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Original Scientific Article

The Impact of Targeted Soccer Training Interventions on YO-YO Intermittent Recovery Test Performance in University-Level Soccer Players

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Abstract

Background. Soccer demands high endurance, speed, and aerobic capacity, making fitness a key performance factor. The Yo-Yo Intermittent Recovery Test Level 1 (YYIR1) is a valid field test to assess these attributes in soccer players.

Objectives. This study aimed to evaluate the effect of a 12-week targeted soccer training program on aerobic endurance in university-level male soccer players.

Materials and methods. A quasi-experimental pretest-posttest design was used, involving 32 university-level male soccer players (aged 17-25) from Visva-Bharati University. Participants underwent a 12-week targeted soccer training program. Aerobic endurance performance was assessed using the YYIR1 test, evaluating accumulated distance, cumulative time, and VO_2max before and after the intervention. Data were analyzed using paired-sample t-tests, with a significance level set at $p < 0.05$.

Results. Among 32 university-level male soccer players, significant improvements were observed in the post-intervention period: accumulated distance (mean increase = 312.5 meters, d = 1.70), cumulative time (mean increase = 2.54 minutes, d = 1.80), and VO_2 max (mean increase = 2.62 ml/kg/min, d = 1.72), all with $p < 0.001$.

Conclusions. According to the study, it was found that the 12-week targeted soccer training intervention led to statistically significant enhancements in aerobic endurance capacities among university-level soccer players, as demonstrated by improvements in YYIR1 test outcomes.

Keywords: soccer, Yo-Yo Intermittent Recovery Test, VO_2max, aerobic fitness, endurance training.

Introduction

Soccer is one of the most challenging sports in the world (Toparlak & Salas, 2022; Gurău et al., 2023). Players must possess strong physical, mental, technical, and tactical qualities to perform at an elite level (Toselli et al., 2022; Verma & Dabshede, 2024). Physical fitness is one of the most critical factors for a soccer player to perform at their best on the field (Iaia, Rampinini, & Bangsbo, 2009). Endurance capacity is vital in soccer, which requires sustained performance over 90 minutes. During the game, players face different situations where they need to showcase their skills, such as demands like speed, endurance, agility, and strength. Players must maintain high performance throughout the match, demanding a high level of physical fitness. Modern soccer requires high endurance, speed, strength, and coordination skills (Andrzejewski et al., 2015). Therefore, players must develop strong aerobic and physical qualities to meet the demands of the game. Various lab tests can measure Aerobic Fitness (VO_2max) accurately. However, for this study, the VO_2max is calculated through the reference table of the Yo-Yo Intermittent Recovery Test, as this table was prepared by testing various subjects (Bangsbo, Iaia, & Krustrup, 2008). Therefore, the YYIR1 is very popular for ballgame players to measure aerobic fitness quality (Castagna et al., 2008).

The Yo-Yo Intermittent Recovery Test Level 1 (YYIR1), developed by Dr. Jens Bangsbo, is a widely used test to evaluate an athlete's ability to repeatedly perform high-intensity intervals with brief recovery periods. It is especially relevant for soccer players, as the sport demands frequent sprints interspersed with short recovery phases. The yo-yo intermittent recovery test is available in two versions: version 1 is for beginners, and version 2 is for advanced players. The trial starts with a beep sound, with certain levels where the speed increases as the time of completing the levels decreases in different groups (Bangsbo, Iaia, & Krustrup, 2008).

The purpose of the YYIR1 is to determine the repeatedly performed interval for a prolonged period. It is a field test assessing the physical performance of athletes. The test layout is 20 × 5 meters for the YYIR1, whereas the 20-meter intervals are back and 5 meters for recovery. The subjects will get 10 seconds of recovery time after every 40 meters (Bangsbo, Iaia, & Krustrup, 2008).

While previous studies have explored aerobic capacity using the YYIR1 in professional or youth athletes, limited research has focused on structured training effects in university-level players in the Indian context. There is a lack of controlled research evaluating the impact of periodized soccer-specific training on aerobic performance in Indian university-level soccer players. This study addresses this gap by applying a periodized training protocol tailored to the inter-university competitive calendar.

