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THE APPLICATION OF FITLIGHT TRAINER SYSTEM IN SPORTS

Borko Katanić[1], Predrag Ilić[1], Aleksandar Stojmenović[1], Manja Vitasović[2]

[1]University of Nis, Faculty of Sports and Physical Education, Serbia
[2]Equestrian Club Gorska Team, Serbia

ABSTRACT

The purpose of this systematic review is to point out the application of the Fitlight trainer system in sports. The following electronic databases were used to search the literature: Google Scholar, PubMed, Medline, Mendeley, 2014-2020. Following the selection procedure according to the relevant criteria, 22 studies were selected as fit to needs of this systematic review. A review of researches that used the Fitlight training system in sports has revealed a rather heterogeneous selection of topics. The results obtained are classified according to the sports in which the research was conducted. The results summary provided us with the insight into the multiple uses of the Fitlight system in sports as a training and measurement tool. It can be used in both individual and team sports. It can test sensory-cognitive and various motor skills: reaction speed, speed of single movement, speed of running, agility. Based on all of the information provided, the possibility of multiple applications of the Fitlight system in sports was highlighted.

Keywords: FITLIGHT TRAINER / FT LIGHT / SPORT / ATHLETE / DATABASE

Correspondence with the author: Borko Katanić, E-mail: borkokatanic@gmail.com

INTRODUCTION

It is well known that different audio and visual signs are used in order to train the speed of athletes' reaction, but experts have sought to advance this field with certain technical solutions. The former Danish handball player, Rasmussen, invented the Octopus Trainer in 2007, which is the predecessor of the Fitlight system and the two are very much alike (Stack, 2020). From the initial model, certain modifications occurred, the system became easier to use, switched to wireless mode, etc. and so in 2012 the Fitlight system gets its present appearance and was released as a new product in the same year.

The Fitlight trainer system (FTS) is a unique system for training speed of reaction in athletes. It consists of LED markers controlled by a tablet controller (Mackala, et al., 2020; Schelly, et al., 2019). The Fitlight system consists of 8 markers that are used as targets for the athlete, as he/she seeks to activate or deactivate them as needed. This training system is designed to collect human performance data related to visual, cognitive, and dynamic reactions. It is portable and easy to set up and use, making it a great tool for both training and testing (Fitlight, 2020).

As a fairly new product on the market, the Fitlight system has so far been put in a little use in scientific research in the field of sports. Currently, there are only about 30 available studies in which this instrument has been used. It is mainly used as a measuring instrument, although its creators emphasize that it can also be used as a training tool to improve performance, primarily speed of reaction and sensory-cognitive abilities.

This indicates that using the Fitlight system in different sports and with different research, topics could lead to some answers in this field. In this regard, this review aims to point out the application of the Fitlight system in sports.

METHODOLOGY

Source of data and strategies

The following electronic databases were used to review the literature. Searches were made using the following keywords: Fitlight, sport, athlete. The search strategy was modified for each electronic database, where possible, to increase sensitivity. All titles and abstracts have been reviewed for potential papers that could be included in the systematic review. Also, reference lists of the previous original researches were reviewed. Relevant studies were obtained after detailed examination, provided they met the required criteria to be included.

Exclusion criteria where: Papers that have not been published in English, research that has not been presented in its entirety (only abstracts), study in which the results have not been clearly presented, repeated research ...

