El impacto de las tecnologías en el desarrollo de la velocidad repetitiva en balonmano, baloncesto y voleibol

The impact of technologies on the development of repetitive speed in handball, basketball and volleyball

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Abstract

Introduction and objective: The study focused on identifying the differences regarding the implementation of a program that uses Fitlight technology and targets the development of simple and reactive repetitive speed in manual and bilateral manual executions.
Methodology: There were 311 subjects in the study, including 243 student-athletes (handball, basketball, and volleyball) and 65 recreational subjects (control group). Study phasing: initial testing; implementing a 6-week experimental program using the Fitlight technology to improve manual, repetitive speed; final testing. Study tests: the Tapping the plates test-unilateral execution with the dominant hand (TP_dominant hand), the random reactive plate touching test_unilateral execution with the dominant hand (TPR_dominant hand), Touching the plates test- bilateral execution (TP_bilateral), Test Touching the plates bilateral execution-random reactive (TPR_bilateral).
Results: The ANOVA analysis highlighted significant differences between the male and female groups, respectively, for all four versions of the Tapping Plate Test, for $p<0.05$. While analyzing the results of the male/female sports game groups, the most significant differences in progress were recorded in TP_dominant hand between Volleyball-Basketball with 0.179/0.126 executions; TPR_ dominant hand between Volleyball-Basketball -0.126/0.086 executions; TP_bilateral between Volleyball-Basketball -0.154/-0.173 executions; bilateral TPR_ between Volleyball-Handball -0.016/-0.033 executions. Analyzing the study results, we found that the control group recorded lower results than all the experimental groups.
Conclusions: The Fitlight technology positively impacted the environment of simple and reactive repetitive speed when practicing an experimental program of specific exercises adapted to team sports games.

Keywords

Fitlight technology; reactive repetitive speed; reaction time; simple repetitive speed; team sport; visual stimulus.

Resumen

Introducción y objetivo: El estudio se centró en identificar las diferencias en la implementación de un programa que utiliza la tecnología Fitlight y apunta al desarrollo de la velocidad repetitiva simple y reactiva, en ejecuciones manuales y manuales bilaterales.
Metodología: En el estudio participaron 311 sujetos, incluidos 243 estudiantes-atletas (balonmano, baloncesto y voleibol) y 65 sujetos recreativos (grupo de control). Fases del estudio: prueba inicial; implementar un programa experimental de 6 semanas utilizando la tecnología Fitlight para mejorar la velocidad repetitiva manual; prueba final. Pruebas de estudio: la prueba de Tapping the plates-ejecución unilateral con la mano dominante (TP_mano dominante), la prueba de toque de placa reactiva aleatoria_ejecución unilateral con la mano dominante (TPR_mano dominante), la prueba de Touching the plates-ejecución bilateral (TP_bilateral), la prueba de Tocar el pagos reactivos aleatorios de ejecución bilateral (TPR_bilateral).
Resultados: El análisis ANOVA de los resultados destacó diferencias significativas entre los grupos masculino y femenino, respectivamente, para las 4 versiones de la prueba Tapping Plate, para $p<0,05$. Al analizar los resultados de los grupos de juego deportivo masculino/femenino, las mayores diferencias en el progreso se registraron en TP_mano dominante entre Voleibol-Baloncesto con 0,179/0,126 ejecuciones; TPR_ mano dominante entre Voleibol-Baloncesto -0,126/0,086 ejecuciones; TP_bilateral entre Voleibol-Baloncesto -0,154/-0,173 ejecuciones; TPR_ bilateral entre ejecuciones de Voleibol-Balonmano -0,016/-0,033 Analizando los resultados del estudio, encontramos que el grupo control registró resultados inferiores a todos los grupos experimentales.
Conclusiones: El uso de la tecnología Fitlight tuvo un impacto positivo en el entorno de velocidad repetitiva simple y reactiva como parte de la práctica de un programa experimental de ejercicios específicos adaptados a juegos de deportes de equipo.

Palabras clave

Tecnología Fitlight; velocidad repetitiva reactiva; tiempo de reacción; velocidad repetitiva simple; equipo deportivo; estimulado visualmente.

Introduction

The use of information has determined the modernization of sports training in team sports games targeting the physical fitness components (Birnstiel & Morschheuser, 2024; Torres-Ronda et al., 2020; Cojanu & Cătănescu, 2010). The specialization of information technologies to the characteristics of sports also required the adaptation of specific terminology; the concept of ''reactive'' associated with the components of physical fitness emerged. (Emmanouil, et al., 2024; Henry, et al., 2016; Kamijo, et al., 2016). Reactivity concepts describe how human movements adapt to various stimuli influenced by information technologies. The visual stimuli provided by the technology are characterized by the versatility of the intensity and duration of the stimulus and the range of colors (Shekar et al., 2021; Silvestri et al., 2023).

