

TRAINING THROUGH TACTICAL PERIODIZATION, AN IMPORTANT BENCHMARK FOR DEVELOPING THE SPECIFIC ENDURANCE OF JUNIOR FOOTBALL PLAYERS

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Abstract: The current paper presents aspects related to several programs used for developing specific endurance, taking as a reference the tactical periodization training model. This framework is considered a modern method in football which directly influences both individual and collective performance.

Material and methods. The aim of this research is to develop specific endurance in order to increase 17–18-year-old football players' aerobic capacity and power, which leads to a high level of performance throughout the entire match. Among modern methods for developing specific endurance are themed games, intermittent exercises, integrated circuits, "large-sided games" (LSG) training and "small-sided games" (SSG) training, which combine physical effort with technical and tactical elements. Monitoring intensity through parameters such as heart rate, distance covered, and movement speed allows the coach to adjust the training volume and intensity for each player. The development program aims to adapt players' bodies to the complex demands of the game, characterized by rapid alternations between high-intensity efforts and short recovery periods. In training, specific endurance is not limited to general aerobic capacity but also involves anaerobic components, motor coordination, and the ability to repeatedly perform sprints, changes of direction, and high-intensity duels. Moreover, recovery periods, nutrition, and sleep play a crucial role in optimizing physiological adaptations.

Results. The paper presents the players' results in the Yo-Yo endurance test, showing significant differences, as the result of using specially designed program, ($p < 0.001$).

In conclusion, through scientific and individualized planning, higher game efficiency and sustainable improvement in sports performance can be achieved, whereas the risk of fatigue and technical-tactical errors can be reduced.

Keywords: tactical periodization, football, endurance, juniors.

Introduction

The current paper presents aspects related to several programs used for developing specific endurance, taking as a reference the tactical periodization training model. This framework is considered a modern method in football which directly influences both individual and collective performance. Specific endurance in football is represented by the player's ability to sustain physical and tactical effort in varied conditions throughout a match, involving aerobic and anaerobic components, as well as rapid decision-making in real game situations.

Zaharia, G. et al. (2023) show that SSGs, also called conditioning games, are the most important in specific training based on the game model. The authors note that the research contributed to highlighting the positive impact of implementing a 8 weeks' experimental training program developed twice a week during the preparatory period. The results showed a significant progress in VO₂max., which determined a significant increase in specific running speed.

Arslanoglu et al. (2024), bring to attention that combined training of maximal aerobic speed and games with small teams, as well as only training for maximal aerobic speed, was an effective method for improving the aerobic capacity of football players. The authors' findings were that the distance covered in the Yoyo test improved significantly. The results showed that the use of LSG and SSG games improved VO₂max. in the experimental group.

Specific resistance must be progressive, integrated into tactical situations and constantly monitored. Tactical periodization allows the adaptation of the volume and intensity of effort depending on the players' level and the competition objectives. Combined physical-tactical exercises, small games and simulations of attack/defense phases can be the most effective methods.

SSGs, MSGs and LSGs require a higher number of accelerations and decelerations and can be used as an effective training modality to increase high-intensity demands on soccer players to develop aerobic capacity. To improve player performance according to match demands, the absolute space

of games should be increased and a larger number of players involved in order to accurately reproduce the movement patterns of the competition (Giménez et al., 2020).

Beato et al. (2023) suggest that some side-by-side game formats are more suitable for specific load parameters (e.g., distance per minute, high-speed running and sprinting are higher during LSGs). The number of accelerations and decelerations is higher in medium-sided games (MSG) compared to other formats. Needless to say, players' positions are influenced by external tasks. Coaches should be aware of the internal and external load requirements of the different game formats (LSG, MSG and SSG); they ought to know whether players' positions can influence these load parameters, which would be critical for planning the training load.

Bangsbo, J. (1994), shows that in elite players, the average rate of effort during a soccer match, estimated from variables such as heart rate, is approximately 70% of maximal oxygen uptake (VO_2max). This corresponds to an energy output of ~5700 kJ (1360 kcal) for a 75 kg person with a VO_2max of 60 ml $kg^{-1} min^{-1}$. Aerobic energy output appears to account for over 90% of total energy expenditure. However, anaerobic energy production plays an essential role during football matches. In 16-18-year-old juniors, the development of this capacity becomes essential, as the game acquires high rhythms and tactical-spatial complexity.

