly after spikes compared to those performed without a previous effort (i.e., from  $23 \pm 7$  jumps to  $17 \pm 9$  jumps); and these variables were significantly correlated ( $r = -0.7$ ). On the other hand, the lactate concentration and number of countermovement jumps were stable across the other resting intervals, without a heart rate steady state. The results indicate that an adequate resting period between spikes allowed participants to achieve a lactate steady state in which the performance was maintained during the exercise. These findings show that resting intervals between 14 and 17 seconds, typical during volleyball matches, are indicated to use in volleyball spike drills due to their capacity to maintain maximal jumping performance.

Cronin, J. B., Bressel, E., Fkinn, L. (2008). Augmented feedback reduces ground reaction forces in the landing phase of the volleyball spike jump. *Journal of Sport Rehabilitation*, 17(2), 148 – 59.

Frequency and magnitude of ground reaction forces (GRF)

have been implicated in causing injuries such as “jumpers knee.” The aim of this study was to investigate whether a single session of augmented feedback concerning landing technique would decrease GRF. A pretest/posttest experimental design was used to assess fifteen female NCAA Division 1 intercollegiate volleyball players. They were required to land on a force platform after spiking a volleyball from a four-step approach before and after an intervention involving visual and aural augmented feedback on correct jumping and landing technique relative to mediolateral (ML), anteroposterior (AP), and vertical (V) GRF normalized to body weight (BW). Augmented feedback was found to significantly ( $P = 0.01$ ) decrease VGRF by 23.6% but not ML (25%,  $P = 0.16$ ) and AP (4.9%,  $P = 0.40$ ) peak GRF. A single session of augmented feedback may be effective in reducing VGRF in collegiate athletes.

Hughes, G., & Watkins, J. (2008). Lower limb coordination and stiffness during landing from volleyball block jumps. *Research in Sports Medicine*, 16(2), 138-154.

The aim of the study was to investigate lower limb coordination and stiffness in five male and five female university volleyball players performing block jump landings. Coordination was assessed using angle-angle plots of the hip-knee, knee-ankle and hip-ankle joint couplings and discrete relative phase (DRP) of right-left joint couplings (i.e., left knee coupled with right knee). Leg stiffness was calculated as the ratio of the change in vertical ground reaction force (GRF) to the change in vertical displacement of the centre of gravity between ground contact and maximum vertical GRF. Knee stiffness was calculated as the ratio of the change in knee joint moment to the change in knee flexion angular displacement between ground contact and maximum knee joint moment. Comparison of the DRP angles between left and right legs indicated reduced symmetry between the left and right legs in females compared with males, which may indicate greater likelihood of ligament strain in females compared with males. Furthermore, females exhibited reduced stability in the coordination between the left and right knee joints than males. Males exhibited significantly greater absolute and normalized leg stiffness and significantly greater absolute and normalized knee joint stiffness during landing compared with females. In conjunction with the coordination data, this may indicate reduced dynamic stability of the leg in females compared with males, which may contribute to the greater incidence of anterior cruciate ligament (ACL) injury in females compared with males.

Sheppard, J. M., Cronin, J. B., Gabbett, T. J., McGuigan, M. R., Etxebarria, N., & Newton, R. U. (2008). Relative importance of strength, power, and anthropometric measures to jump performance of elite volleyball players, *Journal of Strength and Conditioning Research*, 22 (3), 758-765.

The purpose of this investigation was to examine the potential strength, power, and anthropometric contributors to vertical jump performances that are considered specific

to volleyball success: the spike jump (SPJ) and counter-movement vertical jump (CMVJ). To assess the relationship among strength, power, and anthropometric variables with CMVJ and SPJ, a correlation and regression analysis was performed. In addition, a comparison of strength, power, and anthropometric differences between the seven best subjects and the seven worst athletes on the CMVJ test and SPJ test was performed. When expressed as body mass relative measures, moderate correlations (0.53-0.65;  $p < \text{or} = 0.01$ ) were observed between the 1RM measures and both relative CMVJ and relative SPJ. Very strong correlations were observed between relative (absolute height-standing reach height) depth jump performance and relative SPJ (0.85;  $p < \text{or} = 0.01$ ) and relative CMVJ (0.93;  $p < \text{or} = 0.01$ ). The single best regression model component for relative CMVJ was the relative depth jump performance, explaining 84% of performance. The single best predictor for relative SPJ was also the relative depth jump performance (72% of performance), with the three-component models of relative depth jump, relative CMVJ, spike jump contribution (percent difference between SPJ and CMVJ), and relative CMVJ, spike jump contribution, and peak force, accounting for 96% and 97%, respectively. The results of this study clearly demonstrate that in an elite population of volleyball players, stretch-shortening cycle performance and the ability to tolerate high stretch loads, as in the depth jump, is critical to performance in the jumps associated with volleyball performance.

