PERIODIZATION OF THE TRAINING PROCESS: COMPARATIVE ANALYSIS OF TWO MODELS THROUGH THE PRISM OF MODERN RESEARCH

ПЕРИОДИЗАЦИЯ ТРЕНИРОВОЧНОГО ПРОЦЕССА: СРАВНИТЕЛЬНЫЙ АНАЛИЗ ДВУХ МОДЕЛЕЙ ЧЕРЕЗ ПРИЗМУ СОВРЕМЕННЫХ ИССЛЕДОВАНИЙ

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Анотації

In this article, two known models of the periodization of the training process are compared: linear and wave. Their effectiveness is analyzed from the point of view of various variables. The narrative review presented in detail examines all the experimentally conducted science works and thereby allows readers to broaden their horizons on this topic. The strengths and weaknesses of both periodic models were identified and outlined.

Key words: periodization, strength training, training process, linear periodization, undulating periodization, biological concept, muscular contraction regimes.

В этой статье сопоставляются две известные модели периодизации тренировочного процесса: линейная и волновая. Анализируется их эффективность с точки зрения различных переменных. Представленный нарративный обзор подробно рассматривает все экспериментально проведенные работы и тем самым позволит читателям расширить свой кругозор по данной теме. Были определены и изложены сильные и слабые стороны обеих периодизационных моделей.

Ключевые слова: периодизация, силовой тренинг, тренировочный процесс, линейная периодизация, волновая периодизация, биологическая концепция, режимы мышечных сокращений.

У цій статті зіставляються дві відомі моделі періодизації тренувального процесу: лінійна і хвильова. Аналізується їх ефективність з точки зору різних змінних. Представлений наративний огляд детально розглядає всі експериментально проведені роботи і тим самим дозволить читачам розширити свій кругозір по даній темі. Були визначені і викладені сильні й слабкі сторони обох періодизаційних моделей.

Ключові слова: періодизація, силовий тренінг, тренувальний процес, лінійна періодизація, хвильова періодизація, біологічна концепція, режими м'язових скорочень.

Statement of the scientific problem and its significance. Periodization of the training process takes one of the key positions in the general system of the problems of physical education and sports, which is aimed at achieving maximum results in physical education / sports. The theory of periodization in sports began to emerge after the 1956 Olympic Games. The idea originates from the model of the Canadian endocrinologist Hans Selye - "a syndrome of general adaptation." Lev Pavlovich Matveev transferred this model to physical education, compared the training plans for athletes. This analysis created a "soil" for building periodic grafics for the 1960 Olympic Games. The successful performance of Soviet athletes in Rome contributed to the popularization of the theory of periodization. In his article "On the Periodization of Sport Training", L. P. Matveyev rightly notes the importance of the "steps" of improving physical training: acquisition-sustenance-creating the necessary conditions for further development-transition.

Such an extensive "chapter" from the whole book called "physical education/sports training" could not but create a large-scale resonance among other specialists in this field. The most famous critics of the classical version of periodization is Yu. V. Verkhoshansky, A. N. Vorobiev and A. P. Bondarchuk, V.B. Issurin.

A. N. Vorobiev criticized Matveyev's position through the prism of individualization. In his book [2], he notes the progressive nature of Matveyev's ideas, but at the same time he doubts the effectiveness of the classical model for the growth of sports results. According to the author, the key disadvantage is the following: "a multidirectional construction of the training load in different periods." Also, Vorobyev criticizes the opponent because of the lack of a "biological concept". Another recognized authority in sports science, VN Platonov [3], speaking in defense of L. P. Matveev, is indignant over Vorobyov's statement - "the repetition of the competitive movement does not give the proper effect." Because, L.P. Matveyev [4], already touched on this issue and noted that the performance of execution of movements in competitive mastered embodiment will only help to slow down the way to achieve a high level of sportsmanship. But, these words concern only the general preparatory stage of the preparatory peri-

