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USE OF THE 30 M ACCELERATION TEST FOR PREDICTING RESULTS AT ATHLETIC TESTS OF SPEED ON 60, 100 AND 200 M IN CHILDREN WITH A RANGE OF 10 TO 11 YEARS

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ABSTRACT. Introduction: The motor quality speed is not just how quickly someone can run, but is, under the influence of their acceleration, maximal speed of the human movement The human movement speed requires a very good level of strength and power, but also depends on the body weight and resistance The body's ability to accelerate (speed) is one of the main fitness components, important to achieve performance in many sports. **Objectives:** The study analysis and statistical process the results of two samples of 105 children that practice football and children who do not practice sports regularly, aged between 10 and 11 years The analyzed period was from December 2018 to February 2019. **Methods:** Methods used in this inquire where preponderant experimental, it was used as assessment method the acceleration test on 30 m, for statistical interpretation it was used the Student t test, D'agostino & Pearson correlation, Unpaired T test with Welch's correction. **Results:** The results showed that students who practice sports (football or basketball) obtained better results at the 30 m acceleration test than children that don't practice sport at all We obtained statistical significant difference comparing the group of football players and basketball players and the unsportsmanlike children group. **Conclusions:** The conclusion of the research highlighted the results of the two groups and, most importantly, that the 30m acceleration test could predict the results that children may have on other specific athletic tests: 60m, 100m and 200m The results were markedly different between athlete students and non-athletes, the athletes performing much better However, we haven't noticed a big difference between football players and basketball players.

Key words: *speed, acceleration, running, human movement.*

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REZUMAT. ***Utilizarea testului de accelerare pe 30 m în predicţia rezultatelor la probele atletice de viteză pe 60, 100 şi 200 m la copiii cu vârste cuprinse între 10 şi 11 ani.*** **Introducere:** Calitatea motrică viteza nu reprezintă doar capacitatea unei persoane să se deplaseze rapid, ci reprezintă, sub influenţa acceleraţiei sale, viteza maximă a mişcării umane. Viteza de mişcare a omului necesită un nivel foarte bun de forţă şi putere, dar depinde şi de greutatea corporală şi de rezistenţa acestuia. Capacitatea individului de a accelera (viteza) este una dintre principalele componente de motricitate, importantă pentru a atinge performanţa în multe sporturi. **Obiective:** Obiectivul cercetării a fost analiza şi procesarea statistică a rezultatelor a două grupe de 105 copii care practică fotbal sau baschet, şi copii care nu practică sport în mod regulat, cu vârste cuprinse între 10 şi 11 ani. Perioada de desfăşurare a studiului a fost cuprinsă între decembrie 2018 şi februarie 2019. **Metode:** Metodele utilizate în acest studiu au fost preponderent experimentale, fiind utilizată ca metodă de evaluare testul de accelerare pe 30 m, pentru interpretarea statistică s-a folosit testul Student t, corelaţia D'agostino şi Pearson, testul T nepereche cu corecţia Welch. **Rezultate:** Rezultatele au arătat că elevii care practică sport (fotbal sau baschet) au obţinut rezultate mai bune la testul de accelerare de 30 m decât copiii care nu practică sport deloc. Am obţinut o diferenţă semnificativă statistic comparând grupul de elevi care practică fotbal sau baschet şi grupul de copii care nu practică nici un sport. **Concluzii:** Concluzia cercetării a evidenţiat rezultatele celor două grupuri şi, cel mai important, faptul că testul de acceleraţie pe 30 m ar putea prezice rezultatele pe care copiii le pot avea la alte teste atletice specifice: 60m, 100m şi 200m. Rezultatele au fost semnificative statistic comparând elevii sportivi şi cei care nu practică sport, sportivii performând mult mai bine Cu toate acestea, nu am observat o mare diferenţă între cei care practică fotbal şi cei care practică baschet.

Cuvinte cheie: *viteză, accelerare, alergare, mişcarea umană*

Introduction

From a physiological point of view, motor activity would oppose the term sensitivity (related path) in order to highlight only the motor component (efferent path) of a reflex act, in response of the central nervous system to muscles (Neagu, 2012).

"Motricity is the set of functions that ensure the maintenance of posture and the execution of movements specific to living beings; it is thought in opposition to the repetition and sensory functions" (Neagu, 2012).

The motor activity, besides its biological dimension, acquires a social dimension, the human motricity, respectively, the movement transforming from a socialized activity, to a socializing one. Each individual has its particularities that represent a specific way by which it presents its motor coding, as a constituent element of what we can define, the mark of its own personality (Neagu, 2010).

Psychological particularities: it represents part of the general selection through which the knowledge of the psychological particularities of the children is realized and their correspondence to certain activities with the strictly delimited requirements. A very important thing in the psychological selection is to ensure the correspondence between the attitudes and aptitudes of the individual. On this basis it guarantees the adaptation to the effort and efficiency to the training or to the physical education hours of the individual (Cojocaru & Ionita, 2008).

