Research Journal of Physical Education Sciences _____ISSN 2320 – 9011
Vol. **8(1),** 1-6, November **(2020)** *Res. J. Physical Education Sci.*

Relationship between anthropometric, body compositions, lower body strength and weightlifting performance of junior weightlifters

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Available online at: www.isca.in
Received 19th September 2019, revised 4th May 2020, accepted 30th August 2020

Abstract

Weightlifting performance is highly associated with maximum strength which depends frame of skeletal muscles composition. The purpose of the study was to find out relationship between anthropometric, body composition, lower body strength and weightlifting performance of junior weightlifters. To achieve the objective, fourteen (N=14) junior national level weightlifters were selected from Jaffna Central College, Sri Lanka, their age ranges were 17 years to 20 years. Participants weightlifting performances were measured from snatch (SN), clean jerk (CJ), bench press (BP), dead lift (DL) and squat (SQ) in various days. Gold standard of anthropometric measurements were conducted to measure weight (WE) in kilogram, height (HE) in meter, shoulder circumference (SHC) and chest circumference (CHC) in centimeter. Lean body mass (LBM) and body mass index (BMI) has been considered a body composition variables (BC). LBM was determined based on Boer formula (1984) and BMI was calculated according to standard BMI formula. Lower body strength (LBS) has been assessed based on standing broad jump (SBJ) recorded in meter and vertical jump (VEJ) recorded in centimeter. Results revealed SN has been correlated with HE (r=0.554), LBM (r=0.586) and SBJ (r=0.567) as well as CJ also with HE (r=0.584), LBM (r=0.593) and SBJ (r=0.591). BP has correlated with HE (r=0.552), WE (r=0.535), LBM (r=0.607) and SBJ (r=0.520). DL has been correlated with SBJ (r=0.689) and VEJ(r=0.611). SQ was correlated with WE(r=0.575), LBM(r=0.605) and SHC (r=0.565). Study concluded that a selected anthropometric measurement such as lower body strength & body composition has been correlated with weightlifting performance.

Keywords: Weight lifting performance, anthropometric, body composition, lower body strength.

Introduction

Weightlifting is a neuromuscular exercise producing maximum force or torque during muscular contraction. Its develop combination of various skeletal muscles, joints and skeletal system. Weightlifting athletes have very strong skeletal and muscle system and related with variables such as strength, body composition, and anthropometric variables are keys to determine weightlifting performance. In every sports performance in almost every sport depends on certain amount of muscles strength[1]. This proven in weightlifting performance which highly demands muscles strength thus objective of this sport is to prove maximum strength in different technique of lifting such as squat, bench press, clean jerk, dead lift and snatch. To achieve this peak performance that training should be given to various dominant muscles those are contributing to reach goal.

It is well understood that body size represents an important factor that affects muscles strength[2,3]. Athletes whose are high body mass index(BMI) may have greater fat mass and muscles hypertrophy which may produce greater strength compare to normal body composition person. Moreover high body mass index athletes have high isotonic and isometric muscles strength compare to ordinary person. Conversely High body mass index athletes have lack of lean body mass tissue. Lack of lean body mass tissue is correlated with high body mass index and fat proportion. Athletes need to increase lean body mass to peak athletic performance. Which contribute to control body weight, to strengthen muscles strength, joint, increasing muscles density and preventing from injury. Always lean body mass tissue contain athletes produce greater absolute strength and relative strength its contribute to the weightlifting performance particularly that lean body mass tissue is related with power and strength as it has high muscles mass. There are exists significant positive relationship between muscles strength and body size[2].

Lower body strength can be measured by vertical jump and standing long jump. Generally this measurement is used to measure leg power. Which helps to proper stable posture during training and it helps for successful attempt. Conversely lack of leg power may lead to failure, unstable and error attempt. But strong leg power is associated with performance improvement progress and can tolerate more work load. Maximum leg strength of weightlifters is strongly correlated with leg power. In this connection lower body strength contributes to develop the

upper body weightlifting technique and performance such as dead lift. Leg power produces greater force which can be transferred to develop the related technique such as snatch, clean jerk and dead lift.

Weight lifting performance may be related with anthropometric variables such as height, weight, shoulder circumference and chest circumference. These variables are enough to determine the relationships between anthropometric variables and weightlifting performance. Specifically height, which contribute to transfer work load to muscular system that muscular system can tolerate excellent load and it help to produce more power which may be related with weight lifting performance such as snatch, clean jerk, squad and bench press. However the correlation studies that have investigated standard test(for example1RM, maximum isometric voluntary force and rate of force development) anthropometrics and movement performance have provided both strong[4-6] and weak correlation to the performance[7,8]. Thus this correlation shows that different result based on the level of subjects such as novice and elite.

