Analysis of Vertical Jump Performance of National Boxers

Rahul Tiwari*, Dr. M. D. Ranga**

ABSTRACT

It has been proved in previous studies that lower limb muscles play a vital role in the moment generation and transfer of energy to punch in Boxing. It is therefore crucial to assess the lower limb parameters for effective training and performance. Purpose of the present study was to analyze the vertical jump performance of national level boxers. Ninety-Eight boxers (n=98, 39 males & 59 females) were tested as subjects of the study. All the boxers were asked to perform counter movement jump (CMJ) on Force Platform (Kistler 9281 EA) to assess the vertical jump. Results of the analysis revealed that both male and female boxers have optimum strength but larger landing impact and lower take off velocity. It has been suggested that the boxers should incorporate proper eccentric exercises for lower limb muscles into their regular training schedule to minimize the knee and back injury. Similarly quickness of movement is also suggested for better punching velocity and its impact.

KEYWORDS : Vertical jump, Boxing, Takeoff force, takeoff velocity, Landing impact.

INTRODUCTION

Vertical jumping ability is of considerable importance in numerous athletic events. Coaches and physical educators have applied various training methods to improve this ability (Bobbert et al, 1986). Vertical jumping performance is determined by a complex interaction among several factors including maximal force capacity, rate of force development, muscle coordination and stretch shortening cycle (SSC) use (Arabatzi et al, 2010).

A number of descriptive studies have reported that punching impact force is one of the main performance indicators in amateur Boxing (Lenetsky et al, 2013; Pierce et al, 2006; Smith 2006). Smith et al, 2000 showed that the maximal punching impact measured using a Boxing-specific dynamometer was more

* Research Fellow, Deptt. of Biomechanics, SAI NS NIS, Patiala
** Senior Scientific Officer, Deptt. of Biomechanics, SAI NS NIS, Patiala

elevated in elite boxers than in intermediate-level boxers and higher in the intermediate-level than in novice boxers. Indeed, Pierce et al, 2006, observed that the boxers who achieved higher cumulative force (number of punches performed multiplied by the impact produced in each stroke during a fight) and greater number of punches won by unanimous decision regardless of the weight category. Based on these findings, punching impact measurements can be used to select boxers, distinguish levels of performance, and for training control purposes.

The punch is a key component of Boxing and various combat sports. It is used to inflict physical damage, develop tactical advantage, and score points against an opponent (Smith, 2006). Punching is a complex motion that involves movement of the arm, trunk, and legs (Turner et al, 2011), but the lower body is considered a primary contributor to an effective punch (Lenetsky et al, 2013; Loturco et al, 2015). Although speed and accuracy are needed for a punch to be effective (Piorkowaski et al, 2011), several studies have shown that punching force is paramount to a fighter's victory (Smith, 2006; Pierce et al, 2006; Loturco et al, 2015). Research done on biomechanics of similar sporting techniques suggests that athletes generate large hand and foot speeds as a result of proximal-to-distal sequencing motion explained as kinetic chain concept. In other words, motion initiated in the larger, heavier proximal body segments and, as the energy increases, proceeds outward to the smaller, lighter distal segments. The way in which these mechanics are associated with distal end maximal speeds can be explained by Bunn's "summation of speed principle" (Cabral et al, 2010). Proximal-to-distal sequences have been reported in several sports. Proximal to distal sequence of peak linear and angular velocities from the legs to the trunk to the wrist in similar sporting athletes has been reported (Cabral et al, 2010).

During a game of Boxing, a boxer performs about 50 punches, comprising sustained forceful contraction to maintain balance and control of the head against defensive pressure. It has been found that strength and power qualities are highly associated with punching impact in elite amateur boxers (Loturco et al, 2016). In the study by Loturco et al in 2016, the selected strength and power variables were vertical jump height (in squat jump and countermovement jump), mean propulsive power in the jump squat, bench press (BP), and bench throw, maximum isometric force in squat and bench press, and rate of force development in the squat and bench press. Sex and position main effects were observed, with higher impact for males compared with females ($p = 0.05$) and the self-selected distance resulting in higher impact in the jab technique compared with the fixed distance ($p = 0.05$). Finally, the correlations between strength/power variables and punching impact indices ranged between 0.67 and 0.85. Because of the strong associations between punching impact and strength/power variables (e.g., lower limb muscle power), this study provides important information for coaches to specifically design better training strategies to improve punching impact. The purpose of the current study is to focus on the vertical jump performance of the national level boxers, as vertical jump performance is one of the crucial indicators of the punching forces in boxing.

