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DZIAŁ III. RÓŻNE

THE STUDY OF THE TOCA FOOTBALL SYSTEM FOR DEVELOPING COMPLEX SPORT-SPECIFIC SKILLS AMONG JUNIOR FOOTBALL PLAYERS

BADANIE SYSTEMU TOCA FOOTBALL POD KĄTEM ROZWOJU ZŁOŻONYCH UMIEJĘTNOŚCI SPORTOWYCH U MŁODYCH PIŁKARZY

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Authors' contribution
Wkład autorów:
A. Study design/planning
zaplanowanie badań
B. Data collection/entry
zebranie danych
C. Data analysis/statistics
dane – analiza i statystyki
D. Data interpretation
interpretacja danych
E. Preparation of manuscript
przygotowanie artykułu
F. Literature analysis/search
wyszukiwanie i analiza literatury
G. Funds collection
zebranie funduszy

Summary

Background. Numerous studies show that in addition to football's physical and cognitive requirements, there is an increasing emphasis on acquiring a high level of technical skills at an early age. The aim of the research is to investigate an innovative football delivery machine used for technical skill development under two different training systems.
Material and methods. Physiological parameters and locomotor skills were examined with a Polar Team Pro device during the study.
Results. Significant differences were found in the results for maximum heart rate (p=0.015), number of sprints (p=0.009), time-proportionate running distance (p=0.000), and high-intensity accelerations (p=0.002) and decelerations (p=0.001).
Conclusions. The football delivery machine provided a more intense training session for athletes in terms of micro-movements. However, in terms of physiological parameters, the intensity did not reach the values measured during a traditional technical training session.

Keywords: Polar Team Pro, TOCA Football System, youth football

Streszczenie

Wprowadzenie. Liczne badania pokazują, że oprócz wymagań fizycznych i poznawczych związanych z piłką nożną, coraz większy nacisk kładzie się na zdobywanie wysokiego poziomu umiejętności technicznych w młodym wieku. Celem pracy jest zbadanie innowacyjnego urządzenia do podawania piłki nożnej, wykorzystywanego do rozwoju umiejętności technicznych w dwóch różnych systemach treningowych.
Materiał i metody. Podczas badania parametry fizjologiczne i zdolności lokomocyjne były sprawdzane za pomocą urządzenia Polar Team Pro.
Wyniki. Stwierdzono istotne różnice w wynikach dla maksymalnej częstości akcji serca (p=0,015), liczby sprintów (p=0,009), dystansu biegu proporcjonalnego do czasu (p=0,000) oraz przyspieszeń (p=0,002) i spowolnień (p=0,001) o dużej intensywności.
Wnioski. Stwierdzono, że urządzenie do podawania piłek nożnych zapewniało sportowcom bardziej intensywną sesję treningową pod względem mikroruchów. Jednak pod względem parametrów fizjologicznych intensywność nie osiągnęła wartości mierzonych podczas tradycyjnej sesji treningu technicznego.

Tables: 3
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Słowa kluczowe: Polar Team Pro, System TOCA Football, piłka nożna dla młodzieży

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Introduction

Initiatives in Hungary aim to encourage an active lifestyle for a better health from childhood [1-5] as well as achievements in professional sports are key strategic area. In today's dynamic world, an increasing number of new ideas are emerging that can bring a qualitative change to the world of professional sports [6]. A characteristic trend in modern football is that football actions occur in an even smaller area that requires a high degree of technical ability, excellent cognitive abilities, and a high level of physical performance [7]. In sports, technical training is of key importance. According to exercise science researchers [8,9], the goal of training is to develop and consolidate motor skills through the practice of technical elements.

Modern tools, new training methods, and additional procedures can be used to increase performance, but we must not forget about the various consequences that come with these new, innovative tools and methods. The novelty of the TOCA Football system lies in the fact that the sport-specific technical elements (first touch, passing, stops and starts, changes in direction, etc.) that form the basis of the technical toolkit of a footballer can be practiced by an athlete at a higher repetition rate than it would be possible with traditional training methods. The higher number of repetitions is due to the nature of the training method and the accuracy of the ball delivery system. Thus, by changing the physical load components in this way, the level of movement coordination at which the sport-specific technical elements become automatic, and thus a level of skill, can be reached sooner. During this type of training, exercises take place in a narrower space and in shorter intervals, which forces the athlete to make many micro-movements.