Some characteristics with varying degrees of hereditary determination are involved in psychic ability. Regarding the nervous system of the analyzers and the sensory-motor structures, the contribution of heredity is higher, while for the skills that involve social adaptation and intellectual organization, exercises and education are decisive (Cojocaru & Ionita, 2008).

The motor development takes place on a stage plan in which we observe different models that include the basic motor purchases, for example: rolling, walking, running, etc It becomes more and more complex, later found in neuromotor development, called coarse and fine motor skills (Cojocaru & Ionita, 2008).

The motor development begins with the motor conduct from the lying position and until the acquisition of the walking. These motor skills are called basic motor purchases. After learning to walk, the child goes to another stage of learning the complex motor skills. Complex motor skills referred to: climbing, jumping, pedaling, swimming, throwing, etc., these skills depend on how motivated his motor development by the environment (Petrut-Barbu, 2012).

Some motor skills are more easily acquired: walking, running, climbing, and others only through a learning organization: swimming, cycling, etc (Petrut-Barbu, 2012).

The motor quality of the speed depends largely on the genetic factors. This is why positive changes in speed are mainly related to the genotype of an individual. Consequently, we cannot develop this motor quality even if we use a long-term training method and an intensive plan for several years. A very important physiological concept, closely related to genetic factors, is the substantial number of fast fibers (white fibers) in the composition of muscles. The ability to selectively excite these fibers is the efficiency of nerve processes, the ability to rapidly pass from excitation to inhibition and vice versa (Djaoui et al., 2017).

The speed of movement has three major components: the speed of reaction, the time of simple movement and the frequency of the movements. Speed is becoming more and more important in contemporary sports activity. The speed of the player is not only related to the level of the physical condition Its structure is much more complex. During a game, it is manifested by the speed of the game actions. As Andrzejewski (2013) has pointed out, the speed of actions is built on the basis of motor and cognitive components that are closely linked. With

the motor component, the speed is controlled neurophysiological (jump, change of direction, sprint, acceleration, dynamic stop, start speed). The cognitive components play a very important role through the processes of receiving and processing information in the analysis centers within the cerebral cortex, e.g (choice of actions, speed of making the right decisions, reaction time, speed of perception and prediction) (Andrzejewski et al., 2013).

Mohr (2016) argued that the new concepts in the training process should emphasize the priority of speed during endurance training. In addition to the development of motor capacity, speed plays an important role in the cognitive components, the process of receiving and processing information in the cerebral cortex occurs invisibly, while movement and speed are observable (Mohr & Krustrup, 2016).

Speed training is based on the genetic availability that infuses this quality very early, during which time it can even be established. The maximum speed point is reached between 18 and 20 years in boys and 15–17 years in girls. After these ages, the speed increases due to other qualities (strength, mobility, coordination, etc.). Due to the increased coordination capacities between 5–7 years, the speed of travel is particularly high. In the first school phase, the frequency and speed of movements (speed of execution) increase dramatically. In the second-level of school, one can intensify the work for speed, especially for the speed of execution and the speed of coordination, but not the speed in the regime of resistance. In the first part of puberty and adolescence, there are significant gains in speed and speed-force (Teodorescu, 2009).

Moving is a fundamental form of human locomotion, a very popular physical activity and the most ubiquitous type of movement in sports. Performance depends on sustained, predominantly aerobic energy production, and the transformation of this energy into forwarding motion, called running/moving economy. Because displacement is a relatively unconstrained movement with many degrees of freedom, the athletes perform the locomotor system using various "techniques". Despite this variability and an intuitive relationship between running technique and performance and effort economy, there is very little objective, robust information on the influence of running technique on performance and / or functional economy (Ahn et al., 2014; Nummela et al., 2012).

Running requires a much more intensive and greater oxygen demand from the body than sedentary life does. The diaphragm contracts to draw air into the lungs, at the same time, the intercostal muscles relax only to contract strongly at the time of expiration while the diaphragm relaxes and is drawn to the chest. The lungs are filled with air and empty to support the runner's need for oxygen with this effort of pulling and pushing. The muscles of the chest besides their action in the breathing mechanisms play an important role in the forward movement (Puleo & Milroy, 2016).

The technical understanding of the functioning economy of the human body has been the focus of many research. Specific factors include, lower members kinematics, spatio-temporal factors, kinetics, neuromuscular factors, shoe surface interaction with soil, and biomechanics of upper and lower member running technique (Moore et al., 2012; Tseh et al., 2008).

Sprint performance is an important factor for many athletic activities and often can define sporting success (Winchester et al., 2008). Specific examples can be seen in track and field such as the sprint events, whereby the fastest athlete usually wins the race. However, sprint performance is not solely important for track and field event outcome (Gomez et al., 2013).