Stanganelli, L. C., Dourado, A. C., Oncken, P., Mancan, S., da Costa, S. C. (2008). Adaptations on jump capacity in Brazilian volleyball players prior to the under-19 World Championships, *Journal of Strength and Conditioning Research*, 22 (3), 741-9.

The under-19 Brazilian volleyball national team has achieved great performances at international competitions. Because the vertical jump capacity is critical for success in volleyball, the purpose of this study was to identify the training-induced adaptations on jump capacity assessed by general and specific tests during 3 different moments (i.e., T1, T2, and T3) of a macrocycle of preparation for the world championship. The sample was composed of 11 athletes from the Brazilian national team-World Champion (age,  $18.0 \pm 0.5$  years; height:  $198.7 \pm 5.4$  cm; and body mass,  $87.3 \pm 5.9$  kg). They were evaluated for jumping capacity by the following tests: squat jump (SJ), countermovement jump (CMJ), and jump anaerobic resistance (15 seconds) (JAR) and standing reach, height, and vertical jump tests for attack and block. Descriptive statistics were computed, and a repeated-measures analysis of variance was used. The Tukey-Kramer post hoc test was used when appropriate. Significance was set at  $P < \text{or} = 0.05$ . The results showed that the training-induced adaptations on the SJ (3.9%) and CMJ (2.3%) were not statistically significant. The JAR showed statistical significance between T2 and T3 (9.6%), while the attack height and block height presented significant differences between T1 and T2 (2.5% and 3.3%, respectively) and T1 and T3 (3.0% and 3.5%, respectively).

The volume of training was quantified between weeks 1 and 9 [10,750 minutes,  $1,194 \pm 322$  min  $\times$  wk<sup>(-1)</sup>] and between weeks 10 and 18 (8722 minutes,  $969 \pm 329$  min  $\times$  wk<sup>(-1)</sup>). This study showed that there were progressive and significant training-induced adaptations, mainly on the tests that simulated the specific skills, such as spike and block, with the best results being reached after the first 9 weeks of training. This probably reflected not only the individual's capacity to adapt, but also the characteristics of the training loads prescribed during the entire macrocycle.

Sheppard, J. M., Gabbett, T., & Borgeaud, R. (2008). Training repeated effort ability in national team male volleyball players. *International Journal of Sports Physiology Research*, 3(3), 397-400.

This case study evaluated the effect of repeated lateral movement and jumping training on repeated effort ability in a group of national team male volleyball players. Twelve volleyball players were assessed on their volleyball-specific repeated movement and jumping abilities using a volleyball-specific repeated effort test (RET) before and after 12 weeks of training. The athletes performed between 8 and 9 volleyball training sessions per week, with 5 to 6 of these sessions including specific training aimed at improving repeated effort ability. Typically these training sessions involved 8 to 12 repetitions of 2 to 3 block jumps over a 9-m lateral distance (i.e., the athletes had to perform jumps and lateral movements, typical of front court play in volleyball). Population-specific repeatability data were used to determine whether any changes that may have occurred in this study were beyond the minimal clinically important difference (MCID) for this testing procedure. Improvements in all variables of the RET were observed for each athlete involved in the study, with a small-to-moderate magnitude observed for the mean changes in each variable (Cohen's *d*, 0.21 to 0.59). All of the improvements in the results exceeded the MCID. These findings demonstrate that the RET is sensitive to training-induced changes. Lateral movement speed and repeated lateral movement speed, as well as jumping and repeated jumping ability are trainable qualities in high-performance volleyball players.

Newton, R. U., Rogers, R. A., Volek, J. S., Hakkinen, K., & Kraemer, W. J. (2006). Four weeks of optimal load ballistic resistance training at the end of season attenuates declining jump performance of woman volleyball players. *Journal of Strength and Conditioning Research*, 20(4), 955-61.

Anecdotal and research evidence is that vertical jump performance declines over the competitive volleyball season. The purpose of this study was to evaluate whether a short period of ballistic resistance training would attenuate this loss. Fourteen collegiate women volleyball players were trained for 11 weeks with periodized traditional and ballistic resistance training. There was a 5.4% decrease ( $p < 0.05$ ) in approach jump and reach height during the traditional training period (start of season to midseason), and a 5.3% increase

( $p < 0.05$ ) during the ballistic training period (midseason to end of season), but values were not different from start to end of season. These changes in overall jump performance were reflective of changes in underlying neuromuscular performance variables: in particular, power output and peak velocity during loaded jump squats, countermovement jumps, and drop jumps. During the first 7 weeks of traditional heavy resistance training, it appears that the neuromuscular system is depressed, perhaps by the combination of training, game play, and skills practice precluding adequate recovery. Introduction of a novel training stimulus in the form of ballistic jump squats and reduction of heavy resistance training of the leg extensors stimulated a rebound in performance, in some cases to exceed the athlete's ability at the start of the season. Periodization of in-season training programs similar to that used in this study may provide volleyball players with good vertical jump performance for the crucial end-of-season games.

