

Review Article

**Comportamiento del consumo máximo de oxígeno durante el
desentrenamiento deportivo en baloncestistas retirados del deporte de
alto rendimiento**

**Behavior of the maximum oxygen consumption during the sports
detraining in basketballs withdrawn from high performance sports**

Ovel Mena-Pérez¹, Raiza Pérez-Osorio²

¹Dr.C. Profesor Titular. Universidad de Cienfuegos. Cienfuegos, Cuba.
ovelenveneucla@gmail.com

²M.Sc. Profesor Auxiliar. Universidad de Granma. Granma, Cuba. rayfely2009@gmail.com

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RESUMEN

El estudio se centra en el desentrenamiento deportivo y está encaminado a valorar el comportamiento de la variable consumo máximo de oxígeno durante esta etapa de la vida deportiva, como elemento de pertinencia para los baloncestistas retirados del deporte de alto rendimiento. Estos demandan readaptaciones en los componentes orgánico, físico y psicológico, atemperadas a las nuevas exigencias del contexto. Para ello se realizó un cuasi-experimento en dos grupos: un grupo control y otro experimental, a quienes se les aplicó en dos momentos durante el desentrenamiento la prueba de carrera sobre 2000m para evaluar capacidad de trabajo aerobio aplicando fórmula de tokmakiddis.

Palabras claves: Consumo máximo de oxígeno; Desentrenamiento deportivo; Capacidad de trabajo aerobio; Fórmula de tokmakiddis

ABSTRACT

The study focuses on sports training and is aimed at assessing the behavior of the variable maximum oxygen consumption during this stage of sports life, as an element of relevance for basketball players retired from high performance sport.

These demand readjustments in the organic, physical and psychological components, tempered to the new demands of the context. For this, a quasi-experiment was carried out in two groups: a control group and an experimental group, to whom the 2000m race test was applied at two times during the detraining to assess aerobic work capacity by applying tokmakiddis formula.

Key words: Maximum oxygen consumption; Sports detraining; Aerobic work capacity; Formula of tokmakiddis

INTRODUCTION

Sports practice as a socio-cultural phenomenon cannot be alien to the benefits of science and research. At present, behind each result are the scientific advances, the use of new technologies, as well as research aimed at responding to the demanding problems emanating from sport and the practice of physical activities in their diversity.

Sports training, according to Verjoshanski, Y. (1991), are a pedagogical, multifactorial process, capable of breaking down, through the application of stimulations, homeostasis and producing an effect of increasing progressive load, which favors physiological processes of response and adaptation of the organism.

Researching high performance training from its roots is of great importance for sports movement professionals, due to the complex and diverse impact it causes on the human body. Currently, advocating, from applied sciences, advocate for sports training as less aggressive a process as possible to the health of the athlete, on the basis of accurate and individualized planning.

Training produces a series of morphological and functional adaptations that are manifested in very different changes in the athlete, both in the short, as in the medium or long term. Modifications in blood pressure, heart rate, skin color, changes in temperature and variations in respiratory rate are common findings found in the short term. While, bradycardia, left ventricular hypertrophy, somatotype changes, pulmonary ventilation modifications, residual volume, are within the morpho-functional modifications that the athlete presents in the medium and long term as adaptive response to physical exercise.

The athlete who is inserted in the sports preparation process, goes through several stages until arriving at longevity, assumes the withdrawal and continues the activity with a tendency to reduce the accumulated training load, which implies a divestment of it, or part from it, through sports training as a stage of the long-term sports preparation process. The above arguments take value when Morales Águila, A. (2011), states that sports detraining *"...is the stage that gives continuity to the sports training process but for prophylactic purposes, so it is considered that an athlete has not completed his long-term sports preparation until it goes through sports detraining."*

Principle number 8 of the Olympic Charter (International Olympic Committee, 1958), refers to the practice of physical and sports activities according to needs. Also the functions 9 and 11 of the Olympism, propose to monitor the health of the athlete during and after his active life, as well as, hold government and non-governmental organizations responsible with the correct social insertion of these subjects.

A sport detraining is a modern term that some authors consider ambiguous. The concept has a controversial nature, because researchers have approached it by maintaining divergent views, which has caused the same term to adopt varied definitions or meanings, and give name to different phenomena of objective reality. From a temporary analysis, it is assumed that detraining has its roots in the classic works of sports training. Ozolin, N.G. (1988), proposed the division of perspective or long-term training in 2 periods for its development: selection and preparation. The second ended with a transition phase at the end of sports life, regardless of the cause of its withdrawal.