Objectives and Hypothesis of the Research

Our purpose was seeing the difference between a football athlete and a non-athlete with a 30-meter acceleration test and to predict the results on other athletic events. The task of this research is to encourage the children who don't practice any sports to start psychical activity and among them with good results to try to support the practice of any sport on a competitive level.

The present research started from the hypothesis that following the introduction of the acceleration test on 30 meters, we will be able to analyze the speed indices of the subjects, as well as to make a prediction for the 60m, 100m, and 200m tests.

The purpose of the research is, first of all, to see the difference between the subjects who practice a sport and those who do not practice, and then we will orientate towards a sports branch for which the motor speed is important. Secondly, we want to compare the results of the two samples, which practice football and basketball.

Design of the Research

Subjects of the research

The study consisted of the analysis and statistical processing of the results of two samples consisting of children who practice football and children who do not practice sports regularly. This investigation was overseen in accordance with the Declaration of Helsinki (2013) and approved by the Ethics Committee of "Lucian Blaga" University of Sibiu before the beginning of the study. It also met the ethical standards for Sport and Exercise Science Research. Due to the fact that the General data protection regulation entered into the appliance on 25 May 2018 (Regulation (EU) 2016/679).

Place and period of the research

Our study compares the level of speed motor quality, through the 30-meter acceleration test, in primary school children, that practice sports and do not practice sports, was conducted over a period of three months, between December 2018 - February 2019.

Testing description

The subjects took a warm-up for 10 minutes while a 30-meter corridor was drawn. The subjects started in a predetermined order, making a sprint for 30 meters, while we registered each individual result. The test was applied 3 times and recorded the best time. In this research, we analyzed three samples, one of 50 subjects who play football, a sample of 20 subjects who practice basketball and another one of 50 students who doesn't play any sport. The average age was 10–11 years. The 50 football players come from the team of the OSK St George club, the basketball players are from the team I.S.K St George and subjects who do not practice sports are part of the fourth grade of the Mikes Kelemen Theoretical High School of St George City. During the testing, we tried to induce a competitive atmosphere, while eliminating all stressors. The materials used in the test were: cones, whistle, and roulette (https://www.brianmac.co.uk/30accel.htm?fbclid=IwAR0ad-1AffS).

Methods of research

Description of the acceleration test on 30, 60, 100 and 200 m

Testing and measuring are the means of collecting information on the basis of which evaluations and subsequent performance decisions are made, but, in the analysis, we must take into account the factors that could influence the results.

The objective of this test is to monitor the development and level of the speed quality of each subject. We recorded the times of the subjects on 30 meters from standing start position.

The test provides a guide to the performance, the potential of the subjects and a means of monitoring the effect of the training on the physical development of the subject.

Inclusion criteria: In this study were included the students (boys) who: the age of the students, between 10–11 years, they were able to make a physical effort, two samples of sportsmen and one of the subjects who do not practice sports, the consent of the parents or legal guardian to participate in this study.

The research has a prospective character, one of the methods used is the quantitative one, which involves collecting and analyzing the data by carrying out measurements. The study was carried out during the hours of physical education and sports, as well as at football and basketball training.

Results

Table 1. Statistical comparison between groups on 30 and 60 m

Acceleration test on 30 m			Acceleration test on 60 m		
Mean	Non-sportive	Football players	Mean	Non-sportive	Football players
	6.375	5.468		9.883	8.812
Std Deviation	0.6231	0.2814	Std Deviation	0.724	0.3365
D'agostino & Pearson omnibus normality test			**D'agostino & Pearson omnibus normality test**		
Passed normality test (alpha=0.05)?	YES	YES	Passed normality test (alpha=0.05)?	YES	YES
Unpaired T test with Welch's correction			**Unpaired T test with Welch's correction**		
P value	P<0.0001		P value	P<0.0001	
Are means signif different? (P < 0.05)	YES		Are means signif different? (P < 0.05)	YES	

The first step in our research was to compare the groups of children that don't practice sports activities and those that practice football at the acceleration test on 30 m and on 60 m. We used the D'agostino & Pearson omnibus normality test and the Unpaired T test with Welch's correction and **found out that the results were statistically significant at p<0.05**. The results can be observed in Table No 1 and also in Figure No 1.

