

Periodization with Undulation Training Load: A Narrative Review

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Abstract

The objective of the study was to explain based on the sportive training literature how the undulation training load (UTL) was structured in each period of the sportive periodization. During the military period the ancient peoples developed the periodization of military training with UTL and in the period of the first records of the sportive periodization the Ancient Greeks created the Tetrad with UTL. The empirical period was from 1917 to 1950; the pioneer periodization was developed with UTL, based on the seasons of the year, the competitive calendar, and the type of training. The scientific period was from 1950 to 1977, the researchers elaborated the traditional periodizations based on exercise physiology for the coach to understand the peak of the sports form, and with UTL. The modern period was from 1978 until the present day, and contemporary periodization was developed for several sports with the UTL. In conclusion, a UTL is a necessity for high-performance sports.

Keywords: *peak, sports form, micro cycle, meso cycle, super-compensation.*

JEL classification: I21; I39

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1. Introduction

Ancient peoples practiced undulation training loads during military training (Marques Junior, 2023a, 2024a) and in the preparation for the ancient Olympic Games with the Greek Tetrad (Costa, 2022). The Tetrad had four days of training with the undulation training load. It was practiced with a day of light training, another medium training, the third day of hard training, and the fourth day of passive or active rest (Marques Junior, 2020; Montero, 2020). In contemporary sport, several researchers recommended the undulation training load (Bondarchuk, 2016; Kozhedub et al., 2022; Marques Junior, 2023b; Osorio et al., 2024; Ozolin, 1987; Verkhoshanski, 1979). The exact moment that several sports researchers recommended the undulation training load is not known, but the Soviet researchers began to study during the years 40 and 50 how to structure the training load of the microcycle (Gomes, 1995; Marques Junior, 2023c).

Until the year '40, the training load of the microcycle was elaborated empirically (Marques Junior, 2022a; Verkhoshanski, 1996). But the moment that the training load of the microcycle had a scientific basis was during the years 50 and 60 (Zakharov, 1992), the Russian in the moment of the Soviet Union, Lev

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Pavilovch Matveev, elaborated the training load based on the athlete's biological adaptation that had the content of the exercise physiology and biochemistry (Tschiene, 1985, 2000; Verkhoshanski, 1999). Matveev explained that the peak of the sports form is based on the chronic adaptation of super-compensation; he had access to the studies of the Russian biochemist Yakovlev in the year 50 (Marques Junior, 2024b). Therefore, the athlete has more chances of achieving the peak with an undulation training load because, during the microcycle the training load is light to heavy (Matveev, 1997).

Undulation training load is prescribed in most of the microcycle sessions training effort (fatigue), and active and/or passive rest (recovery) for the athlete to obtain adequate physiological, technical, and tactical adaptation (Havenga et al., 2025; Manso e Suárez, 2021; Padilla, 2017; Platonov, 2004; Villar, 1987). Undulation training load is related to three factors combined in the heterochronism of adaptation and recovery, biological rhythms and environmental factors, and the relationship between effort volume and intensity (Matveev, 1991). Therefore, several types of periodizations were developed with an undulation training load because this type of load is healthier for the athlete (Borzov, 2019; Marques Junior, 2024c; Moura et al., 2023).

The objective of the study was to explain, based on the sportive training literature, how the undulation training load was structured in each period of the sportive periodization.

2. Methods

The articles were selected from September to December of 2024 in 10 databases (Google Scholar, PubMed, Research Gate, Scielo, Redalyc, Scopus, DOAJ, ScienceDirect, Semantic Scholar, and Latindex) with the following keywords: sports periodization, sportive periodization, training, and periodization. The printed books the author used in the library and printed articles were sent by e-mail to the author by his Italian friend G. B.

3. Results

3.1 The Military Period and the Period of the First Records of the Sportive Periodization

The periodization has five historical moments that are related development of undulation training load. The first historical moment was the military period. Ancient peoples (Chinese, Romans, Greeks, and Egyptians) developed the periodization of military training (Marques Junior, 2024d). The period of Ancient Greece until 300-500 AD was the period of the first records of the sportive periodization that created the ancient sports periodization (Costa, 2022). During the military period and period of the first records of the sportive periodization, the



coach prescribed an undulation training load because during the military or athlete practiced stimulation in some sessions and recovery in other sessions.

The Tetrad was a micro cycle developed by the Ancient Greeks to prepare the athletes for the Ancient Olympic Games (Padilla, 2017). This microcycle was created during the period of the first records of the sportive periodization. The Tetrad had four days of training with the undulation training load, it was practiced a day of light training, another medium training, the third day of hard training, and the fourth day of passive or active rest (Marques Junior, 2020; Montero, 2020).

The Tetrad was used during the Roman military training because the Romans conquered Greece (Marques Junior, 2024a). Rome was a militarized nation, and a popular sport was the gladiator fight in the Colosseum (Marques Junior, 2025a). The gladiators used the Tetrad to prepare the athletes for the sportive combats (Marques Junior, 2021). Therefore, Tetrad was used a lot in the military and sportive training.

Figure 1 presents the Tetrad. Undulation training load in each Tetrad was in percentage with 75 to 100% of hard load, 50 to 70% of medium load, and 10 to 40% of light load or rest load (Marques Junior, 2023b). The Tetrad received criticism from ancient researchers, the undulation training load had little variation, and the athlete practiced the same training load in 4 days (Stocking, 2016).

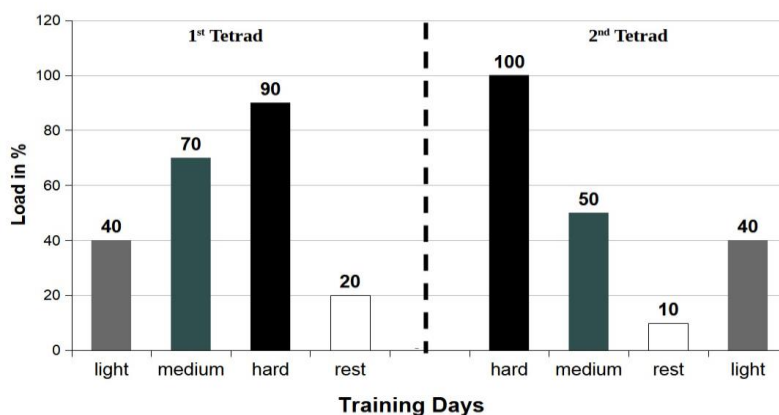


Figure 1. Two types of Tetrad with 4 training days each (Adapted from Costa, 2022).

3.2 Empirical Period

The empirical period was from 1917 to 1950, this third historical moment that was elaborated the pioneer periodization (Marques Junior, 2024d). In the empirical period occurred the Russian Revolution of 1917, the moment that was inserted into Soviet universities the study of sportive periodization, and this continued in the Soviet Union since 1922 (Marques Junior, 2017, 2019, 2022b; Oliveira, 2008). Therefore, Soviet researchers were important for the evolution of



the sportive periodization, and also the Soviet researchers studied the training load used in the sportive periodization (Graham, 2002; Marques Junior, 2024e, 2025b).

The pioneer periodization empirical period was elaborated based on the seasons of the year, in the competitive calendar, and the type of training (general, special, and competitive) (Bondarchuk, 2016; Silva, 2000; Marques Junior, 2020, 2024b; Tubino and Moreira, 2003). In between the years 20 and 30, the Finnish athletics coach Pihkala used the undulation training load to structure the training of the long-distance and middle-distance runners (Tubino and Moreira, 2003). Pihkala's periods were organized based on the seasons of the year with undulation training load, in the competitive calendar, and type of training (Marques Junior, 2020). The most famous athlete that Pihkala trained was the Finnish Paavo Nurmi, who won several Olympic medals in 1920, 1924, and 1928.