The movement complexity, the adaptation requirements of motor and technical skills to variable conditions, the trend of dynamism of physical and technical training, and the increasing performance requirements of the athletes characterize team sports games. (Duarte, et al., 2012; Badau, 2024, Durukan et al., 2023) The reaction time is an essential indicator of repetitive speed, which is defined by the time required to perform several repetitions of the same movement (Baba et al., 2024; Hassan et al., 2023; Catanescu, & Cojanu, 2021; Mickevičienė et al., 2008; Nechita, 2018). Execution speed, repetitive speed, and coordination are essential components of physical fitness with a significant impact on the performance of athletes practicing team sports games (Delmas et al., 2018; Casamento-Moran, 2019). Team sports games are characterized by a wide variety of technical procedures performed with the dominant or bilateral hand and whose efficiency is conditioned by the level of development of motor skills and motor skills (Moreno et al., 2022; Farley, 2020; Stöckel & Weigelt, 2012). Studies in the motor skills field have shown that both coordination and especially speed are dependent on the nature and versatility of the movement and the improvement of reaction time speed (Tarkka & Hautasaari, 2019; Trofimova et al., 2020; Lakhani et al., 2014). Reaction time, repetitive speed, and manual coordination to visual stimuli can determine the improvement of the players' motor parameters performance with an impact on the technical mastery and performance specific to sports games (Erickson, 2021; Forni et al., 2022). Using technologies such as Fitlight and modern digitalization trends is relevant and imperative to understanding ways to optimize athlete performance in various team sports. The use of modern technology that involves visual stimuli, such as Fitlight (Fitlight, 2024), in the process of preparation and the evaluation of the reactive parameters of physical fitness, is an effective way of optimizing the motor and technical potential of athletes who practice team sports (Hassan, et al., 2022; Willberg et al., 2023). Fitlight technology can be used both in the preparation process and in the assessment of the level of the development of reaction time, repetitive speed, and manual coordination due to the setting possibilities and versatility of the light spots (Myers et al., 2022; Ezhov et al., 2021; Fitlight, 2024). It provides real-time information that contributes to the efficiency of movement training (de-Oliveira et al., 2021; Myers et al., 2022; Ezhov et al., 2021; Turdaliyev et al., 2024).

The Fitlight technology was implemented in the study to prepare and evaluate the simple and reactive repetitive speed of athletes practicing handball, basketball, and volleyball. By analyzing the specialized literature, we identified that the approach to the reactive components of physical fitness has been studied in different sports (Forni et al., 2022; Duda, 2020). However, a few comparative studies have been carried out between other games. The studies highlighting how the Fitlight technology influences repetitive speed and unilateral and bilateral hand coordination through the comparative analysis of handball, basketball, and volleyball players have not been addressed until now. The present study adapted the Plate Tapping Test to unilateral and bilateral manual executions and Fitlight technology. Current training trends in team sports require performing technical actions in speed conditions, which increases sports mastery and efficiency. The use of information technologies to develop technical skills in reactivity conditions has begun to diversify in the last period due to the specialization of technologies according to the characteristics of sports. The dynamization of sports training through technologies determines the increase of diversification possibilities and real-time monitoring of the execution parameters of technical skills specific to different sports. Adapting the training program using Fitlight technology in team sports will facilitate understanding how the repetition speed can be improved, directly affecting sports efficiency.

The study aims to expand the knowledge on how implementing an exercise program that uses the Fitlight technology will determine the development of simple and reactive repetitive speed in handball, basketball, and volleyball athletes. Previous research has not compared Fitlight technology applications across team sports in depth. The innovative aspects of the study consist of the conception and implementation of an experiment program by adapting exercises to improve manual, repetitive speed using Fitlight technology. In addition, we adapted the Tapping Plate test to evaluate simple and reactive repetitive speed using Fitlight technology. The study focused on identifying the differences regarding implementing a program that uses Fitlight technology and aims to develop simple and reactive repetitive speed in unilateral and bilateral manual executions between athletes who practice handball, basketball, and volleyball.

Method

Participants

The total number of subjects included in the study was 311, of which 243 were student-athletes and 65 were recreational students, who formed the control group. The 243 athletes had the following gender structure: 118 (48.5%) female and 125 (51.5%) male athletes. The athletes were structured into groups according to the team's sport they played and gender as follows: male group (MG): handball 35 (28%) subjects, basketball 31 (24.8%) subjects, volleyball 29 (23.2%) subjects; female group (FG): handball 33 (27.9%) subjects, basketball 30 (25.4%) subjects and volleyball 27 (22.7%) subjects. For the reliability of the study, we also evaluated 68 subjects who do not practice performance sports but only for recreational purposes, divided into two groups according to gender: 33(48.5%) female and 35 (51.5%) male. The inclusion criteria for the groups of athletes are age between 18-25 years old, active athletes, good health, completion of the 4-week training program, and completion of all study tests. Inclusion criteria for the control groups were as follows: age between 18-25 years old, good health, and performance on all study tests.