METHODOLOGY

The present study was conducted on 98 national level boxers, who attended the National Camp held at NS NIS, Patiala. Subjects (n=98) consist of 39 males and 59 females of 23.3 ± 3.3 and 21.7 ± 5.6 years of age respectively. All the boxers were from different weight category (Table 1).

Table - 1: Details of subjects (n=98) participated in current study (according to weight category)

S. No.	Males (n=39)		Females (n=59)	
	Weight category	Number of boxers	Weight category	Number of boxers
1	49 kg	05	48 kg	06
2	52 kg	05	51 kg	05
3	56 kg	05	54 kg	09
4	60 kg	05	57 kg	07
5	64 kg	03	60 kg	06
6	69 kg	05	64 kg	07
7	75 kg	02	69 kg	06
8	81 kg	04	75 kg	04
9	91 kg	03	81 kg	02
10	+91 kg	02	+81 kg	07
Total	**39**		**59**	

Force platform (FP), KISTLER 9281 EA was used to find out the force production during vertical jump performance. Participants were required to wear proper sports clothing including sports shoes. Five minutes warm up session was given to the participants before commencement of the test. Following standard instruction and procedure, participants were asked to perform countermovement vertical jump (CMJ) (Figure 1) on force platform at frequency of 200 Hz.

Along with the force applied during take off and ground reaction force (GRF) while landing, software (Bioware) connected to FP also calculated Vertical displacement of the center of gravity, take off velocity and power. Take off force and landing impact were calculated by dividing the force produced during take off and landing by body weight.

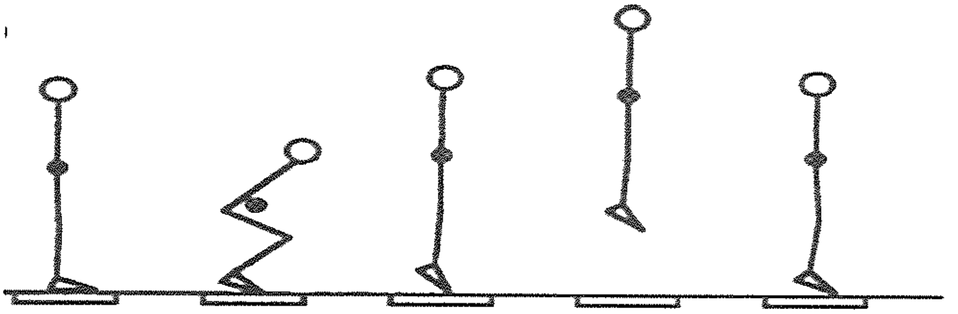

Fig. -1: Sequence of action in a Counter movement jump (Linthorne 2001).

RESULTS & DISCUSSION

Table-2: Mean and standard deviation (SD) of various parameters recorded while performing CMJ by Male subjects.

S. No.	Wt. Cat.	Take-off Force (xBW)		Landing Impact (xBW)		Vertical Displacement of CG (cm)		Take-off Velocity (m/s)		Power (W)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	49 KG	2.65	0.54	5.6	1.75	32.2	2.33	2.23	0.06	1844.2	244.5
2	52 KG	2.28	0.36	5.26	0.69	34.3	5.29	2.36	0.16	1835.7	198.1
3	56 KG	1.98	0.36	6.39	1.56	30.9	6.08	2.18	0.24	1589.1	129.8
4	60 Kg	1.91	0.55	6.78	1.38	35.4	6.63	2.34	0.23	1888.2	243.6
5	64 KG	2.71	0.45	6.11	0.84	27.7	1.9	2.05	0.05	2179.9	202.1
6	69 Kg	2.40	0.4	6.29	1.82	28.4	4.61	2.06	0.20	2191.2	426.9
7	75 KG	2.19	0.36	6.02	1.00	30.8	13.6	2.16	0.50	2196.5	354.6
8	81 KG	2.41	0.17	5.69	1.91	24.4	4.86	2.04	0.32	2415.0	376.5
9	91 KG	1.98	0.33	5.94	1.75	31.9	3.34	2.22	0.09	2621.3	566.0
10	+91 Kg	1.90	0.26	6.26	2.35	27.7	4.13	2.02	0.14	2660.0	201.8

Table-3: Mean and standard deviation (SD) of various parameters recorded while performing CMJ by Female subjects.

