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Hand grip strength, leg explosive power and vertical jump performance among Nigerian university male basketball players and healthy controls

Chidozie Emmanuel Mbada[1], Sadiq Adebayo Quadri[1], Saturday Nicholas Oghumu[2], Kayode Oke Israel[3], Francis Fasuyi[4], Adewale Isaiah Oyewole[1]
[1]*Department of Medical Rehabilitation, Faculty of Basic Medical Sciences, Obafemi Awolowo University, Ile-ife, Osun state Nigeria*
[2]*Department of Physiotherapy, Faculty of Allied Medical Sciences, University of Calabar, Calabar, Cross River State, Nigeria*
[3]*Department of Physiotherapy, Faculty of Basic Medical Sciences, University of Benin, Benin City, Edo State Nigeria*
[4]*Department of Physiotherapy, Faculty of Allied Medical Sciences, University of Medical Sciences, Ondo, Ondo State, Nigeria*

Abstract. *Aim*. Given the complex nature of modern professional basketball play, there are conflicting reports on the correlations among hand grip strength (hgs), leg explosive power (lep) and vertical jump performance (vjp), hence this study. *Material and Method* Sixty consenting students (30 basketball players and 30 non-athletes) from the Obafemi Awolowo University, Ile-ife, Nigeria were purposively recruited into the study. Hand grip strength was assessed using hand grip dynamometer, vjp was assessed using standing vertical counter movement jump with arm swing using the jump-reach-test, while lep was determined using Sawyer predictive power equation. Anthropometric measures of body weight (wt), height (ht), and body mass index (BMI) were obtained. Data was analyzed using descriptive statistics of mean and standard deviation. Inferential statistics of Pearson product moment correlation analysis and multiple regressions were employed. Alpha level was set at $p<0.05$. *Results*. Significant positive correlation was found between hgs and BMI in basketball players only ($r=0.406$; $p=0.026$); and significant positive correlation was found between lep and BMI in both basketball players ($r=0.476$; $p=0.008$) and non-athletes ($r=0.644$; $p=0.000$). Significant positive correlation was found between lep and vjp in basketball players ($r=0.812$; $p=0.000$) as well as between hgs and lep ($r=0.516$; $p=0.004$). However, no significant correlation between hgs and vjp ($p>0.05$). A significant ($p<0.05$) predictive value for vjp was obtained when lep, age, ht, hgs, BMI, wt was added to the multiple regression model for basketball players with 99% of adjusted r^2. *Conclusion*. LEP correlates strongly with vjp in male basketball players but moderately with hgs. Also, hgs among other factors is a predictor of vjp in male basketball players.
Key words: *hand grip strength, leg explosive power, vertical jump performance, basketball players*.

Introduction

Basketball is a game of both explosive power and dynamic movements which requires strength for better performance (1).

Hand grip strength (hgs) and leg explosive power (lep) are primary requirements in basketball for repetitive high intensity activities such as passing, rolling, bouncing, throwing, shooting, and catching the ball (2). Hand grip strength has been used extensively in literature as a predictor of multiple outcomes among a variety of populations in health and diseases (3). It is used as an indicator for forearm strength (4), whole body skeletal muscle mass (5, 6), lower extremity strength (7, 8), onset of sarcopenia (9), nutritional index, cardiovascular health and diseases (10), health of rotator cuff muscles (11), and overall body physical activity performance (4).

On the other hand, lep is a determinant of successful sporting performance in basketball players (12). The measurement of lep by coaches through strength and conditioning programs has been used as an indicator to determine athlete`s performance level to workload during the training regime (12).

Quite commonly, the vertical jump performance (vjp) is used to measure both vertical jumping distance and power output of athletes (12, 13). The lep measured by means of vertical jump is said to be highly dependent on the maximum power of the leg extensor muscles in basketball players (14). Also, vjp training and biomechanics is reported to be a preventive measure for lower extremity injuries (15).

