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THE IMPACT OF MODERN TECHNOLOGIES ON THE BALANCE OF BASKETBALL PLAYERS WITH AGES BETWEEN 13-14

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Abstract: *This preliminary research investigates the effectiveness of Fitlight technology in enhancing the balance and reactive balance skills of male basketball players aged 13-14. Employing a comprehensive research design, the study involved 19 athletes from the "LPS Târgu-Mures" team over an eight-week period. The effectiveness of a specific training programme was evaluated through a series of Y balance tests and Reactive Y balance tests. The results demonstrated significant improvements in the athletes' balance capabilities, as evidenced by increased mean distances and Cohens effect sizes in the Y balance tests and enhanced reaction times in the Reactive Y balance tests.*

Key words: *balance, reactive balance, fitlight*

1. Introduction

In order to play basketball, players must be able to perform certain moves, like passing and receiving the ball while balancing on one leg, looking in both directions, maintaining constant visual contact with their opponents and teammates, and shooting when in physical contact [15]. The balance of the body is influenced by several factors including the height of the body's center of mass [8], [1]. Balance was proved to be an important aptitude in the performance of basketball players [10]. Basketball players have high levels of balance, equivalent to the athletes in soccer, gymnastics, dance [2], [5], [7]. Effective athletic performance is largely dependent on an athlete's capacity to modify their responses in a wide range of circumstances [9]. In this perspective, balance and visuomotor reaction time are two very important and strongly related components of sports performance [4], [6], [11], [14]. Taking all of this into consideration we consider when evaluating basketball players balance we must take also evaluate their reactive balance ability.

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2. Purpose

The purpose of this research is to explore the efficacy of incorporating "Fitlight" technology into the training regimen of male basketball players aged 13-14. This study, conducted at the conclusion of their season, aims to not only assess but also improve the athletes' balance, a fundamental aspect in basketball. Additionally, the research seeks to shed light on the importance of reactive balance as a critical factor for basketball players, understanding how quick and adaptive responses to changing game situations can impact their overall performance.

3. Hypothesis

Based on the assumption that by implementing the "Fitlight" technology in a training program at the end of the season is possible to test and improve the balance of male basketball players with ages between 13-14.

4. Research Methods

A combination of tailored research methods was employed to effectively address the study's objectives: Bibliographic Study Method, Observation Method, Testing Method, Experimental Method, Statistical-Mathematical Method. Each of these methods was carefully chosen and adapted to suit the specific needs of the study, ensuring a comprehensive and scientifically robust investigation into the effects of modern training technologies on young basketball players.

5. Content of the Experiment

a. Period and place of the research

An initial research was carried out from April 13 to June 13, 2023. The first set of evaluations for the athletes was carried out on April 13 and 14. Subsequently, a training regimen spanning eight weeks was introduced, consisting of three weekly sessions. Each session involved five different exercises utilizing fitlight technology. This phase concluded with a final evaluation conducted on June 12 and 13. The entire process was hosted at the sports facility of "Liceul Teoretic Gheorghe Marinescu" in Târgu-Mureș.

b. Subjects and Groups

The research focused on 19 athletes from the "LPS Targu-Mures" team, who concluded their participation in the U14 Romanian championship prematurely on March 5, 2023. The scheduling of the U14 Romanian championship facilitated the selection of this group, as they had an extended off-season period. This allowed the athletes to concentrate more effectively on their personal development. The season's premature conclusion for the team, stemming from their inability to secure a berth in the final tournament, is indicative of a moderate proficiency in basketball. This outcome highlights an intermediate skill level within the competitive landscape of the sport.

c. Fitlight technology used in testing and training program

In the initial phase of our study, we employed Fitlight technology for both training and evaluative purposes. This technology features plate-like devices, each illuminated by RGB LED lights, which serve as interactive targets to be deactivated by the players during exercise-specific routines. These versatile

training tools are designed to be positioned in a range of locations, including walls, poles, or directly on the ground, catering to various sport-specific drills. The customization of each light is facilitated through the FITLIGHT® smartphone application. This app offers a selection of engaging and user-friendly in-built programs to manipulate the light settings. Additionally, it provides the capability for users to design personalized exercises or modify existing ones. For our study, this application was instrumental in developing each of our training routines as well as the upper limb reactive response test.

d. Experimental study programe

This experimental research spanned eight weeks, featuring three training sessions each week, with each session comprising five distinct exercises. We developed a total of 27 exercises, classified into three primary categories: stationary exercises, dynamic movement exercises, and exercises involving active or semi-active defenders.