S. No.	Wt. Cat.	Take-off Force (xBW)		Landing Impact (xBW)		Vertical Displacement of CG (cm)		Take-off Velocity (m/s)		Power (W)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	48 KG	2.27	0.71	3.62	1.24	28.1	3.23	2.04	0.13	1255.6	614.5
2	51 KG	2.16	0.24	4.13	1.55	25.8	8.94	1.91	0.38	1293.5	285.0
3	54 KG	1.94	0.46	4.06	1.39	26.1	4.25	1.95	0.20	1336.2	150.0
4	57 Kg	1.97	0.39	4.58	1.51	24.8	3.43	1.90	0.16	1340.4	210.0
5	60 KG	1.93	0.43	3.85	0.91	21.6	7.22	1.70	0.27	848.96	603.7
6	64 Kg	2.08	0.63	4.59	0.81	29.9	1.98	2.08	009	1226.8	818.2
7	69 KG	2.04	0.39	5.36	1.10	25.0	5.76	1.89	0.24	1573.4	411.2
8	75 KG	1.98	0.31	4.27	1.62	27.6	2.26	1.99	0.09	1455.9	879.6
9	81 KG	2.00	0.28	4.15	0.21	22.3	1.55	1.74	0.58	1579.5	249.6
10	+81 Kg	1.95	0.41	3.96	0.40	24.4	3.95	1.83	0.14	1628.6	715.5

Take off force is the indicator of muscular strength in lower limbs, which should be at least twice the body weight, as there is strong association between punching impact and strength/power variables of lower limb muscles (Loturco et al, 2015). Landing Impact is an indicator of the ability to absorb shocks and is the amount of ground reaction force exerted on lower limb as a result of landing after a CMJ. It, which should be as low as possible, otherwise there will be more chances of knee and back injury to the players (McNair et al, 1999). In current study, both the groups shows take off force more than twice their body weight but landing impact in male boxers is higher than that of females. Take off velocity shows the quickness of the muscular contraction in lower limb and in boxers this should be as high as possible for better performance/punching. Boxers in present study has take off velocity as 2.16 m/s and 1.9 m/s in males and females respectively, which should be more than 3.0 m/s to have an impactful punch (McNair et al, 1999). Power, the strength-speed characteristic, recorded both the group needs to be improved for effective transfer of the forces from lower limb to the punching hand.

Practical Implications

- Eccentric exercises for lower limb muscles should be incorporated into the regular training schedule for minimizing the knee and back injury.
- Improvements in take off force (strength) and take off velocity (quickness) is required for better punching velocity and its impact.

REFERENCES

Arabatzi Fotini, Kellis Eleftherios & De Villarreal Eduardo (2010). Vertical jump biomechanics after plyometric, weight lifting and combined (weight lifting + plyometric) training. Joutnal of Strength and Conditioning Association: 24(9) / 2440-2448.

Bobbert, M.F., Mackay, M., Schinkelshoek, D., Huijing, P.A. & Schenau, G.J. Van Ingen (1986). Biomechanical analysis of drop and countermovement jumps. Eur J Apply Physiol 54:566-573.

Cabral Silvia, Joao Filipa, Amado Sandra & Veloso Antonio (2010). Contribution of trunk and pelvis rotation to punching in boxing. Confrence proceeding of the annual meeting of the American soc. Vol.1.

Lenetsky, S., Harris, N., & Brughelli, M. (2013). Assessment and contributors of punching forces in combat sports athletes: Implications for strength and conditioning. Strength Cond J 35: 1–7.

Linthorne Nicholas, P. (2001). Analysis of standing vertical jumps using a force platform. . Americal Journal of Physics, November; 69(11): 1198–1204.

Loturco, I., Artioli, G.G., Kobal, R., Gil, S. & Franchini, E. (2015). Predicting punching acceleration from selected strength and power variables in elite karate athletes: A multiple regression analysis. J Strength Cond Res 28: 1826–1832.

McNair Peter, J. & Harry Prapavessis (1999). Normative data of Vertical Ground Reaction Forces During Landing From a Jump. Journal of Science and Medicine in Sports 10.1016/S1440-2440(99)80187-X.

Pierce, J.D., Reinbold, K.A., Lyngard, B.C., Goldman, R.J., Pastore, C.M. (2006). Direct measurement of punch force during six professional boxing matches. J Quant Anal Sports 2.

Piorkowski, B.A., Lees, A., Barton, G.J. (2011). Single maximal versus combination punch kinematics. Sports Biomech 10: 1–11.

Smith, M.S. (2006). Physiological profile of senior and junior England international amateur boxers. J Sport Sci Med 5: 74–89.

Smith, M.S., Dyson, R.J., Hale, T., & Janaway, L. (2000). Development of a boxing dynamometer and its punch force discrimination efficacy. J Sports Sci 18: 445–450.

Turner, A., Baker, E., Miller, S. (2011). Increasing the impact force of the rear hand punch. Strength Cond J 33: 2–9.

-----0-----