RESULTS

Table 1. Systematic review and characteristics of the research involved

First author and year	Sample of particip.	Gender	Age	Sample size (n)	Study topic	Number and schedul	Measu. characte ristics	Results	Conclusion
Zwierko, (2014)	E: HP C: NA	M	19,8	24	Analysis of the ability to maintain attention during serial response tasks between elite handball players and non-athletes	8 h on c	TT RT	RU and T TT ($p<0.01$), NA>HP TT (1:43:13 - 41:56, $p<0.01$); NA = HP RT ($p<0.01$)	The results showed that NA achieved significantly longer test time, and slightly longer reaction time and greater variability across tasks. That is, it shows that handball players have a higher level of ability to maintain attention than non-athletes
Florkiewicz, (2015)	E: HP C: NA	M + F	20,3	28	Testing the effectiveness of a specific perceptual training program to improve visual-motor processing	8 h on c 8 h on c	SVP EHC RT PT	HP: PT on SVP ↑ ($p<0.001$), EHC ↑ ($p <0.001$) and RT ↑ ($p<0.01$)	A six-week training program has shown that perceptual skills are subject to change and can be improved by appropriate training. The positive effects obtained after a period of six weeks of training are limited. A perceptual training program in sports practice in handball is recommended.
Guðmundsdóttir, (2017).	E1: BP E2: BS C: BR	M + F	18,8	35	Anthropometric and physical characteristics of elite, sub-elite and recreational badminton players	8 h on c	CMJ T505 GS TVO2 RA MBT	BP>BS and BR in CMJ, T505, GS TVO2 ($p<0.05$); BP-BS-BR in RA, MBT; M rc=-0.47 - -0.83 for MBT, CMJ, T505 and TVO2; F rc= -0.51 - -0.86 for MBT, CMJ, T505, TVO2 and GS	Differences were found in several physical fitness tests between the elite group compared to the BS and BR groups, but this difference was not significant between the elite and sub-elite groups in any of the motor tests. A moderate to very strong correlation was found between four tests of physical fitness in men and five tests in women.
Smith, (2017)	E: RP	M	20,3	37	Differences in anthropometric and physiological characteristics in student rugby players	4 h on c	S7 10m 20m LD TVO2	MiS and PoS <PrS in S7 ($p<0.001$), 10m ($p<0.001$) and 20m ($p=0.004$); PoS<MiS and PrS in TVO2 ($p<0.001$); MiS<PoS and PrS ($p=0.005$)	Most of the positive anthropometric and physiological adaptations occurred during the first half of the season when conditioning training focused on technical skills. The reason for the increased maximum aerobic power and agility may be because rugby players become leaner and adapt to fitness training. During MiS and PoS led to fat reduction, increased agility, speed, and maximum oxygen consumption.
van de Water, (2017)	E: BP C: BR	M	24,6	24	Assessing the cognitive performance of badminton players	3 f on w	RE RT IC CV CCV	RE for RT (ICC=0.626, CV=6%), RE for IC (ICC=0.317, CV=13%), CV BP>BR for RT ($F=6.650$, $p <0.05$); CCV for RT BP ($\rho=0.70$, $p<0.01$), BR ($\rho=0.70$, $p<0.05$)	The reproducibility and validity of the inhibitory control assessment have not been confirmed, however, BRIT seems to be a reproducible and valid measure of reaction time in badminton players. Response time measured by BRIT can serve as a starting point in a training program aimed at improving the performance of badminton players.
Bekris, (2018)	E: FP C: FA	M	16,7	48	Assessment of dribbling technique and visual skills in young elite football	2 h on c	T TVS ST	FP and FA T> TVS (~ 2.5s, $p<0.01$), FP> FA in ST (~3s, $p<0.01$) and FP <FA in NM	Both groups were slower on the test with visual signs compared to the test without. FE performed all tests faster than FA. The average