Research design

The study period: May-June 2024; the study phasing: initial testing (IT) in the first week; 6 weeks of implementing an experimental program to develop the speed of simple and reactive repetitions; a week for the final tests (FT). All participants in the experimental groups carried out the experimental program. The exercises within the experimental program were adapted to Fitlight technology and the specifics of the team sports selected for the study. The Faculty of Physical Education and Mountain Sports Ethics Committee approved it under no. 401/06.12.2023. Participation in the survey was voluntary; the study respected the principles of the Declaration of Helsinki.

Testing procedure

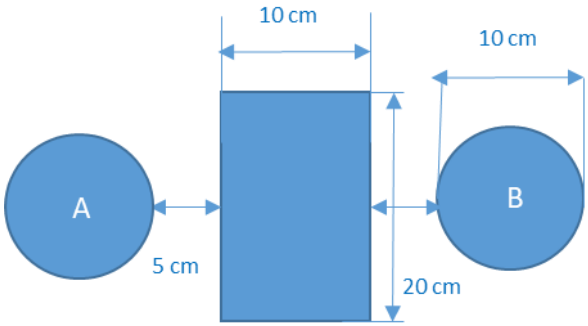
Within the study, four versions of the Tapping Plate Test will be performed: the standardized version of the Tapping the plates test-unilateral execution with the dominant hand (TP_dominant hand) and three variants adapted for this study: The random reactive plate touching test_unilateral execution with the dominant hand (TPR_dominant hand), Touching The plates test bilateral execution (TP_bilateral) and test touching the plates bilateral execution - random. reactive (TPR_bilateral). In the specific training process for sports players, repeating a technical skill with speed and technique parameters is essential for increasing the efficiency of executions (Torres-Ronda et al., 2022; Keller et al., 2020). Evaluation of manual repetition speed using the Plate Tapping test in sports games has shown that using sensors or information technologies ensures the reliability and validity of the results. Evaluation of manual repetition speed by using the Plate Tapping test in sports games shows that the use of sensors or information technologies ensures the reliability and validity of the results (Mancini et al., 2024; Arede et al., 2020; Marković et al., 2020).

The evaluation requirements: the performer is placed in front of a table, L/l of at least 1/1/m, height at the level of the umbilical region of the subject on which the test specific to the study is marked as in Figures 1-4. The circles will be placed to the right and the left of the rectangles/rectangles; the centers of all the geometric figures should be aligned. The examiner measures in seconds the time required for each circle A/B to be touched correctly 25 times, a total of 50 touches. The evaluator counts the number

of correctly touched circles out loud. For Motor Test 1,2, the spare hand is placed on the cross in the middle of the rectangle, and the dominant hand performs the test. For Motor Test 3,4, each hand is placed on the corresponding rectangle on the same side depending on the direction of execution (the right hand is in the right rectangle, and during the test, it touches the circle on the right, and the left hand on the left side). The test starts with the verbal "Start" sign and ends with the "Stop" sign. Each motor test is performed 2 times, and the best-achieved result is quantified in the study—test 1. Touching the plate test is part of the Eurofit test battery, and we adapted the motor tests 2-4 for this study. In tests 2 and 4, we added Fitlight sports with blue and red colors, according to Figure 2,4. Description of the motor tests of the study:

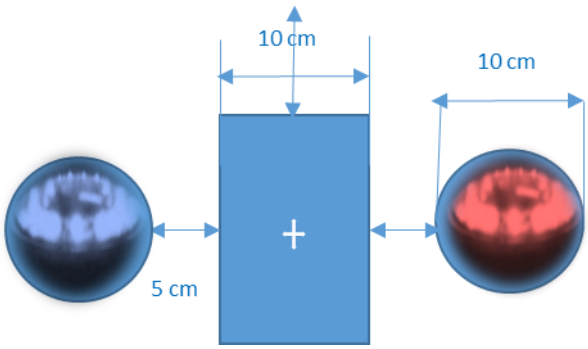
-Test 1. Touching the plates—unilateral execution with the dominant (TP_dominant hand). The spare hand is placed on the cross in the middle of the rectangle, and the dominant hand performs the test. The total number of touches is 50: 25 touched with the right hand and 25 touched with the left hand (Figure 1).

Figure 1. TP_ dominant hand - unilateral



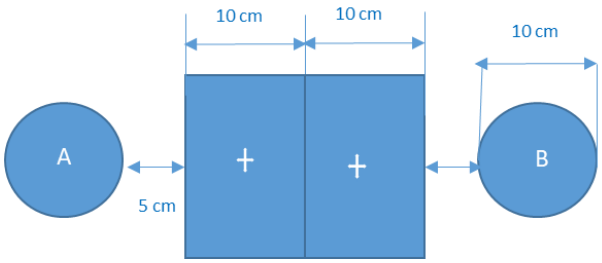
-Test 2. Touching the plates reactive randomly- unilateral execution with the dominant hand (TPR_dominant hand), touching the Fitlight corresponding to the color of the spot that illuminates (lights up), randomly one of the two colors red or blue, and the performer must touch the sport in the corresponding circle the color of the respective spot. If the spot that illuminates is red, touch the spot on the red right side with the red light, and if the spot that illuminates is blue, touch the spot on the left side with the left hand. Total touches are 50, 25 with the right hand and 25 with the left (Figure 2).