Stationary Exercises: These exercises require players to perform drills from a static position. An example includes dribbling while stationary, reacting to the light signals from a Fitlight device mounted on a wall. The light colors signal different dribbling maneuvers, for instance, red indicating forward dribbling, blue for dribbling between the legs, and green for behind-the-back dribbling.

Exercises with Dynamic Movement: These drills are designed to incorporate player movement across the playing area. For instance, players might navigate through a series of strategically arranged Fitlights, moving quickly while keeping control of the ball. Such exercises are aimed at enhancing agility, rapid changes in direction, and balance.

Exercises with Active/Semiactive Defender: These drills mimic real-game situations by incorporating an opponent. They encompass a range of activities such as lateral shuffles, offensive and defensive dribbling maneuvers, and contesting shots, all synchronized with Fitlight signals. The Fitlight system, integral to this training, uses different colored lights that players must respond to, thereby sharpening reaction times, decision-making skills, and specific basketball techniques like dribbling, passing, and shooting. The exercises are designed to progressively evolve from basic stationary drills to more intricate, movement-based and interaction-focused drills, ensuring a thorough development of the athletes' physical and technical competencies.

e. Applied Tests

The Y Balance Test is an assessment tool used to evaluate balance in high-performance athletes. It involves taking measurements in three distinct directions, often represented in the shape of the letter “Y”, to assess the flexibility and stability of the lower limb.

To perform the test, the individual stands on one leg and reaches with the other leg in three different directions. This is done in a controlled and repeated manner, maintaining balance on a single leg. The measurements consist of the maximum distance a person can reach in each direction without losing their balance.

The purpose of the test is to assess the symmetry and stability of the lower limb, identify potential muscular imbalances, or difficulties in motor control. Implementing this test yielded a total of six evaluative

outcomes, comprising three results derived from balancing on the right leg and an additional three results from balancing on the left leg.

We have also devised an innovative test to assess the balance and reaction capabilities of players using Fitlight devices arranged in a Y-formation, spaced 55 cm apart. This configuration was chosen based on the minimum result obtained in the classic Y Balance Test, serving as an initial benchmark for evaluation.

The test procedure requires players to maintain balance on one leg and respond swiftly to the light signals emitted by the Fitlight devices. Both the average reaction time to the illumination of these devices and the precision of the movement are measured and recorded for each player. This method offers a nuanced understanding of a player's reactive balance capabilities, integrating both stability and response efficiency in a dynamic setting.

In conclusion, our comprehensive assessment framework encompasses a total of eight distinct tests, meticulously designed to evaluate the balance and reactive capabilities of high-performance athletes. The traditional Y Balance Test contributes six of these evaluations, with three measurements each for the right and left legs, focusing on the maximum distance reached in each direction while maintaining balance. Complementing this, our novel Reactive Y Balance Test, employing Fitlight devices in a Y-formation, adds two further crucial assessments. These additional tests not only measure the traditional aspects of balance and stability but also incorporate the critical elements of reaction time. Together, these eight tests provide a holistic and detailed analysis of an athlete's lower limb stability, and reactive balance abilities, essential for high-level athletic performance.

f. Statistical processing

During the initial phase of data analysis, the Fitlight application was utilized to automatically compute each participant's mean reaction time. These data, along with the balance test outcomes, were then integrated into the IBM SPSS 26 software. This step was essential for calculating various statistical measures such as the minimum and maximum values, average (Mean), Coefficient of Variation (CV), Standard Deviation, Standard Error of Mean, and the 95% Confidence Interval, which includes both the lower and upper bounds. Additionally, the T paired Test (t), degrees of freedom (df) associated with the test statistic, the level of significance (p), and Cohen’s effect size were evaluated. For interpreting Cohen's effect size, the criteria were set as follows: above 0.20 indicated a small effect size, above 0.50 suggested a medium effect size, and values over 0.80 were considered to represent a large effect size. The threshold for statistical significance in this research was established at $p < 0.05$ for all analyses.

6. Results

The descriptive statistics in the study provide a thorough analysis of the balance and reactive balance capabilities of young basketball players, reflecting their development from the initial testing (IT) to the final testing (FT). These statistics offer insights into various components of the athletes' performance, shedding light on the impact of the training program.