Therefore, the undulation training load was used by several coaches because this organization of the load is based on exercise physiology. For example, after three hard training, the athlete practiced a recovery training session because active rest recovers the athlete faster from the training fatigue. The active rest was discovered by Russian physiologist Ivan Setchenov in 1903 (Zakharov, 1992). However, during this period exercise physiology was poorly developed for the coach to use in the periodization training load (Verkhoshanski, 2001).

Figure 1 presents a pioneer periodization elaborated by English Thomas based on the season of the year of Western Europe, with an undulation training load (stimulus and recovery) based on competition (Tubino, 1993).

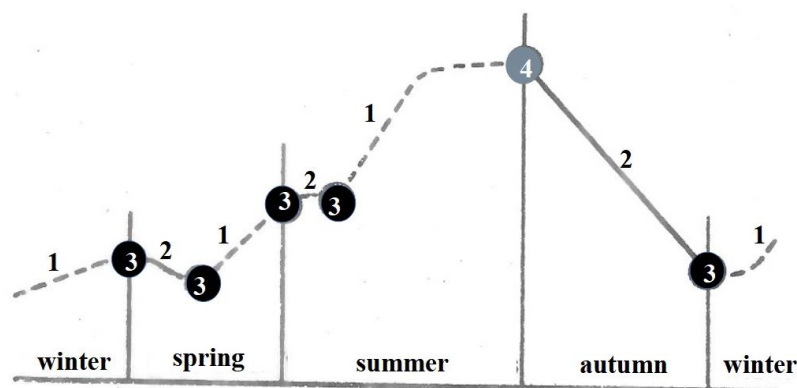


Figure 2. Example of periodization with undulation training load; the number 1 is training stimulus (dashed line), 2 is recovery training (solid line), 3 is competition (circle), and 4 is target competition (circle) (Adapted from Tubino, 1993).

In 1939, before the 2nd World War, German athletics coach Woldemar Gerschler elaborated interval training, which was important for volume and intensity control (Hegedus, 1985; Tubino and Moreira, 2003). The volume of interval training is composed of sets, repetitions, distance, and workout duration.



But the intensity of this training is composed of velocity, race time, rest, and action in the interval. Then, the coach with the interval training can structure the running training with an undulation training load, this was used by the Czechoslovakian runner Emil Zatopek in the years 40 and 50 (Nett, 1954; Oliver, 2008a). During this period, in the years 40 and 50, the Hungarian athletics coach Mihaly Igloi prescribed in the interval training the undulation training load, presented in figure 3 - an Igloi's micro cycle with an undulation intensity of each training stimulus times (Oliver, 2008b). The undulation intensity of Igloi was in percentages of 75 to 100% of hard load, 50 to 70% of medium load, and 10 to 40% of light load (Marques Junior, 2023b).

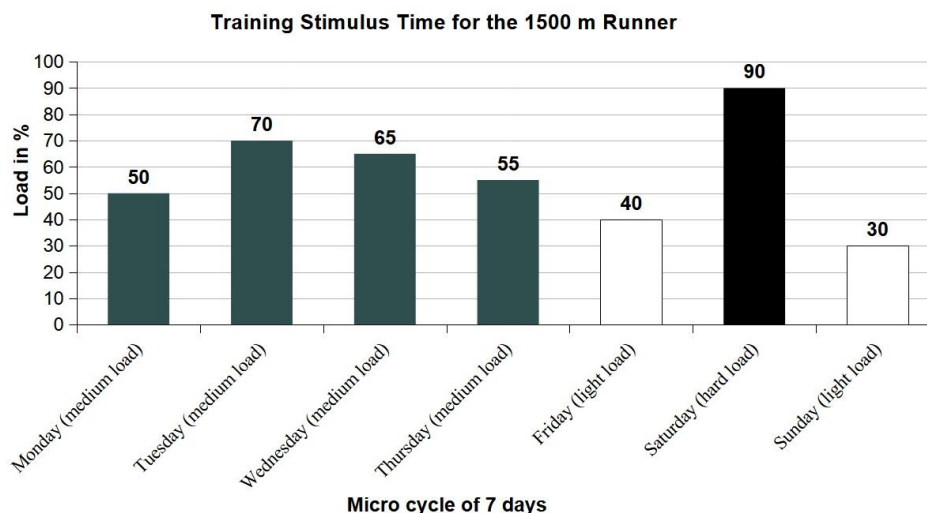


Figure 3. Undulation intensity of Igloi's micro cycle (Adapted from Oliver, 2008b).

In 1945, after the 2nd World War, the Soviet Union invested massively in sports, and the study of sportive periodization was given much attention in universities (Bompa, 2002; Marques Junior, 2022b). This resulted in the creation of 6 periodizations developed by Soviet researchers in the empirical period, and 2 periodizations of other countries – Finland and England (Marques Junior, 2023d). In 1950, Soviet researcher Letunov criticized the period and micro cycle of periodization, arguing they were not based on biological adaptation (Silva, 2000; Tschiene, 1985). Therefore, periods and micro cycles were restructured without the contents of exercise physiology and biochemistry.

Despite these limitations of periodizations during the empirical period, the Soviet researcher Ozolin elaborated in 1949 a pioneer periodization for athletics (Gomes, 2009; Marques Junior, 2020). Ozolin created the 1st schematic drawing for a type of periodization. In Ozolin's drawing, there is an undulation between



volume (dashed line) and intensity (dotted line), and a solid line of the athletic form that is the peak of the sports form (Bompa, 2002). Ozolin's schematic drawing is similar to Matveev's schematic drawing, perhaps this occurred because Ozolin was Matveev's teacher at the university (Marques Junior, 2024b). Figure 4 presents Ozolin's schematic drawing.

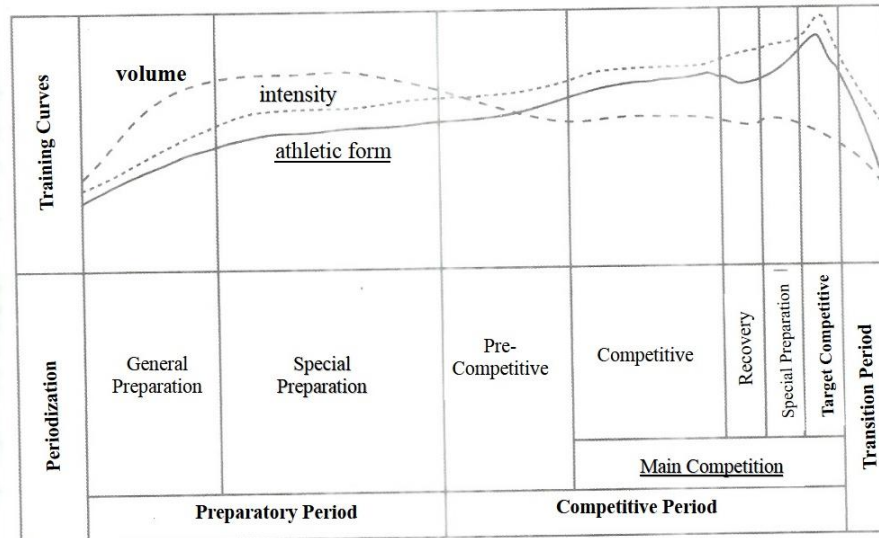


Figure 4. Ozolin's schematic drawing with undulation between volume and intensity (Adapted from Bompa, 2002).