od. Yu.V. Verkhoshansky in the article "Horizons of the scientific theory and methodology of sports training" [5] emphasized the importance of the biological aspect and called for strengthening the priority of biology in the scientific and practical search. He attributes the following regularities to the natural scientific foundation of the theory and methodology of physical culture: the development of the adaptive mechanisms of the organism, the process of formation, sports and technical skill, the morphofunctional specialization of the organism in the course of many years of training, the relationship between the dynamics of the athlete's state in the long stages. In addition to the biological aspect, Verkhoshanskii stresses [6] the absence of sound practical recommendations and the neglect of the results of experimental work in traditional periodization. Matveev [7] has no doubt about the importance of modeling in sports, but he also points out three points that even the simplest biological model of the training process should not be deprived of: 1) the system of influences on the athlete; 2) a systemic response to these impacts; 3) the logical links between "A" and "B". In the opinion of A. P. Bondarchuk [8], their "periodization approach" with like-minded people deserves attention, since it implies recommendations of a more in-depth character with respect to the means of training, the duration of different periods and has a clear classification of the types of exercises used.

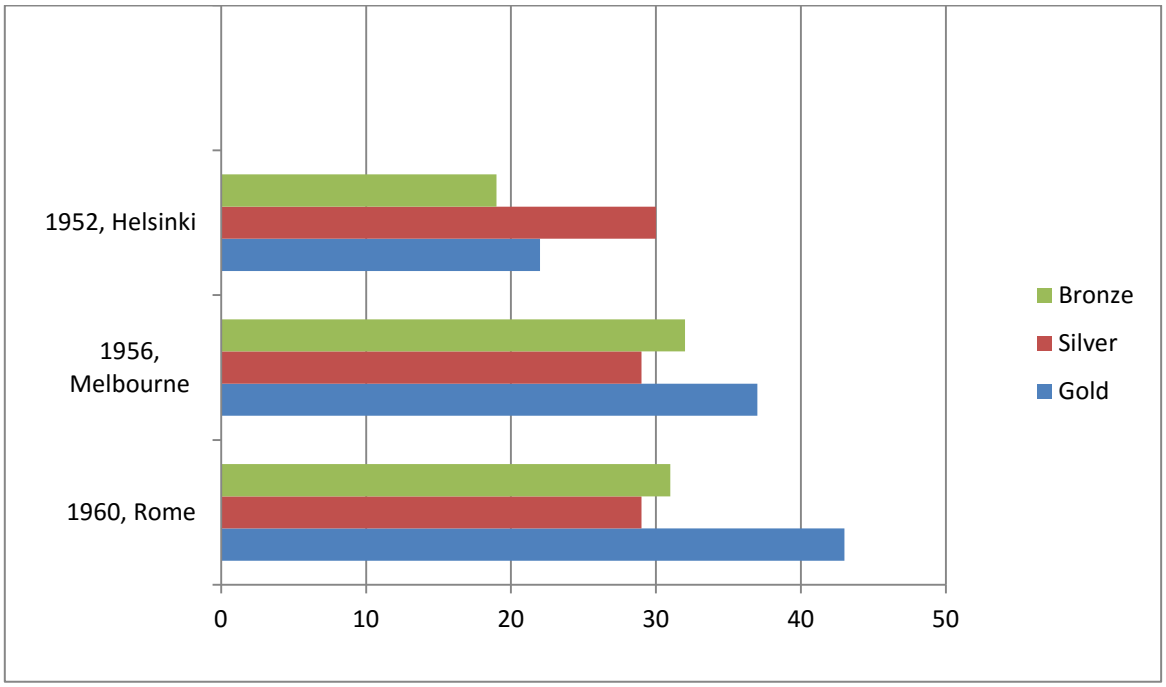

Figure 1. Statistics of the USSR performances at the Summer Olympic Games (1952, 1956, 1960)

The purpose of the study is to compare two periodization models of training.

Objectives of the study:

1. Conduct an analysis of foreign scientific literature on the topic of "periodization of the training process."
2. Evaluate the level of efficiency of models in different variables.
3. Show their strengths and weaknesses.

Methods of research – theoretical analysis, systematization of scientific data.