Several relationship studies have been conducted among novice, junior, elite athletes to find out the relationship of variables with performance. These studies have been conducted for non- Asian athletes to find out variables which are related with weight lifting performance. Their heritage may not have similar features such as anthropometric, body composition, skeletal and muscular system with Asian. Therefore present study need to examine the variables which are mostly influencing on weightlifting in our country athletes. Therefore purpose of the study was to find out relationship between anthropometric, body composition, lower body strength and weightlifting performance of junior weightlifters.

Methodology

The participants those have won the medals in provincial weightlifting competition and go for school junior national championship that fourteen (N=14) weightlifting representatives were recruited for this study from Jaffna Central College, Sri Lanka. Participant's age range was between 17 to 20 years had two year of experience in weightlifting competition and training. Who had shown no more interest on this study was eliminated. Consent has been collected from participants and parents. Anthropometric variables such as WE, HE, CHC and SHC were measured by standard tools. HE was measured by stadiometer in meter. SHC and CHC were measured in centimeter. Body WE was measured by weighing machine and recorded in kilogram. Body composition variables such as BMI, LBM was measured by standard test item. BMI was calculated by standard formula like weight/ height × height and LBM was calculated by Boer formula, (1984) LBM (kg) = (0.407 * wtKg) + (0.267 * htCm) - 19.2. LBS was measured by VEJ and SBJ, SBJ was recorded in meter and VEJ was recorded in centimeter. SN, CJ, BP, DL, SQ performance was measured in various days recorded in kg.

Statistical Analysis: Present study need to find out relationship between variables and performance therefore Pearson's r, the Pearson Product - moment correlation coefficient was administered. Significant level of P value was fixed at 0.05 levels' value indicate that relationships strengthen and weakness. For this statistical analysis MINI TAB 17.1 version was used.

Results and discussion

Analyzing result of Pearson product correlation revealed that SN has correlated with HE (r=0.554), LBM (r=0.586) and SBJ (r=0.563). CJ performance showed correlation with HE (0.584), LBM (r=0.593) and SBJ (r=0.591). BP performance prove correlation with HE (r=0.552), WE (r=0.535), LBM (r=0.607) and SBJ (r=0.520). DL has correlated with SBJ (r=0.689) and VEJ (r=0.611). SQ performance has been correlated with WE (r=0.575), LBM (r=0.605) and SHC (r=0.565).

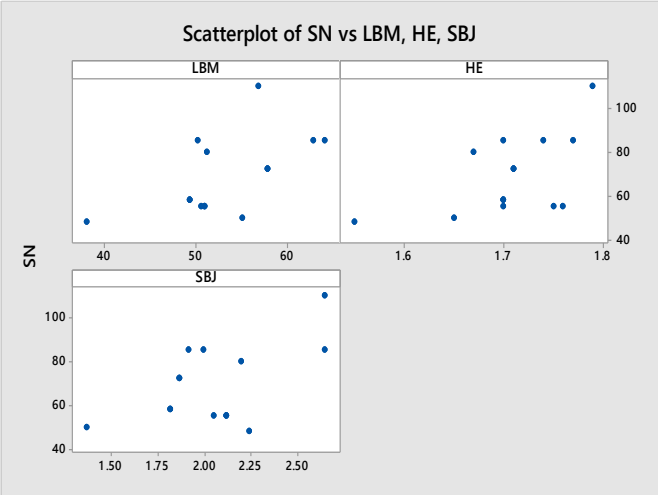

Figure-1: Scatter Plot Shows the Relationship of Variables and Weightlifting Performance. Plot of SN vs LBM, HE, SBJ.

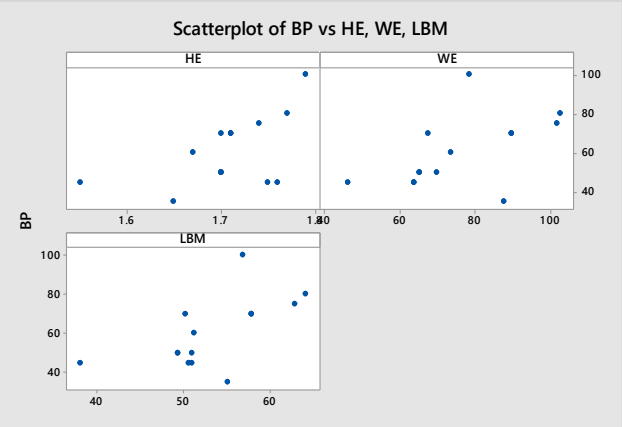

Figure-2: Scatter Plot of BP vs HE, WE, LBM.

