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DETERMINANTS OF STANDING LONG JUMP PERFORMANCE IN 9-12 YEAR OLD CHILDREN

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Abstract The aim of this study was to identify the most significant variables that contribute to standing long jump (SLJ) performance in young boys and girls. Standing long jump (SLJ), vertical counter movement jump (CMJ), 10 m and 20 m time were measured in 59 boys and 66 girls aged 9-12 years. Technique during the SLJ (SLJtech) was rated by an experienced investigator. Two-way ANOVA revealed increases in anthropometric and performance parameters by age, but no differences between boys and girls. SLJ was negatively correlated with 30 m sprint time ($r = -0.68$, $p < 0.01$) and positively correlated with CMJ performance ($r = 0.58$, $p < 0.01$), while SLJ_{tech} had a high correlation coefficient with SLJ performance ($r = 0.68$, $p < 0.01$). Stepwise multiple linear regression analysis with SLJ performance as the dependent variable, showed that 74.9% of the variance of SLJ performance could be explained by CMJ, SLJ_{tech}, 30 m sprint time, body height and peak leg power expressed per kg body mass, with CMJ, SLJ_{tech} and 30 m time contributing mostly (71.2%). Other anthropometric variables that were deemed to influence SJL such as leg length, weight and BMI were not found to contribute to SLJ performance in this age group. Due to the large contribution of technique to SLJ performance, this test may not produce valid results when the aim is to assess leg power in children aged 9-12 years.

Key words: Jump, countermovement jump, growth, anthropometric, regression analysis

INTRODUCTION

Standing long jump (SLJ) is a multi-joint movement that is commonly used to assess explosive leg power [18]. Due to its simple and time-efficient implementation that does not require any equipment, it is routinely used by coaches of several sports for talent selection and prediction of potential [5]. Also, SLJ performance is significantly correlated with physical characteristics, such as lean leg volume [9] and other explosive muscular strength tests of the lower body [7].

However, body dimensions may significantly affect performance when SLJ is used for the assessment of leg muscle power in children, since taller individuals may jump longer than shorter ones with the same leg muscle power [8]. The most important factors for this outcome are the higher center of mass and the longer leg length in taller children [3], which increase the trajectory of the center of mass and thus SLJ performance. Wakai and Linthorne [25] divided SLJ performance (distance) into three parts: (a) the take-off distance, which is defined as the horizontal distance between the take-off line and the jumper's centre of mass at the instant of take-off, (b) the flight distance, which is the horizontal distance travelled by the center of mass while airborne and (c) the landing distance, which is defined as the distance between the center of mass and the heels of the feet at the instant of landing. Both the takeoff and landing distances are strongly affected by leg length, i.e. they are greater in an individual with longer legs, while the flight distance mainly depends on leg muscle power. Consequently, during physical development, children may increase SLJ performance simply because height and leg length are increased.

An additional important factor that may influence SLJ performance is skill. Skill in children does not only depend on practice, but it is influenced by neuromuscular maturation [3]. Compared with vertical countermovement jump, SLJ requires more coordination of movements, timing and technique, since both the takeoff angle and the position of the limbs during takeoff and landing may change the horizontal distance jumped [1, 8, 17, 20]. In that respect, individuals with greater strength that allows them to lift their legs higher during landing, and/or children with a more mature neuromuscular system may have an advantage. Furthermore, anthropometric characteristics such as body mass and body composition may negatively affect SLJ performance. Brunet et al [4] reported significant negative correlations between Body Mass Index and Waist

Circumference with SLJ performance in children aged 8 and 10 years old, while Malina and Reyes [15] mentioned that increased centrally distributed subcutaneous fat negatively affected motor performance of 8-11 year old children. However, this does not necessarily imply that these children have low muscle power. It rather reflects a decreased power-to-weight ratio. Gender may also affect SLJ performance with boys performing better than girls [6, 13, 19], but this occurs only during puberty and not in early childhood.

Based on the above there is a need to assess and quantify the most significant variables that contribute to SLJ performance in children. This will help to establish the validity of this test to evaluate leg muscle power in growing individuals. Therefore, the purpose of this study was to establish the determinants of SLJ performance in boys and girls aged 9-12 years old.