Materials and Methods:

Participants

A total of 32 participants, aged between 17 and 25 years (Age = 22 ± 1.78 years), were selected using purposive sampling. No random assignment to groups was performed, as the study involved only one intervention group. All participants were inter-university soccer players from the Visva-Bharati University team, a prestigious Central University recognized as an institute of national importance in Santiniketan, West Bengal, India.

Before selecting the participants, a priori power analysis was performed using G*Power software (version 3.1.9.2, University of Kiel, Germany). The analysis employed an effect size of 0.80, an alpha error probability of 0.05, and a statistical power 0.95 (Kang, 2021). This ensured an adequate sample size to detect meaningful differences or effects.

The sample size determination test revealed a sample size of 23 for the study. However, to compensate for participant attrition, 32 participants were considered as the sample for the study. All the included participants in the study were free from acute or chronic medical conditions. The participants possessing serious medical contraindications (hypertension, recent heart surgery, uncontrolled diabetes) or with significant cognitive impairments, as advised by physicians, precluding them from engaging in vigorous physical activities, were excluded from the study. On average, the participants exercised eleven months per year for at least three years (3.4 ± 0.8 years) with five 150-minute sessions, weekly and one practice match every two weeks and one competition every three months. The research received approval from the Institutional Ethical Committee of Visva-Bharati (A Central University) Santiniketan, West Bengal, India, ensuring that it adhered to requisite ethical standards and guidelines (VB/IECHR/03/2024) and registered through Clinical Trials Registry-India (CTRI/2025/02/080710, registered on: 17/02/2025). Furthermore, the study adhered to the guidelines outlined in the Declaration of Helsinki (World Medical Association Declaration of Helsinki, 2013). The participants had given written consent after thoroughly understanding the study's objectives, potential benefits, risks, and future implications. See Figure 1 for the study flowchart to illustrate this one-group pretest-posttest quasi-experimental design.

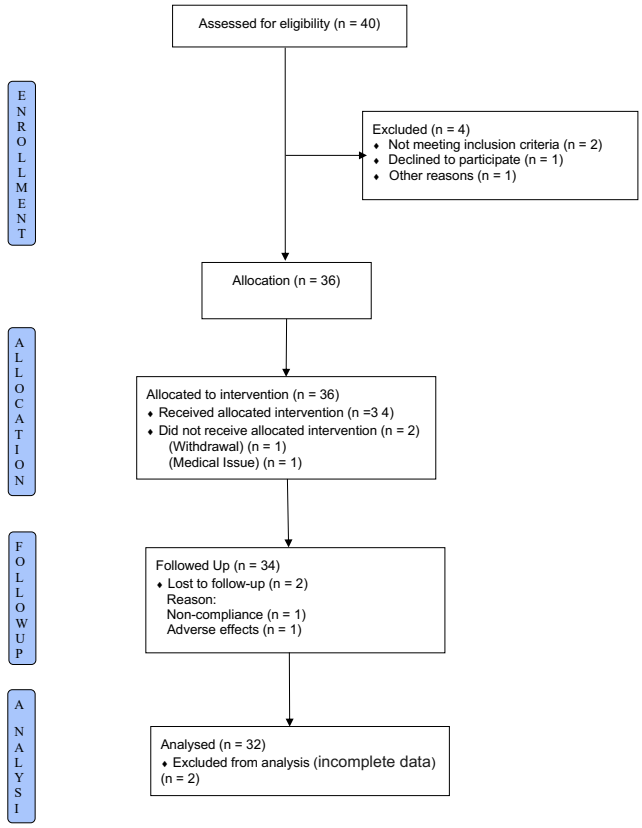

Fig. 1. Study Flowchart for the Quasi-Experimental One-Group Pre-test–Post-test Design

Study Design

The research employed a quasi-experiment utilizing a one-group pretest-posttest design Figure 1), citing the limited number of participants (Knapp, 2016). The participants were tested before and after the exposure to twelve weeks of the Soccer Training Interventions program. The participants were instructed not to be involved in any other types of physical interventions which might have influenced the sole effect of the Soccer Training Interventions program. The pre-test was completed three days before the start of the training program, whereas the post-test was completed three days after the completion of the twelve weeks of the soccer training program.