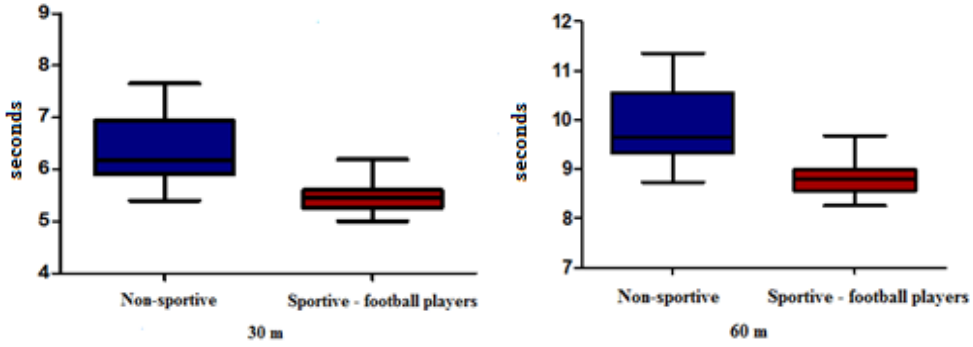


Fig. 1. Statistical comparison between groups on 30 and 60 m

Table 2. Statistical comparison between groups on 100 m and 200 m

Acceleration test on 100 m			Acceleration test on 200 m		
Mean	Non-sportive	Football players	Mean	Non-sportive	Football players
	15.35	13.72		31.17	27.81
Std Deviation	1.097	0.5185	Std Deviation	2.252	1.077
D'agostino & Pearson omnibus normality test			**D'agostino & Pearson omnibus normality test**		
Passed normality test (alpha=0.05)?	YES	YES	Passed normality test (alpha=0.05)?	YES	YES
Unpaired T test with Welch's correction			**Unpaired T test with Welch's correction**		
P value	P<0.0001		P value	P<0.0001	
Are means signif different? (P < 0.05)	YES		Are means signif different? (P < 0.05)	YES	

The results in Table 2 and Figure 2 presented the comparison between unsportsmanlike and football players at the 100 m and 200 m acceleration test. We also used the D'agostino & Pearson omnibus normality test and Unpaired T test with Welch's correction and **discovered a statistical significant difference with p<0.05 between the two groups of children**.

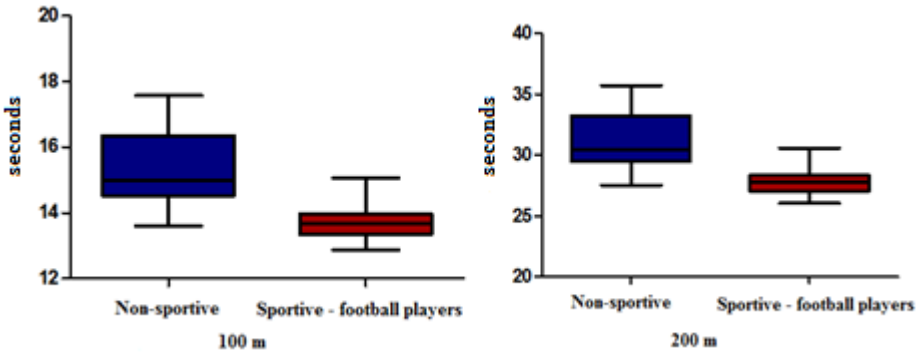


Fig. 2. Statistical comparison between groups on 100 and 200 m

The following steps were to analyze and compare the unsportsmanlike children group and the basketball group of children at the 30 m and 60 m acceleration test. For statistical analysis it was used the D'agostino & Pearson omnibus normality test and the unpaired T test with Welch's correction. The results that can be observed in Table 3 and Figure 3 between those **two groups was a statistical significant difference at p<0.05**.

Table 3. Statistical comparison between groups on 30 and 60 m

Acceleration test on 30 m			Acceleration test on 60 m		
Mean	Non-sportive	Basketball players	Mean	Non-sportive	Basketball players
	6.375	5.500		9.883	8.852
Std Deviation	0.6231	0.3504	Std Deviation	0.7244	0.4195
D'agostino & Pearson omnibus normality test			**D'agostino & Pearson omnibus normality test**		
Passed normality test (alpha=0.05)?	YES	YES	Passed normality test (alpha=0.05)?	YES	YES
Unpaired T test with Welch's correction			**Unpaired T test with Welch's correction**		
P value	P<0.0001		P value	P<0.0001	
Are means signif different? (P < 0.05)	YES		Are means signif different? (P < 0.05)	YES	