					players and beginners		NM	(p<0.01) in all tests	number of visual errors was significantly lower in FE compared to FA in all tests (p <0.01). The results showed the importance of assessing dribbling along with visual stimuli in FE and FA.
Coh, (2018)	E: A C: NA	M + F	20,9	76	The speed of reversing direction and reactive agility as an independent skill when using the same movement patterns	7 h on c	CODS RA	CODS and RA A> NA (p<0.05), CODS and RA SC (r=0.62, r=0.60), 30m lateral CODS and RA LC (r=0.54, r=0.58)	Existing findings suggest that the CODS and RA groups are two distinct and independent skill domains that define responsiveness. These qualities should be considered separately, which involves the diagnosis of various independent tests, as well as the development of these skills by different training methodologies.
Reauter, (2018)	E: FS C: AS	M + F	20,2	94	Differences between reactive agility on unplanned and pre-planned movements	7 h on c	CODS RA UA	FS> AS CODS (-1.73s; 13.1%), RA (-2.34s; 14.3%), UA (-2.84s; 17.9%)	Agility in football as a motor skill represents different physical qualities. Therefore, it should be diagnosed and developed with separate assessments and training. RA is a dominant feature in football and therefore needs to be developed through a different, more specific training regimen.
Taylor, (2018)	E1: Ar E2: Anr	F	15,4	43	Differences in hip biomechanics between groups that respond and do not respond to ACL injury prevention program		HA HFA HFM KAA KE	Ar> Anr HA (p=0.02) F> KO (p = 0.07); HFA (p=0.02), HFM (p <0.001), KAA (p<0.001), KE (p=0.001)	Following ACL-IPP, athletes who exhibit the greatest reduction in knee joint amplitude exhibit greater hip adduction and exhibit corresponding improvements in hip and knee flexion kinematics. These results can help therapists identify individuals who may not respond to ACL-IPP and determine individual training for those at higher risk of injury.
Tsolakis, (2018)	E1: FeM E2: FeF	M + F	13,4	21	Exploring sports-specific correlates in sports performance in fencing in men and women	6 f on w	VRJ VCRL VCRLS CODS AV LV CMJ SJ LJ	FeM > FeF in SJ (p=0.008), CMJ (p = 0.008), VRJ (p=0.001), RJH (p = 0.05), LJ (p=0.001), 10 m sprint (p=0.005); FeM>FeF VRJ, VCRL, VCRLS (p=0.001); AV-LV (p=0.01), CODS -AV (p=0.05), LV (p=0.05) SLV (p=0.01)	The strength training program has led to a significant improvement in physical parameters. Therefore, it is recommended to integrate strength exercises as a regular regimen in the physical conditioning protocol in order to develop the physical performance of young swordsmen.
Vargas, (2018)	E1: T E2: T	M + F	20,9	12	The impact of reducing training volume during a taping on the performance in taekwondo	4 f on w	KMT KRT CMJ DJ SJ GNR ACMJ	G50%>GNR y MS (P=0.01), SJ (P=0.01), CMJ (P=0.01), ACMJ (P=0.01) DJ (P=0.01), KRT (P=0.03), KMT (P=0.04)	The block periodization training model provided an improvement in the fitness and motor skills of taekwondists. The group using a three-week tapering strategy, which implied a 50% reduction in training volume, performed better in all measured parameters than the group that trained regularly.
Coh, (2019)	E: A C: NA	M + F	20,9	76	Planned and unplanned activity in the diagnostics of athletes	7 h on c	CODS RA	CODS and RA SMR (sig=0.075), S>NS RA (p<0.05), S>NS CODS	The results of this study showed statistically significant differences between the two types of agility among samples of athletes and non-athletes.