Although a control group would strengthen internal validity, logistical challenges, ethical concerns in withholding training, and limited player availability made it impractical. This design still allows for a meaningful evaluation of

within-subject improvements, but generalizability should be interpreted cautiously.

Training Intervention

The 12-week training program was designed to enhance the overall performance of inter-university-level soccer players. It focused on five key areas: strength training, technical skills, speed and agility, endurance, and tactical awareness.

Each week included five training sessions of 150 minutes each, totaling 750 minutes per week. The program integrated strength, endurance, technical, tactical, and speed-focused training tailored for inter-university soccer players. In addition, one full practice match was scheduled every two weeks, and official competitions were held every three months.

Testing Protocol

Yo-Yo Intermittent Recovery Test Level 1 (YYIR1) and the audio for the YYIR1, which Dr. Jens Bangsbo created, were considered for the test. Before the test, all the players were well-instructed and demonstrated with a demo, and then the researcher took the test. The subject stood behind the starting line, started running 20 meters on the sound of 'GO," and touched the end-bound line with a beep. Again, they will return to the starting line within the beep sound without stopping and rest for 10 seconds in the 5-meter recovery zone for the recovery time. Accumulated distance refers to the total distance (in meters) the participant covers before the test ends. Cumulative time represents the total

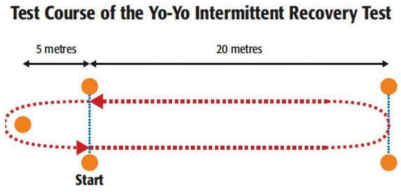

Fig. 2. The test course of the Yo-Yo Intermittent Recovery Test-1. The full course shows the player's movement during the run and the dotted line for the recovery period

duration (in minutes) completed in the test. VO_2 max was estimated using the standard YYIR1 lookup tables Bangsbo et al. (2008) provided based on the total distance covered. In the early stage, the speed was slow, but it got increasingly faster as the test progressed (Sports, 2008).

Statistical Analysis

Descriptive statistics were used to describe the data on the YYIR1 performance of the pre-test and post-test of the soccer player's accumulation distance, cumulative time, and VO_2max. To ensconce the validity of this study's statistical analysis, the researcher measured the assumption of normality of data. The Shapiro-Wilk test was used to assess the normality of data distribution. The Shapiro Wilk test showed that the data collected from the variable's accumulation distance pre and post-test, Cumulative time pre and post-test, and VO_2max pre and post-test through the YYIR1 test were normal. Thus, the normality of data further leads to subsequent analysis.

Table 1. Twelve weeks of targeted soccer training intervention

Phase	Weeks	Component	Intensity	Volume/Type	Frequency	Rest Between Sets
1	1–4	Strength Training	70–80% of 1RM	3–4 sets of 8–12 reps	2x/week	60–90 sec
		Technical Skills	Moderate	30–45 min	2x/week	–
		Speed & Agility	Moderate	Short sprints (10–20 m)	1x/week	–
		Endurance	Moderate	Long runs (5–8 km), Intervals	1x/week	–
		Small-Sided Games	Moderate	3v3, 5v5 (20–30 min)	1x/week	–
		Practice Match	Match Intensity	Full 11v11 (60–90 min)	1 match/2 weeks	–
2	5–8	Strength Training	80–90% of 1RM	3–4 sets of 6–8 reps	2x/week	90–120 sec
		Technical Skills	High	45–60 min	2x/week	–
		Speed & Agility	High	Sprints (20–30 m)	1x/week	–
		Tactical Training	Moderate to High	Set-piece positioning drills	1x/week	–
		Small-Sided Games	High	7v7, 9v9 (30–45 min)	1x/week	–
		Practice Match	Match Intensity	Full 11v11 (60–90 min)	1 match/2 weeks	–
3	9–12	Strength Training	70–80% of 1RM	2–3 sets of 4–6 reps	2x/week	60–90 sec
		Technical Skills	High	30 min	2x/week	–
		Speed & Agility	Maximum	Sprints (30–40 m)	1x/week	–
		Tactical Training	Match Intensity	Positional play, set pieces	1x/week	–
		Small-Sided Games	Match Intensity	11v11 simulations (60–90 min)	1x/week	–
		Practice Match	Match Intensity	Full 11v11 (60–90 min)	1 match/2 weeks	–
		Competition	Peak Intensity	Full game (90 min)	1 competition/3 months	–