3.3 Scientific Period

During (1939 to 1945) and after the 2nd World War, exercise physiology and biochemistry achieved significant evolution, and researchers studied military training (Tipton and Folk, 2014). The researcher studied the military in the heat, cold, and fatigue of combat actions (Folk, 2010). These studies on physiological and biochemical responses had the objective of better military preparation (Wilmore and Costill, 2001). In the years 60 and 70, exercise physiology and biochemistry had significant progress because technological advances occurred in the instruments used to collect data (Marques Junior, 2025c). These events of exercise physiology and biochemistry also influenced sports. For example, in 1952, the West German athletics coach Gerschler with the West German physiologist Reindell determined based on studies of exercise physiology that interval training needs to be practiced with distances of 100 and 200 meters, a maximum of 100 repetitions, and with walking and/or jogging during the active rest of 1 minute (Hegedus, 1985; Tubino and Moreira, 2003). These researchers detected that the active rest of 1 minute caused a decreased heart rate, improved cardiac performance, and the athlete had a faster recovery from effort (Cobley, 2011; Ramos, 1967).



Sport biochemistry in the Soviet Union began in 1927. In 1950 Yampolskaya detected that the recovery depends on the type of exercise, intensity, and volume of this training for the athlete has a short or long recovery, which can result in super-compensation (Yakovlev, 1975). Therefore, the type of training (aerobics, velocity, and other) has different recovery times (heterochronism of recovery), then the coach needs to structure the training load based on the recovery time. For example, the plyometric training has 48 hours of recovery after the training (Villar, 1987). Then, in a week, the coach prescribes for the athletes on Monday the plyometric training, this training high load for the lower limbs, on Tuesday and Wednesday the athletes practiced the aerobic running recovery training. Undulation training load occurred during these three days of training, and the athlete achieved the recovery of the plyometric training (48 hours is equal to 2 days of recovery). Therefore, recovery time is important content for the coach to structure the undulation training load (Matveev, 1991).

In the period from 1949 to 1959, the Russian biochemist Nikolay Yakovlev, in the time of Soviet Union, discovered the super-compensation of muscle with the increase of glycogen and phosphocreatine during post-exercise recovery and with training (Viru, 2002). The evolution of exercise physiology and biochemistry in the Soviet Union (Yakovlev, 1975), and the recommendations of Soviets Letunov in 1950 and Prokop in 1959 that the coach needed to structure the micro cycle based on exercise physiology and biochemistry influenced Lev Matveev (Verkhoshanski, 1999). Lev Pavilovch Matveev had access in the year 50 to Yakovlev's studies on super-compensation, and he used the super-compensation to understand the chronic adaptation of training that caused the peak of the sports form (Dantas, 1995; Marques Junior, 2024b). This initiative of Matveev caused the elaboration of micro cycle structured based on exercise physiology and biochemistry (Tschien, 1985, 2000). Therefore, the micro cycle in the years 50 and 60 were structured with a scientific basis (Marques Junior, 2023c; Zakharov, 1992) with the objective of the athletes achieving the peak of the sports form (Api and Arruda, 2022; Marques Junior, 2024f).

From 1950 to 1977 the scientific stage of periodization occurred, the moment that the sports researchers created the traditional periodizations that were structured based on biological adaptation and all the conceptions had the objective of the chronic adaptation of the super-compensation that was the peak of the sports form (Costa, 2022; Manso et al., 1996; Naglak, 1979). During the scientific period, only the Soviet bloc countries developed a type of traditional periodization – a total of 5, an of the reasons for this was that in the Soviet Union, the theme of sportive periodization was a line of research at universities (Marques Junior, 2020; Nádori, 1989). In 1961, the Soviet Union founded the Soviet Central Planning for all Soviet Bloc for sportive periodization studies (Stone et al., 2021). Until 1964, periodization was only known in the Soviet Bloc, when Matveev defended his doctoral thesis about traditional periodization (Marques Junior, 2023e).



In 1965, Matveev's thesis was published as a book in Moscow, then the East Germany. Peter Tschiene translated Matveev's book in 1968 into German language and sent some books to West Germany (Krüger, 1974). In the United States of America (USA), periodization began to be known in 1966 with the translation of the periodized training of the Soviet Brumel, who was a high jump champion (Freeman, 1989). Periodization became officially known by coaches in the USA and in Western Europe in the 70s and 80s (Freeman, 1989). At the 1972 Olympic Games, West Germany used Matveev's periodization to prepare the athletes for this competition (Manso and Suárez, 2021). Most Soviet bloc countries used Matveev's periodization in athletics for the 1972 Olympic Games in Munich, West Germany (Krüger, 1973).

The sessions of the traditional periodizations have the objective of the super-compensation, moment that occurs training stimulus, and recovery training, the undulation training load is more adequate in this situation (Matveev, 1991). For example, in a micro cycle occurred three sessions that caused fatigue in the athlete, and after two days of rest, the athlete achieved super-compensation (Matveev, 1997). The second micro cycle had a higher load than the first micro cycle because of the super-compensation and had three sessions that caused fatigue in the athlete, and after two days of rest, the athlete achieved other super-compensation. The third micro cycle was with a higher load than the second micro cycle because of the second super-compensation, this cycle was equal to the second micro cycle. The super-compensation is detected in competition or by control tests (Marques Junior, 2022a). The three micro cycles were structured with 3 days of stimulus and 2 days of recovery, the structure was of 3:2 + 3:2 + 3:2. Figure 5 presented the undulation training load of each micro cycle with the effect of the super-compensation.

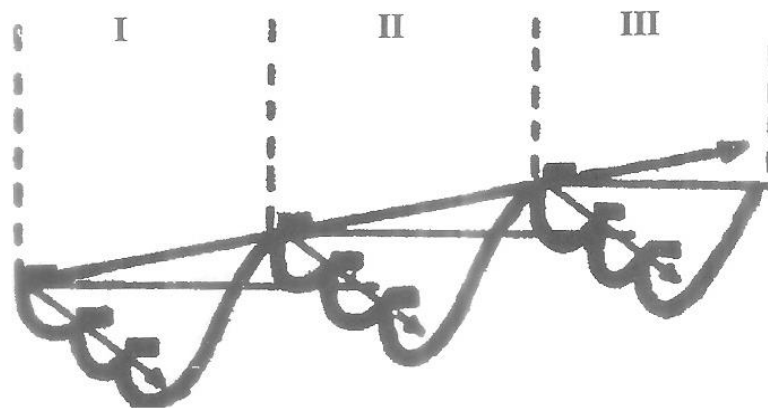


Figure 5. I is the first micro cycle, the black rectangle is the load of each session, and the ascending line is the recovery of the athlete which resulted in the super-compensation. II is the second micro cycle, and III is the third micro cycle, both had the same content as the first microcycle (Extracted from Matveev, 1997).



In the scientific period, the Russian Matveev elaborated his traditional periodization in the years 40 and 50, in 1952 the Soviet Union applied Matveev's periodization to prepare the Soviet athletes for the 1952 Olympics (Marques Junior, 2024b). Matveev structured his periodization with a diluted load, in this type of load the athlete practices the exercise with several motor capacities (aerobic, strength, technical and tactical, and others) in a same training. Undulation training load in this periodization occurs with the volume and intensity, at a certain moment the volume is greater, and at another is the intensity (Matveev, 1991). This usually occurs according to the period (preparatory, competitive, and transition). In 1962, the Hungarian László Nádori developed a traditional periodization adapted of Matveev's periodization (Nádori, 1989). Nádori's periodization the athlete participates in many competitions in all periods (foundation, pre-season, competition, and transition), this is achieved with an undulation of volume and intensity. Figure 6 presents the schematic drawing of Nádori's traditional periodization with the undulation training load.