								(p<0.05), RA and CODS 13.5% -22.3%	The more complex the movement structure, the greater the difference between planned and unplanned agility. Further implying that these characteristics must be treated separately.
Liu, (2019)	E1: KE E2: K C: NA	M + F	18-24	159	Easy and chosen response time among elite karate players, beginners and non-athletes	8 f on w	RT	RT NA (335.4 ±73.05 ms), K (306.33±47.05 ms) KE (292.33 ± 45.4 ms); KE>K RT (p<0.001), K> NA RT (p<0.01)	The results show that long-term karate training improves reaction time among young people and that there is a significant difference between elite athletes and beginners in karate when it comes to RT. This study shows that FTS can be a potential standardized tool for estimating reaction times by light stimulation.
Millikan, (2019)	E: AS C: NA	M + F	20,9	22	Development and reliability of four clinical neuro-cognitive gait trials, implications for restoring active decision making	2 h on c 2 h on c 2 h on c 3 h on c	PP RT ICC *Cα*	PP ICC>0.85 (0.87-0.92) , *Cα*>0.8 (0.88-0.92); RT ICC>0.85 (0.88-0.98) , *Cα*>0.8 (0.88-0.98)	The visual response times of athletes from different sports are very different and specific, so it is impossible to determine the differences between them. In general, it is suggested that exercises to improve reaction times should be included in the training plan, with specific technical and tactical tasks for a particular sport.
Mitchell, (2019)	E: Ho SRC C: Ho nSRC	M + F	14,5	34	Controlling the balance of youth hockey players with and without a history of concussion during kicks	5 h legs	SRC nSRC	RT NS (335.43±73.05 ms), E (306.33±47.05 ms) c (292.33±45.4 ms); E>C RT (p<0.001), K> NS RT (p<0.01)	Go / No-Go tasks that address choice and speed of decision can objectively identify differences among young athletes with and without prior SRC. It should be noted that defects in visual-motor control and balance may persist after recovery.
Serrien, (2019)	E1: FG E2: FG	M	23,5	32	Determining changes in visual-motor response performance and motor control between differential learning and contextual interference in goalkeeping tasks	6 f on w	VMRT	VMRT between DL and CI (BF_{10}≈8688.1 ± 0.7%); VMRT DL ↓> CI 95% HDI = -30 ms	Differential learning achieved a greater improvement over contextual interference in VMRT after training, but after one hour of rest, differences were no longer observed. Both groups showed improved motor control, as evidenced by a stronger synergy of post-training movement, with no difference between DL and CI.
Zakharova, (2019)	E: FS	M	14,7	24	Assessment of speed and coordination parameters that affect specific agility in football		RT VMRT WT	6F VMRT<270 ms excellent, 4F VMRT>320 ms (poor), 4F 16.7% RT ↑, WT 12.56 ±3.38W/kg	The proposed system of laboratory tests for the assessment of the structural components of agility, which are extremely important in football, has allowed identifying the weaknesses of athletes, which should be improved. Therefore, testing for unplanned agility should include tests for simple and complex reaction rates, coordination tests, and assessments of speed and power.
Mackala, (2020)	E1: TS E2: IS	M + F	20,9	70	Assessment between performing pre-planned and unplanned agility, comparison between individual and team sports	6 h on c 7 h on c 5 h on c 7 h on c	CODS RA FR LA UN J	IS LA-RA p<0.008, UN-RA p<0.036, SC-CODS p<0.027, CODS-J p<0.01; TS FR-CODS r=0.62, LA-CODS r=0.60	TSs showed a stronger association between sprinting and CODS. In RA conditions, both jump and sprint showed stronger correlations in the individual athlete group. Agility performance measured by CODS and RA should improve with increasing motor ability. The tests applied are multidimensional, but the Spatio-temporal adjustment is required to implement them in a

									particular sport
Örs, (2020)	E1-7: A C: NA	M + F	18-25	48	Assessment and comparison of visual abilities between different sports	8 h on t	RT	RT (p=0.009), 3. (p=0.038), 4. h (p=0.047), 5. (p=0.022), 6. (p=0.044), 7. (p=0.041), 8. (p=0.011), 9. (p=0.019), 10. (p=0.023)	According to the results, it can be said that the visual response times of the field players are very specific and insufficient for discrimination. Analysis of visual reaction time and anticipation should be included in the design and implementation of a visual training program aimed at enhancing athletes' visual skills as part of a strategy to improve their sports performance.
Snyder, (2020)	E: FS C: NA	M + F	21,5	43	Comparison of balance control between football players and non-athletes during the dynamic tasks of responding to visual signal	5 h legs	dCOP RMS	F<NS ML dCOP RMS (p=0.005), F & NS ND<D ML dCOP RMS (p=0.003), F<NS AP dCOP RMS (p=0.02)	Trained football players achieved significantly lower levels of dCOP than non-athletes in tests, especially in ML. Not only do footballers show better balance control, but also better proprioception and use sensor-motor information as well as improved executive functions controls. This allows for excellent lower extremity abilities, which are reflected in improved performance during a sports competition.
Vargas, (2020)	E1: T E2: T	M + F	20,9	12	The relationship between sleep efficiency and physical performance in taekwondists	4 Ф на 3	KMT KRT SEF CMJ DJ SJ GNR ACMJ	SEF-KRT (r=-0.83; p=0.04), SEF6-CMJ (p=0.04), DJ (p=0.01), KMT (p=0.04), G50% SEF-KRT (p=0.01), CMJ (p = 0.04), DJ (p=0.02); G50% SEF-KMT (p=0.01);GNR SEF-SJ (p=0.01), ACMJ (p=0.01), DJ (p=0.04); GNR SEF-KMT (p=0.03)	Group analyzes showed no significant correlation between sleep efficiency and physical performance. Individual analysis showed that the performance of three participants was related to sleep efficiency. Current evidence does not support the general contention that sleep efficiency is related to physical performance.
Wilke, (2020)	AS	M + F	27,4	13	Examination of perceptual-cognitive functions during athletic movement	8 h legs 8 h arms 7 h on c 3 h on c	SR CR ICC RL	ICC RL 0.60-0.94 (p<0.05); UL and LoL SR (r=0.69, p=0.014); UL and LoL CR (r=0.76, p=0.004)	All tests except one dimension of the test showed satisfactory reliability. The conclusion is that the tests presented show moderate to high reliability and can therefore be used for scientific testing.