According to da Silva et al. [10] and Schimpchen et al. [11], we can state that energy-intensive high-intensity starts, stops, turns, and changes in direction (i.e., micro-movements) characterize 21st-century football. A study by Taylor et al. [12] reveals that in an average handball match there is some change in rhythm from the athletes every 5-6 seconds, while in football matches there is one every 3-4 seconds. Based on the above discussion, it can be said that the TOCA Football System, following the trends, emphasizes the development of sport-specific technical elements. Last year, the Hungarian Football Association included it in the regular corporate tax program as an eligible training program, so in the future more and more football academies and sports associations will include the tool in their youth training programs. Therefore, this topic is particularly relevant to sports experts. Nonetheless, based on the literature research it can be stated that the device and the effect of the training method have not yet been studied and that there are no available data on it.

Consequently, the aim of our research is to examine the TOCA Football System within the framework of a comparative survey, with the help of which we can answer the following question: What are the differences between a traditional technical training session and a training session using the TOCA Football System in terms of the physiological and locomotor parameters that can be measured by the Polar Team Pro system (total distance covered, changes in heart rate, number of sprints, number of high-intensity accelerations and decelerations, etc.)?

Material and methods

Characterization of the study group

In the spring of 2022, we examined eight U14 youth footballers in the Hungarian youth first division championship (NBI) of one of the leading football academies in Hungary. The research sample included the key talents of the relevant age group of the academy, the participants of the "Talent Program." The football players in the study were all field players (Table 1).

Table 1. Descriptive statistics for endurance, anthropometric, and body composition variables

	Age	MA	BH (cm)	BW (kg)	BF%	SMM (kg)	VO_2max (ml/kg/min)	HRmax (bpm)
Average	12.38±0.52	12.97±0.67	162.38±9.96	44.39±7.05	9.31±4.85	21.93±4.26	55.41±5.63	209.25±12.42

Notes: MA = morphological age; BH = body height; BW = body weight; BF% = body fat percentage; SMM = skeletal muscle mass; VO_2max = maximum aerobic capacity; HRmax = maximum heart rate.

Testing protocol

The study was conducted during a traditional technical training session and a training session using a TOCA Football System. The players' heights were measured using the standard stadiometer technique. The subjects were measured with their head in the Frankfort horizontal plane. The calculation of morphological age can be summarized with the following formula:

$$MA = 0.25 * (BH\ age + BW\ age + PLX\ age + CA) \pm C\ (years)$$

where MA is morphological age, BH age is the age corresponding to the table value to which the subject's height is closest, BW age and PLX age are interpreted in the same way as for height, CA is calendar age, and K is any necessary correction [13]. A bioimpedance measurement method was used to measure body weight, muscle mass, and body fat percentage (InBody 770; InBody Co., Ltd., Seoul, South Korea). During the training sessions, we recorded data using a Polar Team Pro tool (Polar Electro Oy, Professorintie 5, FI-90440 Kempele, Finland). The athletes in the study had a sporting history of more than five years and in the past six months had attended training sessions at an association football club five times a week, out of which at least one session included the use of the TOCA Football System. A Yo-Yo intermittent recovery test (YYIR1) and a laboratory exercise test (Bruce protocol) – chosen based on the research by Fang et al. [14] – were also performed on the athletes to assess accurate physiological characteristics and to determine the expected maximum heart rate (HRmax) and aerobic capacity (VO_2max) [15]:

$$VO_2max = (Final\ distance\ (in\ meters) \times 0.0084) + 36.4$$

Based on the exercise tests, it can be established that the examination group was homogeneous in terms of expected endurance performance [16] and maximum aerobic capacity [17].

