Relationship between hand grip strength and postural static balance among undergraduates of a Nigerian university

Adesola O Ojoawo[1], Aduralere P Afolabi, Babatunde E Arayombo[2], Odunayo T Akinola[3]
[1]*Department of Medical Rehabilitation, Faculty of Basic Medical Sciences, College of Health Sciences, Obafemi Awolowo University, Ile Ife, Nigeria*
[2]*Department of Anatomy and Cell Biology, Faculty of Basic Medical Sciences, College of Health Sciences, Obafemi Awolowo University, Ile Ife, Nigeria*
[3]*Department of Physiotherapy, Faculty of Basic Medical and Health Sciences, College of Health Sciences, Bowen University, Iwo, Nigeria*

A**bstract**. Hand grip strength (HGS) is a useful functional measure of the integrity of upper extremity. The study is designed to evaluate the relationship between HGS and static balance among undergraduates of a Nigerian university. *Material and Method*. Four hundred undergraduates (229 males and 171 females) selected consecutively of the Obafemi Awolowo University, Ile-Ife, participated in the study. The hand grip dynamometer was used to measure the grip strength while the participants were on standing and the static balance performance was measured using one-leg stance and stop clock. Data were analysed using descriptive and inferential statistical. Alpha level was set at 0.05. *Result*. The result showed that there was a significant correlation ($r=0.136$; $p<0.05$) between balance performance and wrist circumference, there was significant relationship ($r = 0.280$; $p < 0.001$) between left grip strength and balance performance. Also a significant relationship ($r= 0.289$; $p<0.001$) between right grip strength and balance performance was found. It was also shown that the there was a significant difference between handgrip strength of the right upper limb of males and females ($t=15.894$; $p=0.000$) and between static balance performance for males and females ($t=5.364$; $p=0.000$). Prediction equation for the right hand grip strength was 31.855 (Ht/m) + 0.284 (Wt/kg) + 1.918 (WrstC/cm) – 65.378, and that of the left hand grip strength was (28.622 (Ht/m) + 0.288 (Wt/kg) + 1.816 (WrstC/cm) –.61.193). *Conclusion*. It can be concluded from the study that increase in hand grip strength can increase static balance performance of individual.
Key words: *hand grip strength, static balance, one legged stance test, dynamometer.*

Introduction

Hand functionality is considered to be vital in most of the daily activities involving upper limb be it carrying loads, lifting objects, opening or closing doors to name a few. Besides, grip, strength can be an important index of general health, nutritional status, overall strength and the amount of protein reserves in the body (1-4). Furthermore, the measurement of grip strength has great importance for occupational health purposes (5). The measurement of grip strength is an important component of the hand rehabilitation because it helps to establish a baseline for treatment and it is a measure of the effectiveness of therapy (6).

Various devices are being used for measuring muscular strength. These include balance, cable-tensiometer, grip dynamometer and strength meter (7, 8). Manual and mechanical methods are normally employed to assess and evaluate hand grip strength in which hand held dynamometer is considered to be a reliable instrument in evaluating grip strength being used widely in rehabilitation (9). It is used to measure the force of flexor muscles of hand generated during gripping the dynamometer.

Balance is the ability to sustain body center of pressure within the base of support necessary to maintain a position in space or a movement in a harmonized and controlled situation and against internal and external perturbation (10). Also, postural balance is often defined as ‘the act of maintaining, achieving or restoring a state of balance during any posture or activity (11). This complicated motor skill justifies the body situation

dynamism and prevents it from falling (12). Adequate postural control allows not only the maintenance of posture when carrying out activities, but it is also essential for the prevention of serious injuries due to falls (13).

The one leg stance test (OLST), where the patient is observed and timed while standing on one leg, is an easy, quick and low-cost test for evaluating the postural balance (14-17). The OLST also referred to as timed single limb stance, single leg stance test, unipedal balance test and one-leg standing balance is a simple test for measuring static aspects of balance that can be used in a variety of settings and requires minimal equipment or training (18). Abnormal OLST time with the eyes open is related to conditions such as peripheral neuropathy and intermittent claudication (19). Decreased eyes open OLST time is also associated with an increased risk for falls (20). Further, the OLST conducted with eyes closed may yield other valuable information. Since patients with medical conditions that impair balance may rely heavily on vision to maintain their balance, it is possible that these patients would be at an increased risk for falls in conditions where visual input is inaccurate or eliminated, such as night time ambulation.