Figure 2. TPR_ dominant hand - unilateral



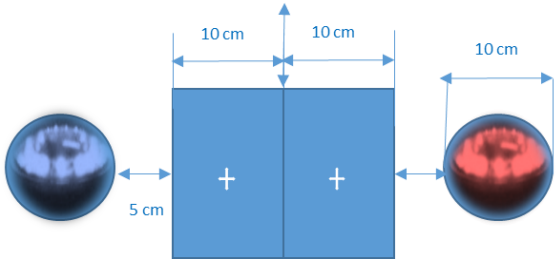
-Test 3. Touching the plates- bilateral execution (TP_bilateral), both palms are placed in the corresponding rectangle, and at the verbal command "Start," the performer touches the circle on the right side with the right hand and returns to the rectangle, then with the left-hand touches the circle on the left side and returns to the rectangle, the test continues until the completion of the 50 bilateral touches (25 touches with each hand) (Figure 3).

Figure 3. TP_ bilateral



-Test 4. Touching the plate's bilateral execution _reactive randomly (TPR_bilateral), idem Test 2 only that this is executed bilaterally. Both hands are placed in the rectangle corresponding to the execution part, and the blue spot is touched with the left hand and the red spot with the right hand, depending on the color that lights up. The total touches are 50, 25 touches with each hand (Figure 4).

Figure 4. TPR_ bilateral



Training procedure

The experimental program implemented by each group lasted 6 weeks/ 2 times a week/ 30 minutes per session. Each experimental group subject performed two manual, repetitive speed exercises in which Fitlight technology was used per training session. The exercises were similar for all the study subjects, regardless of their sport. The exercises were adapted to the particularities of age and the purpose of the study. They concerned manual, repetitive speed exercises in conditions of reactivity, in which the Fitlight had various geometrical arrangements, and the executions were mainly performed with the dominant hand but also with the non-dominant one, unilaterally or bilaterally.

Data analysis

Statistical-mathematical analysis with IBM-SPSS 26, the statistical parameters: arithmetic mean (X) standard deviation (SD.), confidence intervals upper is lower for 95% (95% CI), t values (for Student t-test), probabilistic significance levels (p). ANOVA variance analysis was used to highlight the statistical significance of the differences between the arithmetic means of the study groups. Statistical probability reference value $p<0.05$.

Results

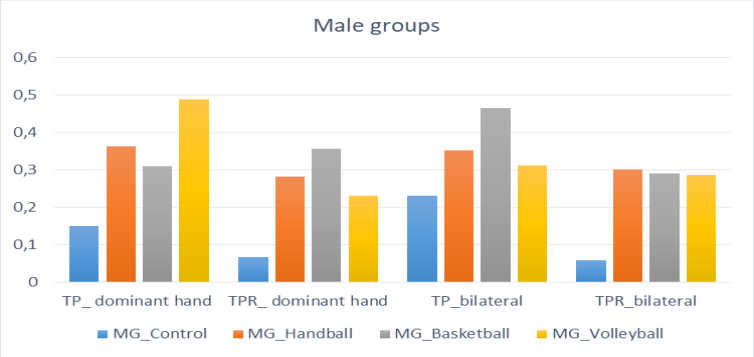
Tables 1-6 present the most relevant results of the study, highlighting the arithmetic averages achieved, the progress recorded between the initial and final testing, and the statistical significance of the Tapping Plate Test results in the standardized and adapted version for the reactive evaluation aspects of simple and reactive repetitive speed.

Table 1. Statistical analyses of the results of the Tapping Plate Test – male groups

Tapping Plate Test	Team Sports	Tests	X	SD	ΔX (IT-FT)	95%CI Upper; Lower		t	p
TP_ dominant hand	MG_Control	IT	11.469	1.322	0.150	0.027	0.274	2.482	0.019
		FT	11.318	1.254					
	MG_Handball	IT	10.738	1.245	0.361	0.130	0.592	3.206	0.003
		FT	10.377	0.926					
	MG_Basketball	IT	10.728	1.192	0.308	0.096	0.519	2.985	0.006
		FT	10.420	0.851					
	MG_Volleyball	IT	11.335	1.118	0.487	0.143	0.831	2.915	0.007
		FT	10.847	0.776					
TPR_ dominant hand	MG_Control	IT	11.965	1.355	0.065	-0.030	0.161	1.395	0.173
		FT	11.900	1.297					
	MG_Handball	IT	11.640	1.258	0.281	0.125	0.586	3.163	0.004
		FT	11.359	1.066					
	MG_Basketball	IT	12.063	1.215	0.356	0.125	0.586	3.163	0.004
		FT	11.707	1.064					
	MG_Volleyball	IT	12.423	1.439	0.230	0.064	0.395	2.853	0.008
		FT	12.193	1.247					
TP_ bilateral	MG_Control	IT	14.053	1.516	0.229	-0.044	0.503	1.703	0.098
		FT	13.824	1.384					
	MG_Handball	IT	13.266	1.078	0.352	0.147	0.558	3.522	0.002
		FT	12.913	0.972					
	MG_Basketball	IT	13.203	1.403	0.465	0.195	0.735	3.529	0.001
		FT	12.737	1.381					
	MG_Volleyball	IT	13.925	1.067	0.311	0.081	0.5405	2.787	0.010
		FT	13.614	1.247					
TPR_ bilateral	MG_Control	IT	15.021	1.189	0.057	-0.016	0.131	1.580	0.124
		FT	14.964	1.151					
	MG_Handball	IT	14.181	0.962	0.301	0.102	0.477	3.177	0.004
		FT	13.890	0.852					
	MG_Basketball	IT	14.181	0.798	0.289	0.093	0.485	3.024	0.005
		FT	13.891	0.939					
	MG_Volleyball	IT	14.212	0.899	0.285	0.095	0.475	3.086	0.005
		FT	13.926	0.901					