Introduction. OBryant and colleagues [9] in 1988 studied the strength and endurance indicators in 96 students and recorded the advantage of periodization in increasing the power capacity and short-term stamina. In the Kraemer et al. Study [10], the periodization group did not differ in effectiveness from the other groups (1 approach to failure, 3 approaches to failure, control group) in strength, weight and body composition (study duration – 14 weeks). McGee et al. [11] studied three methods (high intensity endurance training)

in young men (27 people) – group 1 – one approach for 12 repetitions to failure, second group – periodization (2 weeks 3x5, 3 weeks 3x3), third group - 3x10 all seven weeks of the study. The periodic model did not have clear superior data. A high volume of training + periodization outstripped the low volume in terms of strength and endurance, but only after 12 and 24 weeks [12]. Testosterone after 12 and 24 weeks increased only in the group with a high volume, and cortisol decreased. In the second group, insulin-like growth factor – 1 (IGF-1) increased after 24 weeks, and after 12 and 24 weeks for the group – a high volume. In the study, the periodization group outstripped the control group not only in the one-repeated maximum (1RM), but also in the rate of decrease in % fat. The most ambitious experiment [14] lasted 9 months and was conducted with the participation of 31 women. During the first six months, the group that followed the periodization increased 1RM in leg press. In other variables, group P also proved to be more effective: anaerobic power, grip strength, jump height, 1RM in leg press, dumbbell presses on shoulders, feed rates (test subjects were tennis players), IGF-1, testosterone, cortisol concentration. The resistance to insulin decreases without dependence, the periodization is applied or not, and the concentration of adiponectin and leptin were not marked by certain changes, but the data were obtained specifically for the linear periodization model. Ahmadizad and his colleagues within the eight-week study did not find the obvious advantage of using periodization to increase strength (1RM in bench press and leg pressures increased in all groups) in young men (32 untrained) [15]. In a recent study [16], a stable number of repetitions was compared to a variety. The experimental group followed the following alternation: 2-4 RM / 8-12 RM / 20-30 RM. All three variables considered (muscle strength, local muscular endurance, muscle volume) were similar for groups. A comparison of the periodization with active rest periods and progressive strength training considered increasing the strength and plateau in performance for 15 weeks of training. The periodization group had a constant increase in strength, while the second group approached the plateau by the end of the study [17].

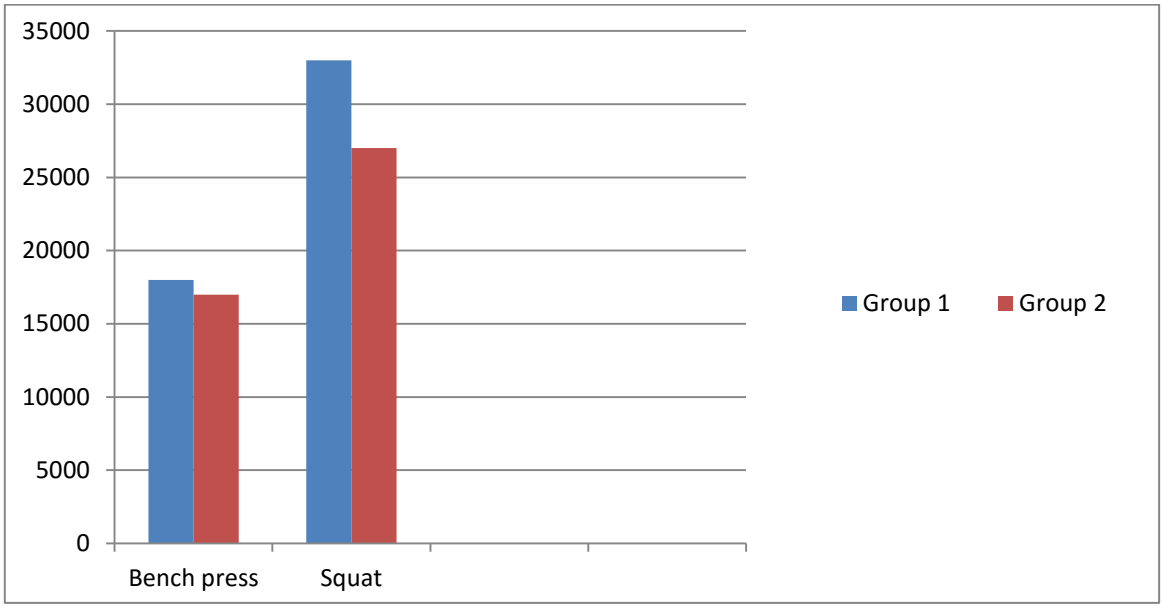

Figure 2. The average workload between groups (Herrick, 1996)