Specific endurance differs from general endurance in that the demands are directly related to the requirements of the match: short sprints, rapid changes of direction, technical actions and integrated cognitive decisions. General training does not optimally develop specific performance, and combining physical exercises with tactical ones increases the efficiency of physiological and cognitive adaptations.

Methods for evaluating the performance of football players have developed significantly in recent years. Fitness profiles and skill levels of a potential elite football player are a valuable resource for coaches in the process of identifying talented athletes. Traditional means of measuring aerobic fitness have focused on the test of "aerobic capacity" or VO_2max . (O'Reilly & Wong, 2012).

It is important that specific endurance is constantly monitored and progressively integrated into the weekly training structure. The training structure will be adapted to the principle of the game: all exercises include physical, technical and

tactical elements. This method promotes specific endurance through complex exercises that simulate real game situations, progressive intensity adapted to tactical requirements and continuous monitoring of the physiological and tactical response of the players.

Material and method

The aim of this research is to develop specific endurance in order to increase 17–18-year-old football players' aerobic capacity and power, which leads to a high level of performance throughout the entire match. Among modern methods for developing specific endurance are themed games, intermittent exercises, integrated circuits, and "small-sided games" (SSG) training, which combine physical effort with technical and tactical elements. Monitoring intensity through parameters such as heart rate, distance covered, and movement speed allows the coach to adjust the training volume and intensity for each player. To streamline training and participation in official competitions, we have designed a work program aimed at increasing athletes' performance. This development program aims to adapt players' bodies to the complex demands of the game, characterized by rapid alternations between high-intensity efforts and short recovery periods. In training, specific endurance is not limited to general aerobic capacity, but also involves anaerobic components, motor coordination, and the ability to repeatedly perform sprints, changes of direction, and high-intensity duels. Moreover, recovery periods, nutrition, and sleep play a crucial role in optimizing physiological adaptations.

Research hypotheses

1. Large-sided games and small-sided games (LSG and SSG) are forms of training perceived as enjoyable and motivating by players.
2. Frequent application of LSGs and SSGs contributes significantly to the development of players' endurance capacity.
3. The integration of tactical periodization, together with the use of the Yoyo test, provides a clear assessment of the level of involvement and effort in training sessions and in official competitions.

Subjects. The research was conducted on an Elite U18 junior team, from a representative children's and juniors' center in Craiova, who plays in the "Youth League".

In our research, we focused on the following aspects:

1. Increasing the total distance covered by players in the match:

- Training sessions focused on game situations and variable intensities (specific to tactical periodization), which aim to increase the ability to repeat intense efforts with short-term recovery.
 - Significant increase in the total distance recorded in the Yo-Yo test (m) as compared to the initial tests.
 - Increase in specific game endurance - the ability to maintain a high level of intermittent effort similar to the requirements of the competition.
2. Improving heart rate recovery (HR Recovery), considering the following:
- High-intensity tactical exercises stimulate adaptations of the cardiovascular and pulmonary systems.
 - Optimal capacity to decrease heart rate after the effort ends.
 - Faster recovery that indicates a superior physiological efficiency and adaptation specific to intermittent efforts.
3. Increasing the maximum speed reached before physical and mental exhaustion because:
- Within tactical periodization, training sessions contain sequences of games with controlled intensity and repeated accelerations.
 - The athlete will reach a higher speed level in the last stages of the Yoyo test.
 - It is important to obtain increased capacity to sustain intense efforts specific to football, due to neuromuscular and energetic adaptations.

Description of the test used in the experiment: 17 and 18-year-old junior footballers (subjects) were tested twice: the initial testing (T₁) was at the beginning of the competition year (in August 2024), and the final testing (T₂) was at the end of

the competition year (in May 2025), as it follows:

Yo-Yo Test IRTL2. There are two work areas: a 20-meter running area and a 5-meter return area. Athletes are positioned along the starting line (1) and start running at the signal on the audio recordings. The athlete turns when the recorded sound signal (2) is heard at the starting point. The athlete runs back and forth between the two lines, in the rhythm set by the audio signals. The athlete should not start running earlier, they should run the full distance and reach each line before or during the audio signal. At regular periods, the time between the audio signals will decrease and, consequently, the required running speed will increase. The starting speed for the Level 2 endurance test is 11.5 km/h and increases by 0.5 km/h approximately every minute. Participants should continue for as long as possible. Some athletes will choose to stop when they reach their physical limit. Others will have to be warned when they don't fit the audio signals. On the second offense they are eliminated from the test.