The participants performed an incremental treadmill exercise test on a motor-driven treadmill (Woodway PPS 55 Med; Woodway GmbH, Weil am Rein, Germany) and a spirometry system (Masterscreen PFT; Jaeger, Hoechberg, Germany). The tests were performed in the spring of 2022 in the Senior Pál Dárdai Football Academy Youth Training Center (id. Dárdai Pál Labdarúgó Akadémia Utánpótlás Edzőközpont). The TOCA Football System trainings were held indoors, while the traditional trainings were held outdoors.

The data were analyzed using IBM SPSS Statistics 24 and Microsoft Excel 2013. First, descriptive statistical calculations were made; a one-sample *t*-test was used to compare the means of the variables, where the margin of error was determined at $p \leq 0.05$.

The Ethics Committee of the University of Pécs issued approval (No. 9119-PTE 2022) to conduct the research.

Results

Over the course of the endurance test, a Yo-Yo intermittent recovery test (YYIR1) and a laboratory exercise test (Bruce protocol) were also performed on the athletes, where the maximum heart rate (HRmax) and maximum aerobic capacity were calculated (VO_2max). Maximum and average heart rate data were recorded during both types of training session (Table 2).

Table 2. The mean and standard deviation of the maximum and average heart rate of the test sample per measurement

	YO-YO IR1 HRmax (bpm)	Bruce protocol HRmax (bpm)	Traditional training HRmax (bpm)	TOCA training HRmax (bpm)	Traditional training HRaverage (bpm)	TOCA training HRaverage (bpm)
Average	209.25±12.42	199.88±13.18	201.25±14.47	184.88±9.61	148.13±12.72	146.38±10.51

Based on Table 2, we can conclude that athletes achieved the highest HRmax with an average of 209.25±12.42 beats per minute during the YYIR1 field test. An average HRmax of 199.88±13.18 beats per minute was measured during the Bruce protocol performed in the laboratory. HRmax values of 201.25±14.47 and 184.88±9.61 beats per minute were recorded during the traditional and the TOCA training sessions, respectively, which according to the T-test comparison indicates a statistically significant difference between the HRmax averages of the two types of training ($p \leq 0.015$). No significant difference was found when comparing HRaverage values: 148.13±12.72 and 146.38±10.51 beats per minute were recorded ($p = 0.710$).

The TOCA training sessions lasted for 55 minutes, while the technical training sessions lasted for 110 minutes. In that timeframe, the athletes covered 3196±388.66 meters on average (an average of 58.11 meters

per minute) during the TOCA training sessions and 4480.88±356.79 meters on average (an average of 40.74 meters per minute) during the traditional technical training session. It can also be seen that, taking into account the total training time, the distance covered during the technical training session was higher, at an average of 1284.88 meters. The smallest deviation was 485 meters, while the largest was 1885 meters. However, if we look at the running performance *pro rata temporis*, we can find a significant difference in the variable of meters per minute ($p \leq 0.001$) (Figure 1).