MATERIALS AND METHODS

PARTICIPANTS

The sample consisted of one hundred and twenty five healthy schoolchildren (59 boys and 66 girls) who voluntary participated in the study. Prior to data collection, informed consent was obtained from a parent of each participant, after a thorough description of the purpose of the study and the possible risks involved. All procedures were in accordance with the Helsinki declaration of 1975, as revised in 1996. Participants had no recent injuries in upper or lower limbs. The physical characteristics of the subjects are shown in Table 1. Subjects were divided into three groups according to their chronological age (10: from 9 to 10 years, 11: from 10 to 11 years and 12: from 11 to 12 years old). Of those children, 52% (33 boys and 32 girls) were involved in systematic training in different sports such as soccer, basketball, volleyball, tennis, ballet, track & field, martial arts, gymnastics and swimming (average training history: 3.2 ± 2.1 years).

PROCEDURES

All children were fully familiarized with the tests, since they regularly performed them during the physical education classes at regular intervals during the school year. In addition, participants also performed two specific familiarization sessions one week before the study where the correct technique of the SLJ, the Countermovement Jump (CMJ) and the sprint acceleration were practiced under the supervision of two experienced track & field coaches. The main tests were performed in three separate sessions, 2-4 days apart. In the first session the anthropometric parameters were measured (height, body mass, leg length). On the second testing day, children were tested in 30 m sprint whereas in the third testing session, children performed the SLJ and the CMJ. On the day prior to the performance tests (second and third sessions), participants were advised to abstain from intense exercise.

On each performance testing day, participants performed a standardized warm-up that included 5 minutes light jogging and 5 minutes dynamic stretches (quadriceps, hamstrings, gluteals, gastrocnemius), followed by running drills and two 30 m progression runs or two CMJ and two SLJ, on the occasion when jumping performance was assessed. These were followed by 5 min rest before the start of the main test.

ANTHROPOMETRY

Body height was assessed with a portable stadiometer (Charder HM-200P Portstad) to the nearest 0.01 m. Leg length was measured with the child standing barefoot by using an anthropometric tape (Physio Supplies, Australia) from the ground to the major trochanter. Body mass (kg) was measured using a Tanita BF-578 digital scale (Tanita Corporation, Tokyo, Japan), to the nearest 0.1 kilogram. Body Mass Index was then calculated by dividing body weight by the height squared. The ratio of leg length to height was also calculated.

10 M AND 30 M SPRINT TIME

Participants were instructed to run 30 m as fast as possible from a standing start. The test was conducted on the asphalt schoolyard and all participants wore sports shoes. Subjects stood 30 cm behind the starting line with the preferred leg in front. The environmental temperature was 21-23^{o} C and the yard was protected from wind. The sprint time for 10 m and 30 m was measured by an electronic timing system which had three gates of photocells (Brower Timing Systems, Salt Lake City, Utah, USA), placed on the starting line and at the 10 m and 30 m marks. The height of the photocell gates was adjusted to approximate the greater trochander height of the participants. All sprint times were recorded to the nearest 0.01 second.

STANDING LONG JUMP (SLJ)

The SLJ test was performed indoors on a non slippery rubber mat. Each subject stood on the starting line with their legs parallel and feet shoulder–width apart. Children were instructed to bend the knees (the depth of the flexion was self-selected) and bring the arms behind the body. Then, with a powerful drive they extended their legs, moved the arms forward and jumped as far as possible. Children performed three jumps with about 2 min rest in between, and the best trial was recorded. The length of the jump was assessed (cm) from the starting line to the heel that was closest to the starting line. All trials were measured to the nearest 0.01 m. To assess the influence of technique during the test an experienced investigator rated technique (SLJ_{tech}) of each trial giving a mark from 1 to 10. The criteria for marking included: coordination of lower and upper limbs, full extension of the legs during push-off, position of the legs and the torso during landing.

COUNTERMOVEMENT JUMP (CMJ)

After the general and specific warm-up, the participants stood upright with the hands held on the hips in order to avoid any effect of arm swing. The knees and hips were then bent with a fast movement to a self-selected depth, while the torso remained erect. Then with powerful extension of the leg joints they jumped as high as possible and landed with the knees straight on the same spot. The height of the CMJ was calculated from flight time that was measured with a highly reliable [11] optical measurement system, Optojump Next (Microgate SRL, Bolzano, Italy). Maximum power was calculated using the equation of Sayers [21] and was expressed relative to body mass (W/kg).