The training microcycles were based on exercises that apply the principles of tactical periodization, aimed at developing specific endurance and leading to improvements in the Yo-Yo test in juniors (U15–U19). Here is an Example of Specific Exercise (see figure 1) for Developing Yo-Yo Endurance: **Possession Game 8vs8+2 Neutrals** (70x50 m):

- **Objective:** To maintain tactical intensity and intermittent effort;
- **Time:** 4 sets x 4 min / 2 min rest;
- **Control:** Heart rate kept between 85–90% of HRmax.
- **Outcome:** Simulating the repeated efforts in the Yo-Yo test (accelerations, stops, restarts).



Figure 1. Possession Game 8vs8 + 2 Neutrals

Results

The paper presents the players' results in the Yoyo endurance test (table 2, figure 2), showing significant differences, as the result of using specially designed program, ($p < 0.001$).

- Training based on game situations and variable intensities (specific to tactical periodization) increases the ability to repeat intense efforts with short-term recovery.
- Total distance recorded in the Yoyo test (m) increases significantly as compared to initial tests.
- Game-specific endurance increases – the ability to maintain a high level of intermittent effort similar to the requirements of the competition.

Table 1. The values of the results obtained by the players in the endurance test

| U18 ENDURANCE YOYO TEST | | | | | | |
|-------------------------|--------|------|---------------------|------------------------------------|---------------------|------------------------------------|
| NR.CRT. | NAME | POST | YOYO T ₁ | VO ₂ Max T ₁ | YOYO T ₂ | VO ₂ Max T ₂ |
| 1. | SUB.1 | FC | 960 | 58,4 | 1040 | 59,4 |
| 2. | SUB.2 | AS | 1080 | 60,0 | 1240 | 62,2 |
| 3. | SUB.3 | AD | 720 | 55,1 | 1000 | 58,9 |
| 4. | SUB.4 | MC | 1040 | 59,4 | 1160 | 61,1 |
| 5. | SUB.5 | FD | 920 | 57,8 | 1120 | 60,5 |
| 6. | SUB.6 | FS | 960 | 58,4 | 1080 | 60,0 |
| 7. | SUB.7 | MC | 1080 | 60,0 | 1160 | 61,1 |
| 8. | SUB.8 | MC | 1240 | 62,2 | 1340 | 63,5 |
| 9. | SUB.9 | MCI | 960 | 58,4 | 1180 | 61,4 |
| 10. | SUB.10 | AC | 1080 | 60,0 | 1160 | 61,1 |
| 11. | SUB.11 | FC | 900 | 57,5 | 960 | 58,4 |
| 12. | SUB.12 | MCI | 1080 | 60,0 | 1200 | 61,6 |
| 13. | SUB.13 | MC | 1040 | 59,4 | 1200 | 61,6 |
| 14. | SUB.14 | FS | 1040 | 59,4 | 1080 | 60,0 |
| 15. | SUB.15 | AC | 1160 | 61,1 | 1240 | 62,2 |
| 16. | SUB.16 | FC | 1000 | 58,9 | 1100 | 60,3 |
| 17. | SUB.17 | AD | 1280 | 62,7 | 1360 | 63,8 |
| 18. | SUB.18 | AS | 820 | 56,5 | 1080 | 60,0 |
| 19. | SUB.19 | FD | 1360 | 63,8 | 1480 | 65,4 |
| 20. | SUB.20 | FC | 1100 | 60,3 | 1120 | 60,5 |
| 21. | SUB.21 | P | 640 | 54,0 | 820 | 56,5 |
| 22. | SUB.22 | P | 440 | 51,3 | 640 | 54 |
| AVERAGE | | | 995,45 | 58,81 | 1125,45 | 60,61 |

