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SCIENTIFIC AND PRACTICAL APPROACH TO PHYSICAL CONDITIONING OF ATHLETES

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Abstract Physical conditioning can be defined as the process of improvement of motoric and functional (energetic) abilities, morphological characteristics, athletes' health status and also improving the skills responsible for those aspects. The realization of physical conditioning as an important aspect of athletes' preparation caused large interest of scientists. That interest is mostly addressed to conditioning qualities of athletes (diagnostics, modelling, relationships, differences), but also to procedures for their improvement (means, methods and programs). There are several basic directions of research of physical conditioning of athletes: diagnostics and modelling of conditioning qualities, the relationships between conditioning qualities, the relationships between conditioning qualities and the success in a certain sport, the differences in conditioning qualities of athletes of different age, gender, rank and kind of sport analysis of exercises of physical conditioning of athletes, modelling and valorization of methodical procedures in physical conditioning. The improvement of conditioning practice is only possible with strong support of scientific research. It is important to ensure the flow of scientific information to sport experts – practitioners.

Key words: physical conditioning, term, meaning, research

INTRODUCTION

TERMS AND MEANINGS OF PHYSICAL CONDITIONING OF ATHLETES

The division of sport preparation goals determined the formation of special aspect of preparation, focused on the development and maintenance of physical characteristics of athletes. Most common term for this aspect of sport preparation is **physical conditioning**.

The word condition comes from the Latin word *conditio* = *settlement, prerequisite*. Foreign words dictionary [16] explains conditioning as the ability to induce work, and conditioning training as low intensity training with the purpose of maintenance of flexibility and enhancement of body preparedness for upcoming competition.

The terms physical preparation, body preparation and functional-motoric preparation are also used for this type of preparation in the Croatian language. Most frequently mentioned terms in international literature are strength and conditioning [2], strength training [31], conditioning [4, 5, 8], sports conditioning [9], physical training [3], physical fitness training [1], physical performance training [6], physical preparation [26], physical conditioning, body conditioning, physical training, motor development, physical development (English) [15], Konditionstraining (German) [11], dvigatelna trenirovkata (Bulgarian) [32], fizičeskaja podgotovka (Russian) [20], preparation physique (French), preparazione fisica (Italian) [28], preparacion fisica (Spanish) [19].

Physical conditioning of athletes made its big entrance in sport preparation system in the second half of the 20th century [7]. It was mostly applied to most popular sports like sport games, combat sports, tennis, but also to other sports where the result mostly depends on physical abilities of athletes. After the period in which technical - tactical training was used to a great extent, improvement of physical (conditioning) abilities became more important than before. Stress due to competition in physical, emotional, intellectual and sensory way seriously endangers athletes' personal integrity. A busy competition calendar, a large number of continental and intercontinental trips, shortened recovery period, tougher and more balanced competition and other factors cause the survival of only the fittest athletes in top sport today. For these reasons coaching staff want to develop the system of sport preparation to the highest level. That level is hard to reach without optimal physical conditioning [13].

Physical conditioning (Figure 1) can be defined as the process of improvement of motoric and functional (energetic) abilities, morphological characteristics, athletes' health status and also improving skills responsible for those aspects [13]. Physical conditioning has its versatile, basic, specific and situational directivity [12]. Domination of each aspect of physical conditioning depends on long term sport development phase, short term training periodization, sport discipline characteristics and the athlete's individual characteristics. It is because of individualization of the physical conditioning process that diagnostics becomes very important. Probability for improvement of the athlete's conditioning status is enhanced by the determination and control of fitness level in different training cycles [23]. Recent times have brought on the need for the use of a variety of additional aspects of conditioning preparation. The reason for that is the increase in effects gained through usage of standard motoric means of conditioning development [20].