Legend: 10/20m-sprint at 10/20m; A-athletes; AP-anterior-posterior; AS-athletes students; ACL-anterior cruciate ligament; ACMJ-countermovement jump with free arm; Anr-athletes non-responder; Ar-athletes responder; AS-athletes students; AV-analysis of variance; BP-badminton professional players; BRIT-reaction time; BS-badminton semiprofessionals; BR-badminton recreational players; C-control group; c-cones; Cα-Cronbach alfa; CCV-concurrent validity; CI-contextual interference; CMJ-countermovement jump; CoM dis.-center of mass displacement; CODS-change of direction of speed pre-planned; COP-center of pressure; CR-choice reaction; CV-coefficient of variation; DJ-deep jump; DL-differential learning; E(1-2)-experimental groups; EHC- eye-hand coordination; F-female; f-frontal; FA-football amateurs; FG-football goalkeeper; FeF-Fencing female; FeM-Fencing male; FR-frontal; FTS- FITLIGHT Trainer System; FP-football professionals; FS-semi-professional football players; ; GL-green/Go LED; GNR-group non-reduction training; GRF-ground reaction force; HA-hip adduction; HFA-hip flexion angles; HFM-hip flexion movement; Ho-hockey players; HP-handball players; IC-initial ground contact; ICC-Intraclass Correlation; INT-intermittent; IS-individual sports; J-jump; KAA-knee abduction angle; KE-knee excursions; KMT-kicking movement time; KRT-kicking response time; LA-lateral; LC-lateral configuration; LJ-long jump; LoL-lower limb; LV-velocity of lunge; M-male; MBT-medicine ball throw; MiS-middle season; ML-medial-lateral; NA-non-athletes; NGL-red/No-Go LED; NM-number of mistakes; NSH-neurocognitive single-leg hop; PC-principal component; h-horizontal; PoS-post season; PrS-preseason; PP-physical performance; PT-perceptual training; RA-reactive agility/non-planned; RE-reproducibility; RL-reliability; RMS-root mean square; RP-rugby players; RPE-Perceived Exertion Rating; RT-reaction time; S7-sum of 7 skinfolds; SC-semi-circle configuration; SEF-sleep efficiency test; SJ-squat jump; SRC-sport related concussion; SR-speed of reactions; ST-speed of test; SVP-speed of visuospatial perception; T-taekwondists; t-table; T505-test agility; TS- team sports; TT-total time; TVO2-maximum rate of oxygen consumption; TVS-test with visual signals; UA-universal direction agility test; UL-upper limb; r-correlations; UN-universal; VMRT-visuomotor response time; VCRL-visual choice reaction lunge; VCRSL- visual choice reaction step and lunge; VRJ-visual reaction jump; vs.-versus; w-wall; WT-Wingate.

DISCUSSION

The review included 22 studies that addressed the use of the Fitlight system in sports. There are only two surveys from years 2014-2015. by the same group of authors, while all other studies from the period 2017-2020. This indicates that these are fairly recent studies because the Fitlight system itself is a new device on the market. The survey included a total of 975 subjects in the aforementioned 22 studies, representing an average of close to 44 participants per study. There were at least 12 examinees in one survey and a maximum of 159. As many as 15 studies were conducted on male and female athletes together, 6 papers were for men only, while only 1 study was based solely on female participants. When it comes to the Fitlight system, 7 or 8 electrodes were used in most studies (in 15 papers). The electrodes were most commonly placed on cones, as they were reaction and agility tests (in 9 studies), then vertically mounted on the wall (6 studies), as well as horizontally on the table (3), which examined the reaction rate of the upper extremities. Other studies did not describe the details of the test protocol. In five studies, the average age of participants was below 18 years, while all other studies ranged from 18-25 years, and in one study the average was over 25 (27.4 years). During the systematic review on the application of the Fitlight system in sports, the predominantly examined category were athletes (7 studies), which includes athletes from different sports classified into one category. This is followed by research on football players (5), handball players (2), taekwondists (2), badminton players (2), and one study each on karate players, swordsmen, hockey players, and rugby players.