Martel, G. F., Harmer, M. L., Logan, J. M., & Parker, C. B. (2005). Aquatic plyometric training increases vertical jump in female volleyball players. *Medicine and Science in Sports and Exercise*, 37(10), 1814-1819.

Numerous investigators have reported that land-based plyometrics can improve muscular strength, joint stability, and vertical jump (VJ) in athletes; however, due to the intense nature of plyometric training, the potential for acute muscle soreness or even musculoskeletal injury exists. Performance of aquatic plyometric training (APT) could lead to similar benefits, but with reduced risks due to the buoyancy of water. Unfortunately, there is little information regarding the efficacy of APT. Thus, the purpose of this study was to examine the effects of APT on VJ and muscular strength in volleyball players. Nineteen female volleyball players (aged  $15 \pm 1$  yr) were randomly assigned to perform 6 wk of APT or flexibility exercises (CON) twice weekly, both in addition to traditional preseason volleyball training. Testing of leg strength was performed at baseline and after 6 wk, and VJ was measured at baseline and after 2, 4, and 6 wk. Similar increases in VJ were observed in both groups after 4 wk (APT = 3.1%, CON = 4.9%; both  $P < 0.05$ ); however, the APT group improved by an additional 8% ( $P < 0.05$ ) from week 4 to week 6, whereas there was no further improvement in the CON group (-0.9%;  $P = \text{NS}$ ). After 6 wk, both groups displayed significant improvements in concentric peak torque during knee extension and flexion at 60 and 180 degrees  $\times$  s<sup>(-1)</sup> (all  $P < 0.05$ ). The combination of APT and volleyball training resulted in larger improvements in VJ than in the CON group. Thus, given the likely reduction in muscle soreness with APT versus land-based plyometrics, APT appears to be a promising training option.

Maffiuletti, N. A., Dugnani, S., Folz, M., Di Pierno, E., Mauro, F. (2002). Effect of combined electrostimulation and plyometric training on vertical jump height. *Medicine and Science in Sports and Exercise*, 34(10), 1638-1644.

This study investigated the influence of a 4-wk combined electromyostimulation (EMS) and plyometric training program on the vertical jump performance of 10 volleyball players. Training sessions were carried out three times weekly. Each session consisted of three main parts: EMS of the knee extensor muscles (48 contractions), EMS of the plantar flexor muscles (30 contractions), and 50 plyometric jumps. Subjects were tested before (week 0), during (week 2), and after the training program (week 4), as well as once more after 2 wk of normal volleyball training (week 6). Different vertical jumps were carried out, as well as maximal voluntary contraction (MVC) of the knee extensor and plantar flexor muscles. At week 2, MVC significantly increased (+20% knee extensors, +13% plantar flexors) as compared to baseline ( $< 0.05$ ). After the 4-wk training program, different vertical jumps considered were also significantly higher compared to pretraining ( $< 0.001$ ), and relative gains were comprised between 8-10% (spike-counter movement jump) and 21% (squat jump). The significant increases in maximal strength and explosive strength produced by the present training program were subsequently maintained after an additional 2 wk of volleyball training. EMS combined with plyometric training has proven useful for the improvement of vertical jump ability in volleyball players. This combined training modality produced rapid increases (approximately 2 wk) of the knee extensors and plantar flexors maximal strength. These adaptations were then followed by an improvement in general and specific jumping ability, likely to affect performance on the court. In conclusion, when EMS resistance training is proposed for vertical jump development, specific work out (e.g., plyometric) must complement EMS sessions to obtain beneficial effects.

Bisseling, R. W., Hof, A. L., Bredeweg, S. W., Zwerver, J., & Mulder, T. (2008). Are the take-off and landing phase dynamics of the volleyball spike jump related to patellar tendinopathy? *British Journal of Sports Medicine*, 42(6), 483-489.

