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ANALYZING THE IMPACT OF BALLISTICS AND PLYOMETRIC MOVEMENT OF STRETCH SHORTENING CYCLE VARIABLES OF HIGH JUMPERS OF TRACK AND FIELD ATHLETES

p.p.112-125


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ABSTRACT

This study aimed to compare the ballistic and plyometric movement of high jumpers of L.N.I.P.E Gwalior. The source of data for this study was 10 students (5 male and 5 female).G sensor was used to collect the data. All the jumps were recorded in the sagittal plane. G studio software is used for the interpretation of data. The variables used in this study were height, takeoff force, impact force, Maximum concentric power, Average speed concentric phase, Peak speed, and Take-off speed. Each athlete performed one squat jump and one counter-movement jump. Both SJ and CMJ have the same 7 variables. Subjects were randomly selected from male and female track and field groups. Stratified Random sampling was used for this study to compare the squat jump and countermovement jump variables we used an independent t-test. The results have exhibited that the obtained value of the independent t-test has shown a significant difference between SJ and CMJ in male athletes in one variable Average speed concentric phase (0.008) and in female athletes significant difference was also found in Average speed concentric phase (0.37). Other variables such as height, takeoff force, impact force, Maximum concentric power, Peak speed, and Take-off speed showed no significant difference between SJ and CMJ.

Keywords: Ballistics training, plyometric training, CMJ, SJ & impact force.

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INTRODUCTION

The term ballistic refers to a method of training, where the athlete's body or an external object is explosively projected into a flight phase. Ballistic exercises, which inherently require increased velocity, have been shown to produce greater force, power output, and motor-unit recruitment when compared to traditional exercise. Ballistic strength training induces different neural adaptations that specifically affect the recruitment and discharge rates of motor units at the beginning of voluntary contraction (gruber, gruber, taube, schubert, & beck, 2007). Ballistic exercises (i.e., those that accelerate throughout the entire concentric movement) may lower the recruitment threshold for motor units (j e desmedt, 1977). Plyometric exercises involve rapid stretching and contracting muscles, known as the stretch- shortening cycle, to generate maximum force in a short amount of time. The SSC involves three ordered phases: (1) Eccentric (braking); (2) amortization; and (3) concentric (propulsion). Plyometric training is strongly associated with the SSC (WILT, 1978). Plyometric training involves the involvement of the lower extremities, but ballistic training involves many upper-body protocols that have been used to enhance ballistic throwing performance (West, Cunningham, Crewther, Cook, & Kilduff, 2013).Ballistic exercises are typically concentric only in nature, meaning an exercise's lowering or yielding phase is removed. This allows more time to produce force, meaning larger loads (e.g. up to 90 % 1RM) can be utilized. So in this study, the Squat jump and countermovement jump are the best indicators of explosive characteristics of the lower limb, The CMJ test showed the highest relationship with the explosive power factor (r= 0.87), that is, the greatest factorial validity (Markovic, Dizdar, Jukic, & Cardinale, 2004). We choose the squat jump for ballistic movement because in the squat jump, were move the eccentric phase, or we can say the downward phase, so we are already in the pre- stretch position for force production and for plyometric movement we choose countermovement jump because it has all three phases of SSC. In plyometric we have eccentric as well as concentric phases. The research was done in the year 2018 on" the topic of

Variability of Plyometric and Ballistic Exercise Technique Maintains Jump Performance" In this research the variables are depth jump, rebound jump, and squat jump (Chandler, Greig, Comfort, & mcmahon, 2018). In above mentioned research the variable of plyometric is depth jump and rebound jump to fill the gap of research I choose countermovement jump as a variable of plyometric movement and compare it with squat jump on different variables of SSC.

DESIGN OF THE STUDY

A total of 10 subjects agreed to participate in the study and were present during the familiarization and anthropometric measurements. 10 subjects 5 were male and 5 were female.(Mean ± SD; age 19 ± 1.2 years; height 165 ± 8 cm; body mass 66.8 ± 7 kg; fat percentage (%) 13.2 ± 2.4)for male athletes.(Mean ± SD; age 18 ± 1.2 years; height 155 ± 8 cm; body mass 52.5. ± 6 kg; fat percentage (%) 17.2 ± 2.2) for female athletes. The study was conducted during the off-season after the completion of the university games. Inclusion criteria for the study were the absence of major lower limb injury in the past 6 months, any other recent injury, or neuromuscular disorder that could potentially limit performing jumps. Subjects reported participation in plyometric training in the past. After the explanation of the procedures, players signed the informed consent form, confirming their voluntary participation in the study.