MG- Male group, TP-Tapping Plate Test, TPR-Tapping Plate Test Reactive, IT-initial test; FT-final test; X-arithmetic average; SD-standard deviation; t-Student's t-test, ΔX-average differences between tests; 95%CI-interval of confidence.

Figure 1. Progress recorded between tests - male groups



The results in Table 1, Figure 1, reveal that MG_Control recorded much less progress than the team sports game groups in all four variants of the Tapping Plate Test. Analyzing in comparison the results of the groups of team sports games, at the initial and the final test, it is found that MG_Volleyball registered the best progress results at TP_dominant hand with 0.487 executions; MG_Basketball at TPR_dominant hand with 0.356 executions; MG_Basketball at TP_bilateral with 0.465 executions; MG_Handball at TPR_bilateral with 0.301 executions. MG_Basketball registered the lowest progress at TP_dominant hand with 0.308 executions, MG_Volleyball at TPR_dominant hand with 0.230 executions; MG_Volleyball at TP_dominant hand with 0.311 executions; MG_Volleyball at bilateral TPR_with 0.285 executions. The progress recorded in all groups' tests was situated between the lower and upper limits of the 95% CI. Analyzing the statistical significance (p) values, we find that MG_Control did not register statistically significant progress. However, for MG of handball, basketball, and volleyball, the statistical progress of the experimental groups of team games was statistically significant. It highlights the effectiveness of the

experimental program in developing simple and reactive repetitive speed. Compared to the sports game groups, the control group recorded inferior results, the cause of which we consider to be insufficient specialization, objectification, and individualization of sports training. The control group demonstrated minimal improvement, likely due to the absence of structured training or exposure to reactive stimuli.

Table 2. ANOVA analyses of the results of the Tapping Plate Test – male groups

Tapping Plate Test	Test	Sum of Squares	Mean Square	F	p
TP_ dominant hand	IT	13.750	4.583	3.044	0.032
	FT	18.077	6.026	6.227	0.001
TPR_ dominant hand	IT	8.589	2.863	1.646	0.018
	FT	9.953	3.318	2.395	0.042
TP_bilateral	IT	17.449	5.816	3.458	0.019
	FT	25.394	8.465	5.280	0.002
TPR_bilateral	IT	16.433	5.478	5.686	0.001
	FT	26.843	8.948	9.377	0.000

TP-Tapping Plate Test, TPR-Tapping Plate Test Reactive, IT-initial test, FT-final test, F-test value, p-probability level.

The analysis of ANOVA helped identify significant differences between the male groups of the study for all four variants of the Tapping Plate Test. Both at the initial and final tests, for all Tapping Plate Test variants, the differences between the arithmetic means of the study groups were statistically significant, for $p<0.05$ (Table 3), which explains the positive impact of the experimental program.

Table 3. Differences in progress recorded in the study at the Tapping Plate Test – male groups

Tapping Plate Test	Group	MG_Handball	MG_Basketball	MG_Volleyball
TP_ dominant hand	MG_Control	0.211	0.158	0.337
	MG_Handball	-	-0.053	0.126
	MG_Basketball	-	-	0.179
TPR_ dominant hand	MG_Control	0.216	0.291	0.165
	MG_Handball	-	0.075	-0.051
	MG_Basketball	-	-	-0.126
TP_bilateral	MG_Control	0.123	0.236	0.082
	MG_Handball	-	0.113	-0.041
	MG_Basketball	-	-	-0.154
TPR_ bilateral	MG_Control	0.244	0.232	0.228
	MG_Handball	-	-0.012	-0.016
	MG_Basketball	-	-	-0.004

TP-Tapping Plate Test, TPR-Tapping Plate Test Reactive, MG- Male Group

Table 3 shows that all three male groups of team sports games have made more significant progress than the control group in all four motor tests. Table 3 highlights the differences in progress made by the male groups of the study in all four variants of the Tapping Plate Test. Analyzing the results of the sports game groups, we find that the most significant differences in progress were recorded in the dominant TP_hand between the volleyball and basketball groups with 0.179 executions; for TR_dominant hand between the volleyball and basketball groups of -0.126executions; for TP_bilateral between the volleyball and basketball groups of -0.154 executions; for TPR_bilateral between the volleyball and handball groups of -0.016 executions. In all the tests, analyzing the differences between the study's control group and the other three female groups, we noticed that the differences were much more significant in favor of the team sports groups. The results demonstrate that Fitlight technology effectively improves both simple repetitive and reactive speed, especially in sports that require high manual coordination, such as volleyball and basketball.