STATISTICAL ANALYSIS

All statistical analyses were performed using the SPSS version 17.0 for Windows (SPCC Inc., Chicago, IL). Data were presented as means and standard deviations. The differences between boys and girls across the three age groups were assessed using two-way Analysis of Variance (ANOVA) for independent samples. When significant main or interaction effects were found, the Tukey's post-hoc test was used to locate the mean differences. Stepwise multiple linear regression analyses were used to identify the determinants of SLJ performance. Statistical significance was set at $p < 0.05$.

RESULTS

Table 1 shows the anthropometric variables by age group and gender. The 2-way ANOVA revealed only an age group main effect ($p < 0.01$). There was no gender main effect or gender x age group interaction for any anthropometric measurement (Table 1). Thus, all anthropometric variables increased from one age group to the next, but there were no differences between boys and girls in any age group (Table 1).

Table 1. Anthropometric variables and indexes by age group and gender (Mean±SD)

AGE GROUP (age in y)	**GENDER**	**Height** (m)	**Weight** (kg)	**BMI** ($kg \cdot m^{-2}$)	**Leg length** (m)
10 (9.6±0.2)	boys (n=16)	1.35±0.07	33.2 ±7.3	18.1±2.6	0.65±0.04
	girls (n=21)	1.37±0.07	35.2 ±7.4	18.6±2.4	0.67±0.04
11 (10.5±0.3)	boys (n=23)	1.44±0.08*	42.5 ±9.4*	20.4±3.1#	0.71±0.05*
	girls (n=17)	1.42±0.06*	39.5 ±8.1*	19.5±2.9#	0.71±0.04*
12 (11.5±0.3)	boys (n=20)	1.49±0.07*‡	45.7±10.2*†	20.3±3.8#	0.74±0.04*‡
	girls (n=28)	1.53±0.08*‡	46.2 ±9.7*†	19.7±3.0#	0.76±0.04*‡

BMI: body mass index. There was an age group main effect for all variables (p<0.01). No gender main effect or gender x age group interaction were found for any anthropometric measurement. * and #: p<0.01 and p<0.05 for age group 10; ‡, †: p<0.01 and p<0.05 for age group 11

Performance variables for boys and girls in each of the three age groups are presented in Table 2. There was a main effect for age group ($p < 0.03$ to $p < 0.001$) for the 10 m and 30 m sprint time and for peak leg power relative to body mass. The 2-way ANOVA of SLJ performance revealed only a marginally significant difference ($p = 0.09$) of SLJ between boys and girls at the age of 12 (Table 2). Furthermore, a gender main effect ($p < 0.05$) was found only for CMJ, i.e. boys had higher CMJ than girls, with no age group main effect or gender x age group interaction.

The 2-way ANOVA for the rating of SLJ technique (SLJ_{tech}) showed a gender x age interaction ($p<0.001$) and Tukey's post-hoc test showed that this rating was similar in all age groups (around 6-7 in a 0-10 scale), but dropped significantly in the girls of the 12 y old age group (5.0 ± 1.3, $p < 0.01$, Table 2). Correlation analysis showed that height and body mass were negatively correlated with SLJ_{tech} of the girls only in the 12 y age group ($r = -0.37$ and 0.40, $p < 0.05$).

Table 2. Performance variables by age group and gender (Mean±SD)

AGE GROUP (age in y)	GENDER	10m (sec)	30m (sec)	CMJ (cm)	SLJ (cm)	SLJ_{tech} (0-10)	POWER ($W \cdot kg^{-1}$)
10 (9.6±0.2)	boys	2.25±0.2	5.82±0.5	21.3±4.3	1.41±0.2	7.1±1.1	21.9±8.4
	girls	2.27±0.1	5.92±0.3	20.3±3.2¥	1.32±0.2	6.4±1.2	21.4±5.8
11 (10.5±0.3)	boys	2.21±0.1	5.70±0.4	21.9±4.5	1.39±0.2	6.1±1.8	27.5±8.0#
	girls	2.21±0.1	5.75±0.5	19.3±4.9¥	1.42±0.2	6.9±1.0	22.9±6.8#
12 (11.5±0.3)	boys	2.14±0.1#	5.46±0.5#	22.2±6.4	1.53±0.2	6.4±1.7	29.2±9.3*
	girls	2.21±0.1#	5.73±0.5#	20.6±3.4¥	1.37±0.2	5.0±1.3†	27.3±6.2*