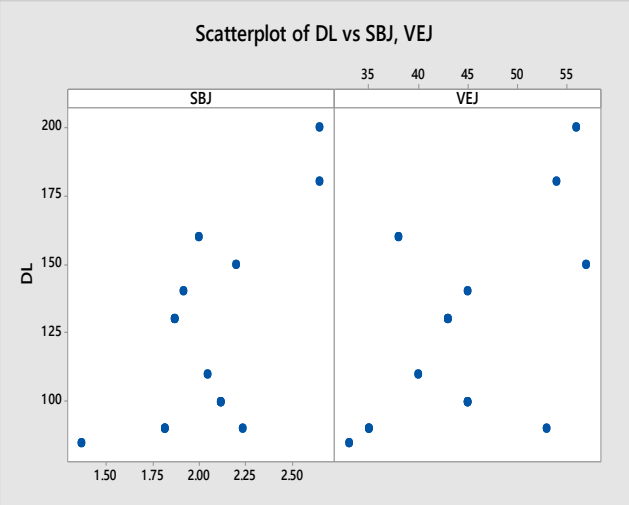

Figure-3: Scatter Plot of DL vs SBJ, VEJ.

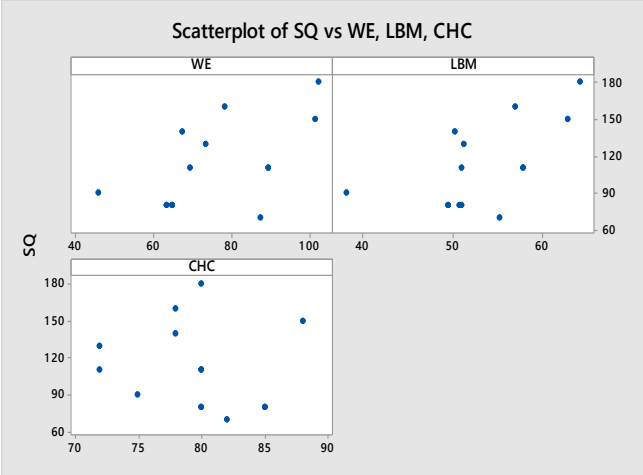

Figure-4: Scatter Plot of SQ vs WE, LBM, CHC.

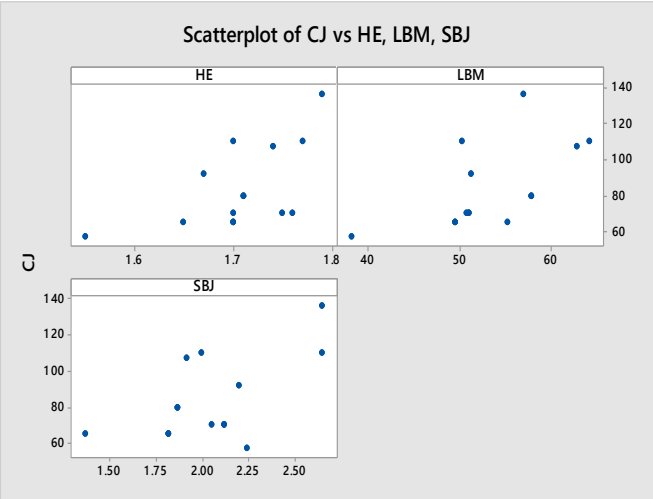

Figure-5: Scatter plot of CJ vs HE, LBM, SBJ.

Table-1: Pearson Coefficient Statistical Relationship Between Anthropometric, Body Composition, Lower Body Strength and Weightlifting Performance.

	Snatch- r- value	Clean jerk r- value	Bench press r- value	Dead lift r-value	Squad r-value
HE	0.554**	0.584**	0.552**	0.479	0.440
WE	0.509	0.506	0.535**	0.408	0.575**
BMI	0.370	0.355	0.387	0.281	0.455
LBM	0.586**	0.593**	0.607**	0.481	0.605**
SHC	0.479	0.477	0.474	0.318	0.565**
CHC	-0.032	0.024	-0.022	-0.169	-0.129
SBJ	0.563**	0.591**	0.520**	0.689**	0.499
VEJ	0.509	0.494	0.423	0.611**	0.415

HE-height, WE-weight, BMI-body mass index, LBM- lean body mass, SHC- shoulder circumference, CHC- chest circumference, SBJ- standing broad jump, VEJ- Vertical jump.

