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The effects of High-Speed Force on the Maneuverability

THE EFFECTS OF THE LOWER LIMBS' HIGH-SPEED FORCE PERFORMANCE ON THE MANEUVERABILITY ABILITY

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Authors' Contribution: A: Study design, B: Data collection, C: Data analysis, D: Manuscript preparation, E: Discussion and conclusion

ABSTRACT

Study aim(s): The aim of the study is to see the effects of the lower limbs' high-speed force performance such as jumping performance and acceleration measured by countermovement jump, standing broad jump and 20 meters run test on the maneuverability ability which is measured by the Illinois agility test in high school boys and girls aged 14-15.

Methods: To ascertain the importance of the effects of the lower limbs' high-speed force performance on maneuverability ability some body measurements were taken, such as Height, Weight, and BMI. To determine the effects of the lower limbs' high-speed force performance on maneuverability ability, the Illinois Agility Test, Countermovement Jump, Standing Broad Jump, and 20 meters run were used. 60 students of 10th-grades from high school "The British School of Kosovo" were included in this paper. 40 of them boys and 20 girls. SPSS 26 packet program was used. The descriptive statistics include; mean, standard deviation, skewness, kurtosis, and percentiles. The effects of other independent variables on the dependent variables have been determined by using regression analysis.

Results: The regression analysis has shown a significant effect of the CMJ free arms, and SBJ tests on the Illinois agility test ($p<0.05$). Also, the partial correlation has shown significance between a dependent variable which is the Illinois agility test, and 20mRT ($p<0.05$). The results show that the group of students with higher maneuverability ability performed better in high-speed force tests compared to the students whose maneuverability ability was lower ($p<0.05$); CMJ free arms ($1\neq2$, $1>3$-4, $2>3$-4, $3>4$), SBJ: ($1\neq2$, $1>3$-4, $2\neq3$-4, $3\neq4$) and 20mRT: ($1\neq2$, $1<3$-4, $2\neq3$-4, $3\neq4$).

Conclusions: It has been concluded that the results of the study determined that jump performance measured by tests such as countermovement jump and standing broad jump affected significantly the maneuverability measured by the Illinois agility test.

Keywords: Quick Force, Speed, Agility, Maneueverability.

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INTRODUCTION

Anthropometric measurements can be used as a basis for physical fitness and to measure the progress of the skill and in this case, we will show the influence of anthropometric measurements in the realization of motor measurements or motor skills. Previous studies have shown that body composition affects various measures of motor ability and motor performance [1].

The problem of the study is based on the fact that school children are considered as a sedentary category and seems that current literature focuses more on body composition and general motor skills features such as body weight, body height, body mass index, and general motor skills which are more required in daily life rather than in a specific movement. School children love to play and learn fundamental skills which are easier, practicing catching, jumping, and climbing lead to adaptations, resulting in improved performance in particular motor skills and in maintaining good levels of physical fitness using these skills in active play [2]. This way, children become increasingly competent in skills by increasing age and experience. Studies on body composition and general motor skills are important and required in health improvement. However, when studies detect a lack of performance in general motor skills or body composition it means that already there is a health problem and we are late in preventing it.

Characteristics of motor skills are the appearance as dimensions of personality in the performance of various human movements and enable successful movements, taking less into account whether they have been acquired through training or not, on the other hand, morphological characteristics represent a basic system of latent anthropometric dimensions [3]. So, in order to predict and prevent health problems, it is necessary to analyze motor abilities that are more specific and harder to hold in high performance. Skills such as high-speed performance is more sensitive and decreases/increases can be detected easier than general motor skills changes. Besides this, there is still a lack of literature and no clear determination of the effects of the lower limbs' high-speed force performance on the maneuverability ability in sportive performance.

So, the analysis of these effects may be helpful in order to determine the correlations and effects of the mentioned variables that are important for athletic performance development. Training resistance interventions typically emphasize high-load exercise; however, the power of muscle has emerged as an important muscle performance characteristic. For muscle power, speed is a component in which force is developed [4, 5].