Athletes have been found to perform better than non-athletes as well as men performing better than women, and this is applied for both planned and unplanned agility tests ($p<0.05$) (Coh, 2019; Coh, et al., 2018). Better time measurements for men can be explained by greater motor potential, especially in terms of explosive power, reactive power, acceleration, and deceleration (Coh, et al., 2018). Existing findings suggest that planned and unplanned agility are two distinct and independent skill domains that define responsiveness. Also, the more complex the structure of the movement, the greater the difference between planned and unplanned agility among samples of athletes and non-athletes (Coh, 2019; Coh, et al., 2018), further implying that these characteristics must be treated separately. Mackala et al. (2020) point out that team athletes have a stronger connection between sprint and planned agility (CODS) in frontal configuration (FR) ($r=0.62$) and lateral configuration (LA) ($r=0.60$), while individual athletes have a stronger correlation between unplanned agility and sprint and jump performance. The visual response times of athletes from different sports are very different and specific, so it is impossible to determine differences between them (Millikan, Grooms, Hoffman, & Simon, 2019; Örs, Cantas, Gungor, & Simsek, 2020). In general, it is suggested that exercises to improve reaction time should be included in the training plan, with specific technical-tactical tasks for a particular sport. One study conducted a program for prevention of anterior cruciate ligaments and found that athletes who showed the greatest reduction in knee joint amplitude showed greater hip adduction and showed appropriate improvements in hip and knee flexion kinematics, which could help therapists identify and determine individual training for those at higher risk of injury (Taylor, Nguyen, Shultz, & Ford, 2018). Wilke, Vogel, & Ungricht, (2020) found that all but one test dimension showed

satisfactory reliability (ICC 0.60-0.94, $p<0.05$). The conclusion is that the tests presented show moderate to high reliability and can, therefore, be used for scientific testing.

The sport that has had the most testing with the Fitlight system is football. In their work, the Slovenian authors found that both groups were slower on the test with visual signals compared to the test without (T>TVS) (~2.5s, $p<0.01$), and those elite footballers performed all the tests faster than amateur footballers (~3s, $p<0.01$). The average number of visual errors was significantly lower in the group of elite footballers (FE) relative to amateurs group (FA) in all tests ($p<0.01$). The results demonstrated the importance of assessing dribbling along with visual stimuli in FE and FA (Bekris, Gissis, Ispyrlidis, Mylonis, & Axeti, 2018). Snyder, & Cinelli, (2020) found that trained footballers achieved significantly lower levels of dicplacment center of pressure (dCOP) than non-athletes in tests, especially in medium-lateral test (ML) ($p=0.005$). Not only do footballers show better balance control, but also better proprioception and use of sensor-motor information, as well as improved executive control functions. Rauter et al. (2018) point out that agility in football represents different physical qualities and therefore should be diagnosed and developed with separate assessments and training sessions. The authors agree that reactive agility is a dominant feature in football and therefore needs to be developed through a different, more specific training regime (Rauter, et al. 2018; Zakharova, Mekhdieva, Krasilnikov, & Timokhina, 2019). In one specific study concerning football, the authors found that differential learning (DL) achieved a greater improvement over contextual interference (CI) in visuomotor response time (VMRT) after training, but after one hour of rest, differences were no longer observed. Both groups showed improved motor control, as evidenced by a stronger synergy of post-training movement, with no difference between DL and CI (Serrien, et al. 2019).