Discussion: Aim of the present study was to examine the relationship between anthropometric, body composition, lower body strength and weightlifting performance among junior weightlifters. Anthropometric measure length and width of particular skeletal which is crucial in weightlifting to tolerate whole load and size of skeletal determine sports performance. Body compositions represent size and dimension of body conversely inappropriate dimension of body lead to poor sports performance. Weightlifting alters any type of body adapted to strong skeletal condition. Leg muscular skeletal is dominants variables to determine lower body strength. This muscles is very strong for weightlifters as influence on weightlifting performance. There is a relationship between maximal strength and performance skills for weightlifting[9]

Result demonstered snatch had significant correlation with height, lean body mass and standing long jump. Height is advantage to transfer work load through skeletal system naturally this skeletal system determines cross sectional area of muscles fiber in athletes. Research found taller athletes have excellent cross sectional area of muscles than shorter and cross sectional area of muscle produce good strength. Therefore this height is warranty to have correlated with weightlifting performance such as snatch which depends on maximum strength and power in various muscles. Maximum strength depends on number of contractile unit. Weightlifting use optimal load to increase contractile unit in skeletal muscles to produce more force. Core, biceps, triceps, calf, hamstring these major muscles have adequate contractile units for stables lifting suppose inadequate power occurred in athletes may face unstable posture which may affect performance. Moreover lean

body mass tissue also associated with snatch performance. Athletes who have greater proportion of lean body mass tissue can produce excellent achievement in snatch and lean body mass tissue is required to produce greater muscles mass which produce more force and power. So always the snatch performance is depend lean body mass tissue which is confirmed in present study (r=0.554). Study revealed snatch performances not only depend on height and lean body mass tissue but it is highly associated with lower body strength. Standing broad jump determine lower body strength and power. Lower body muscles does not possess adequate cross sectional area of muscles as it is predominately possess type I muscles fiber conversely hamstring muscles has type II muscles fiber as dominants but it is unknown among weight lifters. Lower body strength contributes to maintain proper technical movement. Always good strength leads to good alignment of biomechanical movement and prevent from injury. When attempting snatch the center of gravity move upward so lower body strength should be enough to succeed in snatch performance therefore present study found positive correlation between lower body strength and snatch performance (r=0.563).

Clean jerk had positive correlation with height, lean body mass, standing broad jump. While performing clean jerk which demand adequate level of muscular strength to overcome gravity force and bar resistance. Always taller athletes should have strong muscular system to maintain balance. Moreover athletes can tolerate greater intensity and volume in weight training as athletes possess high cross sectional area of muscles which lead to increase number of type II muscles fiber and contractile unit which is advantage to the taller athletes. Thus present study found that clean jerk performance is correlated with height (r=0.584). Height influences on muscles hypertrophy in skeletal muscles that lead to increase lean body mass. Lean body mass tissue also related with hand grip strength. This should be enough to hold the cross bar. Additionally weight lifting athletes have high lean body mass tissue as nature of training and it is a predominate variables in clean jerk to do more power attempt. Always arm muscles have more lean body mass tissue compare to leg muscle as arm muscles are having better cross sectional area of muscles and muscles mass. Successful clean jerk require greater number of contractile unit to produce force in shortest burst time particularly in arm muscles. This contractile unit proportion is highly depending on nature of training, and muscle strength. Lower body strength can be measured by standing broad jump which performance depend on number contractile unit on other hand lack of contractile unit in leg muscles may lead poor clean jerk performance and muscle strength. When you do regular weight lifting exercise lower part of muscles is a predominates in training as it tolerates all part of muscular exercise which is impacting on lower body strength thus it contribute to have correlated with clean jerk (r=0.591). Even when the athletes do training for bench press that lower body strength also should concern to successful attempt.

Dead lift is a power lifting, measure maximum strength of related muscles. This is performed with loaded barbell lifted off the ground to the level of the hip. Dead lift strengthen rectus abdominals and oblique's muscles which contributes to the excellent hard working conversely lack of muscles development may predispose one to injury[10]. Therefore weight lifters need to consider the improvement of muscles strength. Maximum strength prevent from injury and it reduce stiffness of lower body muscles that contribute for successful attempt of weightlifting moreover dead lift attempt is highly correlated with leg power which can be measured by vertical jump and standing broad jump. According to several authors, successful in dead lift attempt depend up on the development of strength as well as power both contribute to vertical jump performance[11-13]. Maximum strength and power increase rate of force developments that response to more efficient of energy expenditure and greater expression of force in mechanically stronger portion of the lift. According to biomechanical principal, rate of force development associated with acceleration capacity which produce correct mechanical attempt in early portion. Lower body strength and power produce greater rate of force development. This is influencing on vertical jump and standing broad jump. Additionally trunk muscles tolerate maximum load of dead lift with collaboration of lower body muscles.