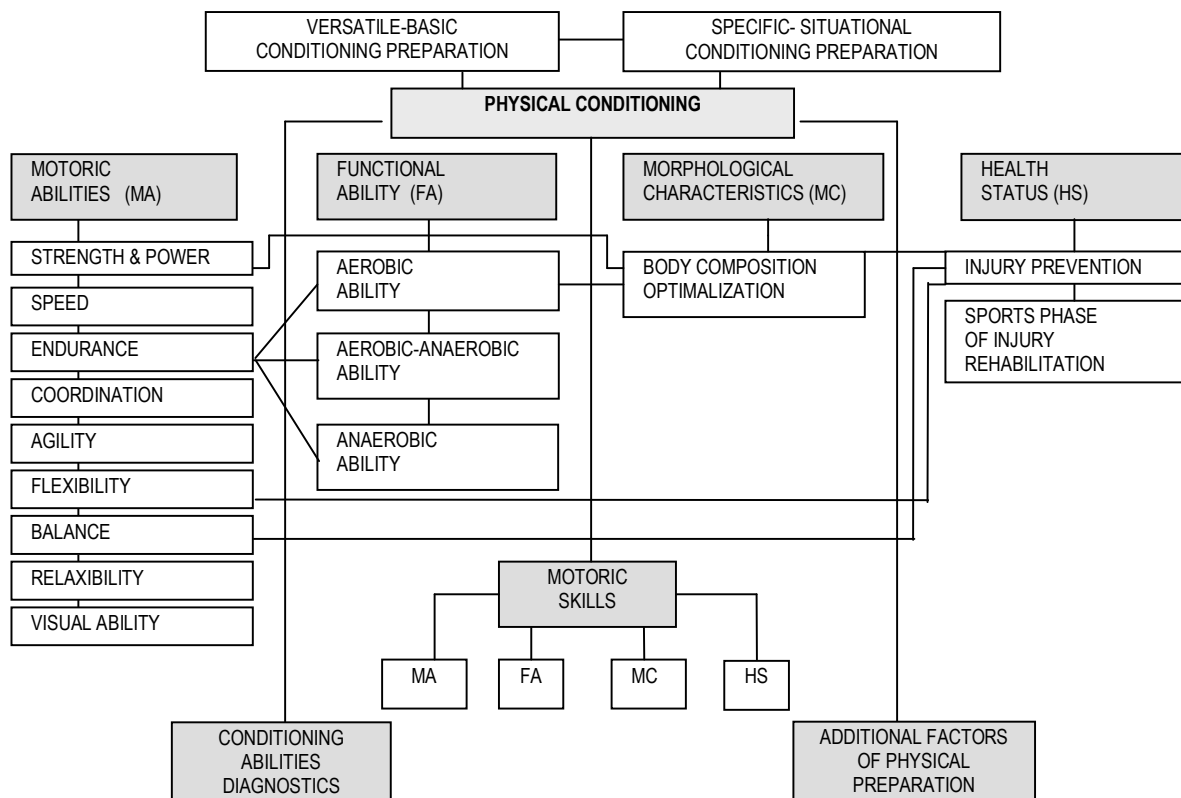


Figure 1. The structure of physical conditioning [13]

Therefore, the purpose of physical conditioning is the improvement and development of human body characteristics. The goal of this system of improvement is to reach a higher level of physical efficacy, which is according to the physical education theory [33] known as physical (conditioning) preparedness. Physical preparedness contains three elements: physical health, physical development and physical efficacy [20, 25, 31, 33]. Combined, these elements determine the morphological-functional potential of a person for performing many, by quantity and intensity, diverse motoric activities. Systematic action on these elements through specific methods and training programs is also known as improvement of physical abilities [29, 33]. In that context, Željaskov [33, 34] views conditioning training as complex process of adjusting, adaptation through process of development and improvement of physical characteristics with strict regard to biodynamic and kinematic structures of a certain sport. However, there are also different opinions about conditioning preparation. Weineck [30] defines conditioning training in both wide and narrow sense. The term condition in a wider sense considers all psychological, physical, technical, tactical, cognitive and social factors of achievement, while condition in its narrow sense is based only on physical factors (endurance, strength, speed and flexibility). Jonath and Krempel [11], talk about three groups of characteristics that define condition. They are physical (strength, speed and endurance), coordinational (flexibility and coordination) and psychological (active and passive interpersonal characteristics). Bompa [3] defines conditioning training as the process with an aim of enhancement of the athlete's physiological potentials and improvement of biomotorical abilities to the highest level. The same author puts conditioning training on the bottom of the training factors pyramid, and makes clear that this type of training represents a prerequisite for development of technical, tactical and psychological qualities. Beachle and Earle [2] see the meaning of physical conditioning in the procedures that help the athlete to reach the highest level of physical accomplishment, and stay injury free.

Of course, there are many other, different definitions of conditioning training. The connection between definitions is the subject of conditioning preparation, which is always the athlete with his or her physical abilities. However, this aspect of preparation has its secondary effects: fatigue delay, recovery acceleration and decrease in the number and severity of injuries [21]. Besides all, physical conditioning should be observed as a part of integral sport preparation. Its primary goal should be securing the prerequisites for emanating the athlete's technical-tactical and psychological qualities of through competition [22].

RESEARCH IN ATHLETES' PHYSICAL CONDITIONING

The realization of physical conditioning as an important aspect of athletes' preparation causes great interest of scientists [18, 27]. That interest is mostly addressed to conditioning qualities of athletes (diagnostics, modelling, relationships, differences), but also to procedures for their improvement (means, methods and programs).