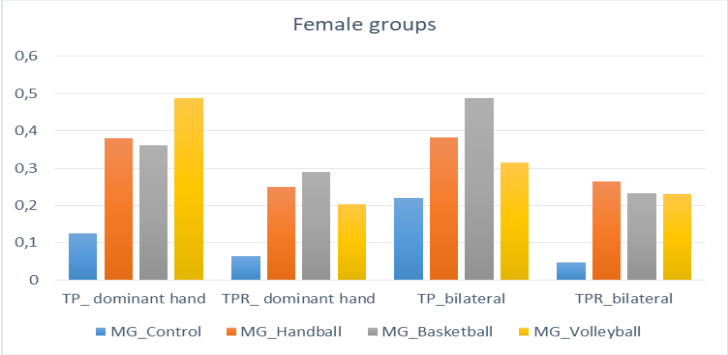
Table 4. Statistical analyses of the results of the Tapping Plate Test – female groups

Tapping Plate Test	Team Sports	Tests	X	SD	ΔX (IT-FT)	95%CI Upper; Lower		t	p
TP_ dominant hand	FG_Control	IT	11.535	1.374	0.126	0.021	0.232	2.445	0.020
		FT	11.408	1.308					
	FG_Handball	IT	10.805	1.292	0.380	0.135	0.625	3.184	0.004
		FT	10.424	0.920					
	GG_Basketball	IT	10.760	1.196	0.362	0.133	0.592	3.224	0.003

		FT	10.397	0.845					
	FG_Volleyball	IT	11.359	1.099	0.488	0.143	0.832	2.910	0.007
		FT	10.871	0.739					
	FG_Control	IT	11.997	1.396	0.063	-0.033	0.158	1.336	0.191
		FT	11.934	1.344					
	FG_Handball	IT	11.689	1.279	0.249	0.041	0.458	2.456	0.021
TPR_ dominant hand		FT	11.440	1.050					
	GG_Basketball	IT	12.030	1.253	0.289	0.063	0.515	2.617	0.014
		FT	11.741	1.042					
	FG_Volleyball	IT	12.426	1.437	0.203	0.037	0.369	2.510	0.019
		FT	12.224	1.243					
	FG_Control	IT	14.117	1.478	0.221	-0.053	0.496	1.643	0.110
		FT	13.896	1.342					
	FG_Handball	IT	13.300	1.075	0.382	0.172	0.592	3.735	0.001
TP_bilateral		FT	12.918	0.965					
	GG_Basketball	IT	13.244	1.423	0.487	0.214	0.761	3.642	0.001
		FT	12.757	1.371					
	FG_Volleyball	IT	13.980	1.062	0.314	0.095	0.534	2.947	0.007
		FT	13.665	1.145					
	FG_Control	IT	15.046	1.204	0.048	-0.024	0.120	1.365	0.182
		FT	14.998	1.169					
	FG_Handball	IT	14.212	0.926	0.264	0.077	0.450	2.896	0.007
TPR_ bilateral		FT	13.949	0.820					
	GG_Basketball	IT	14.225	0.801	0.233	0.010	0.455	2.140	0.041
		FT	13.992	0.897					
	FG_Volleyball	IT	14.219	0.889	0.231	0.053	0.410	2.662	0.013
		FT	13.987	0.889					

FG – female group, TP-Tapping Plate Test, TPRA-Tapping Plate Test Reactive, IT-initial test; FT-final test; X-arithmetic average; SD-standard deviation; t-Student's t-test, ΔX-average differences between tests; 95%CI-interval of confidence.

Figure 2. Progress recorded between tests - female groups



The progress recorded in all tests by all groups was situated between the lower and upper limits of the 95% CI. Analyzing the statistical significance (p) values, we find that FG_Control did not register statistically significant progress, but FG of handball, basketball, and volleyball registered statistically considerable progress, for $p<0.05$. The fact that the progress of the experimental groups of team games was statistically significant highlights the effectiveness of the experimental programs for the development of simple and reactive repetitive speed. The results in Table 4 and Figure 2 show the relevance of the fact that FG_Control recorded much less progress compared to the team sports groups in all four variants of the Tapping Plate Test. In Table 4, it can be seen that the best progress among the groups of team sports games was integrated by: FG_Volleyball to TP_dominant hand with 0.488 executions; FG_Basketball at TPR_dominant hand with 0.289 executions; FG_Basketball at TP_bilateral with 0.487 executions; FG_Handball at TPR_bilateral with 0.264 executions. The lowest progress was registered by: FG_Basketball at TP_dominant hand with 0.362 executions; FG_Volleyball at TPR_dominant hand with 0.203 executions; FG_Volleyball at TP_bilateral with 0.314 executions; FG_Volleyball at bilateral TPR_dominant hand with 0.231 executions. The control group's results, which were much lower than those of the other study groups, resulted from insufficiently specialized sports training focused on specific objectives for sports performance. The lack of use of light stimuli by integrating Fitlight technology into the training process of the control group resulted in lower progress than the team sports groups.