In the Y balance test from the right foot forward, players showed a notable increase in their mean distance achieved, moving from 93.632 cm in IT to 101.842 cm in FT. However, the variability among players increased, as suggested by the higher standard deviation and CV in the FT. This pattern of improvement, coupled with increased variability, was also observed in the Y balance test from the right foot to the left, where the average distance increased significantly from 80.895 cm to 91.579 cm.

The Y balance test from the right foot to the right initially presented the highest variability, but the final test showed marked improvements in both the range and the average distance, with a significant reduction in the CV. This indicates an overall enhancement in balance and coordination for this specific movement.

For the Y balance test from the left foot forward, the players demonstrated improved balance, as evidenced by the increased average distance from 94.684 cm in IT to 103.684 cm in FT, and a decrease in CV, suggesting more consistent performances.

In the Y balance test from the left foot to the left, there was a substantial improvement in the average distance reached, along with a decrease in variability, indicating enhanced balance and agility in lateral movements on the left side.

Similarly, the Y balance test from the left foot to the right showed improvement, not only in the average distance reached but also in the consistency of the performances, as reflected in the decreased CV in the FT.

Conversely, in the Reactive Y balance tests, there was a remarkable improvement in reaction times. The mean reaction time for the right foot decreased from 0.835 seconds in IT to 0.722 seconds in FT, and for the left foot from 0.784 seconds to 0.691 seconds, indicating faster and more efficient responses. Interestingly, unlike the Y balance tests, the variability in reaction times decreased in the FT. The lower standard deviation and CV indicate more consistent performance among the players, likely due to targeted training focusing on reactive balance and coordination.

Overall, the descriptive statistics from the study demonstrate significant improvements in the balance and reactive abilities of the basketball players as a result of their training. The increases in mean distances in the Y balance tests and the decreases in reaction times in the Reactive Y balance tests are clear indicators of enhanced performance. While there is an increase in variability in the Y balance tests, the decreased variability in the Reactive Y balance tests suggests a more uniform improvement in reactive capabilities. These findings are invaluable for coaches and trainers, offering concrete evidence of the effectiveness of the training program and guiding future training approaches.

Descriptive statistics regarding Y balance test Table 1

		N	Min	Max	Mean	Std. Dev.	CV
Y balance test from right foot forward	It	19	70.000 cm	110.000 cm	93.632 cm	13.124	14.017
	Ft	19	80.000 cm	120.000 cm	101.842 cm	13.459	13.215
Y balance test from right foot to the left	It	19	65.000 cm	101.000 cm	80.895 cm	12.215	15.100
	Ft	19	75.000 cm	105.000 cm	91.579 cm	10.808	11.802
Y balance test from right foot to the right	It	19	55.000 cm	104.000 cm	74.053 cm	13.890	18.757
	Ft	19	70.000 cm	110.000 cm	85.789 cm	11.088	12.925
Y balance test from left foot forward	It	19	75.000 cm	110.000 cm	94.684 cm	11.431	12.073
	Ft	19	85.000 cm	120.000 cm	103.684 cm	9.405	9.071
Y balance test from left foot to the left	It	19	55.000 cm	100.000 cm	72.684 cm	13.772	18.948
	Ft	19	65.000 cm	105.000 cm	82.895 cm	11.939	14.403
Y balance test from left foot to the right	It	19	60.000 cm	100.000 cm	77.895 cm	11.789	15.135
	Ft	19	70.000 cm	105.000 cm	85.526 cm	9.413	11.005
Reactive Y balance test from right foot	It	19	0.510 sec	1.288 sec	0.835 sec	0.231	27.718
	Ft	19	0.512 sec	0.912 sec	0.722 sec	0.145	20.005
Reactive Y balance test from left foot	It	19	0.521 sec	1.181 sec	0.784 sec	0.210	26.803
	Ft	19	0.501 sec	0.911 sec	0.691 sec	0.146	21.177

N- number of players;It- Initial testing; Ft- Fina testing; Min- Minimum; Max- Maximum;
Std. Dev.-Standard deviation; CV- Coefficent of variability