Table 2. Average U18 endurance YOYO test

| U18 ENDURANCE YOYO TEST | | | | | |
|-------------------------|---------------------|------------------------------------|---------------------|------------------------------------|-------------|
| TESTS | YOYO T ₁ | VO ₂ Max T ₁ | YOYO T ₂ | VO ₂ Max T ₂ | p |
| AVERAGE | 995,45 | 58,81 | 1125,45 | 60,61 | $p < 0.001$ |

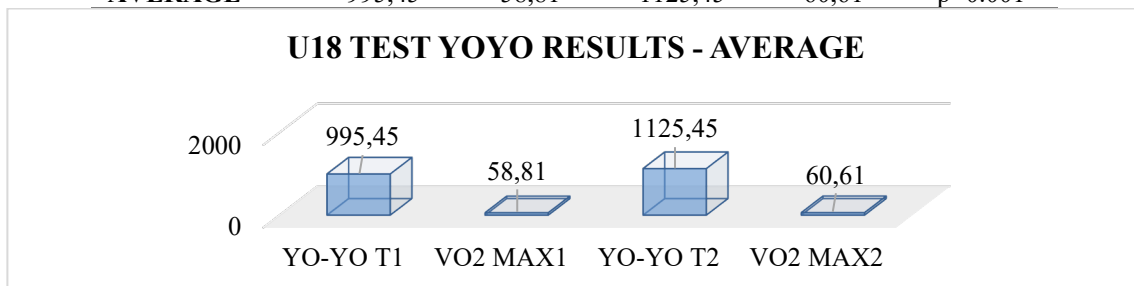


Figure 2. U18 Yoyo test results average

Interpretation of the results obtained in the Yoyo test (differences T₁ - T₂) are presented in figure 3

- The team average increased from 995.45 m to 1125.45 m, which represents an average increase of +130 m ($\approx +13\%$);
- In parallel, the average VO₂ max. increased from 58.81 to 60.61 ml/kg/min. (+1.8 ml/kg/min). This is clearly a significant progress, indicating a real improvement in aerobic capacity and tolerance to intermittent exercise.
- This progress is specific to football and shows that the training program was effective.

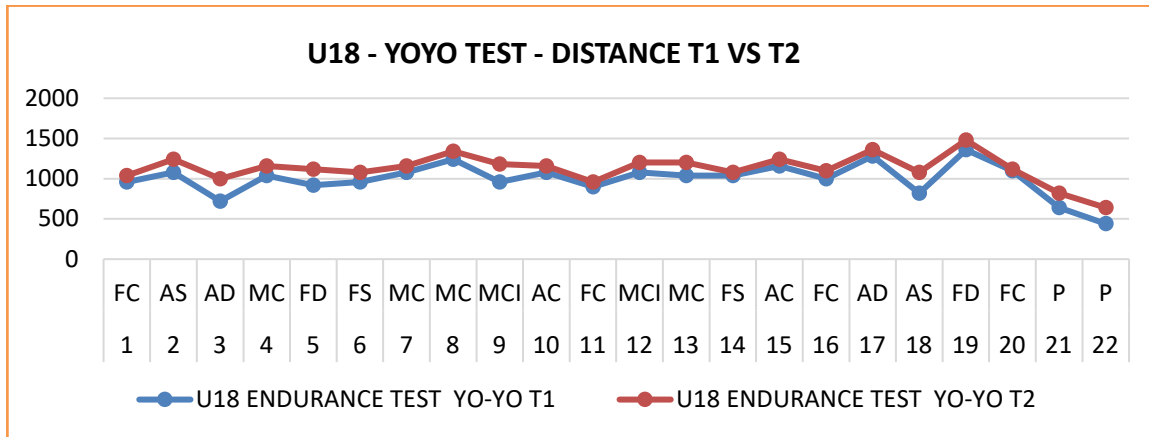


Figure 3. U18 Yoyo distance T₁ vs. T₂

Analysis of the progress recorded by players in positions

1). Goalkeepers (P) register the weakest level, but the highest percentage progress:

- SUB.21: 640 → 820 m;
- SUB.22: 440 → 640 m;

2). Full-backs (FS, FD) register a very good trend, as it follows:

- SUB.6 FS: +120 m;
- SUB.14 FS: +40 m (the smallest progress, but on good values);
- SUB.5 FD: +200 m;
- SUB.19 FD: 1360 → 1480 (the best result of the whole group!);

3). Central defenders (FC) register a lower progress. Thus, we note the following aspects:

- SUB.11 FC: 900 → 960 m (little progress);
- SUB.16 FC: 1000 → 1100 m (little progress);
- SUB.1 FC: +80 m;

- SUB.20 FC: +20 m (practically stagnant).

