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Conditioning for Basketball: Quality and Quantity of Training

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ABSTRACT

THE PURPOSE OF THIS PAPER IS TO FILL THE GAP ON THIS TOPIC PROPOSING A TRAINING METHODOLOGY FOR BASKETBALL CONDITIONING. THE METHODOLOGY IS BASED ON SPECIFIC PROGRESSION ACCORDING TO TASK ORIENTATION, APPROACHING LEVELS, AND PLAYER’S INDIVIDUAL NEEDS AND DEMANDS OF THE APPROACHING LEVELS. THIS INCLUDES TRAINING ORGANIZATION, CONTENT PROGRESSION (GENERIC ENDURANCE TRAINING, HIGH-INTENSITY INTERVAL TRAINING, REPEATED-SPRINT TRAINING, WITH OR WITHOUT CHANGES OF DIRECTION, SMALL-SIDED GAMES, AND ACTUAL BASKETBALL), AND GENERAL RECOMMENDATIONS FOR CONDITIONING TRAINING FOR BASKETBALL. THE PROPOSED METHODOLOGY IS BASED ON THE LATEST SCIENTIFIC EVIDENCE AND THE AUTHORS’ PRACTICAL EXPERIENCE WITH ELITE PLAYERS. FOR A VIDEO ABSTRACT OF THIS ARTICLE, SEE VIDEO SUPPLEMENTAL DIGITAL CONTENT 1, [HTTP://LINKS.LWW.COM/SCJ/A128](http://links.lww.com/scj/A128).

OVERVIEW

Currently basketball demonstrates an increase in the physical demands of competition because of changes in the rules and evolution of strategies (8,18). Basketball players require well-developed physical fitness to play successfully (25). The main physical characteristics in a basketball player are (a) running faster than the opponents, (b) having strength and balance to endure contacts and hits involved in the game, (c) jumping higher and faster than the adversaries, (d) being able to do the 3 aforementioned points more times than their opponents during the game with less fatigue. Furthermore, these tasks must be carried out with teammates, against opponents and in relation to a ball and a court, meaning optimally in relation to a specific context. An “optimal” action does not necessarily require the peak potential of the player, but it makes sense to think that a greater potential will allow a greater availability of resources.

Although the predominant energy system in basketball is still under study, most authors agree that competitive basketball is an intermittent high-intensity physical activity that requires well-developed aerobic and anaerobic fitness (30). Castagna et al. (14) summarize very well the current knowledge state about this issue: “although basketball performance is

thought to be mainly dependent on players’ anaerobic ability (2), high aerobic fitness is also important for improved performance, specifically maximal aerobic power ($\dot{V}O_2\text{max}$) is considered to improve the ability to recovery from the anaerobic efforts during the game (43).” Furthermore, it is crucial to take into account that physical demands are depending on age (15), gender (20), playing position (7), and playing time (16).

Studies regarding external load in basketball reveal that players run between 4,500 and 7,500 m per game, perform up to 1,000 different actions (defense, sprinting, changing direction, jumping, walking, etc.) (6,30), perform about 45 jumps (8,30), and that just few game sequences last more than 40 seconds (5). The density of game activity (work-to-rest ratio, work:rest) varies depending on the action, intensity and the moment of the game. Thus, medium- to high-intensity actions have a 1:1 density, with 15 s of duration approximately (15 s work and 15 s recovery) (35). High- to maximal-intensity actions last 2–5 s (2 s predominantly) (8) and have a 1:10 density (2 s work and 20 s recovery) (8,25,30).

KEY WORDS:

conditioning; team-sports; basketball; training; periodization

High-intensity activity requires longer rest periods. Ben Abdelkrim et al. (6), however, reported a mean work-to-rest ratio of 1:3.6, with a higher value recorded in the first half compared with the second half, in male basketball games. Most of these actions require the anaerobic system, both lactic and alactic (20,24). Regarding heart rates (HRs), the highest values are between 188 and 195 bpm, and the mean (HR_{mean}) ranges from 169 to 180 bpm, representing the 85–90% of HR_{peak} (6,29,30,32,34). According to these characteristics, the ability to repeat high-intensity efforts is an important fitness component for team-sport athletes and hence basketball players (22,40). Nevertheless, it would be necessary to carry out specific assessments of your own team.