The causal mechanism of the chronic sports injury patellar tendinopathy is not well understood. The aim of the present study was to compare ankle and knee joint dynamics during the performance of the volleyball spike jump between healthy volleyball players ( $n = 8$ ) and asymptomatic volleyball players with previous patellar tendinopathy ( $n = 7$ ). A cross-sectional design and inverse dynamics were used to estimate ankle and knee joint dynamics. From these multiple biomechanical variables, a logistic regression was performed to estimate the probability of the presence or absence of previous patellar tendinopathy among the volleyball players studied. Several biomechanical variables improved the prediction of the presence or absence of previous patellar tendinopathy. For landing, ankle plantar flexion at the time of touch-down, and knee range of motion during the first part of impact, and for take-off, loading rate of the knee extensor moment during the eccentric countermovement phase of take-off were predictive. As interaction effects, the presence or absence of previous patellar tendinopathy were correctly predicted by ankle and knee range of motion during the first part of impact, by loading rate of the knee extensor moment during

the eccentric phases of take-off and landing, and by knee angular velocity during the eccentric phases of take-off and landing. Smaller joint flexion during the first part of landing impact, and higher rate of knee moment development during the eccentric phases of the spike-jump landing sequence, together with higher knee angular velocities, might be risk factors in the development of patellar tendinopathy in volleyball players.

Malliaras, P., Cook, J. L., & Kent, P. M. (2007). Anthropometric risk factors for patellar tendon injury among volleyball players. *British Journal of Sports Medicine*, 41(4), 259-63.

Abnormal imaging in the patellar tendon reveals pathology that is often associated with knee pain. Anthropometric measures of body size and mass, such as height, weight and waist-to-hip ratio (WHR), have been individually associated with abnormal imaging. The aim of this study was to investigate the anthropometric factors that have the strongest relationship with abnormal imaging in volleyball players. Height, weight, body mass index (BMI), waist girth, hip girth and WHR were measured in a cohort of 113 competitive volleyball players (73 men, 40 women). The univariate (ANOVA) and multivariable (discriminant function analysis) association between abnormal imaging and these anthropometric factors were investigated. No significant association was found in the female volleyball players. A significant univariate association was observed between abnormal imaging and heavier weight, greater BMI, larger waist and hip girth and larger WHR in the male volleyball players. Waist girth was the only factor that retained this association in a multivariable model ( $p < 0.05$ ). Men with a waist girth greater than 83 cm seem to be at greater risk of developing patellar tendon pathology. There may be both mechanical and biochemical reasons for this increased risk.

Suda, E. Y., Amorim, C. F., Sacco, E. de C. (2009). Influence of ankle functional instability on the ankle electromyography during landing after volleyball blocking. *Journal of Electromyography and Kinesiology*, 19(2), e84-93.

The purpose of this study was to describe, interpret and compare the EMG activation patterns of ankle muscles - tibialis anterior (TA), peroneus longus (PL) and gastrocnemius lateralis (GL) - in volleyball players with and without ankle functional instability (FI) during landing after the blocking movement. Twenty-one players with FI (IG) and 19 controls (CG) were studied. The cycle of movement analyzed was the time period between 200 ms before and 200 ms after the time of impact determined by ground reaction forces. The variables were analyzed for two different phases: pre-landing (200 ms before impact) and post-landing (200 ms after impact). The RMS values and the timing of onset activity were calculated for the three studied muscles, in both periods and for both groups. The co-activation index for TA and PL, TA and GL were also calculated. Individuals with FI presented a lower RMS value pre-landing for PL ( $CG = 43.0 \pm 22.0$ ;

IG=26.2 ± 8.4, p<0.05) and higher RMS value post-landing (CG=47.5 ± 13.3; IG=55.8 ± 21.6, p<0.10). Besides that, in control group PL and GL activated first and simultaneously, and TA presented a later activation, while in subjects with FI all the three muscles activated simultaneously. There were no significant differences between groups for co-activation index. Thus, the rate of contraction between agonist and antagonist muscles is similar for subjects with and without FI but the activation individually was different. Volleyball players with functional instability of the ankle showed altered patterns of the muscles that play an important role in the stabilization of the foot-ankle complex during the performance of the blocking movement, to the detriment of the ligament complex, and this fact could explain the usual complaints in these subjects.

Smith, C. E., Nyland, J., Caudill, P., Brosky, J., & Caborn, D. N. (2008). Dynamic trunk stabilization: a conceptual back injury prevention program for volleyball athletes. *Journal of Orthopaedic and Sports Therapy*, 38(11), 703-720.

The sport of volleyball creates considerable dynamic trunk stability demands. Back injury occurs all too frequently in volleyball, particularly among female athletes. The purpose of this clinical commentary is to review functional anatomy, muscle coactivation strategies, assessment of trunk muscle performance, and the characteristics of effective exercises for the trunk or core. From this information, a conceptual progressive 3-phase volleyball-specific training program is presented to improve dynamic trunk stability and to potentially reduce the incidence of back injury among volleyball athletes. Phase 1 addresses low-velocity motor control, kinesthetic awareness, and endurance, with the clinician providing cues to teach achievement of biomechanically neutral spine alignment. Phase 2 focuses on progressively higher velocity dynamic multiplanar endurance, coordination, and strength-power challenges integrating upper and lower extremity movements, while maintaining neutral spine alignment. Phase 3 integrates volleyball-specific skill simulations by breaking down composite movement patterns into their component parts, with differing dynamic trunk stability requirements, while maintaining neutral spine alignment. Prospective research is needed to validate the efficacy of this program.