A dependent t-test was computed as inferential statistics to compare the difference between the accumulation distance pre-test with the post-test, Cumulative time pre-test with the post-test, and VO_2max pre-test with the post-test. In addition to the t-test results, the effect size was ascertained using Cohen's d, and the 95% Confidence Interval (CI) was delineated. The level of significance was set at $p \leq 0.05$. All analyses were carried out using JAMOVI Version 2.4 software.

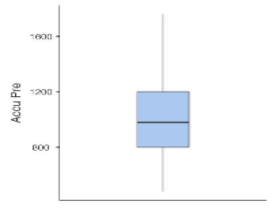

Fig. 3. Pre-Test Accumulated Distance Distribution

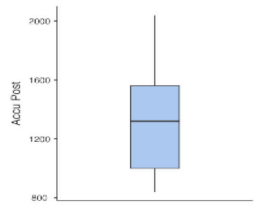

Fig. 4. Post-Test Accumulated Distance Distribution

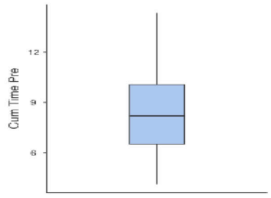

Fig. 5. Pre-Test Cumulative TimeFig

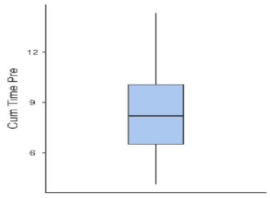

Fig. 6. Post-Test Cumulative Time

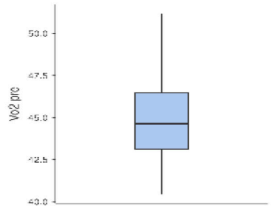

Fig. 7. Pre-Test VO_2max

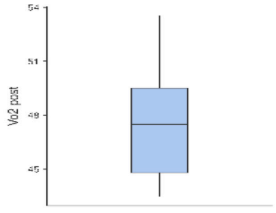

Fig. 8. Post-Test VO_2max

Results

In Table 2, the descriptive and inferential statistics were applied to acquired data from accumulation distance (pre-test and post-test), Cumulative time (pre-test and post-test), and VO_2max (pre-test and post-test). Significant differences were found between the accumulated distance pre-test with the post-test, cumulative time pre-test with the post-test, and VO_2max pre-test with the post-test, as the p-value was $p<0.05$.

The descriptive statistics of aerobic-endurance variables from the Yo-Yo Intermittent Recovery Test Level 1 (YYIR1) indicate a significant improvement in the participants' performance following the intervention. The accumulated distance (AD) covered increased from a pre-intervention mean of 1020.00 meters (SD = 980.00) to a post-intervention mean of 1332.50 meters (SD = 1320.00), reflecting enhanced endurance capacity. Similarly, the cumulative time (CT) improved from a mean of 8.45 minutes (SD = 8.19) to 10.99 minutes (SD = 10.84), indicating better cardiorespiratory fitness. Furthermore, VO_2max (VO) increased from 44.97 ml/kg/min (SD = 44.63) to 47.59 ml/kg/min (SD = 47.48), suggesting a positive impact on aerobic fitness levels. Notably, the skewness values for all variables decreased post-intervention, indicating a more balanced and consistent performance distribution among the participants. Overall, the results demonstrate the effectiveness of the training intervention in enhancing aerobic endurance and cardiorespiratory performance in inter-university soccer players. Figures 3 through 8 present the box plots, indicating no significant outliers and that this study's data distribution is normal.

The paired samples t-test results in Table 3 indicate statistically significant improvements in all measured variables following the intervention. The accumulated distance (AD) showed a significant increase from the pre-test to the post-test ($t = -9.64$, $df = 31$, $p < .001$), reflecting enhanced aerobic capacity. Similarly, cumulative time (CT) also improved significantly ($t = -10.19$, $df = 31$, $p < .001$), indicating better cardiorespiratory endurance. Additionally, VO_2max (VO) increased significantly ($t = -9.64$, $df = 31$, $p < .001$), demonstrating improved aerobic fitness. The highly significant p-values ($p < .001$) across all variables highlight the effectiveness of the training intervention in boosting aerobic endurance and cardiorespiratory performance among inter-university soccer players.