Squad is compound strength associated with multiple skeletal muscular system and joints which develops the core muscular strength. Clavicle bone is a shoulder bone influence on shoulder circumference. Which features may be correlated with squad lifting performance as it is major factor to tolerate total load on shoulder which make good flat form to other skeletal muscular system for free of movement. Regular power lifting training may increase hypertrophy of muscles which attached with clavicle and scapula bone that increase type II muscles fiber. This is strongest muscles fiber to upload more work load and weight. When adopt maximum work load on muscles which increase number of contractile unit to produce more power. Study found height also has relationship with squat performance even taller athletes showed high center of gravity and gravity force, the squat performance has been correlated with height that squat load distributed to various skeletal and muscular system. Height is advantage to athletes to develop muscular character rapidly this accumulate type II muscles in all dominate muscles. The athletes who have type II muscles fiber as dominate in you squat related muscular system they can only achieve peak performance therefore present study revealed the athletes showed various height which had correlation with squat performance. Some previous study revealed that weight and squat performance correlation is unclear but the present study found correlation and justified scientifically. Always weight lifters have high muscles mass, high density of bone and bone mass of skeletal system which influence on weight of athletes. Moreover when attempting squat movement is slower thus lead to increase weight and lean body mass tissues to produce more strengthen other hand reduce fat proportion. Compound squat

exercise rapidly involve in muscles growth after session which gain weight to achieve better performance. It was ensured in present study (r=0.575).

Bench press is a stable exercise used to strengthen triceps brachia, pectoral major with anterior, deltoid and traps muscles of upper body. Which contributes to the best performance accompany with skeletal system. Height also depends on skeletal frame structure of athletes. Taller athletes have good long bone which helps to free of movement and preventing from injury conversely short athletes produce good strength but limited movement. Bench press performance may be associated with strength, muscular endurance, hypertrophy, neuromuscular function which can be improved by proper musculoskeletal system. Besides weightlifters athlete has well enlargement of upper body as regular weight training can increase enlargement and hypertrophy of upper body. It contains adequate number of types II muscles fiber in upper body more over training has impact on heart hypertrophy too this also influence in performance. When athletes perform bench press majority of work loaded on hand muscles these muscles contain high contractile unit to produce more force. Athletes arm muscles has high cross sectional area of muscles fiber among taller athletes which may associate with bench press performance. While performing bench press upper body rapidly accumulate hypertrophy and muscles mass which affect weight of athletes. Weight lifters weight is exemption compare to ordinary person as they contain high muscles mass and muscles hypertrophy. Developing muscles hypertrophy and muscles mass may be correlated lifting performance. Weight training increased bone density that leads to influence on weight. The presence positive relationship between Body weight and the performance[14]. These weights strengthen bench press performance rather than obesity weight. Overweight of obesity person accumulate lot of adverse substance that lead to negative sports performance. However athletes who have greater number of lean body mass tissue that also lead increase weight. This weight may be correlated with bench press performance. Weight that we can predict absolute and relative strength for male and female body lifters[15]. Always upper body has sufficient lean body mass tissue to produce more power specifically biceps, triceps deltoid, pectoral muscles have adequate lean body tissue to produce power in shorts burst of time. Lean body mass tissue proportion strengthens ligament, joint, cartilage of arm, elbow joint to make successful attempt. Conversely Lacking of lean body mass tissue may cause anabolic hormones and testosterone multifactorial problems which lead poor performance. Thus present study found that lean body mass tissue is correlated with bench press.

Conclusion

Maximum strength is a one of key factor to determine muscular related sports like weightlifting. Which are completely strengthened skeletal system, body composition and muscular characters. Lean body mass included in body composition which determine strengthens of muscles as well height has relationship with performance as it is possess large cross section variables. Leg power determine lower body strengthens. Therefore present study concluded that HE, LBM and SBJ variables have been correlated with weight lifting variables and some variables such as BMI, CHC have not correlated with weightlifting performance. BMI may not appropriate to measure weightlifters performance relationship.

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