Gabbett, T. J. (2008). Do skill based conditioning games offer a specific training stimulus for junior elite volleyball players? *Journal of Strength and Conditioning Research*, 22(2), 509-517.

This study investigated the specificity of skill-based conditioning games and compared the effectiveness of skill-based conditioning games and instructional training for improving physical fitness and skill in junior elite volleyball players. Twenty-five junior volleyball players (mean age ± SE, 15.6 ± 0.1 years) participated in this study. Heart rate data were collected on all players during the Australian Junior Volleyball Championships. After the competition, players

were randomly allocated into a skill-based conditioning games group (n = 12) or an instructional training group (n = 13). Each player participated in a 12-week training program that included 3 organized court training sessions per week. No significant differences (P > 0.05) were detected between competition and skill-based conditioning games for the percentage of time spent in low-intensity, moderate-intensity, and high-intensity activities. Skill-based conditioning games induced improvements in vertical jump, spike jump, speed, agility, upper-body muscular power, and estimated maximal aerobic power, whereas technical instruction improved only spike jump and speed. Conversely, instructional training induced meaningful improvements in all measurements of skill, whereas improvements in technical skill after skill-based conditioning games were uncommon and typically small. The results of this study show that skill-based conditioning games offer a specific training stimulus to simulate the physiological demands of competition in junior elite volleyball players. Although the improvements in physical fitness after training were greater with skill-based conditioning games, instructional training resulted in greater improvements in technical skill in these athletes. These findings suggest that a combination of instructional training and skill-based conditioning games is likely to confer the greatest improvements in fitness and skill in junior elite volleyball players.

Gabbett, T., Georgieff, B., Anderson, S., Cotton, B., Savovic, D., & Nicholason, L. (2006). Changes in skill and physical fitness following training in talent identified volleyball players. *Journal of Strength and Conditioning Research*, 20(1), 29-35.

This study investigated the effect of a skill-based training program on measurements of skill and physical fitness in talent-identified volleyball players. Twenty-six talented junior volleyball players (mean ± SE age, 15.5 ± 0.2 years) participated in an 8-week skill-based training program that included 3 skill-based court sessions per week. Skills sessions were designed to develop passing, setting, serving, spiking, and blocking technique and accuracy as well as game tactics and positioning skills. Coaches used a combination of technical and instructional coaching, coupled with skill-based games to facilitate learning. Subjects performed measurements of skill (passing, setting, serving, and spiking technique and accuracy), standard anthropometry (height, standing-reach height, body mass, and sum of 7 skinfolds), lower-body muscular power (vertical jump, spike jump), upper-body muscular power (overhead medicine-ball throw), speed (5- and 10-m sprint), agility (T-test), and maximal aerobic power (multistage fitness test) before and after training. Training induced significant (p < 0.05) improvements in spiking, setting, and passing accuracy and spiking and passing technique. Compared with pre-training, there were significant (p < 0.05) improvements in 5- and 10-m speed and agility. There were no significant differences between pre-training and post-training for body mass, skin fold thickness, lower-body muscular power, upper-body muscular power, and maximal aerobic power.

These findings demonstrate that skill-based volleyball training improves spiking, setting, and passing accuracy and spiking and passing technique, but has little effect on the physiological and anthropometric characteristics of players.

Tilp, M., Wagner, H., Muller, E. (2008). Differences in 3D kinematics between volleyball and beach volleyball spike movements. *Sports Biomechanics*, 7(3), 386-397.

The purpose of this study was to identify differences between volleyball and beach volleyball spike jump movements performed on an indoor surface and sand surface respectively. Eight elite male volleyball players performed spike jump movements on both surfaces. An eight-camera motion capturing system (250Hz) was used to generate 3D kinematic data. Seven groups of variables representing the kinematics of the centre of mass, the countermovement, the approach phase, and the angular amplitudes and maximal velocities of the lower and upper limbs were examined using Hotelling's T<sup>2</sup>(2). Significant differences were observed in the movement of the centre of mass ( $P < 0.05$ ), the countermovement, the kinematics of the approach phase, and the angular amplitudes of the lower limbs. However, no significant differences were observed either in the maximal angular velocities of the lower and upper limbs, or in the amplitudes of the upper limb motion. In conclusion, the participants showed significant adaptation to changed movement conditions. As a result of the compliance of the sand surface, the participants slowed down their movements, especially during the phase of transition from knee flexion to extension and during the extension phase. Furthermore, the participants demonstrated changes in foot position to reach the greatest height possible.