Based on the previous information the aim of the study targets the determination of the effects of the lower limbs' high-speed force performance such as; jumping performance and acceleration measured by countermovement jump, standing broad jump and 20 meters run test on the maneuverability ability which is measured by the Illinois agility test in high school boys and girls aged 14-15.

METHOD

Study design

To ascertain the importance of the effects of the lower limbs' high-speed force performance on maneuverability ability, some body measurements were taken, such as; Height, Weight, and BMI. To determine the effects of the lower limbs' high-speed force performance on maneuverability ability, the Illinois Agility Test, Countermovement Jump, Standing Broad Jump, and 20 meters run were used.

Study Sample

The population from which the research sample was taken for this paper is defined as the population of 10th-grade students of the high school "The British School of Kosovo" where 60 students were included in this paper. 40 of them boys and 20 girls. The study was conducted according to the

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Declaration of Helsinki. Before measuring, all students and their parents were properly informed of the nature of the study.

Data Collection Tools

Body height is measured with an anthropometer, the entity being measured must be barefoot, in sportswear, and standing on a firm horizontal base. The head position should be in such a position that the lower edge of the eye and the upper edge of the external ear cavity is in a horizontal position (Frankfurt horizontal). The entity's body posture should be relaxed and straight, feet together, while the meter stands to the entity's left. After checking the position of the entity and the instrument (anthropometer), he lowers the horizontal arm of the anthropometer to the partial part of the head (the highest point of the head -vertex). The body weight and body mass index were measured with medical scales (Tanita BC 545 N Innerscan Segmental Personal Body Analysis) and the data was read with an accuracy of 0.1 kg. Sprint test 20m, measurement was performed according to Bjelica and Fratrić's protocol (the result is given with an accuracy of 0.1 sec) [6]. For Illinois Agility Test were administrated a standard version from previous literature [7]. The Countermovement jump (test was performed on a contact mat platform [8], and the Standing Broad Jump test) measurement was conducted according to the Nešić' protocol [9].

Data analysis

In the data analysis, SPSS 26 packet program was used. The distribution of the data has been tested by using the skewness (> 1 - positive, 0 - normal, < - 1 - negative) and kurtosis (> +2 leptokurtic, 2 mesokurtic, < -2 platykurtic) values. The descriptive statistics include; mean, standard deviation, skewness, and kurtosis. The effects of other independent variables on the dependent variables have been determined by using Linear regression analysis (including the zero-order and partial correlations). In order to double-check the results, the Illinois agility test results have been categorized into groups: 1 (low), 2 (under average), 3 (upper average), and 4 (high). The One-way ANOVA has been applied and the Illinois agility test was a factor while the countermovement jump, standing broad jump, and 20 meters run tests have been dependent variables.

FINDINGS

Table 1. Descriptive statistics

	V	N	X̄ ±Ss	Skew	Kurt
Girls	H	19	164.842±4.21	-.447	-.838
	W	19	67.2±2.95	.507	1.019
	BMI	19	93.5±5.43	-.340	-.717
	IAT	19	21.66±1.37	1.097	.494
	CMJ	19	29.8±5.55	-.960	2.868
	SBJ	19	136.4±22.01	.728	.208
	20M	19	4.640±.466	-.441	-1.093
Boys	H	40	178.6±7.64	-.402	-.061
	W	40	75.0±4.43	-.095	.508
	BMI	40	99.2±6.44	-.894	1.086
	IAT	40	19.05±1.91	.096	-.746
	CMJ	40	40.1±6.56	.126	-.184
	SBJ	40	190.2±30.70	.105	-.785
	20M	40	3.791±.392	2.266	7.496

V: Variables, Skewness (> 1 - positive, 0 - normal, < - 1 - negative), Kurtosis (> +2 leptokurtic, 2 mesokurtic, < -2 platykurtic. H-Height (cm), W-Weight (kg), BMI- Body Mass Index, IAT- Illinois Agility Test (sc), CMJ- countermovement jump (cm), SBJ- Standing Broad Jump (cm), 20m-20 Meters Run (sc).