The main part. Six research studies are responsible for the search criteria: Baker (1994), Peterson (2008), Stone (2000), Prestes (2015), Vanni (2010), Kok (2009), Souza (2014). Baker and colleagues [18] were the first to compare the linear and wave periodization (22 men, 12 weeks) in strength (bench press, squat), increase in lean muscle mass (LMM), the effectiveness of the vertical jump, the level of neural activity (LNA). LNA did not undergo changes and did not have direct dependence on force indicators, when both 1RM definitely correlated with LMM.

Stone et al. [19], following to colleagues, attempted to compare two periodization models

(linear and wave) with each other and with a control group. The influence of three strength training programs on a one-repeated maximum (1 RM) in squats was compared. Participants in the study were 21 students. The criteria for selection in the study: 1 RM > 110 kg and > 1.3 x body weight and the ability to complete > 80% of the scheduled reps.

Group 1 – 5x6 (in the basic exercises and 3x8 for the auxiliary exercises), 5 people.

Group 2 – linear periodization model, 9 people.

Group 3 – wave periodization, 7 people.

For groups 1 and 2, the number of repetitions was programmed almost identically (720 and 730 repetitions), in group 3, 18 and 19.4% less repetitions (590). 1 RM was measured before and after 12 weeks.

Table 1

Exercise schedule

Exercise	Monday	Wednesday	Friday
Squat	+		+
Bench press	+		+
Incline bench press	+		+
Power clean		+	
Shrug		+	
Pull downs		+	

Groups 2 and 3 managed to show greater results in 1RM (group 1 141.4 +/- 28.1-155.4 +/- 23.7, group 2, 124.8 +/- 12.0-143.4 +/- 12.1, and group 3 - 132.8 +/- 17.0-153.3 +/- 19.3). Derived variables were the squatting on the body weight and the gain in the squatting x coefficient Sinclair (method of eliminating differences in body weight). The percentage difference between groups 1 and 2 is as follows: squat = 33, squat = 5, Sinclair's formula = 33. For the third group: squat = 46, squat = 67 and Sinclair = 109. The results clearly show the superiority of periodization over a constant repetition scheme in increasing 1RM, even when the repetitions are equalized (group 1 vs group 2) or with fewer repetitions (group 1 versus group 3).

Table 2

Training variables – average values for 12 weeks of training

Group	The average weight of the barbell	Load volume	Relative intensity	% of total number of repetitions	Total number of completed repetitions	The average number of repetitions for 1 approach
1	95	58, 805	67	86	619	6.0
2	76	47, 804	61	86	629	6.6
3	96	50, 581	72	88	529	5.2

Peterson and his colleagues [20] evaluated the influence of periodization models on "adaptation to fitness" and the degree of transition to specific tasks related to the work of subjects (firefighters, 14 people). Testing consisted of evaluation: muscle strength, sprint speed and hop ability, special tasks for firefighters. At the end of the 9-week study, both models demonstrated their potential for strength increase, but the wave periodization proved to be more successful in the remaining tests. The data indicate a great benefit of the use of wave periodization for the multidimensional development of muscle strength. The study supports the wave periodization to provide a higher level of performance for the execution of specific tasks.