The strength of one's grip plays a key role in injury prevention and overall strength development (21-23). Measurement of grip strength can also be an important component in body strength evaluation and can provide us a quick assessment of upper body strength. Grip strength is correlated with the strength of the upper extremity, general body strength and some anthropometric measurements (24) and therefore is often accepted as an objective measure of upper extremity function (24-26). Hand grip strength measurement is useful in the assessment of individuals who is suffering from impairments in daily life tasks, measurement of the integrity of upper extremity function, and effectiveness of hand rehabilitation procedures (27, 28). This study was therefore designed to examine if the strength of the hand grip will relate with the balance performance of undergraduate students in Obafemi Awolowo University (OAU), Ile Ife, Nigeria.

Material and Method

All the measurements was carried out in the Department of Medical Rehabilitation, (Obafemi Awolowo University), Ile Ife, Nigeria.

Participants. The participants were male and female undergraduates of OAU with age ranged from 15 to 30 years. *Inclusion criteria.* Undergraduates with no history of neuromuscular or musculoskeletal disorders.

Exclusion criteria. Undergraduates who did not volunteer to participants with disability or previously involved in musculoskeletal disorder will not be allowed to participate in the research of this study.

Instruments: hand grip dynamometer (Wo Li Biao, Japan), used to measure the grip strengths of the participants; bathroom weighing scale used to measure the weights of the participants.; stadiometer, used to measure the heights of the participants; stop watch: This was used measure the amount of time in seconds the subject was able to stand on one limb.

Sampling technique. Consecutive sampling was used to select the subject.

Research Design. This study is a correlation study that evaluated the relationship between hand grip strength and postural balance.

Sample size. 50% (0.5) of the population was used. The population of OAU students as at 2014 was 30,000. Hence sample size formula for proportions with population greater than 10,000 was used: $n = z^2pq/d^2$ (29) - where: n = the desired sample size (when population is greater than 10,000); z = 1.96 at 95% confidence interval; p = assumed proportion of persons having knowledge of Physiotherapy, because it is not available from literature, 50% was used (0.50); q = 0- p = 0.05; d = absolute standard error = 0.05; n = (1.962 x 0.5 x 0.5) / (0.05)2 = 384 participants (29).

Therefore 400 undergraduates were recruited for the study.

Procedure. Ethical approval was obtained from the Health Research and Ethics Committee of Institute of Public Health, College of Health Sciences, Obafemi Awolowo University Ile Ife, Nigeria. The purpose and procedure of the study was explained to each participants and a written consent was obtained to participate in the study.

Prior to the data collection, the subjects' ages, heights, and weight were recorded. A brief interview preceded the determination of the subjects' muscular strength, to know the subjects' dominant hand and to screen individuals with previous musculoskeletal injuries. During the interview, the following questions were asked: which of your hands do you use mostly? which hand do you write with? which hand do you eat with? which of your hands do you use for domestic work like sweeping, washing plates, cutting grass, handling plates and cups? if engaged in sporting activities, which hand do you use to throw ball, or handle table

tennis? which hand do you use to open and close doors? If a participants gives 4 or more answers in favour of a hand, then the hand was considered dominant.

Measurement of hand grip strength. Instructions was given to the participants in the same sequence and form which include; requesting for maximum effort during each test, proper positioning of the dynamometer in the hand with the upmost handle resting on the thenar eminence of the hand with the fingers to maintain a firm grip. Proper method of applying a maximum pressure on the test instrument. Participant was instructed to squeeze the handle of the dynamometer as hard as possible. Verbal encouragements was offered during the test by commanding the subjects to "pull" for each shoulder and elbow handle position with a 5 minutes rest interval.

One-leg stance test. Springer's et al., protocol was used to carry out the test. Participants stood barefooted on the limb of their choice with eyes open (18). The other limb was raised so that the foot was near but not touching the knee of the stance limb. Participants was asked to focus on a spot on the wall at eye level in front of them, for the duration of the eyes open test. Prior to raising their limb, participants was instructed to cross their arms over the chest. A stopwatch was used to measure the amount of time in seconds the participants was able to stand on one limb. Time commences when the participants raise the foot off the floor. Time ends when the participants either: uncross arms; use the raised foot i.e. moved it toward or away from the standing limb or touch the floor; move the weight bearing foot to maintain his balance i.e. rotate foot on the ground; or a maximum of 45 seconds had elapsed. The procedure was repeated 2-3 times and each time was recorded on the data collection sheet. The average of the times was recorded.