10m and 30m: 10 m and 30 m sprint time; CMJ: countermovement jump; SLJ: standing long jump; SLJ_{tech}: rating of standing long jump technique (0-10); POWER: peak power during a countermovement jump expressed per kg body mass. There was an age group main effect for all variables ($p<0.01$). No gender main effect or gender x age group interaction were found for any variable, except for CMJ. * and #: $p<0.01$ and $p<0.05$ for age group 10 (age group main effect); †: $p<0.01$ for boys and girls in all age groups (age group x gender interaction); ¥: main effect for gender ($p<0.05$) with no age group main effect or gender x age group interaction.

Since there was no difference between boys and girls for the parameters measured, the regression analysis was performed for the pooled data for boys and girls. The correlation matrix for the variables used in the regression analysis is presented in Table 3. As expected, SLJ was negatively correlated with 30 m sprint time ($r = -0.68$, $p < 0.01$) and positively correlated with CMJ performance ($r = 0.58$, $p < 0.01$), while SLJ_{tech} also had a high correlation coefficient with SLJ performance ($r = 0.68$, $p<0.01$). Height ($r = 0.11$, n.s.), weight ($r = -0.07$, n.s.) and leg length ($r = 0.12$, n.s.) did not correlate with SLJ performance in these 9-12 year old children. Height and leg length ($r = -0.25$ and -0.23, $p < 0.05$) were negatively correlated with 30 m ($r = -0.25$ and -0.23, $p < 0.05$) and 10 m ($r = -0.22$ and -0.21, $p < 0.05$) sprint time, indicating an increase in running speed with increased height.

Table 3. Correlation matrix (Pearson product-moment correlation coefficient r) for the variables used in the regression analysis (n=125)

VARIABLE	CMJ	30m	SLJ_{tech}	Power	Height
SLJ	0.58**	-0.68**	0.68**	0.48**	0.11
CMJ		-0.56**	0.33**	0.80**	0.03
30m			-0.35**	-0.58**	-0.25**
SLJtech				0.14	-0.28**
Power					0.50**

SLJ: standing long jump; CMJ: countermovement jump; 30 m: sprint time; SLJ_{tech}: rating of standing long jump technique; POWER: peak power during a countermovement jump expressed per kg body mass. **$p<0.01$ statistically significant correlation.

The results of the stepwise multiple linear regression analysis for the assessment of the determinants of SLJ performance are presented in Table 4. Only the following five parameters had significant contribution and were included in the stepwise multiple regression model: CMJ, SLJ_{tech}, 30 m sprint time, body height, and peak leg power expressed per kg body mass. The addition of each of these parameters caused a significant change in R^2, so that 74.9% of the variance of SLJ performance could be explained by the variance of those five parameters.

Another way to group the results is by training history and gender. Of all children, 52% declared that they were training regularly (56% of the boys and 49% of the girls). Interestingly, when dividing the children in "trained" or "untrained", there was no difference between trained and untrained boys and girls in any anthropometric variables. However, performance variables were greater in trained boys (but not in trained girls), compared with their untrained counterparts (Table 5). Also, the rating of SLJ technique was significantly lower in untrained girls, compared with both trained girls and trained and untrained boys (Table 5).

Table 4. Stepwise multiple linear regression analysis for the assessment of determinants of SLJ performance

Model	R	Adj R^2	SEE	R_2 Change	F change	Sig. F Change
a	0.579[a]	0.330	0.169	0.335	61.975	0.000
b	0.781[b]	0.604	0.130	0.275	86.099	0.000
c	0.848[c]	0.712	0.111	0.108	46.564	0.000
d	0.863[d]	0.736	0.106	0.026	12.035	0.001
e	0.872[e]	0.749	0.104	0.015	7.628	0.007

a. Predictors: (Constant), CMJ
b. Predictors: (Constant), CMJ, SLJ_{tech}
c. Predictors: (Constant), CMJ, SLJ_{tech}, 30m
d. Predictors: (Constant), CMJ, SLJ_{tech}, 30m, Height
e. Predictors: (Constant), CMJ, SLJ_{tech}, 30m, Height, POWER

SLJ: standing long jump; CMJ: countermovement jump; 30 m: sprint time; SLJ_{tech}: rating of standing long jump technique; POWER: peak power during a countermovement jump expressed per kg body mass