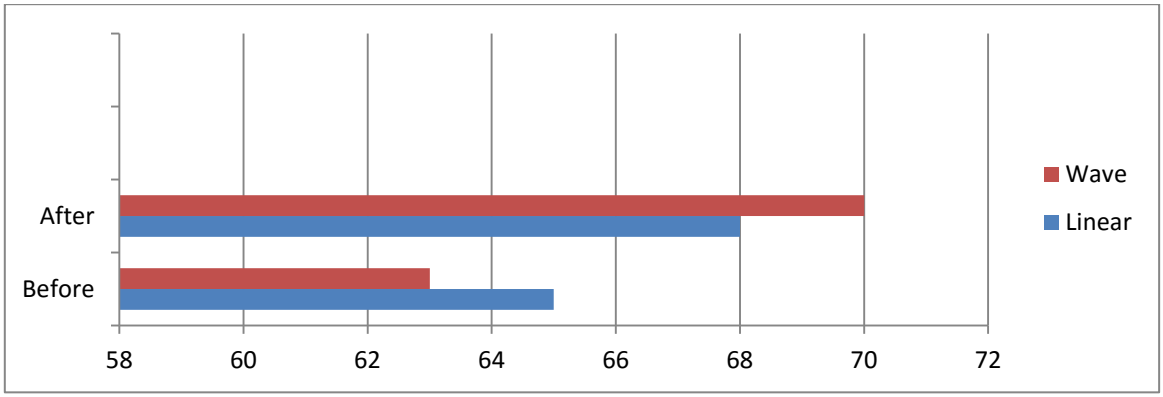

Figure 3. Vertical jump

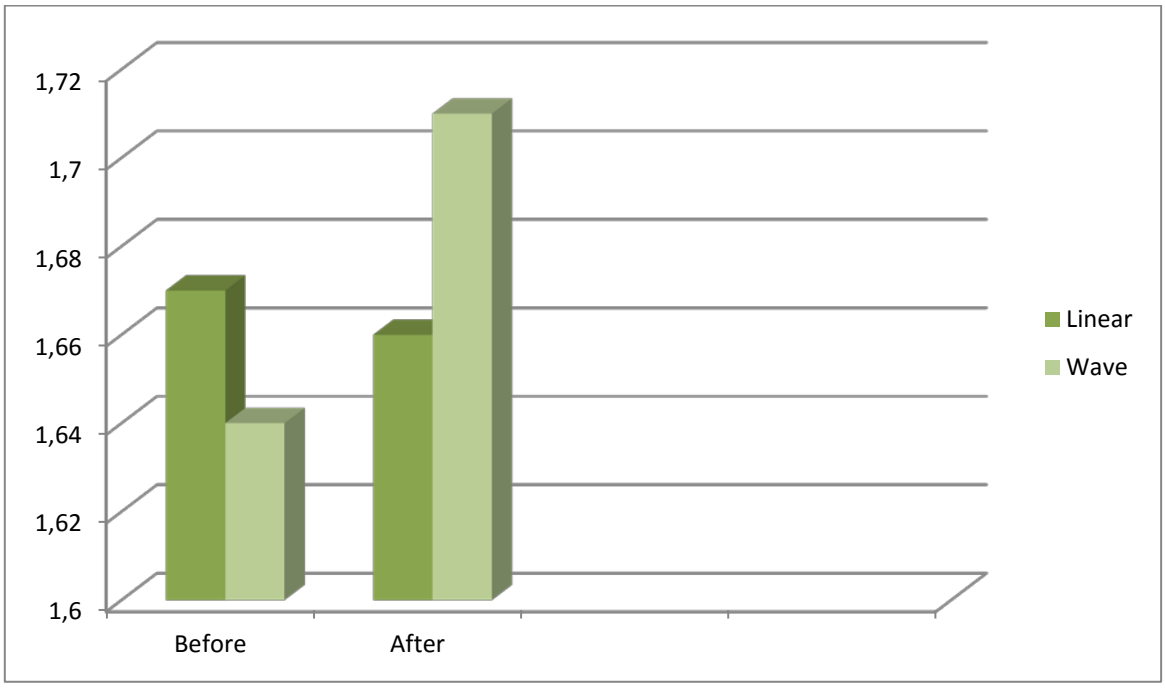

Figure 4. Maximum speed of development of force

Table 3

Preliminary and post-test statistics (Peterson, 2008)

	Traditional periodization		Wave periodization	
	Before	After	Before	After
Power indicators in the bench press	100 +/- 24	108 +/- 23	102 +/- 28	119 +/- 24
Force indicators in the squat	119 +/- 15	139 +/- 12	136 +/- 31	163 +/- 31
Long-jump	225 +/- 22	240 +/- 19	234 +/- 18	244 +/- 20
Peak output power (30% of 1RM)	2486 +/- 380	2688 +/- 310	2811 +/- 378	2999 +/- 451

In 2014 [21], Souza and colleagues focused on the study of the quadriceps and cross-sectional areas (CSA) of the quadriceps muscle after three different training regimes: the absence of periodization (AP), linear (LP) and wave (WP) in 31 physically active men.