There are several basic directions of research of athletes' physical conditioning:

- **Diagnostics and modelling of conditioning qualities** – the creation and valorization of measuring instruments for conditioning qualities, the creation of model values of conditioning qualities for different sports, age, gender and quality level and also structure of conditioning qualities.
- **Relationships between conditioning qualities** – the determination of the connection between certain major characteristics (for example, relationships between motoric abilities and morphological characteristics), but also relationships between lower rank qualities (for example, relationships between explosive strength and pure muscle mass).
- **Relationships between conditioning qualities and the success in certain sports** – the determination of the connection between the level of certain motoric abilities and situational efficacy of an athlete.
- **Differences in conditioning qualities of athletes of different age, gender, rank and kind of sport** – the determination of the differences between the level of motoric, functional and morphological characteristics, and motoric conditioning knowledge between athletes of different age, gender, training and competition rank and sport.

- **Analysis of exercises of physical conditioning of athletes** – structural, anatomical, biomechanical, and energetic analysis of exercises used for improvement of an athlete's conditioning qualities.
- **Modelling and valorization of methodical procedures in physical conditioning**– the creation of procedures for the improvement of conditioning characteristics in isolated conditions (procedures include motoric and ergogenic means, loads, methods and methodic forms, equipment, locations) and the effect analysis of the same procedures has on changes in conditioning qualities.
- **Modelling and valorization of physical conditioning programs** – the creation of physical conditioning programs in real training/competition cycles, and the effect analysis of those programs has on changes in conditioning qualities.

Scientific approach to physical conditioning research comes from biomedical, natural, social and humanity and methodological scientific disciplines [21, 24]. Currently, the largest scientific production on physical conditioning exists within physiology, biomechanics, biochemistry, sports medicine and kinesiology of sport [10, 34]. Fundamental and applied research approaches also exist in this area of research [14].

Fundamental research within physical conditioning is a part of the large area of sport sciences research, which is oriented on proving the existing, and gaining new information about human body reactions to physical exercise. On the other hand, applied research on physical conditioning tends to create and valorize most efficient procedures for changing of conditioning characteristics. Something like that would be unimaginable without referring to fundamental research. It is also important to properly present research to sport experts who apply new information in daily training [17, 18]. This procedure is called transfer of scientific information into training practice, and it is done by people scientifically educated and with practical experience in sport training. They are highly qualified experts who are able to "decode science language into practical language" and actually give meaning to performing scientific research.

It seems that "reading" of scientific information for its application to the training process became the largest problem of sport preparation. The same is applied to unjustified separation of scientists and practitioners. Simple, but not easy double solution can be found by respecting both sport research continuum and sport knowledge continuum (Figure 2). Both continuums show logic and necessity of research order that will result in practically usable information for the direct realization of the training process.

Figure 2. Continuum examples for research in sport and sport knowledge (the goal: stretch - shortening cycle)

	PHYSIOLOGY	BIOMECHANICS	EXERCISES ANALYSIS OF CP	METHODICAL RESEARCH OF CP	PROGRAM EFFECTS RESEARCH IN CP
RESEARCH	Contractile mechanisms research within SSC	Kinetic and kinematic movement parameters research suitable for SSC	SSC manifestation research in different motoric exercises	Research on different methodical procedures for development of SSC	Research on training effects of different programs for development of SSC
KNOWLEDGE	Knowledge of physiologic mechanisms dominating in SSC	Knowledge of movement characteristics that activate SSC	Knowledge of efficacy of different motoric exercises on SSC	Knowledge of suitable methodical procedures for development of SSC	Knowledge of proper training programs for development of SSC

CONCLUSION AND PRACTICAL APPLICATION

Indubitable need for development and maintenance of an athlete's physical abilities justifies the existence of the conditioning aspect of sport preparation. Terminology differences when considering physical conditioning do not disregard the need for clear positioning of physical conditioning in theoretical sport systems and real sport practice. The improvement of conditioning practice is only possible with strong support of scientific research. Of course, it is important to ensure the flow of scientific information to sport experts – practitioners. The reason for that lies in the fact that physical conditioning is more dependable on scientific information than the other aspects of sport preparation. Besides, the effects of physical conditioning are easy to measure in both laboratory and field, even in competition conditions.

