Preliminary Study on the Changes in Muscle Composition in Sports Games

Bogdan Alexandru Hagiu[a], Radu-Mihai Iacob[a], Alexandu-Rareș Puni[a]

[a] *"Al.I. Cuza" University, Iași, Faculty of Physical Education and Sport, Romania*

Abstract

In order to evaluate how volleyball and basketball games and their corresponding training sessions coincide with changes in the composition of the muscles put to work, we used the method of the repeated effort at submaximal weight to test a lot of volleyball players and one of basketball players. The results show that the muscles involved in the specific effort required by volleyball exercises retain their typical proportion in muscle fiber types, while in the case of basketball the typical proportion of fast-twitch fibers is replaced by the slow-twitch fibers.

Keywords:volleyball, basketball, slow-twitch fiber, fast-twitch fiber

Hypothesis

Our present research is based on the hypothesis that, similarly to the change in the proportion of muscle fiber types characteristic to the muscles required in various sports [3, 4, 5, 7], volleyball and basketball training, too, have this effect on the addressed muscles. Considering that the two sports in discussion bear differences in the types of exercise and the specific training required, and that the fast-twitch fibers facilitate the short-term anaerobic efforts [10] characteristic to basketball, we assume there will also be differences in terms of the changes in the composition of the muscles involved in that particular effort.

PurposeThe purpose of our paper is to evaluate how the volleyball and basketball games and their specific training coincide with changes in the composition of the muscles involved, and implicitly to improve the specific training methodology, given the fact that the changes in the proportion of muscle fiber types can be realized through electromyostimulation [9].

Methods

The research was conducted on 7 performance volleyball players from A.C.S. Penicillina Iasi and 5 performance basketball players from C.S. Politehnica Iași.

We used the indirect method to estimate the composition in muscle fiber types within the muscle [6]:

- we determined the weight corresponding to a maximum repeated effort (1 RM);
- the subjects performed as many repetitions as possible with 80 out of 1 RM;
- if less than 7 repetitions, we considered that the muscle contains more than 50% fast-twitch fibers;
- if more than 12 repetitions have been carried out, it is considered that the muscle contains more than 50% slow-twitch fibers;
- if the subjects performed between 7 and 12 repetitions, it is considered that the muscle contains an equal proportion of slow and fast-twitch fibers;
- a 15-minute break between exercises is observed.

In our study we evaluated the composition of muscle fiber types in the groups of or in the individual muscles required during the specific game or training, by using the vertical bar paddling (tight grip) and leg press for volleyball players (Figure 1) and Scott bench dumbbells (biceps isolation) and the extension of the forearm with the dumbbell, with the simultaneous locking of the elbow (triceps isolation) for the basketball players (Figure 2).

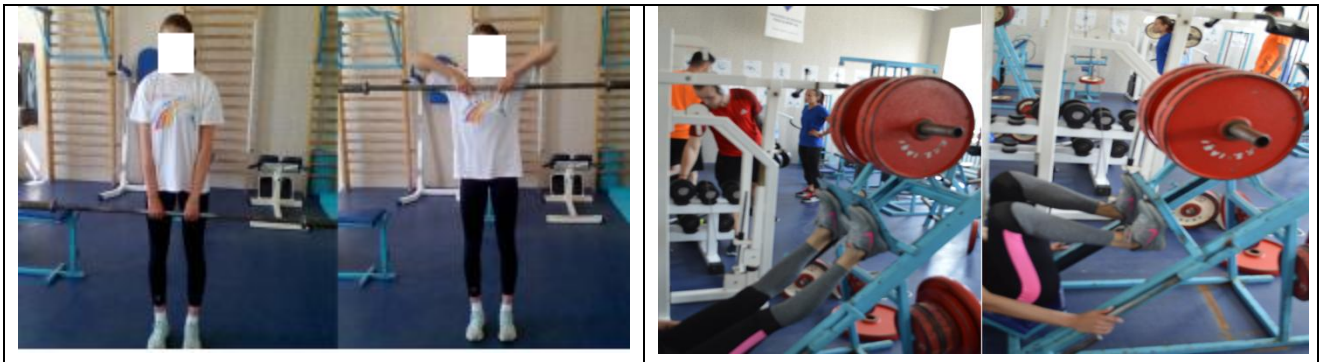

Figure 1. Exercises for testing muscle composition in volleyball players (left - vertical bar paddling with tight grip, right – leg press)

Figure 2. Exercises for testing muscle composition in basketball players (left - isolation of the biceps, right - triceps isolation)

Results

The anthropometric characteristics, age and the number of repetitions with submaximal weights are listed in Table no.1 for volleyball players (vertical bar paddling with tight grip and leg press), and in Table no. 2 for basketball players (biceps and triceps isolation exercises).