1RM increased only in the groups of AP and WP (17 %, 13 %), and the control group and LP (after six weeks) had very low rates – 7 % and 1 %, respectively. On the basis of the CSA, in addition to the control group, all groups received an increase of 5 % (AP – 5.1, LP – 4.6, WP – 5.2). Kok et al. [22] in their 9-week study received similar improvements in various indicators (for 20 young women): 1RM in squat: LP – 35 %, WP – 41 %; 1RM in bench press: LP – 22 %, WP – 28 %; Squat with counter-movement: LP – 10 %, WP – 9 %; Throwing bench press: LP – 11 %, WP – 14 %; Grip strength: LP – 1 %, WP – 2 %; CSA – For LP, the greatest increase occurred in the first three weeks, while the WP received the best results from the initial level of 3 weeks and from 3 weeks to 6 weeks. With linear and wave periodization, the mineral density of bones remains unchanged despite the increase in power indicators (maximum force – LP – 37–73 %, WP – 40–70 %, submaximal force – LP – 82–114 %, WP – 70–102 %). For creatine kinase and delayed muscle pain, the highest rates were recorded in the first mesocycle in 27 women (premenopause). Evaluation of [23] neuromuscular and function and functional capabilities, as well as body composition and cytokine indices, did not reveal a difference between LP and WP in 49 elderly women. Participants equally improved walking, lifting to the biceps, 1RM in the leg press.

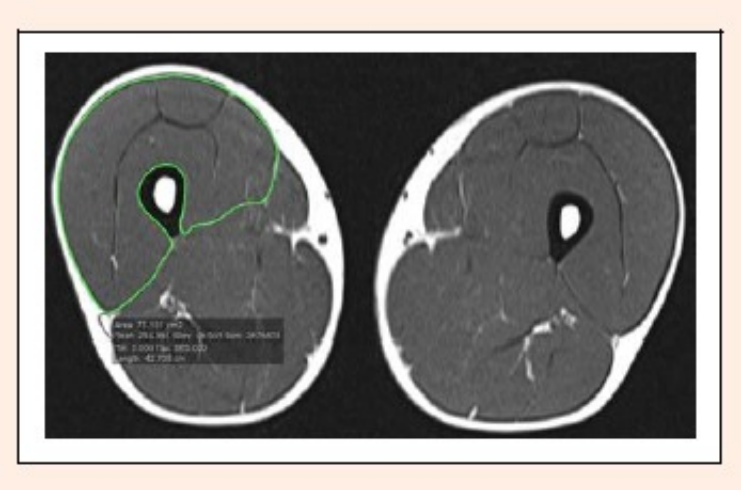

Figure 5 The cross-sectional area of the dominant quadriceps muscle

Conclusions.

1. In general, on the basis of a small number of studies, where two models (LP and VP) were compared, it is extremely difficult to construct convincing arguments, but the wave periodization has a minimal advantage.

2. The level of neural activity and power indicators are not directly interrelated.

3. Periodization with alternating high-low intensity can promote a strong push to increase strength and endurance.

4. Periodic models – 2 weeks 3x5 / 3 weeks 3x3 and 2-4 RM / 8–12 RM / 20-30 RM do not have obvious advantages over the absence of periodization.

5. High volume training using periodization reduces cortisol. There was a rise in testosterone after 12 and 24 weeks, with low-volume training this was not observed. However, it is worth noting the minus of this study in the absence of the third group – low-volume training with periodization.

6. A long experiment involving the female supports the effectiveness of the use of periodization to increase grip strength, 1PM in bench press and bench press, dry muscle mass, anaerobic power, jump height, increased testosterone and lower cortisol.

7. Resistance to insulin is absolutely independent of periodization.

8. Perhaps for untrained men, it is not essential to adhere to periodization in the training process.

9. In one study, the periodization (weeks 1–5 – 3x1,3,3,3 repetitions / 10,5,5,3x3 repetitions, weeks 7-10 – 3x1,3,3,3 reps / 10,5,5,3, weeks 11–15 – 3x1,3,3 / 10,5,3x2) did not differ in performance from 1x8-12 to failure, 3x10 without failure.

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