Palao, J. M., Gutierrez, D., & Frideres, J. E. (2008). Height, weight, body mass index, and age in beach volleyball players in relation to level and position. *Journal of Sports Medicine and Fitness*, 48(4), 466-471.

This study tried to determine the height, weight, Body Mass Index (BMI), and age of peak performance beach volleyball players with regard to their level of play and their role. The men's and women's pairs that classified in the World Tour and in the Olympic Games during seasons 2000-2006 were analyzed (625 males and 617 females). A descriptive, correlational, and longitudinal design was used. The variables studied were: height, weight, age, BMI, level (World Tour ranking), and player role (blocker, defense specialist, or no specialization). The data were obtained from the webpage of the International Federation of Volleyball. The average characteristics for males were 1.93 m, 88-89 kg, a BMI of 23.8-24.1, and an age range of 29-31 years, and for females, they were 1.77-1.79 m, 66-68 kg, a BMI of 19.2-21.1, and an age range of 27-29 years. Beach volleyball players are older and have smaller anthropometric characteristics when compared to indoor volleyball players. Male players present similar values for age and height across rankings. For both genders, with regard to weight and BMI, the higher the level,

the larger the value. For women, the players at a higher level presented higher values of age, height, weight, and BMI. With regard to role, the blocking specialists were taller than the defense specialists. The pairs that share the blocking and defense responsibilities have intermediate values.

Zetou, E., Giatsis, G., Mountaki, F., & Komninakidou, A. (2008). Body weight changes and voluntary fluid intakes of beach volleyball players during an official tournament. *Journal of Science and Medicine in Sport*, 11(2), 139-145.

The aim of this study was to calculate sweat rates (measured by weight changes), voluntary fluid intakes, and fluid balance of beach volleyball players during a tournament. Data were collected during the 3 days of the tournament for male players ( $n=47$ ) age  $M=26.17$  (S.D.=5.12) years old. Participants were weighed before the warm up and they reweighed immediately after the game. The differences in body weight were calculated in grams. The voluntary fluid intake of players during the game was also recorded by observers, whose inter and intra reliability were evaluated (inter  $r=0.89$  and intra reliability  $r=0.93$ ). Fifty matches took place with a  $M=42.2$ min duration per match. A wide individual variation appeared in fluid intake and sweat loss. The calculated average sweat rate, fluid intake rate and fluid balance of players during each match were  $M=1440$ ml,  $M=731$ ml and  $M=-0.8\%$ , respectively. Air temperature ranged from 26 degrees to 38 degrees C ( $M=33.58$  degrees C, S.D.=2.8) and humidity from 42% to 75% ( $M=56.04\%$ , S.D.=8.7) and both were measured in each day of tournament, at the beginning and at the end of each game. Although players' dehydration (-0.8%) was of mild level, it was more or less the same as it was reported in other team sports studies. ANOVA did not prove differences between elite and non-elite athletes in sweat loss and fluid intake ( $p>.01$ ). Sweat rate was associated only with humidity ( $r=.99$ ,  $p<.01$ ) and with fluid intake ( $r=.315$ ,  $p<.05$ ). The athletes should be aware of the great significance of fluids and to intake greater quantities in order to prevent weight loss and at the same time loss of vital elements that would cause their performance to decline.

Pfirmann, C. W., Josst, B., Pirkl, C., Aitzetmuller, G., & Lajtai, G. (2008). Quadriceps tendinosis and patellar tendinosis in professional beach volleyball players: sonographic findings in correlation with clinical symptoms. *European Radiology*, 18(8), 1703-1709.

The purpose of this investigation was to assess quadriceps and patellar tendinosis in professional beach volleyball players and to correlate ultrasound findings with clinical symptoms. During a grand-slam beach volleyball tournament, all 202 athletes (100 men and 102 women) were invited to participate. Sixty-one athletes (38 male, mean age of 29.6, 23 female, mean age of 27.1) were included. The dominant leg was right in 51 athletes (84%) and left in 10 athletes (16%). Lysholm knee score and pain during the game was assessed using a visual analogue scale. Sonography of the quadriceps tendon and the patellar tendon was performed by

a blinded sonographer. Sonographic findings were compared between both legs and correlated to clinical findings using a regression analysis. Quadriceps tendinosis was diagnosed in 13 (21%, dominant leg)/21 (34%, non-dominant leg), patellar tendinosis in 13(21%)/18(30%). Only sonographic findings at the quadriceps tendon were significantly associated with pain: thickness of the quadriceps tendon (mean diameter 6.9 mm/7.1 mm, significant for both legs  $P = 0.011/P = 0.030$ ), abnormal echo texture (11/16;  $P = 0.001/P = 0.228$ ), areas with positive power Doppler signals (mean number 0.3/0.4;  $P = 0.049/0.346$ ), calcifications (mean number: 0.9/1.1;  $P = 0.021/0.864$ ). A relationship between findings at patellar tendon was not found. Quadriceps tendinosis is as common as patellar tendinosis in professional beach volleyball players. Thickening and structure alteration of the quadriceps tendon is associated with anterior knee pain during beach volleyball.

