

# A Brief Introduction to the Physiology of Basketball

Introduction to Coaching

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The purpose of this research paper is to provide a brief introduction to the physiology of basketball. The American Sport Education Program’s ideas on the physiology of basketball, expressed in Successful Coaching (2004), will be compared to my own ideas on the subject. Various peer-reviewed journal articles will determine the correct information to either prove or disprove my view on the physiology of basketball.

Table 1: Thoughts on the energy and muscular fitness demands of basketball ,provided by ASEP and me (Martens, R. 2004).

Activity	Energy System: Aerobic	Energy System: Anaerobic	Muscular Fitness: Flexibility	Muscular Fitness: Strength	Muscular Fitness: Endurance	Muscular Fitness: Speed	Muscular Fitness: Power
Offense and Defense (ASEP)	Medium to high	High	Medium	Medium	Medium to high	High	Medium to high
Rebounding (ASEP)	Low to medium	High	Medium	Medium to high	Medium	Medium to high	High
Offense and defense (mine)	Medium	High	Medium	Medium	Medium to high	High	Medium to high
Rebounding (mine)	Low	High	Medium	Medium to high	Medium	Medium to high	High

The American Sport Education Program believes that basketball demands a medium to high aerobic system for offense and defense and a low to medium aerobic system for rebounding. I believe that a basketball player should require a medium aerobic system for offense and defense and a low aerobic system for rebounding. I do not agree with ASEP because most of the running in basketball is done in the form of sprinting. It is important to have a medium aerobic system to kick in when the anaerobic system needs to recover, but it is not possible to have both the highest possible anaerobic system and aerobic system at the same time. According to the journal, *Dependence of Intensity of Specific Basketball Exercise from Aerobic Capacity* (A. Gocentas, A. Landor, and A. Andziulis, 2004), in a basketball specific exercise, the higher the heart rate was the lower the amount of oxygen was needed. As a consequence, as the anaerobic system needs to recover, the aerobic system must take over. A basketball player is able to perform more efficiently with a strong aerobic system because it puts less strain on the heart while reducing the metabolic impact, providing the anaerobic system with a faster recovery time. A strong negative correlation was found between intensity and aerobic fitness. Basketball is a sport founded on movements that require quick stopping, turning, jumping, and sprinting. Due to this fact, the aerobic system should not be trained to be used at a high level because the heart rate will be too elevated for the aerobic system. ASEP is not correct. Although a strong aerobic system is needed to support the recovery of the anaerobic system, a high aerobic system is not necessary. ASEP and I are both correct in thinking that rebounding requires low aerobic fitness.

The American Sport Education Program and I both determined offence, defense, and rebounding to require a high anaerobic fitness level. According to the journal, *Maximal Anaerobic Power Test in Different Sport Disciplines* (Popadic Gacesa, Jelena Z; Barak, Otto F; Grujic, Nikola G, 2009), basketball has the second largest values for anaerobic power parameters based on peak power, explosive power, and mean power. Basketball also has the second largest value for mean power based on the athlete's body mass. The exact values can be observed in table 2.

Table 2: Statistics of various values of anaerobic power based on sport (Popadic Gacesa, Jelena Z; Barak, Otto F; Grujic, Nikola G, 2009).

Sport	Values of anaerobic power parameters					
	PP (W)	PP/BW (W·kg <sup>-1</sup> )	EP (W·s <sup>-1</sup> )	EP/BW (W·s <sup>-1</sup> ·kg <sup>-1</sup> )	MP (W)	MP/BW (W·kg <sup>-1</sup> )
Boxing	715.14 ± 90.27	9.27 ± 1.16	116.49 ± 28.22	1.49 ± 0.28	517.31 ± 56.76	6.72 ± 0.86
Wrestling	765.53 ± 174.57	9.76 ± 1.80	125.32 ± 33.90	1.59 ± 0.33	516.11 ± 89.98	6.63 ± 1.14
Hockey	835.19 ± 238.09	10.14 ± 2.26	130.37 ± 42.90	1.57 ± 0.41	565.70 ± 131.05	6.89 ± 1.14
Volleyball	1023.48 ± 128.05	11.71 ± 1.56	153.53 ± 31.29	1.75 ± 0.33	671.92 ± 67.10	7.77 ± 1.10
Handball	754.85 ± 175.28	8.58 ± 1.56	104.26 ± 33.74	1.19 ± 0.35	528.35 ± 95.66	6.02 ± 0.80
Basketball	1001.60 ± 149.70	10.69 ± 1.67	153.52 ± 32.90	1.64 ± 0.35	669.15 ± 77.07	7.15 ± 0.96
Soccer	742.95 ± 120.12	9.72 ± 1.35	107.22 ± 23.85	1.41 ± 0.32	517.78 ± 78.54	6.78 ± 0.87

PP = peak power; EP = explosive power; MP = mean power; BW = body weight.