Thus, given the relevance of hgs, lep, and vjp in sporting performance, it becomes pertinent to know if there exists any correlation among these parameters of athletes especially among basketball players.
Strong correlation between hgs and quadriceps strength among older adults has been reported (16) while other studies even indicate that hgs could be a surrogate for quadriceps strength (7, 17). Similarly, previous studies have demonstrated strong correlation between lep and the vjp among soccer and basketball players (13, 15).
However, there are conflicting reports on the correlation between hgs and vjp. It was alleged that there was no significant correlation between hgs and vjp (18), whereas in another study significant correlation between hgs and vjp was reported (19). Hence, several factors could be said to interplay for the variations in the correlational indices of hgs, lep, and vjp among athletes. Physical and physiologic traits of individual players are said to be responsible for players output in sports (20) in addition to the assertion that a given individual hgs is dependent on geographic and ethnicity factors (21).
Given the composite nature of modern professional basketball teams and the dearth of studies on the correlational indices of hgs, lep, and vjp, this study was designed to examine the correlation indices of hgs, lep with vjp among university male basketball players.

Material and Method

Sixty participants comprising of 30 male basketball players and 30 non-athletes from the Obafemi Awolowo University (OAU), Ile-ife, Nigeria were purposively recruited for this study. The basketball players were elite male athletes in the university team who were 18 years and older, and the controls were undergraduates from the same university. All participants were without any defect or disability of the upper or lower limbs limiting the ability to engage in the tests.
Exclusion criteria was based on any positive history of recent musculoskeletal injury and cardio-respiratory diseases (hypertension, cardiac disorders, asthma etc.) or obvious neurological condition. Ethical approval was sought from the Ethical and Research Committee of the Institute of Public Health, OAU.
All participant gave signed informed consent following full disclosure of the purpose of the study. Anthropometric measures of body weight and height were collected using standard bathroom weighing scale (Camry, India) and height meter (Height-o-meter, USA). Hand grip strength was assessed with digital hand grip dynamometer (Camry, USA) while leg explosive power was determined using Sawyer predictive power equation: (60.7 • height vj (cm)) + (45.3 • body mass (kg)) – 2055 (22).
Assessment of handgrip strength. Participants' dominant hands were first identified by instructing them to hold and write with pencil. Then instructions on how to perform the procedure was given and demonstrated to the participants. Each participant was seated with the shoulder of the dominant arm adducted, elbow flexed to 90 degrees and the wrist and forearm in neutral position while the non- dominant arm rested beside the body. Participants were given clear instruction when to start and stop contractions and encourage to squeeze the handgrip dynamometer as hard as possible. The *participants* were instructed to execute isometric hand muscles contractions for 5 seconds on three sets by squeezing the handgrip dynamometer and the greatest force that was exerted between the sets was recorded and taken as the grip strength. Sixty seconds rest interval between the sets was emphasized to avoid muscle fatigue.
Assessment of vertical jump performance. Vertical jump performance was assessed using standing vertical counter movement jump with arm swing using the jump-reach-test.
Instructions on how to perform the vjp were given and demonstrated to the participants (figure 1). First, they were educated on how to perform the counter movement jump. Then standing – reach- height was noted by instructing each subject to touch the magnetic jump and reach board flatfooted. Thereafter the subject performed the standing vertical counter movement jump with arm swing. The distance during jump and reach test was subtracted from the distance reach during standing reaching height. The participants repeated this test three times and the average of the recorded distances was used to assess subject's performance. Also, subjects could rest for 30s between each jump and were encouraged to put more effort to their next jump.
Data was summarized using descriptive statistics of percentages, mean and standard deviation. Inferential statistics of Pearson product moment correlation analysis was used to determine the relationship between variables. Multivariate analysis of ANCOVA and multiple regressions were used to determine the mediators

and predictors of hgs, lep and vjp. Alpha level was set at p<0.05. Data analysis was carried out using SPSS 16.0 version software (SPSS inc., Chicago, Ill., USA).