The skewness and kurtosis values have shown that most of the tests resulted with normal distribution, excluding the Wight, Illinois agility, countermovement jump, 20 meters run in boys, and body mass index in boys where the tendency to have upper and lower results than he appeared normal. While the standing broad jump test resulted in positive skewness and leptokurtic distribution.

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Table 2. The effects of body composition, jump performance, and acceleration on maneuverability (Illinois agility test) performance

Tests	F	ANOVA	R	B	p	Zero-order	Partial
CMJ	17.556	.000	.565	-.076	.028	-.637	-.294
SBJ				-.015	.032	-.596	-.288
20M				.074	.858	.441	.024

B: Unstandardized coefficient. R- R square CMJ-countermovement jump (cm), SBJ- Standing Broad Jump (cm), 20m-20 Meters Run (sc).

The R square value has shown that 56% of variances are explained by the results of the regression analysis. The regression analysis has shown a significant effect of the CMJ free arms, and SBJ tests on the Illinois agility test (p<0.05). Also, the partial correlation has shown significance between a dependent variable which is the Illinois agility test, and 20mRT (p<0.05). Whereas zero-order resulted in not changing the results of the analysis (p>0.05).

Table 3. differences in high-speed tests performance based on the categorization (1: low, 2: under average, 3: upper average, 4: High) of the Illinois agility test values

T	IAT (sec)	X̄ ±Ss	F	P	Post Hoc
CMJ	1 (<18.20)	42.26±6.08	11.817	.000	1≠2
	2 (18.20-20.25)	40.93±6.68			1>3*, 4*
	3 (20.26-21.20)	32.46±4.30			2>3*, 4*
	4 (>21.21)	31.28±7.77			3>4
SBJ	1 (<18.20)	205.0±22.9	8.614	.000	1≠2
	2 (18.20-20.25)	177.8±32.2			1>3*, 4*
	3 (20.26-21.20)	152.8±30.5			2≠3*, 4*
	4 (>21.21)	154.8±40.4			3≠4
20M	1 (<18.20)	3.74±.25	4.44	.005	1≠2
	2 (18.20-20.25)	3.88±.41			1<3*, 4*
	3 (20.26-21.20)	4.35±.57			2≠3, 4
	4 (>21.21)	4.28±.75			3≠4

**Differences between groups are statistically significant. CMJ-countermovement jump (cm), SBJ- Standing Broad Jump (cm), 20m-20 Meters Run (sc). T: Tests, IAT Categories (sec)*

Table 3 carries out the results which show that the group of students with higher maneuverability ability performed better in high-speed force tests compared to the students whose maneuverability ability was lower (p<0.05); CMJ free arms (1≠2, 1>3-4, 2>3-4, 3>4), SBJ: (1≠2, 1>3-4, 2≠3-4, 3≠4) and 20mRT: (1≠2, 1<3-4, 2≠3-4, 3≠4).

DISCUSSION

To ascertain the importance of the effects of the lower limbs' high-speed force performance on maneuverability ability some body measurements were taken, such as; Height, Weight, and BMI.

To determine the effects of the lower limbs' high-speed force performance on maneuverability ability, the Illinois Agility Test, Countermovement Jump, Standing Broad Jump, and 20 meters run were used. Results of the study determined that jump performance measured by tests such as countermovement jump and standing broad jump affected significantly the maneuverability measured by the Illinois agility test. Although the Illinois agility test does not contain a sharp turn (turns are curved lines) and is constructed to measure maneuverability, its performance is correlated to the jump performance. So, the stretch and shortening cycle (SSC), elastic force deposited in the tendons during the eccentric contraction, and action-reaction forces may be the factors that cause the correlation between jumping performance and maneuverability measured by the Illinois agility test. Based on the literature, the correlation between the different performance tests means that a faster time on the agility or the sprint test correlates with a greater explosive jump and endurance jump capacity.