In comparison to other sports, basketball is superior in using the anaerobic system. It is only second to volleyball, which requires little to no aerobic fitness. ASEP and I are both correct. Basketball players must have a high aerobic system to perform well in offense, defense, and rebounding.

ASEP and I both agreed that a medium amount of flexibility is needed for basketball. Basketball requires sprinting, one- legged jumps, two-legged jumps, and demands that the athlete is most often in an athletic stance. Due to these physical demands, it is important to be flexible to enhance movements, increase speed, and prevent injury (Martens, R. 2004). A common sports injury in basketball is the tearing of the anterior cruciate ligament (ACL). According to Effects of Sports Injury Prevention Training on the Biomechanical Risk Factors of Anterior Cruciate Ligament Injury in High School Female Basketball Players (Lim, B. Lee, Y. Kim, J. An, K. Yoo, J. Kwon, Y. 2009) by organizing an injury prevention program that included a warm-up, stretching, strengthening, plyometrics, agility, and alternative exercise warm-down , flexibility could be increased. Increased flexibility resulted in improved biomechanical properties which lessened the occurrence of an injury to the ACL. ASEP and I are both correct.

ASEP and I both agree that for offence and defense there is a medium need for strength and for rebounding there is a medium to high need for strength. Offense and defense are not heavily dependent on strength because for the majority of the time the basketball is only in one athlete's hands. This means that this one athlete only needs enough strength to be able to control the ball. Because the ball weighs within the range of 18 -22oz, depending on the gender of the team, only a medium amount of strength is needed. More interactions between athletes occur while rebounding. The athlete must jump towards the hoop , have enough strength to rip the ball out of another athlete's hands, and land with complete control of the basketball. This requires more strength because the athlete must account for the weight of the basketball and for the force applied by the opponent. For landing purposes, it is important to have strong legs to prevent any injury. Strength in basketball does depend on the athlete's position to an extent, although all basketball players need a significant amount of muscle strength. Forwards were found to have the most strength when lower-body strength was tested (Delextrat, A. Cohen, D. 2009) This may be due to the fact that they are the intermediate position between the guard and the center. The forward covers more area than the center while performing the main task of rebounding. Muscle strength was also found to be important for preventing injury (Ziv, G. Lidor, R. 2009) ASEP and I are both correct.

ASEP and I both agreed that for offense and defense the amount of endurance needed is medium to high and the amount of endurance needed for rebounding is medium. It takes endurance to continually sprint and jump throughout a basketball game. The journal, Ultra Short-Term Heart Rate Recovery After Maximal Exercise in Continuous Versus Intermittent Endurance Athletes (Ostojic, S. Markovic, G. Calleja-Gonzalez, J Jakovljevic, D. Vucetic, V. Stojanovic, M. 2010), concluded that continuous sports take less time for the heart beat to recover after short-term, maximal exercise because the body is trained to do so. The intermittent sports had higher heart beats 10 and 20 seconds

after the exercise. These results suggest the importance of endurance in both intermittent and continuous sports. Basketball is classified as an intermittent sport because there are natural stopping points in the game, allowing the athlete to rest. For this reason, basketball has only a medium to high requirement of endurance. It is important to strive for endurance in basketball because having a quicker recovery time allows for less waiting before the next spout of maximal effort can be achieved. ASEP and I are both correct.