4). The midfielders (MC, MCI) have the best global indicators. The midfielders (subjects 4, 7, 8, 9, 12, 13) show already high initial results (1040–1240 m.). This indicates a substantial increase (80–220 m.). VO₂ max. constantly above 59–63 ml/kg/min.

5). The wingers (AS, AD) show that they have made large, but more heterogeneous progress:

- SUB.3 AD: 720 → 1000 m (+280 m, one of the largest jumps);
- SUB.17 AD: 1280 → 1360 m (excellent values);
- SUB.2 AS and SUB.18 AS: good progress (approx. +200–260 m);

6). Center forwards (AC) have made good progress:

- SUB.10 AC: 1080 → 1160 m;
- SUB.15 (AC): 1160 → 1240.

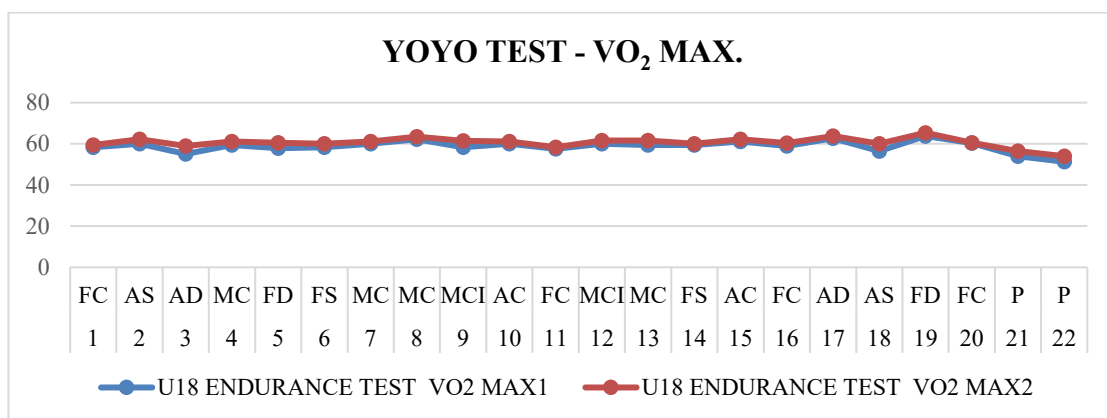


Figure 4. U18 Yoyo VO₂ max. T₁ vs. T₂

From the data set, we find that the average increase in the Yoyo test is significantly positive for all athletes in terms of distance covered (between +80 and +280 m) and increases between +1.0 and +3.8 ml/kg/min. for VO₂ max (figure 4). In the case of the tested group p < 0.001, which shows us that the differences are extremely

statistically significant, and the improvements cannot be due to chance. The effectiveness of the training program is confirmed, which produced a real strong effect at the level of the U18 team.

Discussion

High performance means to adapt training methods to the needs of modern football,

converging towards successful players with a good technical, tactical, physical, theoretical and psychological level (Păun et al., 2022). Even though there are some views that SSGs may not fully prepare players for the most extreme match situations, the use of these games has nevertheless reproduced many of the demands of the match. (Guneralp et al., 2025). However, there are premises for achieving superior results in training and, consequently, in the game. The study by Caldeira et al. (2022) showed a difference in locomotor intensity indicators when the field size changes in LSG. The larger field size led to increasing the distance covered and the loads during official matches.

The development of specific endurance in 16-18-year-old juniors must be integrated into the tactical planning of training. Tactical periodization provides an optimal framework that combines physical and mental effort with technique and tactics, which is directly related to cognitive development and prepares players effectively for competition demands. The use of specific mentally demanding exercises must be carefully introduced into the practical activity.