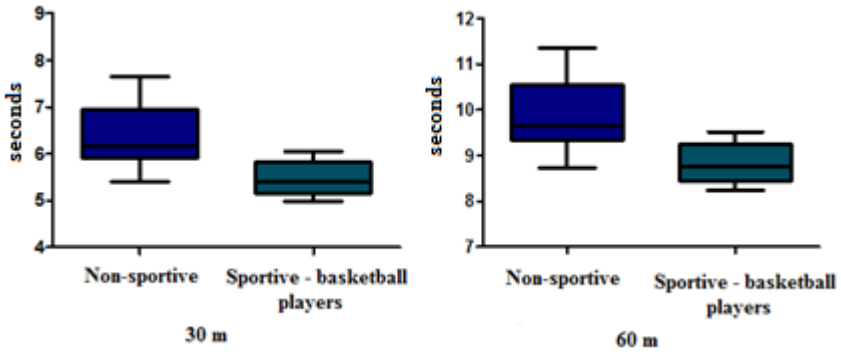


Fig. 3. Statistical comparison between groups on 30 and 60 m

Table 4. Statistical comparison between groups on 100 and 200 m

Acceleration test on 100 m			Acceleration test on 200 m		
Mean	Non-sportive	Basketball players	Mean	Non-sportive	Basketball players
	15.35	13.78		31.17	27.92
Std Deviation	1.097	0.6466	Std Deviation	2.252	1.343
D'agostino & Pearson omnibus normality test			**D'agostino & Pearson omnibus normality test**		
Passed normality test (alpha=0.05)?	YES	YES	Passed normality test (alpha=0.05)?	YES	YES
Unpaired T test with Welch's correction			**Unpaired T test with Welch's correction**		
P value	P<0.0001		P value	P<0.0001	
Are means signif different? (P < 0.05)	YES		Are means signif different? (P < 0.05)	YES	

The next decision was to analyze the difference between unsportsmanlike children and children that practice basketball at the 100 m and 200 m acceleration prediction test. The results presented in Table 4 and Figure 4 were calculated using the D'agostino & Pearson omnibus normality test and the unpaired T test with Welch's correction. **It was found a statistical significant difference at p<0.05, between unsportsmanlike children and children that practice basketball at both prediction acceleration tests.**

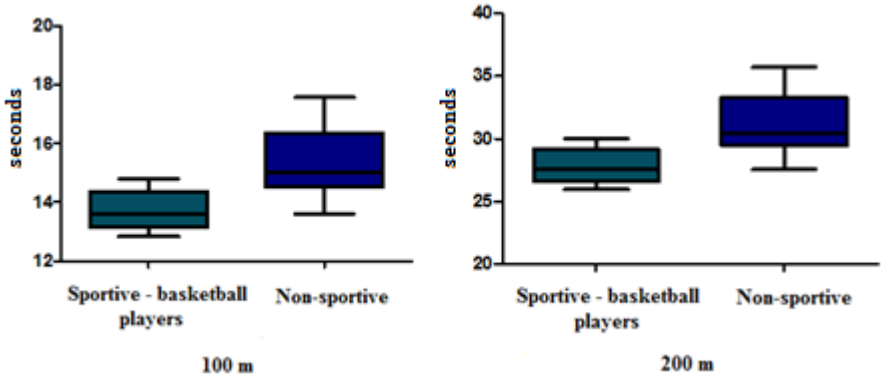


Fig. 4. Statistical comparison between groups on 100 and 200 m

Table 5. Statistical comparison between groups on 30 and 60 m

Acceleration test on 30 m			Acceleration test on 60 m		
Mean	Football players	Basketball players	Mean	Football players	Basketball players
	5.468	5.500		8.812	8.852
Std Deviation	0.2814	0.3504	Std Deviation	0.3365	0.4195
D'agostino & Pearson omnibus normality test			**D'agostino & Pearson omnibus normality test**		
Passed normality test (alpha=0.05)?	YES	YES	Passed normality test (alpha=0.05)?	YES	YES
Unpaired T test with Welch's correction			**Unpaired T test with Welch's correction**		
P value	0.7324		P value	0.7269	
Are means signif different? (P < 0.05)	NO		Are means signif different? (P < 0.05)	NO	

At Table 5 and Figure 5 we calculated the difference between the group of children that practice football and those that practice basketball at the 30 m and 60 m prediction test. The results were calculated using the D'agostino &

Pearson omnibus normality test and the unpaired T test with Welch's correction. **No significant statistical difference was found between the two groups of children at a p-value of 0.7324 and 0.7269 (p<0.05).**

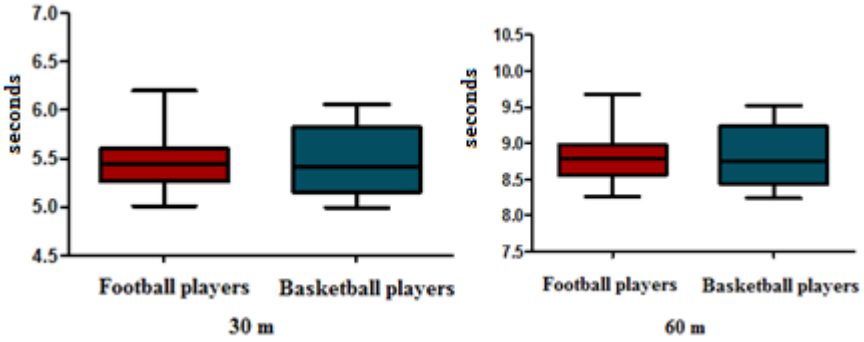


Fig. 5. Statistical comparison between groups on 30 m and 60 m

Table 6. Statistical comparison between groups on 30 and 60 m

Acceleration test on 100 m			Acceleration test on 200 m		
Mean	Football players	Basketball players	Mean	Football players	Basketball players
	13.72	13.78		27.81	27.92
Std Deviation	0.5185	0.6466	Std Deviation	1.077	1.343
D'agostino & Pearson omnibus normality test			**D'agostino & Pearson omnibus normality test**		
Passed normality test (alpha=0.05)?	YES	YES	Passed normality test (alpha=0.05)?	YES	YES
Unpaired T test with Welch's correction			**Unpaired T test with Welch's correction**		
P value	0.7408		P value	0.7480	
Are means signif different? (P < 0.05)	NO		Are means signif different? (P < 0.05)	NO	