Figure 1. Vertical jump performance being demonstrated at the research site

Results

Table I shows the comparison of general characteristic of the athletes and the non-athletes. The mean ages of the athletes and non-athletes were 23.3±3.58 years and 23.0±2.04 years. Height, weight, and BMI of the athletes were significantly higher in athletes than non-athletes (p <0.05).

Table I. Independent t-test comparison of general characteristic of the athletes and the non-athletes

Variable	athletes (N=30) (mean ± SD)	non-athletes (N=30) (mean ± SD)	t-cal	p-value
age (years)	23.3±3.58	23.0±2.04	0.488	0.628
height(m)	1.84±0.10	1.73±0.07	4.93	0.001
weight (kg)	77.70±10.02	63.83±8.62	5.74	0.001
BMI (kg/m^2)	23.54±4.44	21.42±2.53	2.28	0.030

BMI = body mass index; SD = standard deviation; kg= kilogram; m= meter.

Table II shows independent t-test comparison of hgs, lep and vjp between the athletes and non-athletes' population. From the results, hgs (50.99±8.86 vs 37.11±9.84, p=0.00) and vjp (61.49±10.17 vs 30.41±7.75, p=0.00) of athletes were significantly higher compared to non-athletes (p<0.05) whereas lep was not significantly higher in male basketball players compared to non-athletes (p>0.05).

Table III shows the correlation matrix among hgs, lep and vjp and the general characteristics of non-athlete. There was no significant correlation between hgs and weight (r=0.389), there was no significant correlation between lep and each of weight (r=0.618; p=0.000) and BMI (r=0.644; p=0.000). Also, there was no significant correlation between vjp and each of age (r=-0.060; p=0.754), height (r=-0.256; p=0.173), weight (r=0.104; p=0.586), BMI (r=0.285; p=0.127). Similarly, there was no significant correlation between vjp and each of hgs (r=0.147) and lep (r=0.068).

Table II. Independent t-test comparison of handgrip strength, leg explosive power and vertical jump performance of the athletes and non-athletes

Variables	athletes (n=30) (mean ± SD)	non-athletes (n=30) (mean ± SD)	t-cal	p-value
hgs (kg)	50.99±8.86	37.11±9.84	5.74	0.00
lep (w)	5.178e3±761.88	3.84e3±661.73	1.11	0.270
vjp (cm)	61.49±10.17	30.41±7.75	13.32	0.00

hgs= handgrip strength; lep= leg explosive power; vjp= vertical jump performance; kg= kilogram; w=watt; cm= centimeter.

Table III. Correlation matrix among hgs, lep and vjp and the general characteristics of non-athlete

	Age	Ht	Wt	BMI	hgs	lep	vjp
Age	1						
ht	r= -0.097	1					
	P= 0.612						
wt	r= -0.030	r= 0.470**	1				
	P= 0.876	p= 0.009					
BMI	r= 0.021	r= -0.086	r=0.838**	1			
	P= 0.913	p= 0.651	p= 0.000				
hgs	r= 0.329	r= 0.160	r= 0.389	r= 0.344	1		
	P= 0.076	p= 0.399	p= 0.034	p= 0.063			
lep	r= 0.175	r= 0.076	r= 0.618	r= 0.6444**	r= 0.233	1	
	P= 0.355	p= 0.691	p= 0.000	p= 0.000	p= 0.215		
vjp	r= -0.060	r= -0.256	r= 0.104	r= 0.285	r= 0.147	r= 0.068	1
	P= 0.754	p= 0.173	p= 0.586	p= 0.127	p= 0.437	p= 0.721	

*** - correlation is significant at the 0.01 level (2-tailed.); *-correlation is significant at the 0.05 level (2-tailed); hgs= handgrip strength; lep= leg explosive power; vjp= vertical jump performance; ht= height; wt= weight; BMI= body mass index*

Table IV. Correlation matrix of age, anthropometric parameters, hgs, lep and vjp of male basketball players