These results suggest that the twelve-week training intervention significantly improved soccer-specific endurance and aerobic capacity.

Table 2. Descriptive statistics of aerobic-endurance variables under YYIR1

Group	N	Mean	SE	Median	SD	Min	Max	Skewness	Kurtosis
AD-Pre	32	1020.00	49.29	980.00	980.00	480.00	1760.00	0.586	0.3510
AD-Post	32	1332.50	57.23	1320.00	1320.00	840.00	2040.00	0.462	-0.6998
CT-Pre	32	8.45	0.40	8.19	8.19	4.12	14.30	0.553	0.0959
CT-Post	32	10.99	0.45	10.84	10.84	7.10	16.40	0.411	-0.7395
VO-Pre	32	44.97	0.41	44.63	44.63	40.43	51.20	0.585	0.3484
VO-Post	32	47.59	0.48	47.48	47.48	43.46	53.50	0.462	-0.6995

High standard deviations reflect broad variation in individual performance levels among participants. Note: AD-Pre - Accumulated distance Pre Test, AD-Post - Accumulated distance Post Test, CT-Pre - Cumulative Time Pre Test, CT-Post - Cumulative Time Post Test, VO - Pre - VO_2max Pre Test, VO - Post - VO_2max Post Test

Table 3. Paired samples t-test with effect sizes

Variable	t	df	p	Cohen's d
Accumulated Distance	-9.64	31	< .001	1.70
Cumulative Time	-10.19	31	< .001	1.80
VO_2max	-9.64	31	< .001	1.72

Effect sizes were calculated using Cohen's d, which indicates large improvements in all performance metrics.

Discussion

The findings of the present study, conducted on 32 young university-level soccer players from Visva-Bharati University, are as follows.

The study's results clearly showed that the targeted soccer training performance on YYIR1 significantly affected the university soccer players' Accumulated distance, Cumulative time, and VO_2max.

The increased performance of accumulated distance, cumulative time, and VO_2max of the soccer players are due to the regular practice of the scheduled training program and the discipline of the players. The capacity for human exercise performance can be enhanced with prolonged exercise training (Hughes, Ellefsen, & Baar, 2018), and increases in mitochondrial enzymes primarily enhance aerobic endurance capability in the muscle (Chandler, 1994). The improvement in stroke volume that results from the enlargement of red blood cells, which adapts independently of changes in red blood cell volume, is a significant factor in training-induced increases in VO_2max (Lundby, Montero, & Joyner, 2017). After 12 weeks, one must increase maximal oxygen absorption, glycolytic enzyme activity, and IR2 test performance (Izzo et al., 2020). Athletes perform better in the Yo-Yo IR tests at greater levels of competitiveness, according to evaluations of elite athletes in various sports involving intermittent exercise (Schmitz et al., 2018). The Yo-Yo intermittent tests, which include data across recreational and competitive levels, age, and gender, are said to be the field testing in soccer that has been meticulously studied (Izzo et al., 2020; Póvoas et al., 2023; Priya, 2024).

Training increases stroke volume and cardiac output, boosting VO_2max (Amanda, Ryan, & Constance, 2011). The trained group experienced a significant increase in VO_2max compared to the untrained group. Highly trained athletes had lower resting heart rates (Whyte, George, & Shavi, 2008). The trained group recovers more quickly from exercise than the untrained group (Dupuy et al., 2024).

In a study, it was demonstrated that Players in the small-sided games (SSG), speed endurance (SER), and combined SSG & SER groups improved Yo-Yo IR1 and Yo-Yo IR2 test performance as compared to the statistically significant control group (Akdoğan et al., 2021).