The last step was to compare the group of children that practice football and those that practice basketball at the 100 m and 200 m predictions of acceleration test (Table 6 and Figure 6). The results were calculated using the D'agostino & Pearson omnibus normality test and the unpaired T test with Welch's correction, and **no statistical significant difference at p<0.05 was found between the two groups at the 100 m and 200 m acceleration prediction test.**

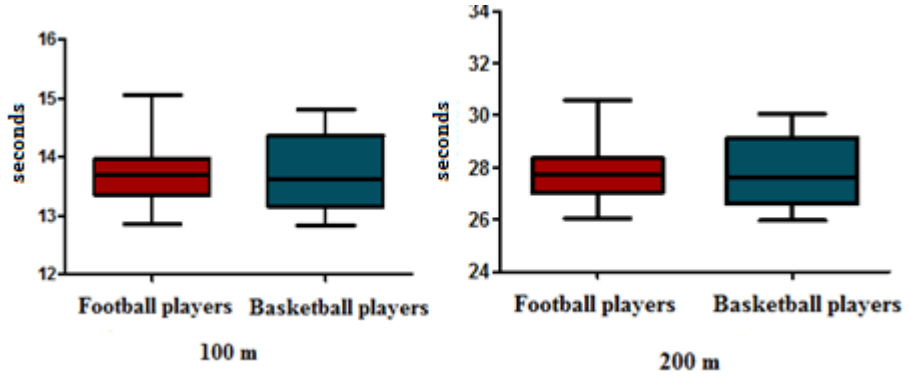
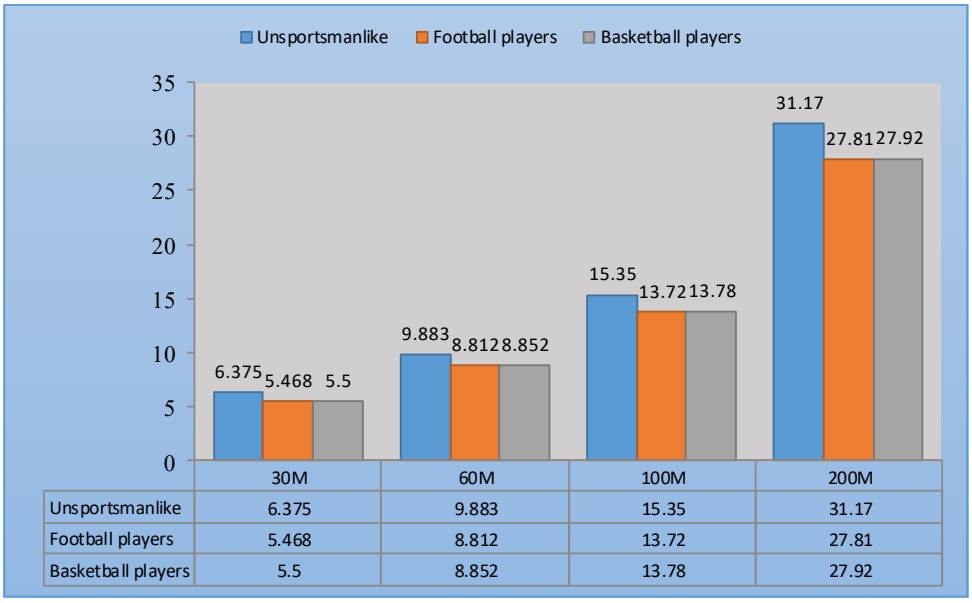


Fig. 6. Statistical comparison between groups on 100 m and 200 m



	30M	60M	100M	200M
Unsportsmanlike	6.375	9.883	15.35	31.17
Football players	5.468	8.812	13.72	27.81
Basketball players	5.5	8.852	13.78	27.92

Fig. 7. Graphical representation of differences between 30 m, 60 m, 100 m and 200 m prediction tests at unsportsmanlike children, football players and basketball players

Discussions

Sprint performance has been shown to be an important determinant of match-winning actions in a wide variety of sports such as rugby, soccer and basketball (Alemdarogu, 2012; Schneiker et al., 2006). Faude, Koch and Meyer (2012) found that straight sprinting is the most frequent action in goal situations in professional soccer with 45% of goals in the German League being preceded

by a sprint by the scoring or assisting player (Nummela et al., 2007). For a majority of team sports, the distance covered during a single sprinting bout typically falls within acceleration phase type distances (<30m) (Rumpf et al., 2016; Wild et al., 2011).