ASEP states that the speed needed for offense and defense is high and the speed needed for rebounding is medium to high. I agree with ASEP. Speed is not as important for the center position (Ziv, G. Lidor, R. 2009). The center's main job is to be as big of a presence as possible in the key. This means they only really cover an area of 12 feet. Although it is important to have speed to get to a rebound, the majority of forward and center athletes are tall enough that speed to the ball is not as important as it would be to a guard. Having speed is extremely beneficial for offense and defense. A fast point guard is very difficult to successfully guard. Offense and defense require high speed. Speed is essential to basketball players and should be worked on in practice to enhance player performance (Ziv, G. Lidor, R. 2009). ASEP and I are correct.

ASEP and I both agree that a medium to high level of power is needed for offense and defense and a high level of power is needed for rebounding. Power is a combination of speed and strength. It is imperative that the forward and center athletes can jump quickly to the ball and have the strength to hold on to the ball to pass it to a teammate. According to the journal Differences in Motor Abilities of Various Types of European Young Elite Female Basketball Players (Erčulj, Blas, Čoh and Bračić, 2009), the power of throwing type and power of jumping type importantly contribute to efficient movements with and without the ball. The ability to be powerful in these movements allows for proper execution of both the technical and tactical elements of the game. The amount of power needed is greater for center and forwards for rebounding. Due to this fact, the level of power needed for rebounding is high. Table 4

illustrates that forwards and centers excelled in the various tests for power, providing evidence that it is essential for players in rebounding positions to be powerful athletes.

Table 3: Description of the test given to athletes to measure power and agility (Erčulj, Blas, Čoh and Bračič, 2009).

Table 1. Description of the sample of variables of the motor tests

Code	Test	Main ability	Unit
CMJ	Countermovement jump	Power of jumping type	Jump height [cm]
DJ25	Drop jump 25 cm	Power of jumping type	Jump height [cm]
DJ25CT			Contact time [ms]
S20	20 m sprint	Power of sprinting type	Run time [s]
D20	20 m sprint dribble	Power of sprinting type	Run time [s]
S6x5	6 x 5 m sprint	Agility	Run time [s]
D6x5	6 x 5 m sprint dribble	Agility	Run time [s]
BBT	Basketball throw (size number 6)	Power of throwing type	Throw length [cm]
MBT	Medicine ball throw (2 kg)	Power of throwing type	Throw length [cm]

Table 4: Statistics of the tests for power and agility given to guards, forwards, and centers (Erčulj, Blas, Čoh and Bračič, 2009).

Table 2. Descriptive statistics of the players by their positions

Variable	Guards (n=35)	Forwards (n=14)	Centres (n=16)	p*
	Mean (SD)			
Age	14.49 (.61)	14.57 (.65)	14.44 (.63)	.839
Playing years	5.20 (1.80)	5.00 (2.25)	4.81 (2.17)	.806
Height (cm)	167.43 (5.70)	174.09 (3.79)	182.93 (3.69)	<.001
Mass (kg)	59.32 (6.00)	61.79 (4.67)	69.05 (7.18)	<.001
S20	3.53 (.16)	3.57 (.15)	3.76 (.18)	<.001
D20	3.81 (.21)	3.85 (.28)	4.11 (.23)	<.001
BBT	713.14 (70.70)	772.14 (54.23)	766.25 (82.86)	.009
MBT	442.35 (39.93)	458.57 (27.41)	466.66 (49.23)	.122
S6X5	9.42 (.51)	9.54 (.45)	9.87 (.42)	.009
D6X5	10.23 (.54)	10.34 (.65)	10.78 (.68)	.015
CMJ	27.66 (4.32)	27.76 (3.63)	24.36 (3.39)	.019
DJ25	26.42 (3.89)	25.17 (4.44)	23.24 (3.99)	.038
DJ25CT	250.91 (64.15)	238.36 (56.64)	247.00 (57.53)	.810

Legend: S20 - 20 m sprint; D20 - 20 m sprint dribble; BBT - basketball throw; MBT - medicine ball throw; S6X5 - 6 x 5 m sprint; D6X5 - 6 x 5 m sprint dribble; CMJ - countermovement jump; DJ25 - drop jump 25 cm height.

In conclusion, ASEP and I agreed with each other on six out of the seven characteristics of basketball including: anaerobic system, flexibility, strength, endurance, speed, and power. I disagreed with ASEP's findings for one characteristic of basketball which included the aerobic system. The research found supported ASEP's and my view on all six of the characteristics listed above. I was found to be correct for the characteristic listed above that ASEP and I disagreed on.



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