Selection of variables

1. Height,
2. Take off Force,
3. Impact Force,
4. Maximum Concentric Power,
5. Average Speed Concentric Phase,
6. Peak Speed
7. Take-Off

THE PROCEDURE OF COLLECTION OF DATA

First, we collect the basic information about athletes like name, age, height, and shoe size. This data was put in G sensor software and the G sensor is put on the lumbar region of the spinal cord. The subjects were performing squat jump and counter movement jump. Each athlete performed one SJ and one CMJ. First in the squat jump athlete comes in a half squat position, hands on hip and after command go, they must go for a vertical jump. In counter movement jump athletes stand tall with proper knee extension hands on hip leg apart according to shoulder width after command go athlete goes first downward and then goes for a vertical jump. Here is a stick diagram of both jumps.

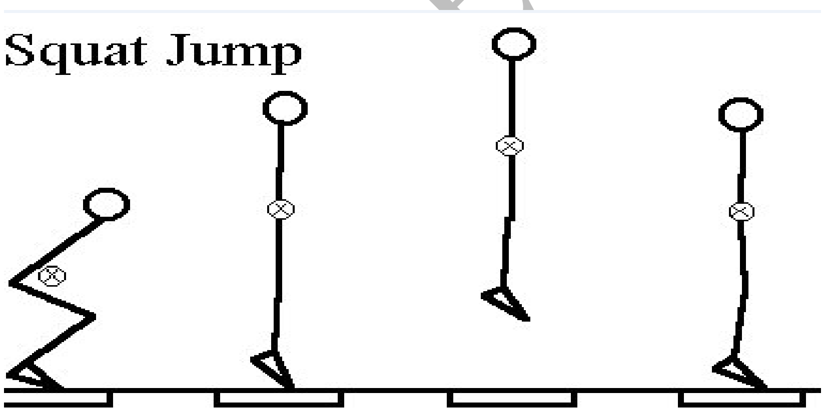

Figure 1: Squat jump with no arm swing

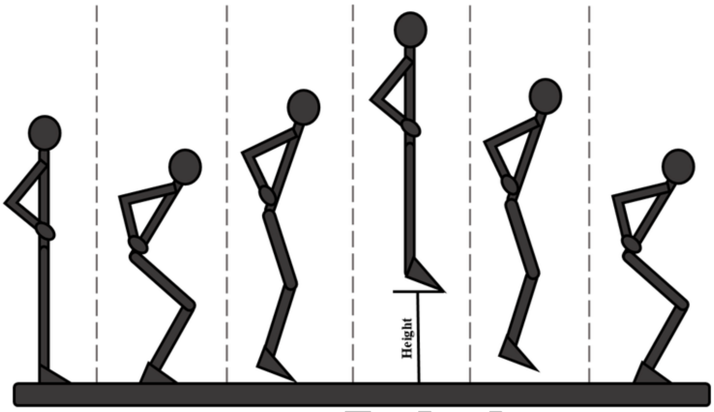

Figure: 2 Counter movement jump with no arm swing

STATISTICAL ANALYSIS

Data were analyzed using IBM SPSS (version 20.0.0) and presented as Mean ± SD. Shapiro–Wilk test approved the normality of the data. An independent t-test with a level of significance of 0.05 % was used for analysis.

Table No: 1

Descriptive statistics of squat jump variables

Variables	Group	Mean	SD
Height(cm)	Male athletes	31.6200	4.071
	Female athletes	27.68	.67
Take off force (KN)	Male athletes	.72	.09575
	Female athletes	.68	.14957
Impact force(KN)	Male athletes	1.08	.34515
	Female athletes	.9160	.2576

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Maximum concentric power(Kw)	Male athletes Female athletes	2.89 2.35	.38820 .531
Average speed concentric phase(m/s)	Male athletes Female athletes	1.004 2.45	.49652 .084
Peak speed(m/s)	Male athletes Female athletes	2.57 1.456	.17082 .09044
Take Off speed(m/s)	Male athletes Female athletes	2.47 2.3460	.18317 .09290

Table No: 2

Descriptive statistics of counter movement jump variables

Variables	Group	Mean	SD
Height(cm)	Male athletes Female athletes	34.00 27.68	1.90 .67971
Take off force(kN)	Male athletes Female athletes	1.72 .68	.0181 .14957
Impact force(KN)	Male athletes Female athletes	2.57 .91	.12227 .257
Maximum concentric power(Kw)	Male athletes Female athletes	2.68 2.35	.11803 .54284
Average speed concentric phase(m/s)	Male athletes Female athletes	1.13 2.45	.34443 .09044
Peak speed(m/s)	Male athletes Female athletes	2.91 1.45	.52123 .08497
Take Off speed(m/s)	Male athletes Female athletes	.76 2.34	.3028 .09290