Only two studies were performed in handball, badminton, and taekwondo. Handball players achieved significantly shorter total reaction times (TT) than non-athletes (1:43:13-41:56, $p<0.01$). In other words, handball players have a higher level of ability to maintain attention than non-athletes (Zwierko, Florkiewicz, Fogtman, & Kszak-Krzyżanowska, 2014). Florkiewicz, Fogtman, Lesiakowski, & Zwierko, (2015) showed that a six-week training program showed that perceptual skills are susceptible to change and can be improved by appropriate training. The Dutch authors have found that the response time measured by reaction time test for badminton players (BRIT) can serve as a starting point in a training program aimed at improving the performance of badminton players. The aim was to examine the reproducibility and validity of the inhibitory control assessment, and it seems that BRIT (badminton reaction inhibition test) can be considered as a reproducible and valid measure of reaction time in badminton players (Van de Water, Huijgen, Faber, & Elferink-Gemser, 2017). Guðmundsdóttir, (2017) found differences in several physical fitness tests between elite group of badminton players (BP) compared to semiprofessional badminton players (BS) and recreational badminton players (BR) groups BP>BS and BR in counter movement jump (CMJ), agility test (T505), grip strength (GS), maximum rate of oxygen consumption (TVO2) ($p<0.05$), but this difference between the elite and sub-elite group was not significant in any of the motor tests. Also in the same study, a moderate to very strong correlation was found between four physical fitness tests in men and five tests in women. When it comes to taekwondo, Vargas, & Jiménez, (2018) examined the training model using block periodization and found that it provided an improvement in the fitness and motor skills of the taekwondo.

The group using the three-week tapering strategy, which implied 50% less training, achieved better results in all measured parameters than the group that regularly trained in motor ability (MS) (p=0.01), squat jump (SJ) (p=0.01), countermovement jump CMJ (p=0.01), countermovement jump with free arm (ACMJ) (p=0.01), depth jump (DJ) (p=0.01) (Vargas, & Jiménez, 2018). Group analyses showed no significant association between sleep efficiency and physical performance. The individual analysis showed that the performance of three participants was related to sleep efficiency. Current evidence do not support the general claim that sleep efficiency is related to physical performance (Vargas, & Jiménez, 2020).

Other sports represented had one study each: karate, rugby, fencing and ice hockey. The results show that long-term karate training improves reaction time among young people and that there is a significant difference between elite athletes and beginners in karate when it comes to reaction time (RT) (p<0.001). This study demonstrates that Fitlight trainer system (FTS) can be a potentially standardized means of estimating reaction time by light stimulation (Liu et al., 2019). Mitchell, & Cinelli, (2019) have shown that Go/No-Go tasks driven by choice and speed of decision can objectively identify differences among young athletes with and without prior sport related concusion (SRC). It should be noted that defects in visual-motor control and balance may persist after clinical recovery. Smith (2017) found in his study that most positive anthropometric and physiological adaptations occurred during the first half of the season when rugby player conditioning training was focused on technical skills (p<0.001). The reason for the increased maximum aerobic power and agility may be that rugby players become leaner and adapt to fitness training. Middle season (MiS) and post season (PoS) led to fat reduction, increased agility, speed, and maximum oxygen consumption. The research, which was based on the training of fencing athletes, concluded that the strength program led to a significant improvement in the physical parameters of athletes. Therefore, it is recommended to integrate strength exercises as a regular regimen in the physical conditioning protocol to develop the physical performance of young fencing athletes (Tsolakis, Tsekouras, Daviotis, Koulouvaris, & Papaggelopoulos, 2018). This review identified some important points:

• Athletes score better than non-athletes on tests of planned and unplanned agility (Coh, 2019; Coh, et al., 2018; Zwierko, et al., 2014).
• Elite athletes perform in tests of reaction speed and agility better than amateur athletes (Bekris, et al., 2018; Guðmundsdóttir, 2017; Liu, et al., 2019).
• Men score better than women on tests of planned and unplanned agility (Coh, 2019; Coh, et al., 2018; Reauter, et al., 2018; Snyder, & Cinelli, 2020; Tsolakis, et al., 2018).
• Planned and unplanned agility are two distinct and independent skill domains that define responsiveness (Bekris, et al., 2018; Coh, 2019; Coh, et al., 2018).
• The average number of visual errors was significantly lower in the elite athletes' group than in amateurs (Bekris, et al., 2018).
• Trained athletes achieved significantly lower levels of body center displacement than non-athletes (Snyder, & Cinelli, 2020).
• Athletes have shown better balance control, better proprioception, and use of sensorimotor information, as well as improved executive control functions than non-athletes (Snyder, & Cinelli, 2020).
• Perceptual skills are subject to change and can be improved by appropriate training (Florkiewicz, et al., 2015).
• The strength program has led to a significant improvement in the physical parameters of athletes (Smith, 2017; Tsolakis, 2018; Vargas, & Jiménez, 2018).
• BRIT can be considered as a reproducible and valid measure of reaction time in badminton players (Van de Water, et al., 2017).