	Age	Ht	Wt	BMI	hgs	lep	vjp
Age	1						
ht	r= -0.175	1					
	P= 0.356						
wt	r= -0.106	r= 0.533**	1				
	P= 0.578	p= 0.002					
BMI	r= 0.077	r= -0.139	r=0.484**	1			
	P= 0.687	p= 0.465	p= 0.007				
hgs	r= 0.129	r= -0.351	r= 0.587**	r= 0.406*	1		
	P= 0.498	p= 0.057	p= 0.001	p= 0.026			
lep	r= 0.088	r= 0.361	r= 0.576**	r= 0.476**	r= 0.516**	1	
	P= 0.643	p= 0.050	p= 0.001	p= 0.008	p= 0.004		
vjp	r= 0.066	r= 0.069	r= 0.002	r= 0.233	r= 0.255	r= 0.812**	1
	P= 0.973	p= 0.716	p= 0.993	p= 0.214	p= 0.174	p= 0.000	

*** - correlation is significant at the 0.01 level (2-tailed.); *-correlation is significant at the 0.05 level (2-tailed); hgs= handgrip strength; lep= leg explosive power; vjp= vertical jump performance; ht= height; wt= weight; BMI= body mass index*

Table IV revealed the correlation matrix among hgs, lep and vjp and the general characteristics of the athletes. Significant positive correlation was found between hgs and weight (0.587; p=0.001) and bmi (r=0.406; p=0.026). Also, hgs correlate positively to lep (r=0.516; p=0.004).
There was no significant correlation between vjp and each of age (r=0.066; p=0.973), ht (r=0.069; p=0.716), wt (r=0.002; p=0.993), bmi (r=0.233; p=0.214), hgs (r=0.255; p=0.174). However, vjp was significantly correlated with lep (r=0.812; p=0.000). Table V showed that a significant predictive value for vjp was

obtained when lep, age, ht, hgs, BMI, wt were added to the multiple regression model for basketball players with 99% of adjusted r2. However, when these same predictors were added to the multiple regression model for vjp in non-athletes, the correlation was not significant and -1.3% was obtained for adjusted r2 (table VI).

Table V. Multiple regression equation of vertical jump performance for male basketball players

Items			df	ss	ms	f	p
Multiple r	0.996a	Regression	6	2976.533	496.089	498.790	0.000[a]
r^2	0.992	Residual	23	22.875	0.995		
Adjusted r^2	0.990						
SEE	0.99729						

df=degree of freedom; ss= sum of square; ms= mean of square; SEE= standard error of estimate, p is significant at 0.05; vjp= vertical jump performance; lep=leg explosive power; ht=height; hgs=hand grip strength; BMI=body mass index; Wt=weight.
Predictors: (constant), lep, age, ht, hgs, BMI, wt)
y=b0+b1x1+b2x2+b3x3+b4x4+b5x5+b6x6
vjp= b0+(b1xage)+(b2xht)+(b3xwt)+(b4xBMI)+(b5xhgs)+(b6xlep)
vjp=35.545 -0.50(age) -1.421(ht) -0.723(wt) -0.052(BMI) +0.071(hgs) +0.016(lep)

Table VI. Multiple regression equation of vertical jump performance for male basketball players

Items			df	ss	ms	f	p
Multiple r	0.443a	Regression	6	342.060	57.010	0.938	0.488[a]
r^2	0.197	Residual	23	1398.625	60.810		
Adjusted r^2	-0.013						
SEE	7.79806						

df=degree of freedom; ss= sum of square; ms= mean of square; SEE= standard error of estimate, p is significant at 0.05; vjp= vertical jump performance; lep=leg explosive power; ht=height; hgs=hand grip strength; BMI=body mass index; t=weight.
Predictors: (constant), lep, age, ht, hgs, BMI, wt)
y=b0+b1x1+b2x2+b3x3+b4x4+b5x5+b6x6
vjp= b0+(b1xage)+(b2xht)+(b3xwt)+(b4xBMI)+(b5xhgs)+(b6xlep)
vjp= -356.234-0.409(age) +215.872(ht) -3.426(wt) +11.124(BMI) -0.111(hgs) -7.502e-5(lep)