Table 5. Performance variables by training history and gender (Mean±SD)

	GENDER	30m (sec)	CMJ (cm)	SLJ (cm)	SLJ_{tech} (0-10)
Trained	**boys (n=33)**	5.49±0.4*	23.1±4.0*	1.51±0.1*	6.9±1.2
	girls (n=32)	5.80±0.4	20.4±3.8	1.40±0.2	6.3±1.3
Untrained	**boys (n=26)**	5.85±0.5	20.2±4.5	1.35±0.2	6.0±1.3
	girls (n=34)	5.79±0.5	20.0±3.5	1.34±0.2	5.6±1.2†

30m: sprint time; CMJ: countermovement jump; SLJ: standing long jump; SLJ_{tech}: rating of standing long jump technique (0-10); *: p<0.01 for all other groups; †: p<0.01 for boys and girls in all other groups.

DISCUSSION

This study showed that performance in SLJ in young boys and girls can be predicted by sprinting ability, vertical jump performance, technique level, height and relative peak leg power. It was hypothesized that body mass, height and more specifically leg length, may affect SLJ performance by modifying relative power output and takeoff and landing distances. However, none of the anthropometric characteristics correlated highly with SLJ performance (r between 0.12 and 0.17, n.s.), indicating that they were not major determinants of SLJ performance in children aged 9 - 12 years. In a recent study, Aouichaoui et al [2] examined the relative contributions of anthropometric variables to CMJ performance in 7-13 year-old boys and girls from Tunisia. Multiple linear regression analysis showed that age, weight, fat free mass, and height were predictors of CMJ height, but the R^2 values for the multiple regression equations were quite low ($R^2 = 0.259$ and 0.328, $p < 0.05$ for girls and boys, respectively). Thus, in that study only about one forth to one third of the variance was explained by these anthropometric variables. Moreover, no other performance measurements were taken in the study so that the contribution of muscle strength and power to CMJ performance could not be assessed. In a similar study in children [3], height explained 21% and 36% of the variance in SLJ in 6 - 10 y old girls and boys, respectively, while it was not a contributing parameter in children between 10 and 13 y old.

However, a contribution of anthropometric parameters such as height, weight and leg length to SLJ performance of children older than 12 y can not be excluded. Temfemo et al [23] assessed jumping ability, leg power and anthropometric characteristics in 11 - 16 y old children and found that jumping performance increased during growth, with gender differences manifesting after the age of 12 and increasing more after the age of 14, probably due to the onset of puberty in both genders that resulted in a much greater increase in leg length and leg muscle volume in boys compared with girls. Greater leg muscle volume may be caused by the increased testosterone secretion in boys around 14 years old [22], which leads to an increase in fat-free mass, as well as by the greater involvement of boys in strenuous physical activities that increase muscle power [16, 19]. On the other hand, puberty in girls is related with increased adipose tissue and decreased strength and power relative to body mass after the age of 14 y [10]. Loko et al [14] reported that although SLJ performance increased linearly between the ages 10 - 12 and remained stable from the age of 13 until the age of 17.

In the present study, a large part of the variance in SLJ performance (71.2%, Table 4) was explained by performance and not anthropometric variables. The relative importance of the determinants of SLJ performance may be estimated by the changes in the coefficient of determination (R^2) when a variable is added in the stepwise multiple linear regression analysis model. As seen in Table 4, the percentage of variance in SLJ performance that could be explained by the five determinants was high (74.9%), while the major part of it was equally accounted for by two parameters: CMJ and the rating of SLJ technique (R^2 change of 0.335 and 0.275, respectively). The contribution of the 30 m sprint time to the regression model was quite lower (R^2 change 0.108), while height and power output contributed by an even smaller degree (R^2 change of 0.026 and 0.015 or 2.6 and 1.5%, respectively).