Finally, the following game intensity modulators should be kept in mind: (a) the head coach's philosophy-strategy, (b) the player's commitment-effort, and (c) the referees-rules. Conditioning training must provide the players

the required fitness levels to perform the coach's philosophy, as well as avoid more resting time, which rules or referees imply.

The training methodology proposal (38) is based on exercise specificity progression according to the task orientation (degree of similarity in relation to actual basketball: general, directed, special, and competitive) (39), the approaching levels (0^- , 0^+ , I, II, III, IV, and V), which are related with the orientation (33) and player needs. This is a pedagogical proposal, which facilitates conditioning training programming, to improve the specific-game demands and the player fitness level. Figure 1 shows our personal adaptation of this philosophy for basketball.

GENERAL ORIENTATION (LEVELS 0^- , 0^+ , AND I)

This orientation is associated with generic endurance training. Unless a player has special needs (e.g., limiting injuries, joint/tendon pain, etc.),

continuous moderate intensity run/bike/swim training is not a priority in basketball. In fact, we suggest high-intensity interval training (HIIT) as soon as possible. Several authors propose HIIT either to improve the cardiovascular responses or fat loss (10,27). The levels 0^- and 0^+ can be performed with any kind of physical activity (running, cycling, swimming, rowing, etc.), and the maximum training volume is determined by the distance covered by players during the game (<4,500–7,500 m (6,30)) or its duration (<40 minutes). The intensity varies depending on physiological aim (aerobic efficiency or aerobic capacity). The most important aim of general orientation is level I, where the main physiological goal is to improve maximal oxygen uptake ($\dot{V}O_{2max}$) characterized by lower volume and higher training intensity. It is important to consider that team-sport athletes require a high level of aerobic fitness to generate and maintain power output during repeated high-intensity efforts and to recover (41). In this level,

Figure 1
Specificity-based training: Orientation and approach level characteristics

Orientation	Approach Level	Similarity	Training Method	Place	Ball	Decision-making	Confrontation format	Intensity	Main metabolic requirement [†]	Bout duration	Density	Example [**]
COMPETITIVE	V	Basketball	Actual game; Simulated game	On court	With	Actual complexity	4v4, 5vX	Optimal [modified rules?]	All	Required	Required	4-6 x [2.4 min '5/5 game']; 2-4 min rest
SPECIAL	IV	Basketball	Small-sided games	On court	With	Complex	(1v1), 2vX, 2v2, 3vX, 3v3, (4vX)	Optimal, but complexity should not lower intensity [modified rules?]	Manageable [format & rules]	Depending on the main fitness goal	Manageable [format & rules]	4 x [3', 3v3, full-court, no FT, no 3p shots]
DIRECTED	III	Basketball-based	Short HIT [RST-COD]	On court	With / Without	None or simple	1v0, 2v0, (3v0)	'All-out'	Depletion of the stored phosphagens [ATP and PCr]	2-5 s [<60 s]	1 : 5-10	2 x [10 x 5 s @'all-out' - 30 s rest]; 4 min rest
	II	Basketball-based	Short HIT [SIT-COD]	On court	With / Without	None or simple	1v0, 2v0, (3v0)	'All-out'	Anaerobic glycolysis [Lactic acid metabolism]	15-40 s [<60 s]	1 : 3-6	3 x [6 x 15 s @'all-out' - 45 s rest]; 4 min rest
GENERAL	I	Run-based / Basketball-based	Short HIT [SIT-COD?]	Off / On court	With / Without	None or simple	None / 1v0, 2v0, (Xv0)	> VO_{2max} [ASR]	Aerobic-Anaerobic transition zone	40-60 s [<60 s]	1-2 : 1	4 x [4 x 40 s @ASR - 40 s rest]; 2-4 min rest
		Run-based / Basketball-based	Long HIT	Off / On court	With / Without	None or simple	None / 1v0, 2v0, (Xv0)	>90% VO_{2max}	Aerobic system [Power / VO_{2max}]	3-5 min [>60 s]	1-2 : 1	4 x 4 min @90-95% VO_{2max} ; 3 min rest
	0^+	Nonspecific [run based]	Continuous or Interval Training	Off court	(With) / Without	None	None	<85% VO_{2max}	Aerobic system [Capacity]	30-40 min [6-10 min intervals]	2-4 : 1	3-4 x 8 min @75-85% VO_{2max} ; 2 min rest
	0^-	Nonspecific	Continuous or Interval Training	Off court	Without	None	None	<70% VO_{2max}	Aerobic system [Efficiency]	30-40 min	1 : 0	30 min @70% VO_{2max}