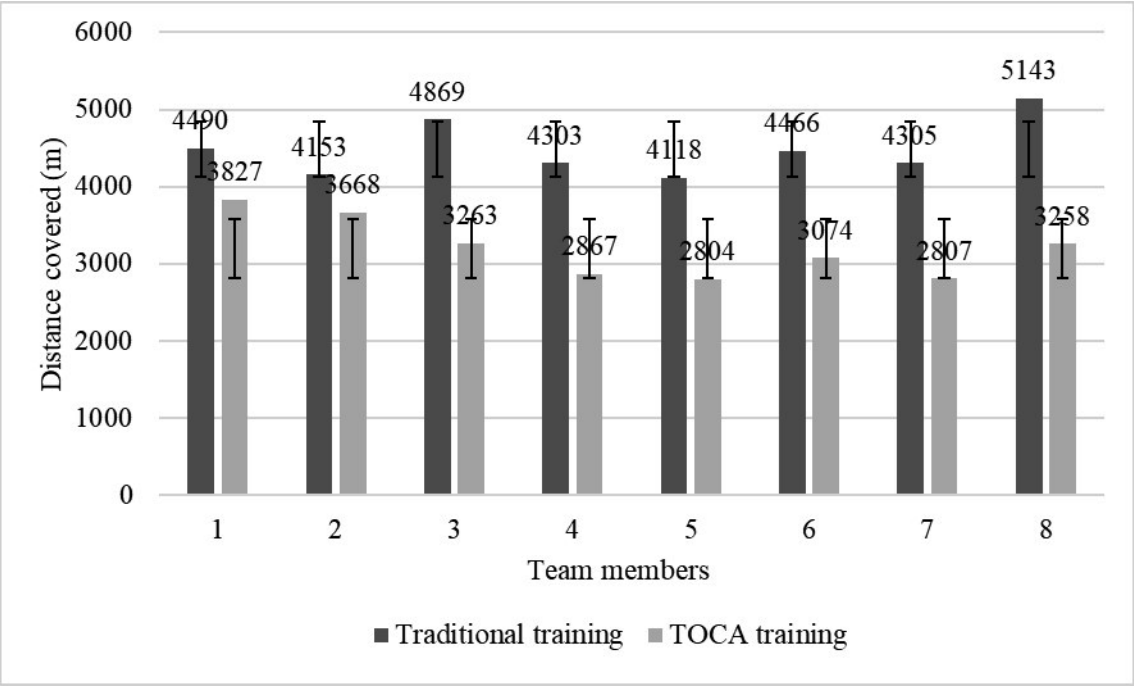

Figure 1. Comparison of running performance

The vertical axis of Figure 2 shows the number of sprints and the horizontal axis shows the difference between the two types of training sessions. Sprint speed was reached on average 8.75±4.53 times during the traditional technical training session and 16±6.45 times during the TOCA training. The sprint speed threshold was previously set at ≥19 km/h, following the age-related recommendation of the Polar Team Pro application. Comparing the sprints of the two training sessions, we found a significant difference between the average measurements.

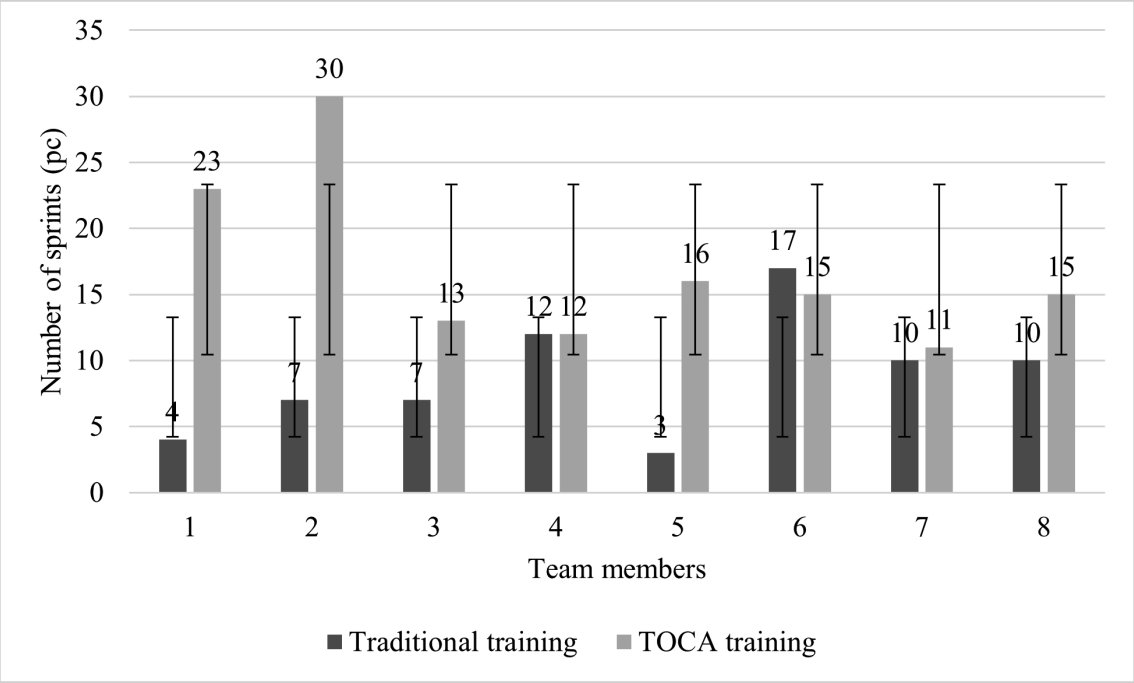

Figure 2. Comparison of the number of sprints

Table 3. Average time between accelerations and between decelerations during the TOCA and traditional technical training session