Table 5. ANOVA analyses of the results of the Tapping Plate Test – female groups

Tapping Plate Test	Test	Sum of Squares	Mean Square	F	p
TP_ dominant hand	IT	13.885	4.628	2.958	0.035
	FT	21.155	7.052	7.143	0.000
TPR_ dominant hand	IT	7.527	2.509	1.390	0.249
	FT	9.038	3.013	2.157	0.097
TP_bilateral	IT	18.459	6.153	3.708	0.014
	FT	28.205	9.402	6.256	0.001
TPR_ bilateral	IT	16.274	5.425	5.687	0.001
	FT	24.838	8.279	8.924	0.000

TP-Tapping Plate Test, TPR-Tapping Plate Test Reactive, IT-initial test, FT-final test, F-test value, p-probability level.

The static ANOVA analysis in Table 5 highlights that in the initial tests, as well as in the final tests, in all variants of the Tapping Plate Tests, the differences between the arithmetic means of the female groups of the study were statistically significant through this analysis, the identification of significant differences between the female groups of the study highlights the effectiveness of the experimental program applied only to groups of team sports games.

Table 6. Differences in progress recorded in the study at the Tapping Plate Test – female groups

Tapping Plate Test	Group	FG_Handball	FG_Basketball	FG_Volleyball
TP_dominant hand	FG_Control	0.254	0.236	0.362
	FG_Handball	-	-0.018	0.108
	FG_Basketball	-	-	0.126
TPR_ dominant hand	FG_Control	0.186	0.226	0.14
	FG_Handball	-	0.04	-0.046
	FG_Basketball	-	-	-0.086
TP_bilateral	FG_Control	0.161	0.266	0.093
	FG_Handball	-	0.105	-0.068
	FG_Basketball	-	-	-0.173
TPR_ bilateral	FG_Control	0.216	0.185	0.183
	FG_Handball	-	-0.031	-0.033
	FG_Basketball	-	-	-0.002

TP-Tapping Plate Test, TPR-Tapping Plate Test Reactive, GG- Female Group

While analyzing the results of the female sports game groups (Table 6), we found out that the most significant differences in progress were recorded in TP_dominant hand between the volleyball and basketball groups with 0.126 executions; for TPR_ dominant hand between the volleyball and basketball groups of -0.086 executions; for TP_bilateral between the volleyball and basketball groups of -0.173 executions; for bilateral TPR_ between the volleyball and handball groups of -0.033 executions. In all tests, analyzing the differences between the control group and the other three groups of the study, we found that the differences favored the team sports groups. The results in Table 6 show that all three female groups of team sports games recorded more significant progress than the control group in all four variants of the Tapping Plate Tests. Fitlight technology optimizes simple and reactive repetitive speed, with increased impact in volleyball and basketball, requiring technical skills under conditions of high manual coordination and speed.

Discussion

The study aimed to identify the differences regarding implementing an experimental program of specific exercises that uses Fitlight technology and aims to develop the speed of simple and reactive repetitive unilateral and bilateral manual executions among athletes who practice handball, basketball, and volleyball. Our results improve understanding of how the use of information technologies in the training process of handball, basketball, and volleyball athletes through integration in specific exercises can determine the development of repetitive speed, dominant unilateral manuals, and bilateral executions.

Analyzing the results, we find that the progress of the control group was lower than that of the experimental male and female groups in handball, basketball, and volleyball. This fact highlights the positive impact of the experimental program implemented in sports game groups. We find that the progress of the experimental groups of team sports games was statistically significant, compared to those of the control group, which were not statistically significant. The comparison of progress differences between

the handball, basketball, and volleyball groups highlighted the best results in the Tapping Plate reactive tests that the basketball and handball groups, male and female, recorded. The men's and women's volleyball and basketball groups had the most significant progress in tests without using Fitlight technology. The superior results of basketball groups compared to other sports games are influenced by the particularities of the games and the greater diversity of visual stimuli within the games.