I, or; ? : optional; () : optional but normally unused; X : a number smaller than the indicated firstly (e.g. 3vX = 3v1 and 3v2, but non 3v3 or 3v4); ASR: anaerobic speed reserve (faster than VO_{2max} speed and slower than maximum sprint speed) (9); VO_{2max} : maximal oxygen uptake; ATP: adenosine triphosphate; PCr: phosphocreatine; [†]: different metabolic processes are closely related and integrated (continuum energetic); [**]: here are shown only a few examples, there are a myriad of options; @: at intensity; min: minutes; FT: free throws; 3p: three points.

physical activity may be sport specific or not: on grass, on basketball court, with or without ball, with or without specific movement patterns or specific-skills, etc. The only premise that should be respected is that the proposed exercises (movement patterns, technical skills, etc.) should not have to limit the physiological demand required to achieve the training goal.

- Level 0⁻: Physical activity not related with our sport. Decision making does not exist. We suggest using different exercises not involving specific-movement patterns: cycling, swimming, rowing, etc. Team-sport coaches usually do this continuous “cardiotraining” with low joint impact (e.g., as recovery workout (42) or with injured players (12)).
- Level 0⁺: Physical activity not related to the sport, but with muscle activity a little more similar to our sport than in level 0⁻. Movement patterns are not specific yet, but exercises should be primarily run based. Decision making does not exist. Intensity is higher than in level 0⁻, and long interval training method is recommended, although continuous methods can be used also on this level.
- Level I: Actions and movement patterns should be similar to those in basketball. Decision making does not exist or is very simple and non-specific. We can work with basketball skills circuits, depending on the player’s level, but technical skills must be consolidated. If the player’s basketball skills are not high enough, it is better to use generic run drills, on or off court. Figure 1 shows the intensity evolution: first, elicit maximal oxygen uptake and after, work on the aerobic-anaerobic transition zone. Exercise intensities should be between 90 and 100% of $\dot{V}O_{2,max}$ (31), and the long HIIT method (>60-second intervals) is the best choice to perform it (3,10,17,37).

DIRECTED ORIENTATION (LEVELS II AND III)

This orientation requires “all-out” efforts and it is divided into 2 levels, both

characterized by short HIIT (<60-second intervals) (10). We suggest doing this type of work on court, with changes of direction (COD) (9) and specific pathways, taking into account playing position needs. Useful resources include tactical situations with specific pathways, offensive or defensive actions, etc. Perform exercise without opposition (1v0, 2v0, 3v0) to facilitate maximal intensity. It may be difficult to reach maximum intensity with more than 3 players on the court (4,13).

- Level II: Exercises simulate sports-specific movement patterns with COD. Decision making is simple and basketball based or does not exist. This level is physiologically associated with lactic acid metabolism. It can be carried out on court by the sprint interval training method (15–40 second “all-out” efforts interspersed with 2- to 4-minute passive recovery periods; 1:3–6) (10).
- Level III: Exercises simulate sports-specific movement patterns with COD. Decision making is simple and basketball based or does not exist. This level is related with acceleration ability (explosive strength), and performing the repeated-sprint training method on court is recommended (sprints lasting 2–7 seconds, preferably 2–5 seconds (40), interspersed with recovery periods lasting generally <60 seconds; 1:5–10) (10).

SPECIAL ORIENTATION (LEVEL IV)

This level is essential for skill-based conditioning, in the form of small-sided games (SSGs) (2v2, 2vX, 3v3, 3vX, and 4vX). Decision making is complex and basketball specific. Several authors have recently argued that SSGs are as efficient as HIIT to develop specific aerobic fitness for the team-sport player (1,11,23,26). Skill-based conditioning benefits include greater transfer of physiological adaptations when the exercise simulates sports-specific movement patterns, athletes simultaneously develop technical and tactical skills under high physical loads and higher motivation of athletes performing sport specific

rather than traditional conditioning (1,28). In this sense, the assessment of rating of perceived exertion may assist players to achieve target exercise intensities during skill drills in basketball (13). However, careful consideration of player skill levels, current fitness, number of players, court dimensions, game rules, work-to-rest ratios, and availability of player encouragement is required (28,36,41); altering these factors we can manipulate the overall physiological and perceptual workload (1). We would like to highlight the following training variables:

- Number of players: reducing the number of players over the same court size results in increments in physiological demands (13). The 2v2 (13) and 3v3 (4) conditions may be considered as a viable training tool when aerobic and anaerobic training stresses higher than actual-game conditions (i.e., 5v5) are required.
- Work-to-rest ratios: when designing training exercises it is important to know the characteristics of the sport, and according to that, to propose exercises supra-, equal-, or infra-, actual-game conditions. If the mean work-to-rest ratio is 1:4 (actually 1:3.6 (6)), we can manipulate the work-to-rest ratios between bouts of exercise, through players rotations (number of players playing on court and number of players resting off court), and during bouts of exercise, modifying game rules (reducing/increasing the stop time: fouls, out of bounds, free throws, etc.) (1,21,36).
- Court dimensions: with the same number of players, increasing the court size results in increments in physiological demands (i.e., full-court games produced significantly higher physiological responses than half-court games (4,32)). However, a smaller playing space entails significantly higher frequencies of technical actions (4,28) and, consequently, more COD. Exercises can be classified by the number of courts required: half court (1/2; the drill is carried out only in half court), half court

Table 1
Calendar example and level distribution

	Phase			
	Off-season		Preseason	In-season
Duration	1–4 wk	2 wk to 5 mo	4–8 wk	6–9 mo
Kind of workouts	—	Individual workouts	Individual and/or team workouts	Individual and team workouts
Main goal	Rest/recovery	Individual needs and aerobic power	Aerobic power and ability to repeat high-intensity efforts	Skill-based conditioning and small-sided games
Secondary goal	—	Ability to repeat high-intensity efforts	Small-sided games and actual basketball	Ability to repeat high-intensity efforts
Levels	0 ⁻	0 ⁺ and I	I, II, and III	IV and V
		II	IV and V	II and III

plus 1 court (1/2 + 1; the drill is carried out in half court plus fast break or transition to opposite basket once), half court plus 2 courts (1/2 + 2; the drill is carried out in half court plus fast break or transition twice, finishing always in the same basket where you started), open court (“X” courts; drills with more than 2 transitions or fast breaks: 3, 4, 5, etc).

- Coach encouragement: This effect could be very important from a practical point of view because the external motivation provided by coach supervision has been shown to achieve greater gains and training adherence (1,36). According to these highlighted points, a good high-intensity exercise into this level could be 2vX or 3vX full-court drills, with coach encouragement all the time, given that limiting dribbling or possession time can be useful tools to increase the intensity. Moreover, the existing research on SSG, particularly in soccer, is informative but more basketball-specific research is needed (28).

COMPETITIVE ORIENTATION (LEVEL V)

Competitive orientation is the most specific skill-based conditioning, involving the most realistic cognitive, physical, and physiological requirements. The

decision making is complex and basketball specific. Exercises are based on 4v4, 5vX, and 5v5. The value of involving a larger number of players in SSGs lies in enhancing team-specific decision-making skills: more teammates and adversaries are involved in the decision-making processes (19). In team sports, conditioning training is a way to improve player capabilities (fitness, cognition, technique, tactic, teamwork, etc.), but never a goal itself. Players must be better at level V (playing actual basketball), not at, for example, level 0⁺ or level III. Nonetheless, training at levels IV and V only could be risky because the tasks are “open” (not allowing an accurate training control), and some players might not receive enough training stimuli (by insufficient effort), losing fitness level. The topic “play as you train and train as you play” is crucial, which means: if your goal is that your team runs every fast break as fast as they can, fights for every ball or collects every rebound, you must demand that in every action of every drill, instilling the attitude you want in your players. The design of exercises at this level should follow the considerations discussed in the “special orientation,” which are common in SSGs. At this level it is typical to use game incentives (e.g., points) or modify other rules.

From a periodization viewpoint, well-controlled training of generic aerobic power development (level I) should be carried out off-season, at early pre-season or for specific player needs. During the pre-season, the authors mainly recommend improving the ability to repeat high-intensity efforts (levels II and III), interspersing SSG or actual basketball (levels IV and V), preparing the players for the high demands of the competition. During the competitive season, skill-based conditioning and SSG will predominate (levels IV and V). There is a risk that involves the ‘decontrol’ of level V. A workout based on level II and/or level III should be performed periodically (once a week or every 2-3 weeks) (Table 1).

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