TOCA training session					
	Sprints*	**Acc. 2-3 m/sec***	**Acc. ≥3 m/sec***	**Dec. 2-3 m/sec***	**Dec. ≥3 m/sec**
Mean + standard deviation	200.03±59.17	69.24±25.28	440.49±210.14	52.55±13.35	806.18±425.52
Traditional training session					
	Sprints*	**Acc. 2-3 m/sec***	**Acc. ≥3 m/sec***	**Dec. 2-3 m/sec***	**Dec. ≥3 m/sec**
Mean + standard deviation	1022.11±632.55	115.76±33.67	2113.04±971.15	117.19±35.68	1010.25±552.89

Notes: * statistically significant differences.

Table 3 demonstrates the average time elapsed between two high-intensity accelerations and two high-intensity decelerations per workout. It shows that on average 69.24±25.28 seconds elapsed between two accelerations with a speed of 2-3 m/sec during the TOCA training sessions, while starts with a similar speed occurred every 115.76±33.67 seconds on average during the traditional training. Starts with a speed of 3 m/sec or more occurred on average every 440.49±210.14 seconds during the TOCA training and every 2113.04±971.15 seconds during the traditional training. The *t*-test comparison showed a significant difference between the two types of training for starts of both 2-3 m/sec (p=0.006) and ≥3 m/sec (p=0.002). As for high-intensity decelerations, it can be established that decelerations with a 2-3 m/sec speed change occurred on average every 52.55±13.35 seconds during the TOCA training and every 117.19±35.68 seconds during the traditional training. Decelerations of ≥3 m/sec occurred on average every 806.18±425.52 seconds during the TOCA training and every 1010.25±552.89 seconds during traditional training. As for speed changes associated with deceleration, we found a significant difference (p≤0.001) in decelerations of 2-3 m/sec between the two types of training. However, no significant difference was found for decelerations of ≥3 m/sec (p=0.331).

Discussion and conclusions

With the selection criteria, we ensured that the number of training sessions per week did not differ from individual to individual, that the selected athletes regularly used the TOCA football delivery system, and that each of them was a participant in the "Talent Program". Considering the results of previous studies, where it

was found that goalkeepers differed significantly from fielders in terms of motor skills, goalkeepers were not included in this survey [18-20]. The aim of the study was to compare a technology-enabled football training system that uses a new and innovative football delivery system against a traditional training session with a similar training goal, in terms of physiological and locomotor parameters that could be measured with the Polar Team Pro. Previous studies have shown that the Polar Team Pro yielded reliable and valid measurements of the parameters we wished to measure [21-23].

Based on the results, it can be established that within the entire duration of the two training systems, the athletes ran more during the traditional training sessions (Figure 1). Traditional training sessions lasted 110 minutes (4480.88±356.79 meters), while the TOCA training sessions lasted 55 minutes (3196±388.66 meters); likewise, the average distance covered was greater in the case of the traditional training sessions. However, the ratio of the distance covered to the training time (in meters/min) reveals a significant difference in running performance over time. Running performance was 58.11 meters/min during the TOCA training sessions and 40.74 meters/min over the course of the traditional training sessions. Thus, based on the statistical analysis, we can conclude that there is a significant difference between these parameters ($p \leq 0.001$) (Table 1).