The epistemological assumptions that characterize sports detraining at present, focus its content, essentially, on describing the consequences suffered by athletes who retire from high performance sport and do not unravel, who are usually, perfect targets of pathologies of maladaptation and inactivity such as: hypertension, diabetes mellitus, sedentary lifestyle, obesity, sudden death, myocardial infarctions and increased toxic habits such as cigarettes, alcohol, drugs among others (Alcaraz , P.E. & Palao, J.M. 2007; and García, M. 2012).

There are other trends in the methodological treatment of sports training. According to Ronconi, M. & Alvero-Cruz, J.R. (2008), current trends to unravel according to their timing are classified as follows: short duration detraining (DCD), less than 4 weeks, and long duration detraining (DLD), greater than 4 weeks.

Unfortunately, the physiological adaptations that occur with physical training are not permanent. A few days after stopping training, there is a significant decrease in cardio-respiratory function and muscle metabolic potential, which coincide with a reduction in physical performance (Ibáñez, S.J. 2001).

These manifestations should be taken into account as elements of relevance to specify the sport training immediately after the athlete retires. These athletes, at the end of their active sports life, continue with a strong will, practicing physical and sports activities but for purposes other than performance and championship, then they talk about sports training as a stage that closes the long-term sports preparation, being a process oriented to increase the quality of life of this community (Barrizontes, F. 1992).

DEVELOPMENT

According to studies published by Mujica, I. & Padilla, S. (2000), elite athletes who interrupt, or reduce, the demands and frequency in their training sessions, begin to experience changes in their body that make them lose the shape in a very little time.

This situation produces the total or partial loss of the adaptations induced by the training, due to the absence of stimuli. The work shows two fundamental alterations in the athlete's organism when it stops preparing. On the one hand, there is deterioration of the cardio-respiratory condition, and on the other, an alteration in its metabolism, that is, in the ability to generate energy and in the ways that are used for it.

Respiratory functions during detraining experience deterioration, with a decrease in respiratory volume of up to 10% to 12% in highly trained athletes. There is a 12% to 14% decrease in muscle strength in these athletes, although age and performance level also influence the decrease in strength. Alterations in the values

of the respiratory quotient (CR) in periods of detraining, translate a high dependence on carbohydrates as a source of energy used in muscle metabolism. The maximum oxygen consumption (VO_{2max}), is the maximum amount of oxygen that the body is able to take and use in a minute. Most of the studies carried out by Mujica, I. & Padilla, S. (2000); Ronconi, M. & Alvero-Cruz, J.R. (2008); Alcaraz, P.E. & Palao, J.M. (2007), show that the maximum oxygen consumption (VO_{2max}) experiences with detraining, a decrease of between 4% and 20%. In individuals with a very high level of aerobic training, it has been shown that after 8 weeks of detraining an 8% loss of maximum oxygen consumption (VO_{2max}) is experienced. The higher the level of training and performance, the greater the deterioration of the value of maximum oxygen consumption (VO_{2max}) during a period of detraining.

In general, it can be verified according to Layus, F., Muñoz, M., Quílez, A.J. & Terreros, J.L. (1990), that the maximum oxygen consumption (VO_{2max}) decreases from 6% to 20%, during a detraining in well-trained athletes. Mujica, I. & Padilla, S. (2000), demonstrated that one of the causes of the reduction of cardiovascular functions during detraining is due to the reduction in blood volume up to 12%, largely due to 9% reduction in plasma volume. 3% of the reduction in blood volume could be attributed to the reduction in the mass of red cells that contribute to the decrease in maximum oxygen consumption (VO_{2max}).

Alcaraz, P.E. & Palao, J.M. (2007), found that the reduction of the maximum oxygen consumption (VO_{2max}) after periods of short and long detraining, is consequent to the reduction of the amount of blood expelled in each beat, due to the lower systolic volume characteristic of the detraining period. This author observed in a group of highly trained endurance athletes that after unraveling the decrease in maximum oxygen consumption (VO_{2max}) was related to the decrease in systolic volume by up to 12%.

The reduction of the maximum oxygen consumption (VO_{2max}) consequent to the loss of the blood volume and the decrease of the systolic volume, during the detraining is related to the changes in the cardiac dimensions. González Díaz, M., Sánchez, A. & Berovides, O. (2003), Ronconi, M. & Alvero-Cruz, J.R. (2008),

observed a significant reduction of between 15% and 33% in the thickness of the left ventricle in 6 Olympic rowing athletes, after a period of detraining. In recent studies of 40 high-performance athletes, undergoing a period of detraining, a significant reduction in the left ventricular cavity was observed up to 7% (Leicht, A.S. 2004).