Table 1. Test results for volleyball players

Subject	Age (years)	Height (cm)	Weight (kg)	**Vertical bar paddling (tight grip)**			**Leg press**		
				1 RM (kg)	80 % RM (kg)	No. of repetitions	1 RM (kg)	80 % RM (kg)	No. of repetitions
S1	25	190	77	33	27	6	150	120	17
S2	20	181	77	33	27	7	150	120	20
S3	25	175	68	33	27	8	150	120	20
S4	27	176	68	33	27	7	150	120	17
S5	21	182	70	33	27	5	150	120	18
S6	21	177	65	33	27	8	150	120	15
S7	21	178	64	33	27	6	150	120	16
Average number of repetitions				**6.71**			**17.57**		
Predominant muscle fiber type				**Fast-twitch fibers**			**Slow-twitch fibers**		

Table 2. Test results for basketball players

Subject	Age (years)	Height (cm)	Weight (kg)	**Biceps** 1 RM (kg)	80 % RM (kg)	No. of repetitions	**Triceps** 1 RM (kg)	80 % RM (kg)	No. of repetitions
S1	20	182	63	12,5	10	18	5	4	37
S2	20	180	76	12,5	10	31	7	5	30
S3	20	170	65	15	12,5	46	7	5	37
S4	21	169	59	12,5	10	36	7	5	25
S5	21	167	63	12,5	10	34	7	5	29
Average number of repetitions						33			31.6
Predominant muscle fiber type						**Fast-twitch fibers**			**Slow-twitch fibers**

Discussion

Compared with the normal proportion of muscle fiber types in the shoulder muscles [8], the estimative method we used for our study shows the preservation of the predominant fiber type (fasy-twitch) in the deltoid muscle of the volleyball players, and the replacement of the fast-twitch fibers with slow-twitch ones in the biceps and triceps of basketball players. In what lower limb muscles are concerned, a synthesis of the previously published studies shows that slow-twitch fibers exist in proportion of at least 50%, with the exception of the right femur [1]. Therefore, we consider that the specific exercises and training in the lower limbs also result in the preservation of the proportion of muscle fiber types. Although fast-twitch muscle fibers facilitate the short-term anaerobic efforts [10] that we appreciate that they are more likely characteristic to playing basketball rather than volleyball, the predominance of slow-twitch fibers in the biceps and triceps of basketball players may be due to the maximum volume of oxygen required, superior to that needed when playing volleyball. Our assumption is based on the fact that the proportion of slow-twitch fibers in the gastrocnemius and the vastus lateralis is directly proportional to oxygen consumption [2]. Thus, the need to increase the number of mitochondria and the amount of myoglobin has probably led to the transition to fibers that have a predominantly oxidative metabolism.

Conclusions

1. The muscles involved in the specific effort required by volleyball training maintain their characteristic proportion in muscle fiber types.
2. In the case of basketball, the characteristic majority of fast-twitch fibers are replaced with slow-twitch fibers.
3. A possible cause for this change would be the maximum amount of oxygen required by training for and playing basketball.

References

1. Beardsley C. *Strength &Conditioning Research*, Online article available from https://www.strengthandconditioningresearch.com/hypertrophy/muscle-fiber-type/#3].
2. Bergh U, Thorstensson A, Sjödin B, Hulten B, Piehl K, Karlsson J. *Maximal oxygen uptake and muscle fiber types in trained and untrained humans.* Med Sci Sports. 1978;10(3):151-4.
3. Fry AC, Schilling BK, Staron RS, Hagerman FC, Hikida RS, Thrush JT.. *Muscle fiber characteristics and performance correlates of male Olympic-style weightlifters.* Journal of Strength & Conditioning Research 2003;17(4):746-754.
4. Howald H. *Training-Induced Morphological and Functional Changes in Skeletal Muscle*. International Journal of Sports Medicine 1982;3(1):1-12.
5. Jansson E, Esbjörnsson M, Holm I, Jacobs I. *Increase in the proportion of fast-twitch muscle fibres by sprint training in males*. Acta Physiologica Scandinavica 1990;140(3):359-63.
6. Karp JR. *Muscle Fiber Types and Training*. 2001; Track Coach 155:4943-4946.
7. Smrkolj L, Škof B. Factors of Success in Endurance Sports; Changing of Muscle Fiber Type. Acta Medica Medianae 2013; 52(4): 69-74.
8. Srinivasan RC, Lungren MP, Langenderfer JE, Hughes RE. Fiber type composition and maximum shortening velocity of muscles crossing the human shoulder. Clin Anat. 2007;20(2):144-9.
9. Thériault R, Boulay MR, Thériault G, Simoneau JA. Electrical stimulation-induced changes in performance and fiber type proportion of human knee extensor muscles. Eur J Appl Physiol Occup Physiol. 1996;74(4):311-7.
10. Wilson JM, Loenneke JP, Jo E, Wilson GJ, Zourdos MC, Kim JS. The effects of endurance, strength, and power training on muscle fiber type shifting. J Strength Cond Res. 2012;26(6):1724-9.