The acceleration test on 30m and the development of the speed motor quality even from an early age (between 11 and 14 years) is an increasingly frequent topic in research studies, because the specialists recognize that it is the most advantageous and important motor quality in sports activities.

The results obtained in our investigation were statistically analyzed with the D'agostino & Pearson omnibus normality test and the unpaired T test with Welch's correction.

After the statistical analysis we obtained statistical significant differences at $p<0.05$ at the 30, 60, 100 and 200 m acceleration test at the comparison of unsportsmanlike group of children compared with the group where children practiced football and basketball. Between children that practice football and children that practice basketball, we didn't find any statistical significant difference.

Previous research has accentuated the importance of acceleration for team sports such as professional rugby league in which 68% of all recorded sprints were less than 20m (Gabbett, 2012), and professional soccer in which the average sprint distance lasts 2–4 seconds and typically covers 10–30m (Di Salvo et al., 2010; Wild et al., 2011). However, maximum velocity sprinting is also important for many sports (Wild et al., 2011)

From a static start maximum velocity is usually achieved at 30–40m for team sports athletes (Duthie et al., 2006; Vescovici, 2012; Young et al., 2008) and between 40 and 70m in elite sprinters (Morin et al., 2015). Although longer distance sprints occur much less frequently in team sports than short sprints (Di Salvo et al., 2010; Wild et al., 2011), maximum velocity is usually reached when a sprint is initiated from a moving start (Duthie et al., 2006). Henceforth, as a majority of sports are inclusive of sprinting (Lockie et al., 2014), sprint ability (i.e the ability to accelerate quickly, achieve a high maximal running velocity and also the ability to maintain maximum velocity) can be deemed vital for sporting performance (Morin et al., 2011).

Conclusions

The body's ability to accelerate (speed) is one of the main fitness components, important to achieve performance in many sports. Speed is one of the main fitness components, important for success in many sports.

As a result of our study, we were able to highlight the results of the two groups of children one that practice sports (football or basketball) and, most importantly, to predict the results that these children may have on other specific athletic tests: 30, 60, 100 and 200 m. The results were markedly

different between athlete students and non-athletes, the athletes performing much better. However, we haven't noticed a big difference between soccer players and basketball players.

Our conclusion on the basis of the hypothesis is that there is an observable difference between the subjects who practice sports versus those who do not practice any sport according to the obtained results. The statistics have shown us the significant difference between the non-sports vs football players and non-sports vs basketball players.

REFERENCES

Ahn, A.N., Brayton, C., Bhatia, T., Martin, P (2014) Muscle activity and kinematics of forefoot and rearfoot strike runners, *Journal of Sports Health Science*, *3*(2):102–12 https://doi.org/10.1016/j.jshs.2014.03.007

Alemdaroğlu, U (2012) The Relationship Between Muscle Strength, Anaerobic Performance, Agility, Sprint Ability and Vertical Jump Performance in Professional Basketball Players, *Journal of Human Kinetics*, *31*(1):87–92 DOI: 10.2478/v10078-012-0016-6

Andrzejewski, M., Chmura, J., Pluta, B., Strzelczyk, R., Kasprzak, A (2013) Analysis of sprinting activities of professional soccer players, *The Journal of Strength and Conditioning Research*, *27*(8):2134–2140 DOI: 10.1519/JSC.0b013e318279423e

Cojocaru A., Ioniță M (2008) *Volei Aprofundare,* Editor Foundation "România de Mâine", Bucureşti, page 40–41

Di Salvo, V., Baron, R., Gonzalez-Haro, C., Gormasz, C., Pigozzi, F., Bachl, N (2010) Sprinting analysis of elite soccer players during European Champions League and UEFA cup matches, *Journal of Sports Sciences, 28*:1489–1494 DOI: 10.1080/02640414.2010.521166

Djaoui, L., Chamari, K., Owen, A. L., Dellal, A. (2017) Maximal sprinting speed of elite soccer players during training and matches, *The Journal of Strength and Conditioning Research, 31*(6):1509–1517 DOI: 10.1519/JSC.0000000000001642

Duthie, G., Pyne, D., Marsh, D., Hooper, S (2006) Sprint patterns in rugby union players during competition, *Journal of Strength and Conditioning Research, 20*:208–214 DOI: 10.1519/R-16784.1

Faude, O., Koch, T., Meyer, T (2012) Straight sprinting is the most frequent action in goal situations in professional football, *Journal of Sports Sciences*, *30*(7):625–631 DOI: 10.1080/02640414.2012.665940

Gabbett, T (2012) Sprinting patterns of National Rugby League Competition *Journal of Strength and Conditioning Research*, *26*: 121–130 DOI: 10.1519/JSC.0b013e31821e4c60