The biomedical control practiced on retired athletes in Cuba constitutes a form of control and to monitor their health. The same is done depending on the particularities of the former athlete and the degree of dispensation in which he is, hence the controls are quarterly, semiannual or annual. The growing population of retired athletes requires practical and valid advice to assess their functional status, in order to unravel in a safe way in order to preserve health and improve their quality of life.

Maximum oxygen consumption (VO₂max), is one of the most important indicators to assess individual functional capacity, and it is measured in the laboratory using sophisticated equipment and specialized personnel. The (VO₂max) can also be predicted by easily applicable field tests, which have the advantage of being more specific.

These tests allow an assessment of the changes produced in the body as a result of the adaptations experienced because of the training. In the present study, the race test applying Tokmakiddis formula was selected as part of the control and evaluation of the sports detraining process. This allows assessing the subject's aerobic abilities, and has been the test used in retired athletes investigated over a distance of 2000m.

In the present research, it was decided to use this test because it has as a reference that it is frequently used as a measure of maximum oxygen consumption (VO₂max) in basketball players, it is easy to apply and is accepted by former athletes. In addition, it allows evaluating other variables such as: the final heart rate, time, speed and metabolic equivalent of work.

There are other tests with a similar purpose, among which the round-trip aerobic endurance test (coursenavette or Leger test), University of Montreal test, Cooper

test or 12-minute test, kilometer, Rockport test or Mile test. The tests mentioned above also have the purpose of measuring the maximum aerobic capacity.

It worked on an experimental design (quasi-experiment), characterized by the assignment of two groups, one control and one experimental, with the application of a pre-test and a post-test. In order to carry out the investigation, we worked with a population of twenty athletes removed from the Basketball sport, members of the first category team of Cienfuegos province, who withdraw when that province is excluded from participating in the Superior Basketball League (SBL), which led to the massive withdrawal of these athletes. Thus arises the need to follow up and the possibility of implementing sports training with them.

Group A (control) is made up of 10 retired athletes, with an average chronological age of 24.5 years, and average sports age in the high performance of 12 years, who worked on sports training based on the program of attention to former athletes which governs the Institute of Sports Medicine and its network of provincial centers. Group B (experimental), is made up of 10 retired athletes, with an average chronological age of 26.2 years and 12.9 years of sports age, who assume to unravel the model proposed by Mena, O. (2014). Both groups were untrained for 48 weeks, with the same frequency, schedule and material conditions. The difference lies in the content (diversity) and form of treatment or cargo handling.

To test the distribution of normality of the variable to be studied, the Shapiro Wilks test was applied because it was the sample with less than 50 subjects. It was obtained as a result that the variable does not have a normal distribution. This normality result favors the application of non-parametric tests, for the statistical processing of the variable studied.

Table. 1. Results of the Shapiro Wilks tests.

Groups and variable	Shapiro Wilks		
	Statistical	Gl.	Significance
(VO2máx) Control	,869	10	,097
(VO2máx) Experimental.	,859	10	,075

The maximum oxygen consumption (VO2max) is very useful since it allows to evaluate the subject's aerobic capacities, specifically its aerobic power. This ability is determined by the ability of the organism to capture, transport and use oxygen

during physical activity, therefore, it is a parameter that indicates the aerobic capacity of work, and globally reflects the oxygen transport system from the atmosphere to its use in muscle. It helps to determine the capacity and aerobic efficiency of a person. A sedentary subject consumes less oxygen than a trained one, because all peripheral and central components are without any aerobic preparation (Gómez Cimiano, J. 2001; Da Silva, J.E., Santos Pereira, J., Natali, A.J., De Souza, R.G., & Martin Dantas, E.H. 2006).

Aerobic training will benefit oxygen consumption, because it will increase the permeability of different cell membranes. Capillarization of stimulated muscles during work sessions, the amount and size of mitochondria, the amount of enzymes belonging to the oxidative system, oxygen and carbon dioxide transport proteins, and the amount of intramuscular and extra-muscular lactic acid will also increase, due to its consumption in different parts of the body.

The previous arguments motivated Barrisontes, F. (1992), to study a group of 100 male non-sports subjects, aged between 26 and 30 in Cienfuegos province, who performed physical activity with a frequency of three to four times per week. It was found that the maximum oxygen consumption (VO_{2max}) in them, behaved in average values of 48.55 ml/kg/min. The results obtained in this study are taken as a reference to compare the behavior of this variable in the subjects studied at the conclusion of the present investigation.