Paired test Table 2

Test	Mean	St. Dev.	Std. Error Mean	CI 95% Lower	CI 95% Upper	t	df	P	Cohen Effect Size
1	-8.211	4.049	0.929	-10.162	-6.259	-8.838	18.000	0.000	0.618
2	-10.684	3.888	0.892	-12.558	-8.810	-11.978	18.000	0.000	0.926
3	-11.737	5.465	1.254	-14.371	-9.103	-9.361	18.000	0.000	0.933
4	-9.000	4.282	0.982	-11.064	-6.936	-9.162	18.000	0.000	0.859
5	-10.211	5.893	1.352	-13.051	-7.370	-7.552	18.000	0.000	0.792
6	-7.632	4.245	0.974	-9.678	-5.585	-7.836	18.000	0.000	0.715
7	0.112	0.104	0.024	0.062	0.162	4.699	18.000	0.000	0.581
8	0.093	0.079	0.018	0.055	0.131	5.098	18.000	0.000	0.513

CI- Confidence Interval; t- t value in a paired t test; df- degrees of freedom; p- significance,
1- Y balance test from right foot forward; 2- Y balance test from right foot to the left;
3-Y balance test from right foot to the right; 4- Y balance test from left foot forward;
5- Y balance test from left foot to the left; 6- Y balance test from left foot to the right;
7- Reactive Y balance test from right foot; 8- Reactive Y balance test from left foot;

The study's paired T test results offer a scientifically robust and detailed analysis of the the balance and reactive balance capabilities of young basketball players. These results, encapsulated in key statistical measures, provide a comprehensive view of the efficacy of the training regimen.

The Y balance test results indicate significant improvements in balance capabilities. The negative mean values, ranging from -7.632 to -11.737 across different directions, reflect a notable increase in the distance reached during the balance tests from initial to final testing. This demonstrates a clear enhancement in the athletes' balance. However, the standard deviation values, while relatively moderate, suggest some variability in the balance improvements among the participants. This implies that, although the overall trend was positive, individual responses to the training varied.

The precision of the mean changes is underscored by the relatively low standard error mean values. Moreover, the narrow 95% confidence intervals provide a high level of statistical certainty about the range within which the true mean improvements in balance lie. The significantly high t-values, coupled with a significance level of 0.000, underscore the statistical significance of the improvements observed in the Y balance tests. The moderate to large effect sizes, as indicated by Cohen's Effect Size, further suggest that the training had a substantial and practical impact on the athletes' balance performance.

The results of the reactive Y balance tests provide additional insights. The positive mean values for both the right and left foot indicate improvements in the athletes' reaction times. Lower standard deviations in these tests suggest a more consistent performance among the athletes in their reactive capabilities, likely attributable to the specific focus of the training on reactive balance. The significant t-values and a significance level of 0.000 confirm the statistical robustness of these improvements. The effect size values, denoting a moderate impact of the training program, highlight the efficacy of the program in improving the athletes' reactive balance abilities.

In summary, the study robustly demonstrates the significant enhancement of both static and dynamic balance capabilities of young basketball players through the implemented training program. The statistical analysis not only confirms the effectiveness of the program but also reveals the varying degrees to which individual athletes benefited from the training. This provides valuable insights for the development of future athletic training programs, emphasizing the importance of customizing training approaches to cater to individual variability among athletes. The comprehensive approach of the study, combining traditional balance assessments with modern reactive balance tests, establishes a nuanced understanding of the multifaceted nature of balance and coordination in sports training. This research thus offers important implications for coaches and trainers aiming to optimize athletic performance through targeted and scientifically grounded training methodologies.

7. Discussions

Boccolini et al. [3] compared the effectiveness of traditional balance training with isotonic training in enhancing balance and vertical jump abilities in young basketball players. This study underscores the significance of physical training methods in improving specific athletic skills without the intervention of technology. Conversely, we introduced a modern technological approach, employing "Fitlight" technology, to assess and improve the balance and reactive balance abilities of a similar age group in basketball.

Villalba et al. [13] delves into the impact of a 6-week plyometric training program conducted on either solid ground or a mini-trampoline, assessing its effects on basketball players' strength, jumping, landing, and balance. It underscores the benefits of conventional ground-based plyometric training for enhancing landing performance and balance, however we adopted a more innovative approach by integrating "Fitlight" technology into the training regimen of young basketball players, focusing on enhancing balance and reactive balance abilities. This technological integration allows for a more precise and individualized assessment of athlete performance, potentially offering superior training adaptability and efficiency compared to the traditional methods evaluated by [13].