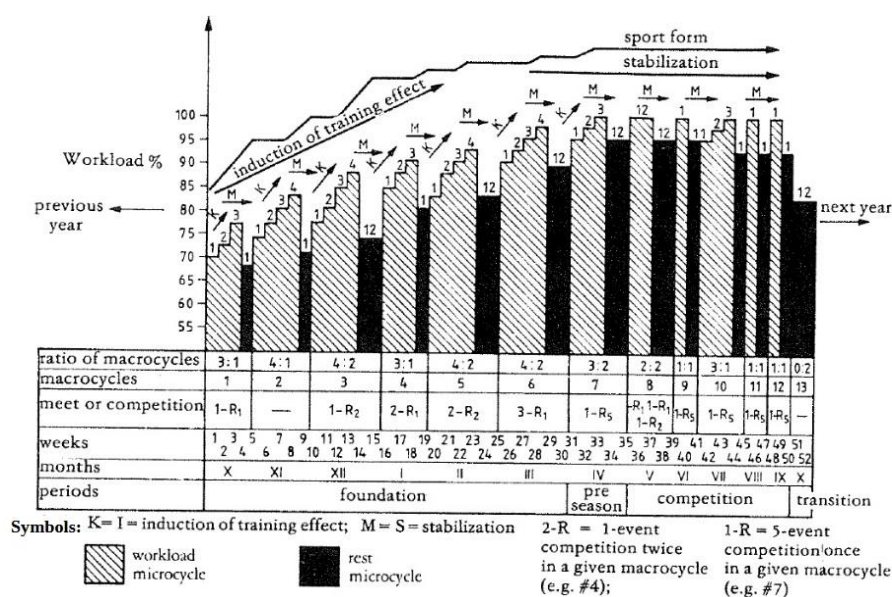


Figure 6. Undulation training load of Nádori's traditional periodization (Extracted from Nádori, 1989).

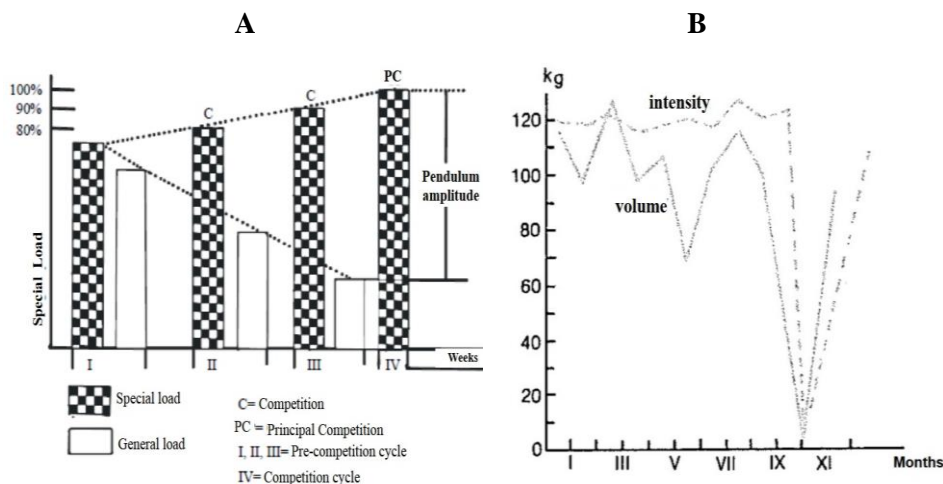
The third traditional periodization was elaborated in 1971 by Russians Arosiev and Kalinin, the pendular periodization of Arosiev and Kalinin the training is practiced with alternation between the general load, and special load, but the special load gradually increases during the year (Marques Junior, 2020). Undulation training load occurs during this alternation between the general load and special load. From 1971 to 1977, the Russian Arkady Vorobiev developed high load system periodization for weightlifting, the training is in small undulation



between volume and intensity, but at certain moments the coach prescribes the “load jump” to avoid stagnation of the athlete (Coronado, 2004; Tschiené, 1985). During this small undulation between volume and intensity, the volume is less than the intensity, but in the “load jump”, the intensity remains greater than the volume (Coronado, 2004; Tschiené, 1985).

Peter Tschiené developed in 1977 the periodization of the structural scheme of high-intensity loads based on his training experience and the results of the Soviet Union studies of sportive periodization (Tschiené, 1985). These ideas of Tschiené elaborate a periodization that occurred when this researcher lived in East Germany, later he went to live in West Germany (Tschiené, 1985). This conception has a high intensification regular load with a minimum load of 80%, the difference between volume and intensity is 20% (Marques Junior, 2024c). Then, the undulation training load between volume and intensity is with a load of 80% and 100%. This high intensity of the training is in most sessions, but when necessary the athlete practices the prophylactic interval which is the recovery training (Costa, 2022). Another activity that increases the intensity of the Tschiené's periodization is the participation of the athlete in many competitions (Tschiené, 1985). Perhaps, this idea of Tschiené of the athlete participating in many competitions was based on Nádori's periodization.

Therefore, undulation training load is essential for the athlete to achieve high performance, this was evidenced at the 1976 Olympics (Rocha, 1976). The swimming and athletics coaches that structured better the traditional periodization with training stimulus and recovery training (the undulation training load) for the athletes, the competitors achieved the peak of the sports form at the 1976 Olympic Games. Figure 7 presents the schematic drawing of some traditional periodizations with the undulation training load.



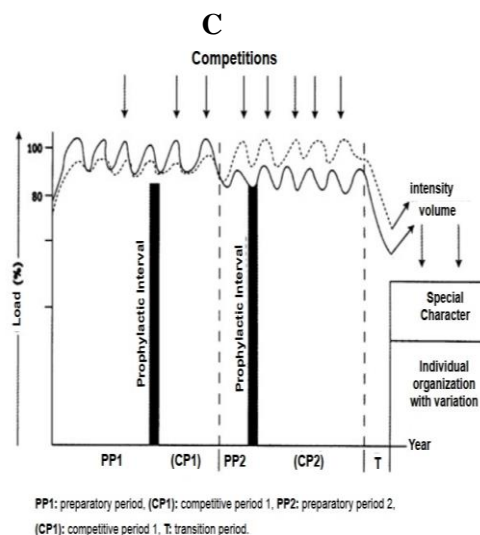


Figure 7. Undulation training load of some traditional periodizations: (A) Arosiev and Kalinin, (B) Vorobiev's "load jump", and (C) Tschien (Extracted from Marques Junior, 2020; Tschien, 1985).

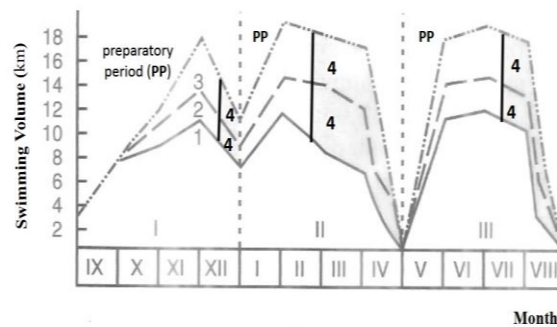
In the year 80, the traditional periodization was used at the Mishold Old swimming training center located in the United States of America (Platonov, 2004). The periodization was composed of 3 macro cycles with different swimming volumes in kilometers (km): macro cycle I was from September to December, macro cycle II was from January to April, and macro cycle III was from May to August. Figure 8A the solid line with number 1 of swimming volume in km was of sprinter, the dashed line with number 2 of swimming volume in km was of middle distance swimmers, and the dotted line with number 3 of swimming volume in km was of long-distance swimmers (Platonov, 2004). The preparatory period and competitive period with number 4 occurred volume undulation for the swimmers to endure the stress (physical, technical, tactical, and others) of the season. The swimming volume in km was greater in the preparatory period than in the competitive period. In all periods (preparatory and competitive), the greatest swimming volume in km was from long-distance swimmers, in second place was swimming volume in km from middle-distance swimmers, and in last in swimming volume in km was from sprinters – see Figure 8A.