Data Analysis. Data was analysed using SPSS version 23. Descriptive and inferential statistical was used to summarize the data. Pearson- product moment correlation was compiled to establish the relationship between the hand grip strength and balance performance. Independent t-test was used to compare the grip strength and balance performance of male and female participants. An alpha level of 0.05 was set as level of significance

Results

Physical characteristics of participants

Table 1 shows physical characteristics of participants. The mean age was 20.44±1.91years. The mean Body Mass Index (BMI), waist circumference, waist to hip ratio (WHR) of participants were 20.21±2.39kg/m², 94.00±72.49 cm and 0.79±0.06 respectively. Shown in table 2 is sex distribution of participants. There are 229 males which represents 57.3% of the population and 171 females which represents 42.7% of the population.

Relationship between grip strength and balance performance

Shown in table 3 is the summary of relationship between balance performance and grip strength of the left and right upper limbs. It was observed that there was significant relationship ($r = 0.280$; $p < 0.001$) between left grip strength and balance performance.

Comparison of grip strength and balance performance of male and female participants

Table 4 reveals the comparison between male and female grip strength and balance performance. The mean of handgrip strength of the right upper limb of males was significantly ($t=15.894$; $p=0.000$) higher than that of females. The balance performance for males was also significantly ($t=5.364$; $p=0.000$) longer than that of females.

Relationship between hand grip strength and anthropometric parameters. Table 5 shows the summary of Pearson Correlation of hand grip strength and anthropometric parameters. There is significant correlation between handgrip strength and Body Mass Index ($r=0.233$; $p<0.05$), wrist circumference ($r=0.495$; $p<0.05$) and waist circumference ($r=0.289$; $p<0.05$).

Prediction of right grip strength from height, weight, and wrist circumference

Shown in table 6 is the summary of regression analysis of predictability of right hand grip strength from height, weight and wrist circumference. The values of constant, height, weight and wrist circumference were -65.378, 31.855m, 0.284kg, and 1.918cm respectively. Prediction equation for right hand grip strength = 31.855 (Ht/m) + 0.284 (Wt/kg) + 1.918 (WrstC/cm) – 65.378.

Prediction of left grip strength from height, weight and wrist circumference

Shown in table 7 is the summary of regression analysis of predictability of left hand grip strength from height, weight and wrist circumference.

The values of constant, height, weight and wrist circumference were -61.193, 28.622m, 0.288kg, and 1.816cm respectively. Prediction equation for right hand grip strength = 28.622 (Ht/m) + 0.288 (Wt/kg) + 1.816 (WrstC/cm) –.61.193.

Table 1. Physical characteristics of participants (N=400)

Variables	Minimum	Maximum	Mean±SD
Age/yrs	16.00	26.00	20.44 ±1.91
Height/kg	1.52	2.01	1.69 ±0.08
Weight/m	37.00	79.00	57.74 ±8.25
BMI/kg/m^2	13.70	29.32	20.21 ±2.39
Wrist C/cm	13.00	19.00	15.99 ±1.14
FRS	8.90	12.20	10.59 ±0.65
Waist C/cm	15.00	94.00	72.49 ±6.69
HipC	72.00	109.00	90.83 ±6.06
WHR	0.15	0.94	0.79 ±0.06

Key*: BMI - Body Mass Index, WrstC - Wrist Circumference, FRS - Frame Size), WaistC - Waist Circumference), HipC- Hip Circumference, WHR - Waist Hip Ratio*

Table 2. Sex distribution of participants

Variables	Frequency	Percentage
Male	229	57.3
Female	171	42.7

Table 3. Relationship between grip strength and balance performance (N= 400)

Variables	StBl	HdgSLt	HdgSRt
StBI	1		
HdgSlt	0.280**	1	
HdgSrt	0.289**	0.885**	1

Key: StBl - Static Balance, HdgSLt - Hand Grip Strength Left Hand, HdgSRt - Hand Grip Strength Right Hand
***Correlation is significant at the 0.001 level.*

Table 4. Comparison of male and female participants grip strength and balance performance (N= 400)

Variables	Male (mean±SD) n=229	Female (mean±SD) n= 171	T	P
HdgSRt	41.25±8.56	27.79±4.99	15.894	0.001**
HdgSLt	38.33±8.56	25.38±5.20	15.153	0.001**
StBl	43.64±5.07	39.15±9.30	5.364	0.001**

Key: HdgSRt - Hand Grip Strength Right Hand, HdgSLt - Hand Grip Strength Left, Stbl - Static Balance)