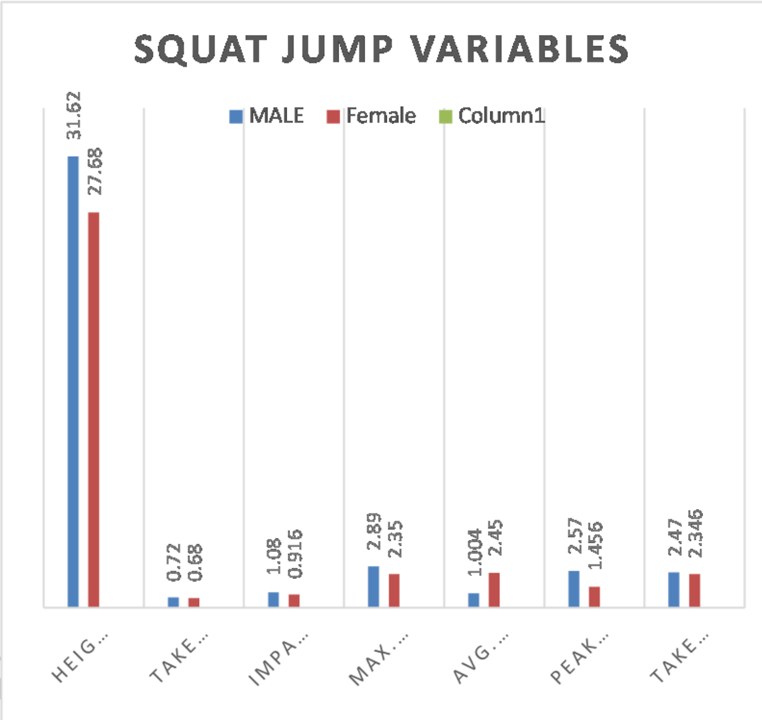

Fig-1
Graphical representation of the mean value of squat jump variables of male and female athletes

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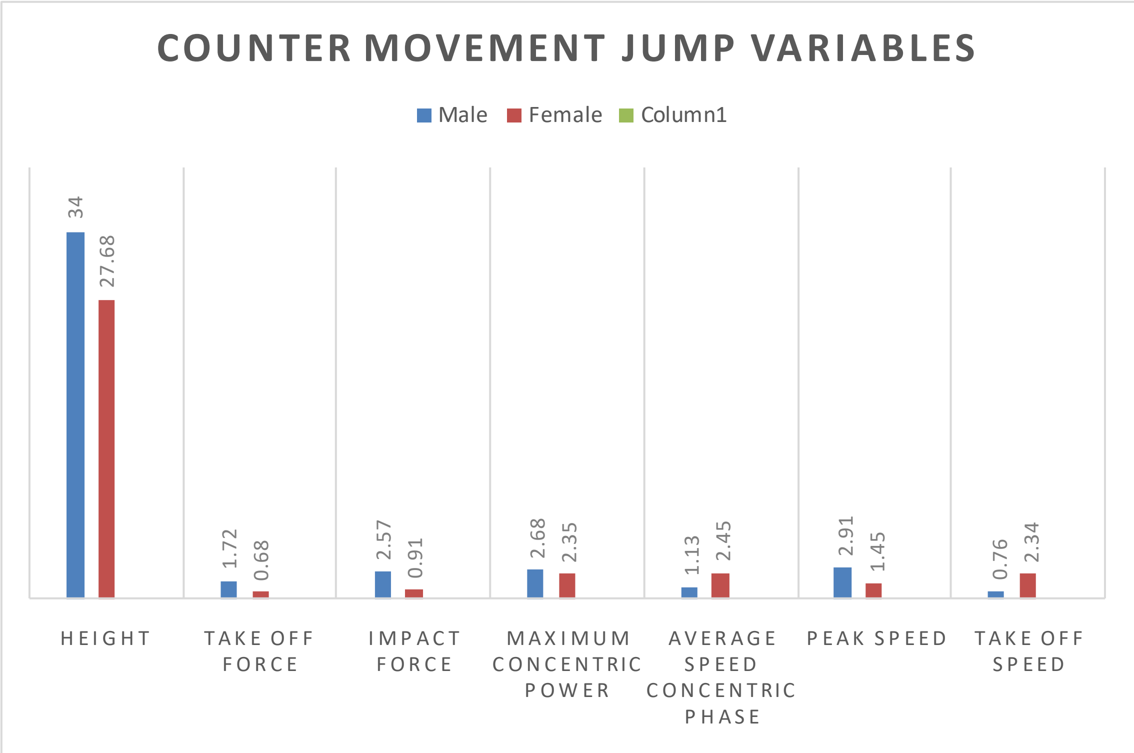

Fig-2

Graphical representation of the mean value of counter movement jump variables of male and female athletes

Table No: 3

Independent t-test for Comparison of squat jump and counter movement jump of female