Table. 2. Results of the study to non-sports subjects.

Group	VO_2 Max. ml/kg/min.
Non-sports subjects.	48.55

Oxygen consumption is determined by three closely related factors that are:

- The oxygen that can be captured in inspiration.
- The oxygen that can be transported in red blood cells.
- The oxygen that is finally absorbed through the pulmonary alveoli.

In turn, oxygen consumption is largely determined by genetic inheritance, but other values such as sex, age, weight, physical condition and training can modify it, although not substantially (Obregón, H. 2009).

The maximum oxygen consumption value (VO_{2max}) in people depends on the individual conditions of each subject. However, there are average values that are

taken as referents to compare the results obtained during the investigation in the variable studied. According to Vaquera, A., Rodríguez Marroyo, J.A., Villa, J.G., García, J. & Ávila, C. (2001), untrained men have relative values between 40 and 55 ml/kg/ min, while women are between 32-38 ml/kg/min. For their part, trained men are between 45 and 55 ml/kg/min, and women between 40 and 50 ml/kg/min. Although in elite athletes these values may be higher, in more recent studies it was found that active high performance male basketball players demonstrate an increase in maximum oxygen consumption (VO₂ Max), which behaved between the values of 55 and 60 ml / kg / min (Obregón, H. 2009).

Table. 3. Average reference values to assess the behavior of VO₂ Max.

Variable	Untrained people		Trained Subjects		Active basketball
VO ₂ Max.	Men	Women	Men	Women	55 y 60 ml/kg/min
	40-55	32-38	55-65	40-50	

As part of the field diagnosis (pre-test), which is carried out before starting the experiment in order to know the physical state and behavior of the maximum functional variable consumption, the 2000m running test was applied, applying the formula of Tokmakiddis Obtaining the following results in both study groups:

Table. 4. Results obtained during the pre-test.

Study group.	VO ₂ max. ml/kg/min
Control group.	54.36
Experimental group.	54.16

As it was possible to appreciate, the results experienced in this variable by both groups object of study, show tendency to keep similarity with the results evidenced by the high performance basketball players studied by Obregón, H. (2009). The foregoing demonstrates the tendency in the athletes studied in the present research to maintain for a time the physical condition reached during the preparation, identified as an accumulated effect of the load.

During the second measurement or post-test the following results could be verified:

Table. 5. Results obtained during the post-test.

Study group.	VO ₂ Max. ml/kg/min.
Control group.	48.76
Experimental group.	48.51

The maximum oxygen consumption (VO₂max), is a variable that gradually increases with age, which reaches the maximum level between 18 and 25 years. This aspect was taken into account in the present investigation when assessing the approximate age ranges in which the subjects studied are, and who performed the detraining.

The average values in terms of maximum oxygen consumption (VO₂max) in the control group, behave in 48.76 ml / kg / min, being also six subjects, for 60%, with responses above the reference values. This is considered to be associated with the readjustments evidenced by these subjects because of unraveling from what is established in the Program that governs Sports Medicine, despite disagreeing in their conception with the theoretical support that favors adaptive processes and individualization during this stage.

When analyzing the behavior of the maximum oxygen consumption (VO₂max) in the experimental group, who untrained from the proposal of Mena, O. (2014), it was found that three subjects, representing 30%, were above the desired levels in this process, which could be associated with the position they played. Of them, two were base players and one forward, who traveled more distance in each game, so the energy expenditure was higher. However, 70% show a behavior of maximum oxygen consumption (VO₂max) in a smaller range when compared to the control group (48.51ml/kg/min), according to the reference values taken for the sports detraining process, which corroborates a favorable evolution of this variable in these subjects when they go through the detraining from the referents assumed in this investigation.

In table 5, the maximum oxygen consumption values (VO₂max) for the control group were shown in 48.76 ml/kg/min, and 48.51 ml/kg/min for the experimental group. The similar behavior of this variable in both groups, may be related to the fact that retired athletes, both from the control group and the experimental group, have performed the detraining, and although by different routes they undergo adaptive transformations in the levels of maximum consumption of oxygen (VO₂max).

The Mann-Whitney U test was used to check if there are significant differences in the behavior of the variable studied, during the pre and post test in both groups. As can be seen, the test revealed that there are no differences in the levels of asymptotic and exact significance in the behavior of maximum oxygen consumption (VO₂max) in both study groups.

Table. 6. Mann-Whitney U test results.