Tassignon [12] introduces the Reactive Balance Test (RBT), a tool integrating neurocognitive components to assess adaptability in functional performance tests, specifically targeting recreational athletes. It emphasizes the need for tests that mirror real-sport situations and the reliability of such assessments. In contrast, we enhance training effectiveness through the use of "Fitlight" technology, applied to young basketball players to improve balance and reactive balance abilities. Our approach offers a more sophisticated, technologically-advanced method, providing more precise and varied data on athlete performance compared to [13]'s focus on adaptability in a controlled environment. While both articles aim to bridge the gap between actual sports contexts, our use of technology like "Fitlight" seems to offer a more nuanced and comprehensive approach to training and performance assessment.

8. Conclusions

Our research based on traditional Y Balance Tests and innovative Reactive Y Balance Tests, utilizing "Fitlight" technology, conducted over an 8 weeks training period, concluded the importance of incorporating modern technologies in basketball training, particularly for developing specific skills like balance and reactive balance in young athletes.

9. Proposals

It is proposed that an evaluation should be conducted not solely on the static balance abilities of young basketball players but also on their dynamic, reactive balance capabilities. This approach takes into consideration the fast-paced nature of basketball, which necessitates quick responses under varying conditions.

References

1. Baige, K., Noé, F., Paillard, T.: *Wearing compression garments differently affects monopodal postural balance in high-level athletes*. In: Scientific Reports. Sep 18; 10(1), 2020, p.15331.
2. Bieć, E., Kuczyński, M.: *Postural control in 13-year-old soccer players*. European journal of applied physiology, 110, 2010 Nov., p.703-8.
3. Boccolini, G., Brazzit, A., Bonfanti, L., et al.: *Using balance training to improve the performance of youth basketball players.* In: Sport sciences for health, 9, 2013, p.37-42.
4. Brachman, A., Kamieniarz, A., Michalska, J., et al.: *Balance training programs in athletes – A systematic review.* In: Journal of human kinetics, 1;58(1), 2017 Aug, p.45-64.
5. Bressel, E., Yonker, J.C., Kras, J., et al.: *Comparison of static and dynamic balance in female collegiate soccer, basketball, and gymnastics athletes*. Journal of athletic training, 42(1), 2007 Jan., p.42.
6. De Noronha, M., França, L.C., Haupenthal, A., et al.: *Intrinsic predictive factors for ankle sprain in active university students: a prospective study*. In: Scandinavian journal of medicine & science in sports, 23(5), 2013 Oct., p. 541-547.
7. Gerbino, P.G., Griffin, E.D., Zurakowski, D.: *Comparison of standing balance between female collegiate dancers and soccer players*. In: Gait & posture, 26(4), 2007 Oct 1; p.501-507.
8. Ghislieri, M., Gastaldi, L., Pastorelli, S., et al.: *Wearable inertial sensors to assess standing balance:* A systematic review. In: Sensors, 19(19), 2019 Sep 20; p. 4075.
9. Glasgow, P., Bleakley, C.M., Phillips, N. *Being able to adapt to variable stimuli: the key driver in injury and illness prevention*? In: British journal of sports medicine, 47(2), 2013, p.64-5.
10. Nikolaos, K., Evangelos, B., Nikolaos, A., et al.: *The effect of a balance and proprioception training program on amateur basketball players' passing skills.* Journal of Physical Education and Sport, 1;12(3), 2012, p.316.
11. Nuri, L., Shadmehr, A., Ghotbi, N., et al.: *Reaction time and anticipatory skill of athletes in open and closed skill-dominated sport.* European journal of sport science, 13(5), 2013, p.431-436 .
12. Tassignon, B., Verschueren, J., De Wachter, J., et al.: *Test-retest, intra- and inter-rater reliability of the reactive balance test in healthy recreational athletes.* In: Physical therapy in sport, 46, 2020, p.47-53.
13. Villalba, M.M., Eltz, G.D., Fujita, R.A., et al.: *Effects of six weeks of plyometric training on the ground vs on a mini-trampoline on strength, jump performance, and balance in male basketball players—Randomized clinical trial.* In: Sport Sciences for Health, 19(3), 2023, p. 829-839.
14. Wilkerson, G.B.: *Neurocognitive reaction time predicts lower extremity sprains and strains.* International Journal of Athletic Therapy and Training, 17(6), 2012, p. 4-9.

15. Zacharakis, E.D., Bourdas, D.I., Kotsifa, M.I., et al.: *Effect of balance and proprioceptive training on balancing and technical skills in 13-14-year-old youth basketball players*. Journal of Physical Education and Sport, 2020 Sep 1; 20(5), p.2487-500.