Bankoff, A. D., Fonseca, N. D. R., Zago, L. C., & Moraes, A. C. (2006). Electromyographical study of the pectoralis major (sternocostal part) and deltoid muscles (middle fibers) in volleyball sequential actions. *Electromyography and Clinical Therapy*, 46(1), 27-33.

The Pectoralis Major muscles (Sternocostal part) and Deltoid (middle fibers) were studied using electromyography in 8 male individuals, who practice volleyball, youth category, aged between 15 and 17 ( $\pm 1.625$ ) years, right-handed, those involved in volleyball for about one year. The objective was to analyze the potential of action of these muscles engaged in the volleyball movements: service, spike, pass, set and blocking with and without ball. The work was developed in the Electromyography and Biomechanics of Posture Laboratory (Physical Education Faculty--State University of Campinas--UNICAMP). To capture the muscle action potential, surface electrodes were set with conductive gel and fixed on the skin, in the center of the muscles. It was used an electromyography Lynx with 6 channels. The apparatus calibration was 2.500 microV, 1199.760 Hz. The low and high pass filter was set at 600-10 Hz. The sequential experiments without ball were performed for 10 seconds, and the sequential experiments with ball in 12 seconds. The Pectoralis Major muscle (Sternocostal part) revealed active during the basic movements of volleyball, (service and spike) in all movements of the extension of the arm, as well as the arm abduction during the pass movement. The Deltoid muscle (middle fibers), in spite of being primary in the abduction, showed the potential of action in all movements practiced in volleyball, however, they were more intense, in the spike and block actions. It is interesting to observe, that the general average and the standard deviation of the Deltoid muscle (middle fibers), were higher in the sequential movements executed without ball.

Marques, M. C., Tillaar, R., Vescovi, J. D., & Gibzakez-Badillo, J. J. (2008). Changes in strength and power performance in elite senior female professional volleyball players during the in-season: a case study. *Journal of Strength and Conditioning*

*Research*, 22(4), 1147-1155.

It is often recommended that in-season training programs aim to maintain muscular strength and power developed during the off-season. However, improvements in performance may be possible with a well-designed training regimen. The purpose of this case report is to describe the changes in physical performance after an in-season training regimen in professional female volleyball players in order to determine whether muscular strength and power might be improved. Apart from normal practice sessions, 10 elite female volleyball players completed 2 training sessions per week, which included both resistance training and plyometric exercises. Over the 12-week season, the athletes performed 3-4 sets of 3-8 repetitions for resistance and plyometric exercises during each training session. All sessions were supervised by one of the investigators as well as by the team head coach. Muscular strength and power were assessed before and after the 12-week training program using 4 repetition maximum bench press and parallel squat tests, an overhead medicine ball throw (BTd), as well as unloaded and loaded countermovement jumps (CMJs). Strength improved by 15% and 11.5% in the bench press and parallel squat, respectively ( $p < 0.0001$ ). Distance in the BTd improved by 11.8% ( $p < 0.0001$ ), whereas unloaded and loaded CMJ height increased between 3.8 and 11.2%. The current findings suggest that elite female volleyball players can improve strength and power during the competition season by implementing a well-designed training program that includes both resistance and plyometric exercises.

Grgantov, Z., Nedovic, D., Katic, R. (2007). Integration of technical and situation efficacy into the morphological system in young female volleyball players. *Collegium Anthropologicum*, 31(1), 267-273.

The aim of the study was to identify morphological structures of young female volleyball players according to age, and to assess the impact of these morphological structures on technical and situation efficacy. A set of 13 morphological measures as predictor variables, a set of 6 technique elements, and assessment of performance quality as criterion variables were employed in a sample of 246 female volleyball players. The sample consisted of 32 players aged 12-13, 147 players aged 14-15, 50 players aged 16-17, and 17 players aged 18-19. Analysis of variance showed the female volleyball players of various age groups to differ significantly according to the variables assessing the longitudinal skeleton dimensionality, and body mass and volume, as well as in all tests used on volleyball technique evaluation. Factor analysis of morphological measures applied across all age groups generally yielded two morphological structures: the one determined by skeleton development, i.e. longitudinal and transverse bone growth, and another one determined by soft tissue development, i.e. muscle and adipose tissue growth. Results of regression analysis revealed the longitudinal skeleton dimensionality to significantly determine the block technique performance across all age groups, and to a lesser extent performance

of the spike technique in the 14-15 and 16-17 age groups. Regression correlation analysis also showed the developed skeleton based on the predominance of longitudinality to be a significant positive predictor of situation performance in all age groups.