During the study, a Yo-Yo intermittent recovery test (YYIR1) and a laboratory exercise test (Bruce protocol) were also performed on athletes, where the maximum heart rate (HRmax) and the maximum aerobic capacity (VO_2max) were calculated. Maximum and average heart rate data were recorded during both traditional training sessions and training sessions using the TOCA Football System (Table 2). Based on the data, we can conclude that the athletes achieved the highest HRmax during the YYIR1 field test, with an average of 209.25±12.42 beats per minute. An average HRmax of 199.88±13.18 beats per minute was measured during the Bruce protocol performed in the laboratory. HRmax values of 201.25±14.47 and 184.88±9.61 beats per minute were recorded during the traditional and the TOCA training sessions, respectively. According to the *t*-test comparison, there was a significant difference between the HRmax averages of the two trainings (p=0.015). No significant difference was found when comparing HRaverage values: 148.13±12.72 and 146.38±10.51 beats per minute were recorded (p=0.710). The higher HRmax values recorded over the course of the YYIR1 test were due to the fact that athletes use the test track regularly, while the laboratory tests took place in a new, foreign environment, which may have affected performance [24-28].

TOCA is a football delivery machine controlled by special software. The TOCA Touch Trainer is able to deliver accurately placed balls, always at the specified speed, to the specified location, in the same way; this allows for more effective training [29]. From the statement from the manufacturer, it can be concluded that thanks to the accurate delivery, certain sport-specific technical elements can be practiced with more repetitions [29]. In the study comparing the two trainings, we tried to substantiate this statement by taking a closer look at the number of sprints, the number of stops and starts, and the number of accelerations and decelerations. Figure 2 shows that the set sprint speed was reached on average 8.75±4.53 times during the traditional technical training sessions and 16±6.45 times during the TOCA training. The sprint speed threshold was previously set at ≥19 km/h, following the age-related recommendation of the Polar Team Pro application. When comparing the numbers of sprints between the two training systems, we found a significant standard deviation between the averages of the measurements, so the number of high-efficiency starts and decelerations reveals more about the intensity of the training session in our case than the running speed itself. The results presented in Table 3 show that with the use of the TOCA Football System, there was a significant difference in the variables for time elapsed between intense accelerations both for 2-3 m/sec (p=0.006) and ≥3 m/sec (p=0.002) and for time elapsed between intense decelerations of 2-3 m/sec (p=0.001). Accelerations with a speed of 2-3 m/sec occurred on average every 69.24 seconds, while accelerations with a speed of ≥3 m/sec occurred every 440.49 seconds during the TOCA training. In contrast, during traditional training, an average of 115 seconds elapsed between two accelerations with a speed of 2-3 m/sec and on average an acceleration with a speed of ≥3 m/sec occurred every 2113 seconds. Decelerations of 2-3 m/sec occurred on average every 52.55 seconds during the TOCA training, while decelerations of ≥3 m/sec occurred on average every 806.18 seconds. In contrast, during the traditional training, an average of 117.35 seconds elapsed between two decelerations with a speed of 2-3 m/sec and on average a deceleration with a speed of ≥3 m/sec occurred every 1010.25 seconds. Consequently, we did not find a significant difference between the trainings in this respect (p=0.331). This finding correlates with the results of Fox et al. [30] and Crang et al. [31], where we can see that the Polar Team Pro device may have limitations when taking measurements indoors.

Taylor et al. [12] and Harper et al. [32] found that high-intensity starts, stops, or changes in direction occur significantly more frequently in the world of international football than in other sports. According to Zalai [33], the extreme physical demands experienced in international football require from 21st-century footballers frequent high-intensity starts, stops, accelerations, decelerations, and high sprint speeds. It can therefore be

established that, in line with modern football trends, these physical challenges occur with a higher number of repetitions when using the TOCA Football System. Zalai [33] also found that one of the cornerstones of catching up with international standards is the development of speed and acceleration, the effective development method of which is to increase the number of sprints taken in high-intensity zones. Previous studies have also reported that faster running speed is affected by the amount of force applied to the ground, in addition to a higher step frequency. This physical axiom – according to which the greater the ground force (action), the greater the reaction force (reaction) – also proves the importance of skeletal muscle in improving the speed of footballers [33,34]. Although our present study does not cover the strength of the lower limb muscle of the subjects, in addition to expanding the sample size in the future, it may also be worth examining this parameter within the framework of an interventional study.

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