Gómez, J., Marquina, V., Gómez, R (2013) On the performance of Usain Bolt in the 100 m sprint, *European Journal of Physics*, *34*(5), 1227–1233 DOI: 10.1088/0143-0807/34/5/1227

Ingebrigtsen, J., Dalen, T., Hjelde, G., Drust, B., Wisloff, U (2014) Acceleration and sprint profiles of a professional elite football team in match play, *European Journal of Sport Science*, *15*:101–110 DOI: 10.1080/17461391.2014.933879

Lockie, R., Murphy, A., Callaghan, S., Jeffriess, M (2014) Effects of sprint and plyometrics training on field sport acceleration technique, *Journal of Strength and Conditioning Research*, *28*:1790–1801 DOI: 10.1519/JSC.0000000000000297

Mohr, M., Krustrup, P (2016) Comparison between two types of anaerobic speed endurance training in competitive soccer players, *Journal of Human Kinetics*, *51*:183-192 DOI: 10.1515/hukin-2015-0181

Moore, I S., Jones, A M., Dixon, S J (2012) Mechanisms for improved running economy in beginner runners, *Medicine Scientific Sports Exercercise, 44*:1756–1763 DOI: 10.1249/MSS.0b013e318255a727.

Morin, J., Slawinski, J., Dorel, S., de villareal, E., Couturier, A., Samozino, P., Brughelli, M., Rabita, G (2015) Acceleration capability in elite sprinters and ground impulse: Push more, brake less? *Journal of Biomechanics*, *48*(12), 3149–3154 DOI: 10.1016/ j.jbiomech.2015.07.009

Morin, J., Edouard, P., Samozino, P (2011) Technical ability of force application as a determinant factor of sprint performance, *Medicine & Science in Sports & Exercise*, *43*(9):1680–8 DOI:10.1249/MSS.0b013e318216ea37.

Neagu, N (2010) *Teoria și practica activității motrice umane,* Editor University Press, Târgu Mureș, page 34–36.

Neagu, N (2012) *Motricitatea Umană Fundamente Psihopedagogice,* Editor University Press, Târgu Mureș, page 23–24.

Nummela, A., Keränen, T., Mikkelsson, L O (2007) Factors related to top running speed and economy, *International Journal of Sports Medicine*; *28*(8):655–61.

Petruţ-Barbu G (2012) *Copilul și motricitatea Program de educare neuromotorie,* Editor Nomina, Ediția a 2-a, Bucharest, page 112–114.

Puleo, J., Milroy, P (2016) *Anatomia alergării,* Editor Lifestyle Publishing, Bucharest, page 47–53.

Rumpf, M., Lockie, R., Cronin, J., Jalilvand, F (2016) Effect of Different Sprint Training Methods on Sprint Performance Over Various Distances, *Journal of Strength and Conditioning Research, 30*(6):1767–1785 DOI: 10.1519/JSC.0000000000001245.

Schneiker, K., Bishop, D., Dawson, B and Hackett, L (2006) Effects of Caffeine on Prolonged Intermittent-Sprint Ability in Team-Sport Athletes, *Medicine and Science in Sports & Exercise, 38*(3): 578–585 DOI: 10.1249/01.mss.0000188449.18968.62

Teodorescu, S (2009) *Antrenament și competiție,* Editor Alpha, MDN, Bucharest, page 64–66.

Tseh, W., Caputo, J L., Morgan, D W (2008) Influence of gait manipulation on running economy in female distance runners, *Journal of Sports Science Medicine*; *7*:91–95 Retrived from: https://www.ncbi.nlm.nih.gov/pubmed/24150139

Vescovi, J (2012) Sprint speed characteristics of high-level American female soccer players: Female Athletes in Motion (FAiM) study, *Journal of Science and Medicine in Sport*, *15*:474–478 DOI: 10.1016/j.jsams.2012.03.006

Winchester, J., Nelson, A., Landin, D., Young, M., Schexnayder, I (2008) Static Stretching Impairs Sprint Performance in Collegiate Track and Field Athletes, *Journal of Strength and Conditioning Research*, *22*(1), 13–19 DOI: 10.1519/JSC.0b013e31815ef202.

Wild, J., Bezodis, N., Blagrove, R and Bezodis, I (2011) A Biomechanical comparison of accelerative and maximum velocity sprinting: specific strength training considerations, *The Journal of the UK Strength and Conditioning Association*, *21*:23-36 Retrived from: https://research.stmarys.ac.uk/id/eprint/336/1/Wild-et-al-Biomechanical-Comparison-of-Accelerative-Maximum-Velocity-Sprinting.pdf

Young, W, Russel, A, Burge, P, Clarke, A, Cormack, S, Stewart, G (2008) The use of sprint tests for assessment of speed qualities of elite Australian rules footballers, *International Journal of Sports Physiology and Performance*, *3*: 199–206 DOI: 10.1123/ijspp.3.2.199