The association of different measures of body strength and power with SLJ has been examined in 6-17 year old children by Castro-Pinero et al [7]. They found that SLJ was strongly associated with CMJ and vertical jump (with arm swing), and also with other upper body strength and power tests, such as basketball throw, push-ups and an isometric arm press tests. They concluded that SLJ may be used as a practical test, low in cost and equipment requirements, for the assessment of general strength in young children. However, the skill required to execute the movement of SLJ correctly may largely affect performance and thus the validity of SLJ performance as a lower leg muscle power index may be reduced. In the present study, technique during execution of SLJ (SLJ_{tech}) was rated by an experienced investigator who gave a mark according to standardized criteria based on coordination of the lower and upper limbs, full extension of the legs during push-off and the position of the legs and the torso during landing. It is important to note that the same investigator rated all of the children's jumps, so that any subjective elements in the judgment were equal for all participants. A similar analysis of skill level in long jump has been recently used to assess fundamental movement skills in Australian preschool children [12]. As noted above, multiple regression analysis revealed the importance of technique for SLJ performance. Furthermore, the results of the two-way ANOVA revealed that SLJ_{tech} was poor for the 12 year old girls and this may have contributed to the marginally ($p = 0.09$) decreased SLJ performance compared with boys in the 12 y old age group (Table 2). The negative significant correlation between height and body mass and the rating of SLJ technique ($r = -0.37$ and 0.40, $p < 0.05$) may indicate that an increase in height and body mass during this period of childhood may adversely affect a test requiring skill and specific muscle power in girls (e.g. to lift the legs fast during landing). Similar conclusions were drawn by Benefice et al [3] who suggested that fatness affects the performance of girls who are over 10 y old, but has no effect on boys. It is possible that girls in the 12 y old group in the present study were entering puberty, which is characterized by increased estrogen secretion that promotes an increase in adipose tissue. Furthermore, girls of that age may be less physically active than boys [24] and this may also contribute to their lower leg power as indicated by the lower CMJ, and possibly to lower strength in other muscles that contribute to good landing technique (e.g. leg flexors, abdominals, etc). Taken together, this evidence highlights the importance of technique for SLJ performance, and may argue against its use as the most appropriate test for the assessment of leg muscle power in young children, especially in girls. This is due to the fact that although the multiple regression showed that SLJ performance depended largely on leg power, it also contained a relatively large element of technique, which may be a confounding variable when leg power is assessed through SLJ performance. Previous studies have also argued that SLJ performance may be affected by anthropometric factors and technique [1, 26]. In the present study, it was shown that anthropometric variables contributed only slightly to SLJ performance in that age group, while technique had a large influence on the distance jumped. Therefore, the assessment of the true lower body power by SLJ performance may not be accurate, especially when comparing individuals with different levels of skill and technique.

On the other hand, 10 m and 30 m sprint performance and leg power calculated from CMJ and body mass increased in both boys and girls from one age group to the next. Sprinting and vertical jumping may be considered as simpler motor skills compared with SLJ; therefore an increase in leg power may be more evident when assessed by a CMJ or a 10 m sprint than by SLJ. However, certain anthropometric characteristics, such as height and leg length, may influence sprint performance. In the present study, height and leg length were negatively correlated with 10 m and 30 m sprint time ($r = -0.21$ and -0.25, $p < 0.05$). This means that as height and leg length increased, running speed also developed. This may be explained in part by the contribution of stride length, which is directly proportional with height and leg length, to running speed.

One finding of the present study was that when children were classified as trained and untrained, there were no differences in anthropometric variables between the two groups, but all performance variables were greater in trained boys, but not in trained girls, compared with their untrained counterparts. The fact that only trained boys had greater motor performance may be related with the type of physical training followed by boys and girls. In the present study, girls who were classified as physically active were involved mainly in sports not involving strenuous power training (e.g. swimming, ballet), while boys were involved in more strenuous sports such as soccer, basketball and track and field. Thus, the term "trained" may not signify the same training loads for girls and boys at that age. Notably, untrained girls had the lowest rating of SLJ technique (Table 5). This would suggest that girls who are not involved in any organized physical activity program are lacking skill and possibly strength and power to execute a demanding task, such as the SLJ, correctly.

CONCLUSION

In conclusion, this study showed that the main predictors of SLJ performance in 9 - 12 year old children were CMJ, SLJ_{tech}, and 30 m sprint time, while height and peak power output contributed to a small degree. Other anthropometric variables that were deemed to influence SJL such as leg length, weight and BMI were not found to contribute to SLJ performance, at least in that age range. Due to the large contribution of technique to SLJ performance, this test may not produce valid results when the aim is to assess leg power in children aged 9 - 12 years.