Figure 8B presents Matveev's traditional periodization practiced by Canadian swimmer Alex Baumann with a volume undulation in 1981 and 1982 (Platonov, 2004). Baumann practiced the macro cycle I from September 1981 to February 1982. The preparatory period had two phases in 1981: general preparation in September and October, and special preparation in November and December. In January and February 1982, the competitive period occurred (see the arrows), and



in the week of February, Alex Baumann practiced the transition period. The macro cycle II was from March to August 1982. In March, the swimmer practiced two weeks of preparatory period of general preparation, and from April to June (3 months) Baumann practiced the preparatory period of special preparation (Platonov, 2004). In July and August, the competitive period occurred (see the arrows), Baumann competed in the World Championship in the 200 and 400 meters (m) medley, but he suffered an injury and had to abandon the competition. In 1982, from September 30 to October 9, Alex Bauman competed in the Commonwealth Games, he won the gold medal in the 200 and 400 m medley. Baumann in the 200 m medley reduced his world record with 2 minutes 2 seconds and 25 hundredths. However, this result of Baumann in the Commonwealth Games is not in Figure 8B, but this traditional periodization that Alex Baumann practiced from 1981 to 1982 prepared this swimmer for the world record at the Commonwealth Games. Figure 8B has the following contents of the volume: 1) the solid line with the number 1 is the volume, 2) the dashed line with the number 2 is the total volume, 3) the white bar is the swimming volume, and 3) the black bar is the strength training volume.

A



B

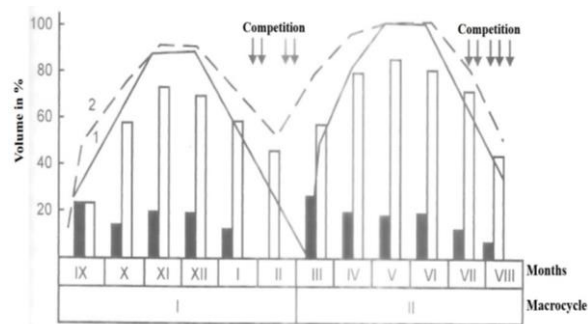


Figure 8. Volume undulation of two swimming periodizations: (A) Mishhold Old, and (B) Alex Baumann (Extracted from Platonov, 2004).



At the 1982 World Championship, Baumann was injured, but the Brazilian Ricardo Prado was the world champion and broke the world record with 4 minutes 19 seconds and 78 hundredths in the 400 m medley event (Marques Junior, 2017b). In 1981, the Prado's coach practiced "load jump" when Ricardo Prado was 16 years old, the swimming volume was 2110 km to 3272 km (Zakharov, 1992). The "load jump" is dangerous because the training load increases very quick and the athlete has a high probability of injury (Matveev, 1991). However, Prado in 1981 had a time in the 400 m medley of 4 minutes 38,8 seconds, but with the "load jump" he achieved in 1981 the second fastest time in the world with 4 minutes 22 seconds and 06 hundredths (Marques Junior, 2017b). Perhaps the cumulative effect of the training load in 1981 (Marques Junior, 2024f) resulted in Ricardo Prado in the world title in 1982 and the silver medal at the 1984 Olympic Games with 4 minutes 18 seconds and 45 hundredths in the 400 m medley event (Marques Junior, 2017b). The Olympic champion in the 400 m medley at the 1984 Olympics was Alex Baumann with 4 minutes 17 seconds and 41 hundredths which was a world record.

Athletics coaches used the undulation training load with the traditional periodization (Moura et al., 2023). For example, in the year 60, the West German triple jump coach applied the traditional periodization in athletes with undulation training load (Kleinen, 1964). The preparatory period of special preparation the West Germany's triple jumpers practiced in the winter in that country. The undulation of types of training occurred during the special preparation, as the coach presented in Figure 9 (Kleinen, 1964).

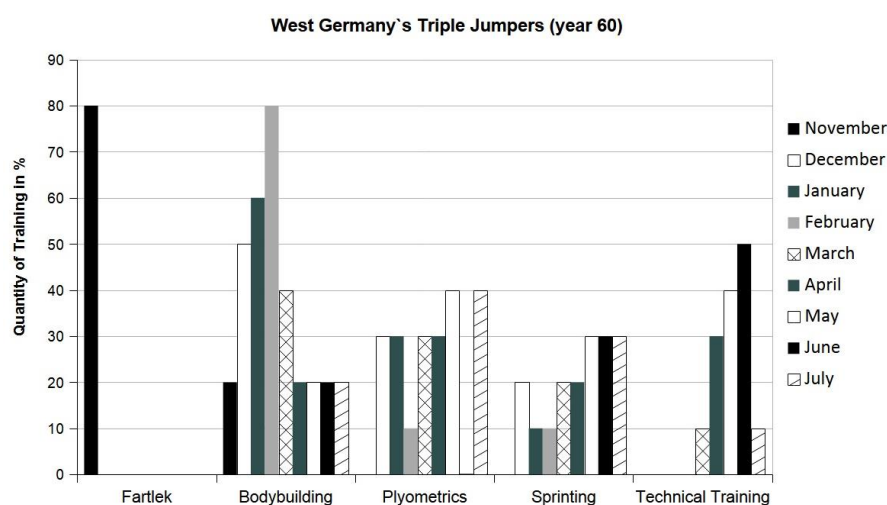
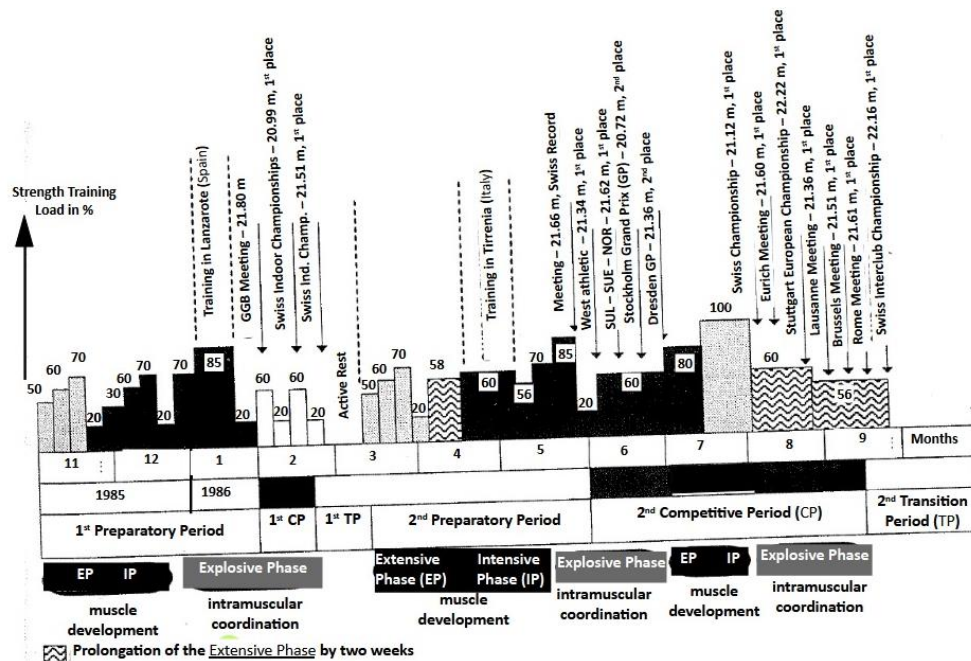


Figure 9. Undulation of types of training of training for the triple jumpers (Extracted from Kleinen, 1964).