• The presented FTS tests show moderate to high reliability (Wilke, et al., 2020).
• FTS can be a potentially standardized tool for estimating reaction time by light stimulation (Liu et al., 2019).

A review of the research so far provides insight into the widespread use of the Fitlight system in sports. However, given that it is a fairly new instrument, it is clear why there are very few studies published. So many popular sports such as basketball, volleyball, athletics, swimming and more do not have any studies using the Fitlight system. This review shows that the Fitlight system can be used in various ways and in different sports. It can be used in both individual and team sports. It can test sensory-cognitive and motor skills: reaction rate, speed of single movement, speed of running, agility. Based on all the information provided, the possibility of multiple applications of the Fitlight system in sports was highlighter.

CONCLUSION

During a systematic review on the application of Fitlight system in sports, few studies were found. The most tested category are athletes, namely represented by a group of young athletes from different sports. Also, it should be noted that in many popular sports there are still no studies using the Fitlight system, which is understandable, as it is a fairly new instrument.

In this review, sports/athlete representation was as follows: athletes (7 studies), football players (5), handball players (2), taekwondo (2), badminton players (2), karate players (1), hockey players (1), rugby players (1), fencing (1).

Based on a survey that was quite heterogeneous in the choice of topics, type of sports, participants, etc. different conclusions were also drawn, which are, in this chapter, separated and classified according to sports categories.

Numerous conclusions have been established and they can be presented according to the following criteria:
(a) Studies which involving combined groups of athletes, identifying:
• Athletes score better than non-athletes on change of direction of speed pre-planned (CODS) and reactive agility (RS) tests.
• Men score better than women on CODS and RS tests.
• CODS and RS are two independent skill domains that define responsiveness.
•The more complex the movement structure, the greater the difference between CODS and RS.
• Team athletes have a stronger correlation between sprinting and CODS.
• Individual athletes have a stronger link between RS and sprint performance.
• The visual response times of different athletes are very different and specific.
(b) Studies dealing with the application of FTS in football have concluded:
• Soccer players are slower on the test with visual clues than on the test without them.
• Elite football players conducted all the tests faster than amateur football players.
• The number of visual errors was lower among elite football players compared to amateurs.

• Football players achieved a significantly lower level of movement of the center of mass than non-athletes.
• Football players showed better balance, proprioception and the use of sensor-motor info.
• Differential learning (DL) achieved greater improvement over contextual interference (CI), but no difference after 1h.
(v) Studies addressing the use of Fitlight trainer system (FTS) in other sports have concluded:
• Handball players achieved significantly shorter reaction times than non-athletes.
• Perceptual skills are subject to change and can be improved by training.
• Elite badminton players scored better on the motor tests.
• Block periodization influenced the improvement in conditioning and motor ability.
• The group using 3-week tapering was better in all parameters.
• There is no relationship between sleep efficiency and physical performance.
• There is a significant difference between elite karate players and beginners in reaction time (RT).
• Go / No-Go objectively identifies differences among young athletes with and without SRC (sport related concussion).
• Most positive physiological adaptation occurred during the first half of the season.
• The strength program has led to a significant improvement in the physical parameters of athletes.
• FTS is a potential standardized tool for estimating reaction times.
• The tests presented show moderate to high reliability.
• Badminton reaction inhibition test (BRIT) can be considered a repeatable and valid measure of reaction time.

In conclusion, based on all the information provided, it is clear that the Fitlight system can be used in various ways and in different sports. It can be used in both individual and team sports. It can test sensory-cognitive and motor skills: speed of reaction, speed of single movement, speed of running, agility. Based on all of the information provided, the possibility of multiple applications of the Fitlight system in sports was highlighted.

Conflicts of interest
The authors declare that there is no conflict of interest regarding the publication of this paper

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