Kishali, N. F., Imamoglu, O., Katkat, D., Atan, T., & Akyol, P. (2006). Effects of menstrual cycle on sports performance. *International Journal of Neuroscience*, 116(12), 1549-1563.

The aim of this study was to examine the effects of menstrual cycle on female athletes' performance. Forty-eight taekwondo athletes, 76 judoka, 81 volleyball, and 36 basketball players (total 241) elite athletes participated in the study. A questionnaire constituted from 21 questions about menstrual cycle applied. A one-way analysis of variance and scheffe tests were performed to assess differences between sport branches about physical and physiological characteristics. Chi square was used to evaluate the regularity of menstrual cycle, performance, and drug taking. The mean age of taekwondo athletes, judokas, volleyball and basketball players were  $20.71 \pm 0.41$ ,  $16.91 \pm 0.27$ ,  $21.22 \pm 0.26$ , and  $21.03 \pm 0.63$  years, respectively. The menarche ages of the athletes were 13.92, 13.22, 13.75, 13.86 years, respectively. 27.8% participated in regional competitions, 46.1% participated in just the national competitions, and 26.1% participated in the international competitions. Whereas the menstrual disorder was seen in 14.5% of the athletes in normal time, during the intensive exercise this ratio was increased to 20.7%. It was determined that during the competition 11.6% of the athletes used drug, 36.9% had a painful menstruation, 17.4% did not have a painful menstruation, 45.6% sometimes had a painful menstruation, and 63.1% of the athletes said that their pain decreased during the competition. First 14 days after the menstruation began, 71% of the athletes said that they felt themselves well. 71% of the athletes felt worst just before the menstruation period, 62.2% of the athletes said that their performance was same during the menstruation, and 21.2% said that their performance got worse. Both in general and during the training the menstruation period of the athletes was found to be regular ( $p < .01$ ). Most of the athletes said that they have a painful menstruation period, and during the competition their pain decreased. As a result of the questionnaire, during the training and competition the number of athletes that did not use drugs were higher than the athletes that used drug ( $p < .01$ ). The number of athletes that felt good before and during the menstruation was  $\pm$ significantly higher ( $p < .05$ ,  $p < .01$ ). Between the menstruation periods the athletes said that they felt better in the first 14 days than the second 14 days ( $p < .01$ ). When the non-menses period and menses period were compared the athletes said that their performance did not change ( $p < .01$ ). It has been concluded that the menarche age was high in the athletes. It has found that the physical performance was not affected by the menstrual period and the pain decreased during the training and competition.

Beals, K. A. (2002). Eating behaviors, nutritional status, and menstrual function in elite female adolescent volleyball players. *Journal of the American Dietetic Association*, 102(9), 1293-6.

Nutritional status, eating behaviors and menstrual function was examined in 23 nationally ranked female adolescent volleyball players using a health/weight/ dieting/menstrual history questionnaire, the Eating Disorder Inventory (EDI), and the Body Shape Questionnaire (BSQ). Nutrient and energy intakes (EI) and energy expenditure (EE) were determined by 3-d weighed food records and activity logs. Iron (Fe), vitamins C, B12, and Folate status were assessed using serum and whole blood. Mean EI ( $2248 \pm 414$  kcal/d) was less than EE ( $2815 \pm 306$  kcal/d). Mean carbohydrate ( $5.4 \pm 1.0$ g/kg/d) and protein ( $1.1 \pm 0.3$ g/kg/d) intakes were below recommended levels for highly active women. Mean intakes for folate, Fe, Ca, Mg, and Zn were less than the respective RDAs/DRIs and almost 50% of the athletes were consuming less than the RDAs/DRIs for the B-complex vitamins and vitamin C. Three athletes presented with Fe deficiency anemia (Hb  $<12$  mg/dL), while marginal vitamin B12 status ( $<200$  pg/ml) and vitamin C status ( $<28$  mmol/L) were found in 1 and 4 athletes, respectively. Approximately 1/2 of the athletes reported actively "dieting". Mean BSQ and EDI subscales scores were within the normal ranges; yet, elevated scores on these scales were reported by 26% and 35% of athletes, respectively. Past or present amenorrhea was reported by 17% of the athletes and 13% and 48%, reported past or present oligomenorrhea and "irregular" menstrual cycles, respectively. These results indicate that elite adolescent volleyball players are at risk for menstrual dysfunction and have energy and nutrient intakes that place them at risk for nutritional deficiencies and compromised performance.

*Journal of Volleyball Sciences*  
**Titles from 1999 to 2009**

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