Table 5. Relationship between hand grip strength and anthropometric parameters

Variables	HdgSLt		HdgSRt	
	R	p	R	P
Age/year	0.201**	0.000	0.203**	0.000
Height/m	0.492**	0.000	0.517**	0.000
Weight/kg	0.522**	0.000	0.536**	0.000
BMI/kg/m^2	0.233**	0.000	0.227**	0.000
Wrist C/cm	0.495**	0.000	0.513**	0.000
FRM	- 0.191**	0.000	-0.194**	0.000
Waist C/cm	0.289**	0.000	0.306**	0.000
HipC/cm	0.144*	0.05	0.153**	0.000
WHR	0.223**	0.000	0.236**	0.000

Table 6**.** Prediction of right grip strength from height, weight and wrist circumference

Variables	B	Beta	T	Sig.
Constant	-65.378		-6.170	0.000
Hgt	31.855	0.260	4.454	0.000
Wt	0.284	0.238	3.639	0.000
WrstC	0.533	0.223	3.601	0.000

Key: WrstC - Wrist Circumference, Hgt, Hdg - Hand Grip Strength, Waist Circumference

Table 7: Prediction of left grip strength from height, weight and wrist circumference

Variables	B	Beta	T	Sig.
Constant	-61.193		-5.724	0.000
Hgt	28.622	0.237	3.966	0.000
Wt	0.288	0.244	3.650	0.000
WrstC	1.816	0.214	3.380	0.001

Key: WrstC - Wrist Circumference, Hgt, Hdg - Hand Grip Strength, Waist Circumference

Discussion

This study was designed to find out the relationship between hand grip strength and postural static balance among apparently healthy undergraduates and also to compare the balance performance and grip strength between male and female participants.

The results of the study revealed that males have greater grip strength than the female participants. This was in support of the study of Kubota and Demura (30). Also a study evaluated the grip strength of boys and girls in two positions; standing with elbow in full extension, and sitting with elbow in 90° flexion and found that grip strength with elbow flexed was higher in boys, but girls had higher grip strength values with elbow extended (28). Research have reported that males have greater muscle strength than females (31). Montoye and Lamphiear evaluated abilities of muscle in males and females, and found a significant difference between the two sexes in the grip and arm strengths especially among people of fourteen years or older (32). Christine described that females sixteen years of age and older have about two-thirds muscle strength of males in the same age groups but these gender differences are closely correlated to differences in physiological maturation found in muscle growth (31). Christine also concluded that gender differences of muscle strength reflect the observed variation between males and females in the physical activities of daily life. In a nutshell, is indicated that that daily activity life pattern determines greatly the handgrip strength (31)

The study revealed that there is significant correlation between hand grip strength and anthropometric parameters. This was in tandem with the study of Fernandes et al., where they found a week relationship between grip strength and some selected anthropometric parameters (height, weight and body mass index) (33). Also similar studies (34, 35) reported a similar findings in their different studies. Anthropometric parameters are important determinant of HGS results. Grip strength is correlated with the strength of the upper extremity, general body strength and some anthropometric measurements (24) and therefore is often accepted as an objective measure of upper extremity function (25, 26).

The study further revealed that there is significant relationship between hand grip strength and balance. The findings of this study was in agreement with the study of Koley and Uppal, (37) where they concluded that standing balance test had strong association with dominant and non-dominant handgrip strength. Kuh et al., conducted a research on grip strength, postural control and functional leg power, and it was observed that those with the worst scores in physical performance tests had higher rates of functional limitations for both upper and lower limbs (38). In a study carried out by by Taekema et al., on elderly individuals, it was verified that HGS was significantly associated with the functionality and gait speed of elderly people aged over 85 years (39). Hand grip strength has been identified as one of the test for Short Physical Performance Battery (40), which has been found o related with the global muscle strength, dependence, and mortality in elderly people (39).

Moreover, it was revealed that there is significant correlation between grip strength and balance performance. Balance is another important factor conditioning mobility (41). From the prediction equation obtained, it can be seen that height has the highest predictability. The prediction equations found in our study was similar to that documented by Rawat (42). It can be concluded from the study that increase in grip strength will enhance postural balance of individual. Also age and anthropometric parameters, are significantly related to hand grip strength and balance performance.

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Corresponding author
Adesola O Ojoawo
Department of Medical Rehabilitation, Faculty of Basic Medical Sciences, College of Health Sciences, Obafemi Awolowo University, Ile Ife, Nigeria
E-mail address: *aoojoawo@oauife.edu.ng*.

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