PRACTICAL APPLICATION

The results of this study will be of benefit to the practitioners seeking to assess muscle power in children with SLJ. The importance of technique and its relatively large contribution to SLJ performance in that age group should not be overlooked. Coaches may consider rating the technique of the young jumpers, so that its influence to the final performance could be estimated. The greater SLJ performance only in trained boys and not in trained girls, compared with their untrained counterparts, may indicate their greater responsiveness to training, and/or the greater participation in strength/power sports.

APPENDIX

Correlation matrix (Pearson product-moment correlation coefficient r) for the variables used in the regression analysis according to the gender are shown at Table 6 and 7. Stepwise multiple linear regression analysis for the assessment of determinants of SLJ performance according to the gender are shown at Table 8 and 9.

Table 6. Correlation matrix (Pearson product-moment correlation coefficient r) for the variables used in the regression analysis (n=59, Boys)

VARIABLE	CMJ	30m	SLJ_{tech}	Power	Height
SLJ	0.67**	-0.76**	0.71**	0.56**	0.23
CMJ		-0.71**	0.35**	0.84**	0.22
30m			-0.46**	-0.68**	-0.33**
SLJtech				0.23	-0.06
Power					0.61**

SLJ: standing long jump; CMJ: countermovement jump; 30 m: sprint time; SLJ_{tech}: rating of standing long jump technique; POWER: peak power during a countermovement jump expressed per kg body mass. ** and * p<0.01 and p<0.05 statistically significant correlation.

Table 7. Correlation matrix (Pearson product-moment correlation coefficient r) for the variables used in the regression analysis (n=66, Girls)

VARIABLE	CMJ	30m	SLJ_{tech}	Power	Height
SLJ	0.42**	-0.58**	0.63**	0.34**	0.04
CMJ		-0.35**	0.25*	0.72*	-0.16
30m			-0.20	-0.44**	-0.22*
SLJtech				0.04	-0.47**
Power					0.44**

SLJ: standing long jump; CMJ: countermovement jump; 30 m: sprint time; SLJ_{tech}: rating of standing long jump technique; POWER: peak power during a countermovement jump expressed per kg body mass. ** and * p<0.01 and p<0.05 statistically significant correlation.

Table 8. Stepwise multiple linear regression analysis for the assessment of determinants of SLJ performance (n=59, Boys)

Model	R	Adj R^2	SEE	R_2 Change	F change	Sig. F Change
a	0.666[a]	0.434	0.167	0.444	45.435	0.000
b	0.841[b]	0.696	0.122	0.263	50.191	0.000
c	0.877[c]	0.757	0.110	0.063	14.996	0.000
d	0.881[d]	0.760	0.109	0.007	1.791	0.186
e	0.889[e]	0.771	0.106	0.014	3.527	0.066

a. Predictors: (Constant), CMJ; b. Predictors: (Constant), CMJ, SLJ_{tech}; c. Predictors: (Constant), CMJ, SLJ_{tech}, 30m;
d. Predictors: (Constant), CMJ, SLJ_{tech}, 30m, Height; e. Predictors: (Constant), CMJ, SLJ_{tech}, 30m, Height, POWER

SLJ: standing long jump; CMJ: countermovement jump; 30 m: sprint time; SLJ_{tech}: rating of standing long jump technique; POWER: peak power during a countermovement jump expressed per kg body mass

Table 9. Stepwise multiple linear regression analysis for the assessment of determinants of SLJ performance (n=66, Girls)

Model	R	Adj R^2	SEE	R_2 Change	F change	Sig. F Change
a	0.422[a]	0.166	0.171	0.178	13.982	0.000
b	0.689[b]	0.458	0.138	0.296	35.454	0.000
c	0.798[c]	0.620	0.115	0.163	27.867	0.000
d	0.837[d]	0.681	0.106	0.064	13.023	0.001
e	0.848[e]	0.696	0.103	0.018	3.944	0.052

a. Predictors: (Constant), CMJ; b. Predictors: (Constant), CMJ, SLJ_{tech}; c. Predictors: (Constant), CMJ, SLJ_{tech}, 30m; d. Predictors: (Constant), CMJ, SLJ_{tech}, 30m, Height; e. Predictors: (Constant), CMJ, SLJ_{tech}, 30m, Height, POWER

SLJ: standing long jump; CMJ: countermovement jump; 30 m: sprint time; SLJ_{tech}: rating of standing long jump technique; POWER: peak power during a countermovement jump expressed per kg body mass

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