The Swiss shot putter Werner Günthor practiced a traditional periodization in 1985 and 1986 with an emphasis on the strength training, the Figure 10 presented strength training load in percentage (%) (Egger, 1993). The periodized training was structured with an undulation training load. The reader can see this athlete training with traditional periodization at: <https://www.youtube.com/watch?v=d4e5cuyqjqw&list=PL4EFEAD938291B69A>, <https://www.youtube.com/watch?v=zJImRx3rpW0&list=PL4EFEAD938291B69A&index=2>, <https://www.youtube.com/watch?v=YqFP9gySw34&list=PL4EFEAD938291B69A&index=3>, https://www.youtube.com/watch?v=frFVhwIy_PU&list=PL4EFEAD938291B69A&index=4.





athlete in maximum conditions and the competitive regularity is necessary to develop the athlete in optimal conditions. Figure 11 presents the peak and competitive regularity of the vertical jump in two sports (Bosco, 1986).

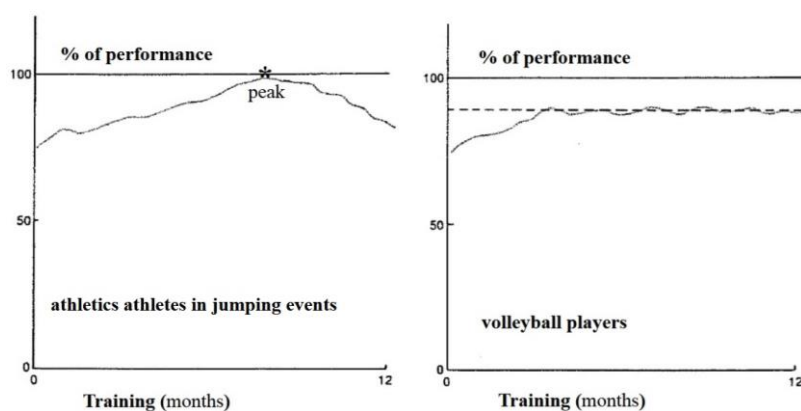


Figure 11. Vertical jumps of the athletics athletes in jumping events achieved the peak, and vertical jumps of the volleyball players achieved competitive regularity (Extracted from Bosco, 1986).

The first contemporary periodization of the modern period was created by Russian Verkhoshanski, the 1st publication of this periodization was in 1979 (Marques Junior, 2023c). Block periodization that was developed by Verkhoshanski had a new content of the sportive training, the concentrated strength load of block A which causes significant fatigue, moment that the motor capacity (strength, velocity, and other) declines and the same occurs in the technique and tactics (Verkhoshanski, 1979). Block B the training is of explosive strength, the moment when the stress of the training load decreases the motor capacity, and technique and tactics begin to improve. In block C occurs chronic adaptation of the super-compensation during the competition, this is the peak, but is called in this periodization of lasting training posterior effect (Verkhoshanski and Verkhoshanski, 2004). Verkhoshanski recommended the undulation training load during the block periodization because the high load of this conception can cause injury and/or overtraining in the athlete (Verkhoshanski, 1979). Undulation training load occurs with the decrease of the training load of blocks A and B and with the use of the recovery microblock – see Figure 12. Therefore, modern period the undulation training load continued in Verkhoshanski's block periodization and this was practiced in other periodizations of this period.

Specific periodization for volleyball is a concept developed in 2011, 2014, 2017 to 2022 with 12 articles by Brazilian Marques Junior for volleyball on the court, sand, grass, and snow (Marques Junior, 2021b, 2022c). The ball training in this conception has a content new, based on the volleyball skill effort by heart rate



and volleyball skill injury the coach determines the training load subjectively before of the athlete practices the technical training and the game situation training (Marques Junior, 2022c). But the game training the coach cannot measure the load subjectively because of the complexity of this task. Marques Junior (2020b) elaborated on the ball training classification (high, medium, and low) based on the effort and injury of the volleyball skill for the coach to structure the ball training (technical and game situation). Ball training is structured based on the objective of the session and with the ball training classification. Then, the undulation training load occurs during the ball training when the coach determines which volleyball skills will be practiced in the session, which can be high, medium, and low (ball training classification) – see Figure 12.

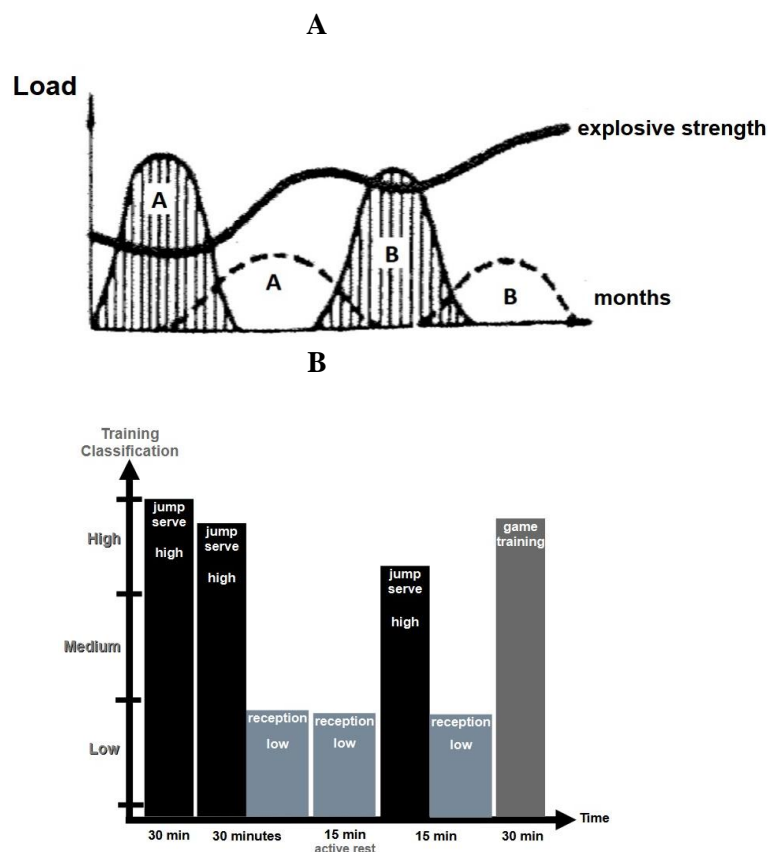


Figure 12. (A) Undulation training load of blocks A and B, in block A the training load decreases and the explosive strength increases, and the same occurred in block B (Extracted from Verkhoshanski, 1979). (B) Undulation training load was structured by the coach before of the technical training and the game situation training based on the ball training classification and with the game training (Adapted from Marques Junior, 2020b).



The coach continued to elaborate in the modern period the contemporary periodization with undulation training load (Kozhedub et al., 2022; Moura et al., 2023). For example, the Brazilian beach volleyball double Zé Marco and Emanuel that was world champion in 1996 and 1997, the coach prescribed undulation training load with the use of three types of periodizations, the ATR block periodization, block periodization, and Tschienie`s traditional periodization (Silva et al., 1998).

The Russian swimmer Vladimir Salnikov during the Soviet Union, was the champion in the 400, 800, and 1500 m crawl swimming events (Marques Junior, 2022b). Salnikov was the Olympic champion in 1980 and 1988, he was the first swimmer to swim 1500 m in less than 15 minutes, with 14 minutes 58 seconds and 27 hundredths. This success of Salnikov was achieved with a type of block periodization because during 10 weeks occurred a concentrated load in each meso cycle (total of 5 mesocycle) that had 2 micro cycles in each meso cycle (Platonov, 2004; Zatsiorsky, 1999). This block periodization was developed by Soviet coach Igor Koshkin. The name of the meso cycles were related to the type of concentrated load, the meso cycles were as follows: 1st) velocity and technique meso cycle occurred in the preparatory period, 2nd) strength and power meso cycle occurred in the preparatory period, 3rd) aerobic endurance meso cycle occurred in the preparatory period with greater intensity, and 4th) super-compensation meso cycle occurred in the pre-competitive period, this period had the objective of preparing the swimmer for the target competition, the super-compensation meso cycle had the objective to recover the swimmer from training fatigue and perform maintenance physical preparation, technique, and tactics (Maglischo, 1999; Platonov, 2004; Zatsiorsky, 1999). The last meso cycle occurred in the competitive period and Salnikov swam the target competition, the name of this meso cycle was the rest and competition meso cycle (Maglischo, 1999; Platonov, 2004). After the rest and competition meso cycle, Vladimir Salnikov practiced a transition period of two weeks (Platonov, 2004). Figure 13 presents the undulation training load of each meso cycle practiced by Salnikov.