Maximum Oxygen Consumption (VO₂Max.) In both groups	
U of Mann-Whitney	44,000
W of Wilcoxon	99,000
Z	-,454
Sig. asintót. (bilateral)	,650
Sig. exact [2*(Sig. unilateral)]	,684(a)

CONCLUSIONS

Favorable organic readjustments were found in the subjects studied, in relation to the maximum oxygen consumption variable, an element that corroborates the feasibility of the methodological ways used by both groups. It is demonstrated at the conclusion of the study, the importance of athletes who withdraw from high performance sport, specify the sports training as a necessary and relevant process to improve their quality of life.

BIBLIOGRAPHIC REFERENCES

- Alcaraz, P.E. & Palao, J.M. (2007). Medios y métodos de entrenamiento de los especialistas en velocidad y pruebas combinadas de la Región de Murcia. *Kronos*, 5(11), 55-62.
- Barrizotes, F. (1992). *Estudio del comportamiento del consumo máximo de oxígeno en población no atletas de la provincia de Cienfuegos*. (Material no publicado) Universidad de Cienfuegos. Cienfuegos, Cuba.
- Comité Olímpico Internacional (1958). Carta Olímpica. Programa para la transición luego del deporte. Actualizado Beijing (2008).
- Da Silva, J.E., Santos Pereira, J., Natali, A.J., De Souza, R.G., & Martin Dantas, E.H. (2006). Efectos crónicos de un programa regular de natación, sobre la tensión arterial de adultos hipertensos. *Revista Internacional de Ciencias del Deporte (RICYDE)*, 4(2), 15-25.

- García, M. (2012). El desentrenamiento en los atletas retirados del deporte de alto rendimiento. *Revista Lecturas: Educación Física y Deportes*, 17(168).
- Gómez Cimiano, J. (2001). Eclecticismo en la valoración del máximo consumo de oxígeno. *Revista Lecturas: Educación Física y Deportes*, 7(42).
- González Díaz, M., Sánchez, A. & Berovides, O. (2003). *Pruebas de función cardiovascular*. (Material no publicado). Instituto Nacional de Medicina del Deporte. La Habana, Cuba.
- Ibáñez, S.J. (2001). *Efectos del desentrenamiento y de la reducción del entrenamiento sobre la aptitud física*. (Material no publicado). Centro de Estudios, Investigación y Medicina del Deporte. Instituto Navarro de Deporte y Juventud. Pamplona, Navarra, España.
- Layus, F., Muñoz, M., Quílez, A.J. & Terreros, J.L. (1990). Distribución por deportes de datos ergoespirométricos de referencia. *Archivos de Medicina del Deporte*, 7(28), 239-343.
- Leicht, A.S. (2004). Cardiovascular stress on an elite basketball referee during national competition. *Br J Sports Med*, 38(4).
- Mena, O. (2014). Propuesta de un programa de entrenamiento físico para desentrenar los baloncestistas Cienfuegueros retirados del alto rendimiento. *Rev. Cub. Med. Dep. & Cul. Fís*, 9(1).
- Morales Águila, A. (2011). *La individualización como garantía de la calidad de vida de los deportistas: necesidad impostergable y evolución de las alternativas de solución*. (Material no publicado) Instituto Superior de Cultura Física "Manuel Fajardo". La Habana, Cuba.
- Mujica, I. & Padilla, S. (2000). Detraining: loss of training-induced physiological and performance adaptations. *Sports Med*, 30, 79. doi: 10.2165/00007256-200030020-00002.
- Obregón, H. (2009). *Características morfo-funcionales de atletas integrantes de la preselección nacional femenina de baloncesto*. (Tesis de maestría no publicada) Facultad de Medicina Enrique Cabrera. La Habana, Cuba.
- Ozolin, N.G. (1988). *Sistemas contemporáneos del entrenamiento deportivo*. La Habana: Científica Técnica.

- Ronconi, M. & Alvero-Cruz, J.R. (2008). Cambios fisiológicos debidos al desentrenamiento. *Apunts. Medicina de l'Esport*, 43,192-198.
- Vaquera, A., Rodríguez Marroyo, J. A., Villa, J. G., García, J. & Ávila, C. (2001). *Análisis descriptivo del perfil fisiológico del jugador de baloncesto de la liga EBA*. En S. J. Ibáñez y M. M. Macías (Ed.), I Congreso Ibérico de Baloncesto (pp. 23-27). Cáceres, España.
- Verjoshanski, Y. (1991). *Entrenamiento deportivo, planificación y programación*. Barcelona: Martínez Roca.