According to previous evidence Díaz-García et al. (2023) suggest that football is a mentally demanding activity, but coaches can change the mental and physical demands of football players, as well as technical-tactical behaviours by using specific psychological strategies.

There is also the possibility that participation in our test was influenced by the status of a starter or substitute within the team. Authors such as Teixeira et al (2022) show that the status of the player as a starter seems to influence the training volume only in sub-elite youth football, unless the covariance between playing time and session duration is taken into account. Consequently, coaches should prioritize complementary training to equalize the training volume and emphasize similar training opportunities for non-starter players. Therefore, future studies in which we will use demanding tests should reconsider the way of communicating with junior players.

Our study shows that *midfielders* stand out for their best aerobic capacity, which is normal, being the position with the highest total movement requirements and intense intermittent activity. Their values are close to the U19–senior performance levels.

The wingers show very good progress, but the initial level was uneven. Players who activate on the sides of the field need high aerobic capacity because they change speeds intensely often.

The full-backs have very good values, especially SUB.19, who has 1480 m at Yoyo, respectively VO_2 max. - 65.4 ml/kg/min. These values are at a semi-professional/senior level.

The center defenders show low progress, and the forwards have moderate values, which is specific to the position on the field.

VO_2 max. values are generally very good for U18. If we analyse the fact that at over 60 ml/kg/min we have a high level, at 62–65 ml/kg/min. an excellent level, specific to well-trained footballers and between 54–57 ml/kg/min are weak/modest values for football that require training intervention, we find that most players are between 58–62, which indicates a well-prepared team.

However, there are 2–3 players who stagnate, which may indicate a deficit in aerobic training, lack of adaptation to intermittent effort or possibly weight problems, physical posture or insufficient recovery. This is a point where the staff can intervene individually.

Therefore, the U18 team has a high overall aerobic profile, comparable to the level of performance academies. The midfielders and full-backs are the best prepared, which corresponds to the game requirements. The wingers have made the greatest progress, which indicates an excellent response to physical training. The center forwards show the least progress and more modest values, which is a point where training needs to be adjusted. The goalkeepers have very good progress, although the demands of their position are limited.

Taking these aspects into account, it is recommended to carefully individualize the personalized training for attackers through high-intensity intervals (HIIT), repeated sprints (RSA) and reduced high-intensity games (3vs3, 4vs4, etc.). It becomes a priority to maintain the excellent level in midfielders and defenders by maintaining the volume of intermittent effort and integrating high-intensity tactical training, but also monitoring players with low progress (SUB.11, SUB.14, SUB.20).

Possible irregularities related to recovery, sleep, training volume, micro-injuries, etc. are to be monitored. For goalkeepers, extremely important players in the team gear, it is recommended to continue progress, but without overloading the aerobic part, but also integrating the specifics of the position: explosion, reaction, plyometrics, etc. We note that between the two tests, the increase is large and extremely significant. We identify advances of 80–280 m, which confirms adaptations to intermittent high-intensity effort,

which clearly confirms a relevant VO_2 max. between T_1 and T_2 : an average increase of approximately 1.8 ml/kg/min. highly statistically significant. The increase in general aerobic capacity is confirmed.

Conclusion

Tactical periodization applied to juniors leads to an integrated development of specific endurance, measurable by increasing Yoyo distance, improving cardiac recovery and increasing maximum speed before exhaustion. These results demonstrate both physiological and functional adaptations, obtained in the context of the game, without isolating physical and tactical training.

At the junior football level, endurance should not be viewed as a simple isolated physical component, but as the result of a complex process of tactical, technical and mental training. Developing specific endurance through football-specific means contributes to the creation of a complete player, capable of maintaining performance in varied playing conditions. By applying the principles of tactical periodization and integrating exercises based on decision and controlled intensity, coaches can train players with superior functional endurance, capable of supporting the demands of modern football.

Midfielders and full-backs show the best values and the most consistent improvements, while center forwards show less progress. Goalkeepers had the highest percentage increase. The results show a solid physical evolution of the group. The Yoyo test confirms the effectiveness of the training program, and the differences between the positions fall within the expectations specific to performance football.

In conclusion, higher game efficiency and sustainable improvement in sports performance can be achieved through scientific and individualized planning, whereas the risk of fatigue and technical-tactical errors can be reduced.

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