Variables		t	Df	Sig.2-tailed	MD	SED
Height(cm)	Equal variance assumed.	-.981	8	.356	-1.02	1.04
	Equal variance not assumed		4.741	.374	-1.02	1.04
Take off force(kN	Equal variance assumed.	-.404	8	.697	-.042	.104
	Equal variance not assumed		7.767	.697	-.042	.104
Impact force(KN)	Equal variance assumed.	-.280	8	.786	-.048	.171
	Equal variance not assumed		7.930	.786	-.048	.171
Maximum concentric power(Kw)	Equal variance assumed.	.070	8	.946	-.028	.399
	Equal variance not assumed		7.373	.946	-.028	.399
Average speed concentric phase(m/s)	Equal variance assumed.	-2.495	8	.037	-.138	.55
	Equal variance not assumed		7.962	.037	-.138	.55

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Peak speed(m/s)	Equal variance assumed. Equal variance not assumed	.595	8 5.289	.568 .576	-.06 -.06	.10 .10
Take 0ff speed(m/s)	Equal variance assumed. Equal variance not assumed	.290	8 5.727	.779 .782	-.028 -.028	.096 .096

Table 3 revealed that the values of the independent t-test of female athletes of Squat jump and counter movement jump are Height (.356), Take-off force (.697), Impact force (.786), Maximum concentric power (.946), Average speed concentric phase (.037), Peak speed (.568), and Take- off speed (.779). Only the Average speed concentric phase has shown a significant difference because the p value of this variable (0.37) is less than 0.05 level of significance. On the other side height, takeoff force, impact force, Maximum concentric power, Peak speed, and Take-off speed are found insignificant because their p-value is more than 0.05 level of significance.

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Table No: 4

Independent t-test for Comparison of squat jump and counter movement jump of males

Variables		t	Df	Sig.2-tailed	MD	SED
Height(cm)	Equal variance assumed Equal variance not assumed	-1.184	8 5.670	.270 .270	-2.380 -2.380	2.010 2.010
Take off force(kN)	Equal variance assumed Equal variance not assumed	-1.222	8 6.035	.257 .257	-.112 -.112	.091 .091
Impact force(KN)	Equal variance assumed Equal variance not assumed	-.238	8 8.00	.818 .818	-.05200 -.05200	.21806 .21806
Maximum concentric power(Kw)	Equal variance assumed Equal variance not assumed	-.089	8 7.393	.931 .931	-.02600 -.02600	.29065 .29065
Average speed concentric phase(m/s)	Equal variance assumed Equal variance not assumed	-3.509	8 4.009	.008 .025	-.736 -.736	.209 .209

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Peak speed(m/s)	Equal variance assumed Equal variance not assumed	-1.206	8 7.11	.262 .266	-.11200 -.11200	.09285 .09285
Take 0ff speed(m/s)	Equal variance assumed Equal variance not assumed	-1.015	8 6.974	.340 .344	-.10000 -.10000	.09849 .09849

Table 4 revealed that the values of the independent t-test of male athletes of the Squat jump and countermovement jump are Height (.270), Take-off force (.257), Impact force (.818), Maximum concentric power (.931), Average speed concentric phase (.008), Peak speed (.262), and Take-off speed (.340). Only the Average speed concentric phase has shown a significant difference because the p value of this variable (0.008) is less than 0.05 level of significance. On the other side height, takeoff force, impact force, Maximum concentric power, Peak speed, and Take-off speed are found insignificant because their p-value is more than 0.05 level of significance.

DISCUSSION ON FINDINGS

The findings of the present study showed that there was no significant difference found in the squat jump and counter movement jump variables of SSC except only in one variable which is the Average speed concentric phase. There was no significant difference in the variable's height, takeoff force, impact force, Maximum concentric power, Peak speed, and Take-off speed. A significant result obtained in the Average speed concentric phase because the speed of contraction in a squat jump is generally slower compared to a counter movement jump because the jump lacks the benefit of the stretch-shortening cycle (SSC), which allows for rapid force production through elastic energy storage but the speed of contraction in a counter movement jump is

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faster compared to a squat jump due to the utilization of the stretch-shortening cycle (SSC). During the counter movement phase, elastic energy is stored in the muscles and tendons as they are stretched, and this stored energy is then released during the subsequent concentric phase, resulting in a more rapid and powerful contraction (Hooren, 2017). There was no significant difference in the variable's height, take off force, impact force, Maximum concentric power, Peak speed, and Take-off speed because It's possible that both squat jumps and counter movement jumps elicit similar levels of muscular activation in the relevant muscle groups. Muscles involved in both types of jumps, such as the quadriceps, glutes, and calf muscles, may be recruited to similar extent during the concentric phase of both movements. This could result in comparable force production and power output despite the differences in jump technique (Kopper & Csende, 2012).

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