The percentage of variability in endurance jump and explosive jump capacity explained by the performance in the sprint and agility tests were 36–60%, respectively 38–49% [10]. However, in order to come to results based on the facts, specific studies are needed.

In order to analyze the effects of the jumping performance on maneuverability ability from a different perspective we categorized the Illinois agility test results and analyzed the differences between the students with low, average, and high maneuverability performance on jumps and acceleration performance.

The results seem to be in line with the effects of the jumping performance on maneuverability. Thus, the students with better results in maneuverability ability also resulted to have higher performance in the countermovement and standing broad jump performance. A previous study that explored change of direction and sprint ability among young physical education students reported that single-leg CMJ performance was the best predictor of change of direction in female students [11]. Also, authors report a significant relationship between agility performance and CMJ, with lower body rate of force development during the jump squat among the best predictors of performance during the agility test [12]. Other studies also have found a lower predictive ability of the CMJ with agility performance [13].

However, the acceleration ability measured by 20 meters run test, has not shown a significant effect on the maneuverability ability based on the regression analysis. While the 20 meters run is a linear movement, the maneuverability contains turns, jumps, lowering and lifting the body, unilateral works, etc. To measure an athlete's linear speed capabilities used solely typical speed tests. The average sprint distance in team sport athletes has been reported to be between 15-21m [14-16] and rarely lasts more than 3 seconds [17-19]. Usually, team sport athletes perform shorter distance sprints compared to track athletes, and for that, it has been suggested that they may achieve maximum speeds within far shorter distances. The Illinois test (According to the NSCA's Guide to Program Design 2012) lasts longer than the 5-10-5 shuttle or T-test, covers more space, requires the athlete to turn in different directions and run at different angles and consists of a greater number of changes in direction [20]. So, the construct of the Illinois agility test which includes maneuverability is different from the 20 meters run test and it may be the reason for the non-significant effects.

As we mentioned in the previous section, in order to double-check results we applied the ANOA analysis where the Illinois agility test results were categorized into 4 groups (low, under average, upper average, and high), excluding the significant differences between the very low and very high results, there were no significant differences between groups with close results in the Illinois agility test. So, this analysis also is in line with the results of the regression analysis mentioned in the previous paragraph. The research found positive relationships between speed and Illinois agility test of female participants, and between speed and agility T-Test of male participants [21]. This shows that the decrease in the speed value, which was determined as the duration, will also reduce the agility value, which was determined as the time. The literature that compared speed values and agility tests. In his study Çakmak (2019) concluded that there was a statistically significant relationship between Illinois agility test values of female footballers and 30m speed [22].

Because the aim of the study was not to make differences between genders and the results aimed at the study are not supposed to be affected by gender, we did not analyze boys and girls separately, However, in order to increase the accuracy and get gender-specific results we suggest that the future studies for the same or similar aims should be based on the separated analyses and results in gender perspectives.

CONCLUSION

We can conclude that based on the construct of the tests included in this research the results of the study determined that jump performance measured by tests such as countermovement jump and standing broad jump, affected significantly the maneuverability measured by the Illinois agility test. So, the stretch and shortening cycle (SSC), elastic force deposited in the tendons during the eccentric contraction, and action-reaction forces may be the factors that cause the correlation between jumping performance and maneuverability measured by the Illinois agility test.

We can also conclude that the Illinois agility test results were categorized into 4 groups (low, under average, upper average, and high), excluding the significant differences between the very low and very high results, there were no significant differences between groups with close results in the Illinois agility test.

CONFLICT OF INTERESTS

No potential conflict of interest was reported by the authors.

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