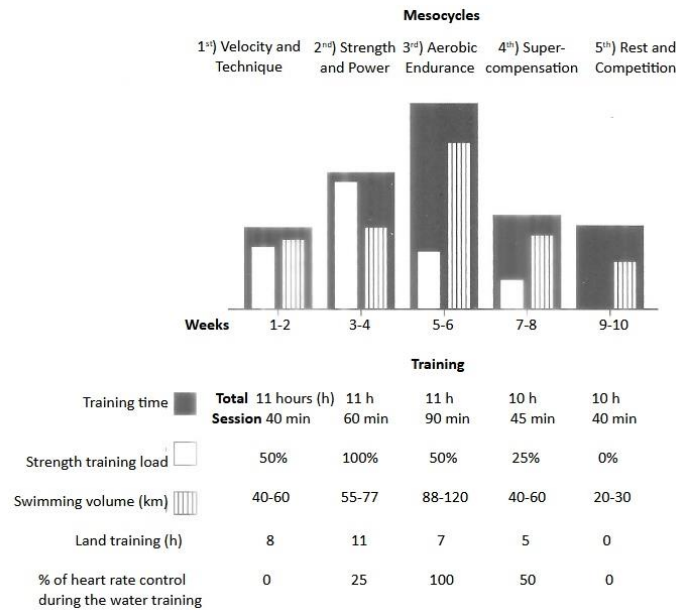


Figure 13. Undulation training load of block periodization practiced by swimmer Vladimir Salnikov (Adapted from Zatsiorsky, 1999).

4. Conclusions

Undulation training load was used in most of the periodizations for the athletes to endure the training load with a structure of training with a stimulus that causes fatigue, but to avoid injury and/or overtraining, the coach needs to prescribe recovery training to occur new training stimuli. The objective of prescribing the undulation training load is for the athlete to achieve the peak and/or competitive regularity in the competition. Undulation training load is more organized when the coach knows how to structure the microcycle and knows the recovery time of each motor capacity. This load occurs more frequently when the athlete participates in many competitions for the athlete to endure the season. In conclusion, an undulation training load is a necessity for high-performance sports.

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References

1. Api, G., Arruda, D. (2022). Comparison of periodization models: a critical review with practical applications. *Journal of Applied Sports Sciences* 2(-): 77-105.
2. Bompa, T. (2002). *Periodização: teoria e metodologia do treinamento*. 4ª ed. São Paulo: Phorte.
3. Bondarchuk, A. (2016). *Soviet sport methods: a detailed book inside the world's greatest system*. Michigan: UAC.
4. Borzov, V. (2019). *Il grande sprint: tra sogno e realtà*. Roma: Scuola dello Sport.
5. Bosco C. (1986). L'allenamento della forza nella pallavolo. *Scuola dello Sport* (-): 18-22.
6. Cobley, J. (2011). Coach profile: Woldemar Gerschler. *Pacing Past*. https://www.racingpast.ca/john_contents.php?id=129
7. Coronado, A. (2004). *Estructura de la planificación del entrenamiento de fuerza en prueba de fuerza-velocidad*. Madrid: INEF.
8. Costa, I. (2022). *Preparación física para el fitness y el deporte de rendimiento: una mirada revisionista*. Mar del Plata: Universidad FASTA.
9. Dantas, E. (1995). *A prática da preparação física*. 3ª ed. Rio de Janeiro: Shape.
10. Egger, J. (1993). La forza ed il suo utilizzo nell'atletica. *Nuova Atletica* - (124): 15-24.
11. Freeman, W. (1989). *Peak when it counts: periodization for American track and field*. California: Tafnews Press.
12. Folk, G. (2010). The Harvard Fatigue Laboratory: contributions to World War II. *Advances in Physiological Education* 34(3): 119-127.
13. Gomes, A. (1995). Sistema de estruturação do ciclo anual de treinamento. *Revista da APEF Londrina* 10(18): 77-84.
14. Gomes, A. (2009). *Treinamento desportivo – estruturação e periodização*. Porto Alegre: Artmed.
15. Graham, J. (2002). Periodization research and an example application. *National Strength and Conditioning Association* 24(6): 62-70.
16. Havinga, J., Green, A., & Swanepoel, C. (2025). Workload monitoring of throwing sport athletes. *Journal of Coaching and Sports Science* 4(1): 41-51.
17. Hegedus, J. (1985). *La ciencia del entrenamiento deportivo*. Buenos Aires: Stadium.
18. Kleinen, H. (1964). El entrenamiento en invierno para acondicionar al atleta de triple salto. *Técnica Atlética* -(47): 17-20.
19. Kozhedub, M., Godun, D., & Vrublevsky, E. (2022). Construction of the annual macrocycle of short-distance runners at the stage in-depth specialization. *Theory and Practice of Physical Culture* -(6): 18-21.



20. Krüger, A. (1973). Periodisierung und selektion der leichtathleten im Olympiajahr. *Leistungssport* (-): 91-99.
21. Krüger, A. (1974). Esperienze di periodizzazione nell'anno olimpico. *Nuova Atletica* (-): 25-28.
22. Maglisco, E. (1999). *Nadando ainda mais rápido*. São Paulo: Manole.
23. Manso, J., Valdivielso, M., & Caballero, J. (1996). *Planificación del entrenamiento deportivo*. Madrid: Gymnos.
24. Manso, J., Suárez, N. (2021). *Periodización deportiva. Por que algunos aún seguíndo entrenando como Neadertales?* Armenia: Kinesis.
25. Marques Junior, N. (2017). A revolução russa e o desenvolvimento da periodização esportiva na União Soviética. *Revista Inclusiones* 4(esp.): 110-127.
26. Marques Junior, N. (2017b). Carga de treino do esporte de alto rendimento: revisitando o conteúdo. *Revista Europa del Este Unida* -(3): 42-74.
27. Marques Junior, N. (2019). Benefícios da revolução russa. *Germinal* 11(1): 210-221.
28. Marques Junior, N. (2020). Breve história sobre a evolução da periodização esportiva. *Revista Edu-física.com: Ciencias Aplicadas al Deporte* 12(25): 33-50.
29. Marques Junior N. (2020b). Specific periodization for the volleyball: the importance of the residual training effects. *MOJ Sports Medicine* 4(1): 4-11.
30. Marques Junior, N. (2021). Periodização da antiguidade: o treino dos gladiadores. *Revista Edu-física.com: Ciencias Aplicadas al Deporte* 13(28): 139-146.
31. Marques Junior, N. (2021b). História da elaboração da periodização específica para o voleibol: estruturação da carga do treino com bola. *Revista Peruana de Ciencias de la Actividad Física y del Deporte* 8(1): 1090-1108.
32. Marques Junior, N. (2022a). Periodização para o esporte contemporâneo. *Revista de Investigación Cuerpo, Cultura y Movimiento* 12(2): 1-32.
33. Marques Junior, N. (2022b). O esporte na antiga União Soviética – parte 2. *Revista Edu-física.com: Ciencias Aplicadas al Deporte* 14(29): 80-101.
34. Marques Junior, N. (2022c). Periodização específica para o voleibol: estruturação da carga do treino com bola. *DeporVida* 19(53): 97-113.
35. Marques Junior, N. (2023a). Periodization in antiquity: the Chinese military training. *Marathon* 15(2): 50-60.
36. Marques Junior, N. (2023b). Análise da síndrome de adaptação geral no entendimento da carga de treino de Matveev. *Lecturas: Educación Física y Deportes* 28(305): 114-129.
37. Marques Junior, N. (2023c). Carga de treino do microciclo da periodização esportiva. *Revista Investigación Cuerpo, Cultura y Movimiento* 13(1): 1-32.
38. Marques Junior, N. (2023d). Periodização de microestrutura: o treino cognitivo. *Olimpia* 20(3): 208-227.