Various previous training studies have shown that improvement in VO_2peak is closely linked to enhancement in Yo-Yo IR1 test performance (Impellizzeri et al., 2008; Ferrari et al., 2008; Spencer et al., 2005; Hunter et al., 2011). Paes et al., in their study, directly measured VO_2peak during Yo-Yo test performance using portable spirometry. The key finding was that changes in direction affect the physiological parameters evaluated during physical tests (Paes & Fernandez, 2024).

This study has some limitations. First, the quasi-experimental design lacked a randomized control group, restricting causal inferences. Second, the sample was drawn from a single university, limiting the generalizability to other populations. Third, participant self-discipline and external activities were not tightly monitored, which could have influenced results. Future studies should consider using randomized controlled trials with larger and more diverse samples.

Conclusions

The twelve-week targeted soccer training intervention significantly improved Yo-Yo intermittent recovery performances, including accumulative distance, cumulative time, and VO_2max in young university-level soccer players. Statistical analysis, supported by paired samples t-tests, revealed substantial gains in post-test scores compared to pre-test scores, highlighting the program's effectiveness. These improvements can be attributed to regular practice, disciplined training regimens, and the players' adherence to the scheduled training program. These findings suggest that university coaches can effectively implement structured, periodized training interventions to improve aerobic endurance in competitive players, even within academic environments. The enhanced aerobic endurance, increased stroke volume, and greater cardiac output resulting from prolonged training contribute significantly to the observed improvements in performance.

Furthermore, the study aligns with existing research indicating that increased VO_2max and enhanced aerobic capacity are vital components of athletic performance, particularly in sports requiring intermittent and high-intensity efforts, such as soccer. The positive outcomes of this training protocol support its potential application in developing university soccer players' aerobic and endurance capabilities.

Future research should aim to explore the long-term impact of varied training interventions on VO_2max and performance metrics, as well as the effects of individual variability in response to training. Additionally, integrating sport-specific drills and monitoring physiological parameters during training could further optimize the effectiveness of targeted soccer training programs.

Acknowledgement

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Conflict of Interests

The authors declare that they have no conflicts of interest

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Вплив цільових тренувальних інтервенцій з футболу на результативність Йо-Йо тесту переривчастого відновлення у футболістів університетського рівня

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 3 табл., 8 рис., 28 джерел.

Історія питання. Гра у футбол вимагає високої витривалості, швидкості та аеробної здатності, що визначає фізичну підготовленість ключовим фактором результативності. Йо-Йо тест переривчастого відновлення рівня 1 (Yo-Yo Intermittent Recovery Test Level 1, YYIR1) є достовірним польовим тестом для оцінки зазначених якостей футболістів.

Мета дослідження. Це дослідження мало на меті оцінити вплив 12-тижневої цільової програми тренувань з футболу на аеробну витривалість футболістів-чоловіків університетського рівня.

Матеріали та методи. У дослідженні застосовано квазіекспериментальний дизайн передтестового і післятестового етапів за участю 32 футболістів-чоловіків університетського рівня (віком 17-25 років), які навчалися в університеті Вісва-Бхараті (Visva-Bharati University). Учасники пройшли 12-тижневу цільову програму футбольних тренувань. Показники аеробної витривалості оцінювались за допомогою тесту YYIR1, який визначав акумульовану дистанцію, кумулятивний час та рівень максимального споживання кисню (VO_2max) перед та після завершення інтервенції. Аналіз даних проводився із використанням t-критеріїв для парних вибірок, рівень значущості встановлено на позначці $p < 0,05$.

Результати. У постінтервенційному періоді серед 32 футболістів-чоловіків університетського рівня спостерігалися значні покращення показників: акумульованої дистанції (середній приріст = 312,5 метрів, d = 1,70), кумулятивного часу (середній приріст = 2,54 хвилини, d = 1,80) та VO_2max (середній приріст = 2,62 мл/кг/хв, d = 1,72), усі показники становили $p < 0,001$.

Висновки. Згідно з результатами дослідження встановлено, що 12-тижнева цільова тренувальна інтервенція з футболу сприяла статистично значущому покращенню можливостей аеробної витривалості у футболістів університетського рівня, про що свідчать поліпшення показників за результатами тесту YYIR1.

Ключові слова: футбол, Йо-Йо тест переривчастого відновлення рівня 1, VO_2max, аеробна підготовленість, тренування на витривалість.

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