Discussion and Conclusion

This study examined handgrip strength and leg explosive power with vertical jump performance among university male basketball players and non-athletes. The basketball players had significant higher height, weight, BMI mean scores than the non-athletes but were comparable in age with the non-athletes. These mean anthropometric scores obtained in this study were comparable to that obtained in previous studies among basketball players and non-athletes. Values of 1.81m for height and 64kg for weight were obtained among 16-year-old Indian basketball players (12) whereas 1.83m for height, 75kg for weight, and 23kg/m^2 for BMI were obtained among 21-year old Ghanian basketball players (20). Similarly, 1.72m for height, 67kg for weight were reported among 22-year-old Japan non-athletes (6). Overall, anthropometric parameters of athletes and non-athletes are reported to be significantly different from each other (23).

The mean value of the hgs and vjp were significantly higher in basketball players than the non-athlete whereas the mean value of the lep was comparable between groups. This finding seems self-contrasting with athletes and non-athletes differing in vjp score but comparable in lep score, as vjp is said to be a measure of lep. It has been found that there could be a drop in muscle force production with consistent stereotyped skill (24), as well as report of muscle inactivity during squat and countermovement jump (25). Thus, vjp and leg scores obtained in the same individual can be mutually exclusive. Nevertheless, the mean scores obtained for hgs, lep, and vjp are comparable to that reported in previous studies among basketball players (26) and non-athletes of the same age category (13, 27).

Furthermore, a random trend in correlation between anthropometric parameters (height, weight, and bmi) and each of hgs, lep, and vjp among male Nigerian basketball players and non-athletes was observed.

The correlation between vjp and anthropometric parameters were not significant in both basketball players and non-athlete populations, whereas significant positive correlation was found between hgs and BMI in basketball players only why the significant positive correlation found between lep and BMI occurred in both basketball players and non-athletes.

This could be as a result of comparable lep scores obtained between basketball players and non-athletes as well as their difference in hgs scores. This finding is in contrast with previous studies that reported strong positive or negative correlation between anthropometric parameters (height and weight) and each of hgs and vjp among athletes (23) and non-athletes (28). Similarly, previous studies (29, 30) revealed a positive correlation between hgs and BMI in healthy non-athletes which is in contrast with the finding of this study. Moreover, significant positive correlation was found between weight and lep only (not with hgs, and vjp) in both basketball players and non-athletes. This finding is at variance with the report that lep had a negative correlation with height, weight and BMI (13). Thus, variations in correlational indices of anthropometric parameters with hgs, lep, and vjp observed in this study among Nigerian male basketball players and non-athletes demonstrates that other factors other than age and gender could be responsible for such variations. This assertion has been reported in previous studies (20).

Ultimately, this study found in basketball players: a significant strong positive correlation between lep and vjp; no significant correlation between hgs and vjp; and a significant correlation between hgs and lep. This finding corroborates with previous studies which demonstrated strong correlation between lep and the vjp among soccer and basketball players (13, 15). However, why our finding agrees with previous studies that hgs has strong correlation with lep (7, 17), it differs from some of such studies who reported their findings in non-athletes (16, 17). Also, our finding of no significant correlation between hgs and vjp agrees with previous report of no significant correlation between hgs and vjp (18) but differs from previous report of significant correlation between hgs and vjp (19). Hence, our findings demonstrate that the vjp correlates strongly with lep among male basketball players and that hgs correlates moderately with lep among them. However, the multiple regression models for vjp obtained in this study suggests that hgs is a predictor of vjp among other factors such as leg explosive power, age, height, body mass index, and weight of male Nigerian basketball players.

In conclusion, this study demonstrates that lep of Nigerian male basketball players correlates strongly with vjp but moderately with hgs. In addition, hgs, lep, age, height, body mass index and weight are significant predictors of vjp in male basketball players.

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Corresponding author
Oghumu Saturday Nicholas,
Department of Physiotherapy, Faculty of Allied Medical Sciences,
College of Medical Sciences, University of Calabar, Cross Rivers State, Nigeria.
E-mail address: *nickyyivieosa@gmail.com*

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