Our results align with previous studies that highlighted the positive impact in the development of physical fitness components by practicing exercises that use Fitghlit technology in the process of preparation and evaluation in team sports games (Cieśluk et al., 2023; Vater & Strasburger, 2021; Falces-Prieto et al., 2021). Fitlight technology was used in different studies to optimize and the assessment of static balance (Verschueren et al., 2019; Prelević et al., 2023), assessment of reaction time to simple movements with the lower and upper limbs (Hassan et al., 2022; Čoh et al., 2018); coordination and velocity (Silvestri et al., 2023; Myhill et al., 2023). Previous studies highlighted the different forms of repetitive speed in basketball, handball, volleyball, or other team sports (Balsalobre-Fernández & Torres-Ronda, 2021; Hunter et al., 2011).

A series of studies have highlighted significant progress in the evaluation of motor capacity components as a result of exercises and sports training programs that use Fitlight technologies (Starczewski et al., 2024; Wang et al., 2024), which also substantiates the results of our study. The analysis of the impact of training programs that use information technologies requires interdisciplinary approaches to highlight the contribution of the exchange of knowledge and good practices from different fields (Pinheiro et al., 2023; Andritoi et al., 2023; Iordan et al., 2021). The improvement of human performance is an essential concern of specialists in the field of motor and sports activities and those in related fields (Bardid et al., 2021; Gherghel et al., 2021; Gurau et al., 2023; Gurau et al., 2023). The use of specialized technologies contributes to optimizing the sport's potential from a physical, technical, and mental aspect (Arede et al., 2020; Örs et al., 2019; Al Hussein et al., 2020). Preparation in sports games is conditioned by the contribution of technologies and devices for monitoring biological and sports parameters (Dellaserra et al., 2014; Kos et al., 2018; Torres-Ronda et al., 2022; Camenidis et al., 2021).

The studies have focused on how different forms of speed influence the training process through the use of technologies in individual sports or team games (Forni et al., 2022; Campanella et al., 2024) in the process of motor and functional recovery and rehabilitation (Verschueren et al., 2019; Martin-Niedecken, 2023). The current demands of sports performance are increasingly high, which requires the modernization of the training process. Studies have highlighted the positive impact of implementing Fitlight technology in improving sports training in team games and individual sports (Silvestri et al., 2023; Forni et al., 2022). Studies have highlighted that Fitlight technology's versatility can be used in different forms and modalities in the training process. The software allows personalized adaptation of exercises and tests, facilitating training specialization about training objectives and sports characteristics (Katanić et al., 2020; See et al., 2021).

The study's limitations include the limited implementation period of the experimental program, which was only 6 weeks; no tests were performed with a unilateral monodominant hand; athletes who also practice other sports or individual sports are not included in the study; subjects under 18 or over 25 years old were not included in the study; and different types of technologies were not used.

The practical implications based on the results of this study, we consider that the training methodology of the athletes can be modernized by including exercises that use information technologies; increasing the efficiency of sports training aims at developing all parameters of physical fitness and reaction time is an essential component; the specialization of information technologies facilitates the dynamism and efficiency of monitoring and evaluating the performance of athletes in real time; coaches can use Fitlight technology using preset programs and tests or by creating new exercises and tests adapted to the specific sport and training plans; the versatility of Fitlight technology facilitates the use of visual stimuli in different colors for different tasks, which can make training more efficient and increase the attractiveness of executions.

Conclusions

The use of Fitlight technologies and their adaptation to the typology of sports training and the objectives of sports training and performance contribute to developing sports athletes' physical and technical components. Our study expands the knowledge of how sports training can be modernized and made more efficient by implementing visual stimulus technologies in training and motor testing. The use of the Fitlight technology positively impacted the improvement of simple and reactive repetitive speed at the level of all groups of athletes included in the study as a result of practicing an experimental program of specific exercises adapted to team sports games: handball, basketball, and volleyball. The study's results highlighted significant differences in all motor tests in both subjects' genders. For all four versions of the Tapping Plate Tests included in the study, it was found that for both genders, the most significant progress was registered by the groups: volleyball with TP_dominant hand, basketball with TPR_dominant hand, basketball with TP_bilateral and handball with TPR_bilateral. Comparing the differences in progress between the handball, basketball, and volleyball groups, it was highlighted that the basketball and handball groups, male and female, recorded the best results in the Tapping Plate reactive tests. The men's and women's volleyball and basketball groups had the most significant progress in tests without using Fitlight technology. When analyzing the results, we find that the control group recorded lower results than the experimental, male, and female groups, respectively, the handball, basketball, and volleyball groups. Future research directions could analyze how different components of physical fitness can develop and influence each other by practicing specific programs that use different information technologies and smart sensors.

Author Contributions

Conceptualization: D.B, A.B., V.E-V., C.E-V., D.F.T., C.C.D., V.D., D.C.M., C.O.M.; methodology: D.B, A.B., V.E-V., C.E-V., D.F.T., C.C.D., V.D., D.C.M., C.O.M.; formal analysis: D.B, A.B., V.E-V., C.E-V., D.F.T., C.C.D., V.D., D.C.M., C.O.M.; writing—original draft preparation: B D.B, A.B., V.E-V., C.E-V., D.F.T., C.C.D., V.D., D.C.M., C.O.M. All of the authors have contributed equally for this article; all of them have equal contribution with the first author. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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