REFERENCES

1. Bangsboo, J. (1994). *Fitness Training in Football*. Denmark: University of Copenhagen.
2. Beachle, R. T., & Earle, W. R. (2000). *Essentials of Strength Training and Conditioning*. Champaign, IL: Human Kinetics.
3. Bompa, T. (1999). *Periodization (Theory and Methodology of Training)*. Champaign, IL: Human Kinetics.
4. Brittenham, G. (1996). *Complete Conditioning for Basketball*. Champaign, IL: Human Kinetics.
5. Brzycki, M., & Brown, S. (1993). *Conditioning for Basketball*. Indianapolis, IN: Masters Press.
6. Clark, M. A. (2001). *Integrated Training for the New Millennium*. Thousand Oaks, Ca: National Academy of Sports Medicine.
7. Čustonja, Z., & Jajčević, Z. (2003). Review of physical conditioning development. In: *Proceedings of 1st International conference Physical conditioning in sport* (pp. 33-40). Zagreb: Faculty of Kinesiology.
8. Epley, B. (2004). *The Path to Athletic Power*. Champaign, IL: Human Kinetics.
9. Foran, B. (Ed.) (2001). *High - Performance Sports Conditioning*. Champaign, IL: Human Kinetics.
10. Hopkins, G. W. (2004). Impact factors of journals in sport and exercise science, 2000-2003. *Sport Science*, 8: 12-19. (sports.org/jour/04/wghif.htm).
11. Jonath, U., & Krempel, R. (1987). *Konditions Training*. Munchen, Germany: BLV Verlagsgesellschaft mbH.
12. Jukić, I. (2001). *Structural analysis of contents of physical conditioning in basketball*. Unpublished Ph D thesis. Zagreb: Faculty of Kinesiology.
13. Jukić, I., Milanović, D., & Metikoš, D. (2003). Structure of physical conditioning. In: *Proceedings of 1st International conference Physical conditioning in sport* (pp. 26-32). Zagreb: Faculty of Kinesiology.
14. Kamen, G. (2001). *Foundation of Exercise Science*. Philadelphia, PA: Lippincott Williams & Wilkins.
15. Kent, M. (1994). *The Oxford Dictionary of Sports Science and Medicine*. New York: Oxford University Press Inc.
16. Klaić, B. (1974). *Veliki rječnik stranih riječi*. Zagreb: Zora.
17. Kraemer, J. W. (2004). The use of science in exercise prescription development. *Strength Cond J.*, 26(1): 48-49.
18. Kraemer, J. W. (2005). The body of knowledge: Use and professionalism. *Strength Cond J.*, 27(1): 33-35.
19. Maldonado, S., Sautu, L.M., Vaquera, A., Lorenzo, A., Refoyo., & Calleja, J. (2001). *I taller preparacion fisica de baloncesto*. Madrid: Asociacion Vasca de Entrenadores de Baloncesto.
20. Matvejev, L. P. (1999). *Osnovi obščih teorij sporta i sistemi podgotovki sportsmenov*. Kijev: Olimpijska literatura.
21. Milanović, D. (1999). Structure and characteristics of scientific researches in sport. In Milanović, D. (Ed.), *Proceedings of 2nd International scientific conference of kinesiology*. (pp. 90 - 95), 22 - 26.09.1999 Dubrovnik, Croatia.
22. Milanović, D., Jukić, I., & Šimek, S. (2003). Integral approach in modelling conditioning, technical and tactical preparation of athletes. In: *Proceedings of 1st International conference Physical conditioning in sport*. (pp. 46-53), Zagreb: Faculty of Kinesiology.
23. Milanović, D. (2004). *Training theory*. Zagreb: Faculty of Kinesiology.
24. Muller, E., Zallinger, G., & Ludescher, F. (Eds.). (2001). *Science in Elite Sport*. New York, USA: E& FN Spon.
25. Platonov, V. N. (1997). *Obščaja teorija podgotovki sportmenov v olimpijskem sporte*. Kijev: Olimpijska literatura.
26. Pyke, S. F. (2001). *Better Coaching (Advanced Coach's Manual)*. (Sec. Ed.). Australian Sports Commission.
27. Rhea, M. (2004). Synthesizing strength and conditioning research: The Meta-Analysis. *J Strength Cond Res.*, 18(4): 921-923.
28. Sassi, R. (2001). *La preparazione atletica nel calcio*. Perugia, Italia: Calzetti – Mariucci Editori.
29. Siff, M. C. (2000). *Supertraining*. Denver, USA: Supertraining Institute.
30. Weineck, J. (1999). *Optimales fusbball training*. Numberg: Institut für Sportwissenschaft der Universität Erlangen.

31. Zatsiorsky, V. M. (1995). *Science and Practice of Strength Training*. Champaign, IL: Human Kinetics.
32. Željaskov, M. (2002). *Osnovi na sportnata trenirovka*. Sofija: Gera Art OOD.
33. Željaskov, C. (2003). Basic physical preparations of top athletes. In: *Proceedings of the International conference Conditioning preparations of athletes*, Zagreb. str.20-25.
34. Željaskov, C. (2004). *Conditioning preparations of athletes*. Beograd: Sportska akademija (In Serbian).

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