39. Marques Junior, N. (2023e). Lev Pavilovch Matveev: a contribuição da carga de treino para a periodização esportiva. *Olimpia* 20(3): 154-170.
40. Marques Junior, N. (2024a). Structuring of the periodization in antiquity: the Roman military training. *Tanjungpura Journal of Coaching Research* 2(1): 1-12.
41. Marques Junior, N. (2024b). Matveev`s sportive periodization: micro cycle concept. *Marathon* 16(2): 115-136.
42. Marques Junior, N. (2024c). Esporte da Alemanha Oriental – parte 2. *Olimpia* 21(2): 72-86.
43. Marques Junior, N. (2024d). Periodização de cargas seletivas aplicada no voleibol. *DeporVida* 21(61): 109-127.
44. Marques Junior, N. (2024e). Carga de treino do esporte. *Revista Edu-fisica.com: Ciencias Aplicadas al Deporte* 16(34): 41-61.
45. Marques Junior, N. (2024f). Periodização esportiva com pico de desempenho. Uma revisão sistemática. *Lecturas: Educación Física y Deportes* 29(312): 172-203.
46. Marques Junior, N. (2025a). Romênia: formação da nação e período soviético. *Revista Edu-fisica.com: Ciencias Aplicadas al Deporte* 17(35): 1-23.
47. Marques Junior, N. (2025b). Ensino do cálculo da carga de treino com Excel: uma revisão narrativa. *Revista Edu-fisica.com: Ciencias Aplicadas al Deporte* 17(35): 159-182.
48. Marques Junior, N. (2025c). History of the plyometric training: a review in sport. *Tanjungpura Journal of Coaching Research* 3(1): 14-31.
49. Matveev, L. (1991). *Fundamentos do treino desportivo*. 2ª ed. Lisboa: Horizonte.
50. Matveev, L. (1997). *Treino desportivo: metodologia e planeamento*. Guarulhos: Phorte.
51. Montero, A. (2020). Sports training in Ancient Greece and its supposed modernity. *Journal of Human Sport and Exercise* 15(1): 163-176.
52. Moura, N., Han, P., Moura, L., Wang, G., & Yuan, T. (2023). Selected factors for triple jump preparation: a case study of an Olympic silver medalist. *International Journal of Sport Scinece and Coaching* 18(3): 1-13.
53. Naglak, Z. (1979). *Entrenamiento deportivo – teoría y práctica*. Barcelona: INEF.
54. Nádori, L. (1989). Theoretical and methodological basis of training planning. In. T. Hortobágyi (Ed.). *Theoretical and methodological basis of training planning with special considerations within a microcycle* (p. 1-25). Lincoln: NSCA.
55. Nett, T. (1954). *Das training des kurz-, mittel-und langstreckenläufers*. Berlin: Verlag.
56. Oliveira, P. (2008). *Periodização contemporânea do treinamento desportivo*. São Paulo: Phorte.



57. Oliver, A. (2008a). Emil Zatopek y el entrenamiento de fondo (1942-1956). *La evolución del entrenamiento de la resistencia – parte I* (p. 141-152). Madrid: Federacion Española de Atletismo.
58. Oliver, A. (2008b). La escuela húngara (1948-1956): Mihaly Igloi y los corredores húngaros y americanos. *La evolución del entrenamiento de la resistencia – parte I* (p. 249-259). Madrid: Federacion Española de Atletismo.
59. Osorio, E., López, J., Guzmán, A., Fernández, L., Raigoza, J., Virgen, J. (2024). Aplicación del modelo ATR, una mirada reflexiva. *Ciencia & Deporte* 9(13): 42-49.
60. Ozolin, N. (1987). Esercizi di condizionamento. *Nueva Atletica* (-):37-41.
61. Padilla, J. (2017). *Planificación del entrenamiento deportivo: un enfoque metodológico de la estructura clásica*. Barinas: Episteme.
62. Platonov, V. (2004). *Teoria geral do treinamento desportivo olímpico*. Porto Alegre: Artmed.
63. Ramos, J. (1967). O interval training segundo Gerschler e Reindel. *Revista de Educação Física* 36(1): 13-21.
64. Rocha P. (1976). O “peak” e o período de competição. *Revista de Educação Física* 45(1): 71-73.
65. Silva, F. (2000). Planejamento e periodização do treinamento desportivo: mudanças e perspectivas. *Revista Brasileira de Fisiologia do Exercício* 1(1): 29-47.
66. Silva, F., Araújo, R., & Batista, G. (1998). Voleibol de praia: o treinamento de uma dupla bicampeã mundial. *Revista Treinamento Desportivo* 3(3): 17-26.
67. Stocking, C. (2016). The use and abuse of training “science” in Philostratus Gymnasticus. *Classical Antiquity* 35(1): 86-125.
68. Stone, M., Hornsby, W., Haff, G., Fry, A., Suarez, D., Liu, J., Ravé, J., & Pierce, K. (2021). Periodization and block periodization in sports. *Journal of Strength and Conditioning Research* 35(8):2351-2371.
69. Tipton, C., Folk, G. (2014). Contributions from the Harvard Fatigue Laboratory. In: C. Tipton (Ed.). *History of exercise physiology* (p. 41-58). Champaign: Human Kinetics.
70. Tschienne, P. (1985). Il ciclo annuale d’allenamento. *Scuola dello Sport* -(2): 14-21.
71. Tschienne, P. (2000). Il nuovo orientamento delle strutture dell’allenamento. *Scuola dello Sport* 19(47-48): 13-20.
72. Tubino, M. (1993). *Metodologia científica do treinamento desportivo*. 11ª ed. São Paulo: Ibrasa.
73. Tubino, M., Moreira, S. (2003). *Metodologia científica do treinamento desportivo*. 13ª ed. Rio de Janeiro: Shape.
74. Verkhoshanski, Y. (1979). Allenamento specifico per la potenza. *Nuova Atletica* (-): 32-33.
75. Verkhoshanski, Y. (1996). Problemas atuais da metodologia do treino desportivo. *Revista Treinamento Desportivo* 1(1): 3-45.



76. Verkhoshanski, Y. (1999). The end of “periodisation” of training in top-class sport. *NSA* 14(1): 47-55.
77. Verkhoshanski, Y. (2001). *Treinamento desportivo: teoria e metodologia*. Porto Alegre: Artmed.
78. Verkhoshanski Y, Verkhoshanski N. (2004). Supercompensazione: mito o realtà? *Scuola dello Sport* 23(62-63): 13-22.
79. Villar, C. (1987). *La preparación física del fútbol basada en el atletismo*. 3ª ed. Madrid: Gymnos.
80. Viru, A. (2002). Early contributions of Russian stress and exercise physiologists. *Journal of Applied Physiology* 92(4): 1378-1382.
81. Wilmore, J., Costill, D. (2001). *Fisiologia do esporte e do exercício*. 2ª ed. São Paulo: Manole.
82. Yakovlev, N. (1975). Biochemistry of sport in the Soviet Union. *Medicine and Science in Sports* 7(4): 237-247.
83. Zakharov, A. (1992). *Ciência do treinamento desportivo*. Rio de Janeiro: GPS.
84. Zatsiorsky, V. (1999). *Ciência e prática do treinamento de força*. São Paulo: Phorte.