ASSESSMENT OF BACK EXTENSOR MUSCLES ENDURANCE OF APPARENTLY HEALTHY NIGERIAN ADULTS

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Abstract

Studies on gender differences in back extensors muscles endurance has been inconsistent and inconclusive. The objective of this study was to evaluate gender differences in timed isometric back extensor muscles endurance among apparently healthy adult Nigerians.

376 apparently healthy consecutive adults whose ages ranged between 21 to 62 years with the mean aged 38.9 ± 13.5 years participated in this study. This consisted of 193 males (38.9 ± 13.9 years) and 183 age-matched (38.9 ± 10.6 years) females. The participants performed the Biering-Sørenson test of Static Muscular Endurance and their height and weight were measured using standard procedures. Percentage body fat was estimated using bioelectrical impedance analysis. Body mass index, lean body mass and body fat mass were calculated.

The result indicated that males exhibited a significantly greater endurance time ($t = 2.48$; $P = 0.014$) than females. The mean endurance times of the males and females in this study were lower than the original Biering-Sorensen values. There was significant correlation between endurance time and each of age, and the measures of adiposity without gender bias. Apparently healthy adult Nigerian males have significantly greater timed back extensor muscles' endurance than the females.

Key words: Gender, back extensor muscles, endurance, Sørenson test, Nigerian adults.

INTRODUCTION

Muscular endurance is the ability of a muscle to contract repeatedly or generate tension, sustain that tension, and resist fatigue over a prolonged period of time.[1] Endurance testing of back extensor muscles examines the localized capability of the extensor muscles of the back to sustain activity. Mechanically, testing of the back extensor muscles endurance can be assessed by timing the ability of a person to hold specific postures or to perform specific movements with or without external load.[2] The endurance of the back extensor muscles have been reported to be related to low back health.[3-5] Low levels of static endurance in the back extensor muscles are associated with higher rates of low back pain (LBP)[6,7], decreased proprioceptive awareness [8], poor balance [9], and decreased productivity in the workplace.[10]

Assessment of the endurance capability of the back extensor muscles is seen to be important in the clinical setting as an outcome tool among healthy and patient population.[11-13] Concern has been to elucidate the determining factors in the performance of endurance testing. Rópponen [14] submitted that this will allow more accurate interpretation of the back function test in evaluating working capacity, investigation of back disorders, as well as being useful in preventive medicine and related to maintenance or enhancement of back muscle function.

Previous studies on the neuromuscular characteristics of the back extensor muscles have demonstrated an association between gender and endurance capacity.[15-17] Numerous reports suggest that females have a greater muscular endurance capacity when compared to males [4, 15-21] but denied in other studies reporting lower endurance among women than men.[22-24] It has been noted that the substantial anatomical, physiological, and morphological differences that exist between men and women may affect their exercise capacity and influence the magnitude of response to exercise.[25] There seem to be an increasing interest in studies on low back endurance in both patients and healthy subjects emanating from various populations with resultant reference data for such populations. However, there is a dearth of studies evaluating the static endurance of back extensor muscles from Sub-Sahara Africa (SSA). Studies on gender differences in back extensors muscles endurance capacity has been inconsistent and inconclusive while the underlying mechanisms explaining these differences are poorly understood. To our knowledge, gender differences in back extensors muscles endurance among Nigerians appear not available. This study therefore aimed to evaluate gender differences in the endurance capacity of the back extensors during static muscular contraction using the Biering-Sørensen test of Static Muscular Endurance (BSME) among apparently healthy adult Nigerians.

MATERIALS AND METHODS

STUDY POPULATION

A total of three hundred and seventy six apparently healthy consecutive adults participated in this study. The participants' ages ranged between 21 and 62 years with a mean of 38.9 ± 13.5 years. One hundred and ninety three (38.9 ± 13.9 years) of the participant were males while their age matched (38.9 ± 10.6 years) female counterparts were one hundred and eighty three. Eligible participants for this study were not engaged in any systematic exercise program of the lumbar or hip extensor muscles as at the time of the study. Other inclusion criteria for the study included the following: that the participants be asymptomatic of LBP for a minimum of one year as at the time of the study; that the participants be without any obvious spinal deformity or neurological disease; that the participant must not have been pregnant; that the participant must not have any disability limiting the ability to exercise; that the participants must not have been involved in competitive sport or athletics; and that the participant must be with no reported history of cardiovascular diseases contraindications to exercise. Participants for this study were screened via interview to ensure that they satisfied the selection criteria for the study. The participants were volunteers who include staff, students and patients' relatives recruited via research advert and invitations from University of Ibadan, University College Hospital, Ibadan and the surrounding metropolis, Ibadan, Nigeria.

Measurements:

Anthropometric measurements included height, weight, Body Mass Index (BMI), Lean Body Mass (LBM) and Body Fat Mass (BFM). A height meter (Seca Mod. 220 C[a], Germany) calibrated from 0-200cm was used to measure the height of each participant to the nearest 0.1cm. The participants' heels, the back and the occiput were touching the stadiometer scale with the participants looking straight ahead during measurement. Body weight in light clothes was measured to the nearest 0.1 kg using a weighing scale (Seca Mod. 762 1019009 C[a], Vogel and Halke, Germany) calibrated from 0 120kg with the participant in standing and shoes off. A Bioelectric Impedance Analysis (BIA) Machine (Omron BF306; Mod. HBF-306-E. C[a], Japan) was used to measure the percentage body fat (PBF) of all participants. BMI, LBM and BFM were calculated.

BMI was calculated by dividing weight in kilograms by height in metres squared (Wkg/Hm^2).

Body Fat Mass (BFM) was calculated from the BIA estimate of the Percentage Body Fat (PBF) using the formula: BFM = (PBF X total body weight) / 100.

Lean body mass (kg) was calculated from the PBF estimate of the BIA.

LBM (kg) was calculated by subtracting BFM (kg) from total body weight (kg).

Procedures:

The ethical approval for this study was obtained from the University of Ibadan / University College Hospital, Institutional Review Committee. The participants were fully informed about the purpose of the study and their consents were obtained before measurements were taken.

The BSME otherwise known as the Sørensen test was used in the assessment of back extensor muscles endurance.[18] It measures how long (to a maximum of 240 seconds) the participant can keep the unsupported trunk (from the anterior iliac crests level up) horizontal while lying prone on a plinth (standard treatment table) with their arms are held along the sides touching their bodies. Prior the test, A Sportop bicycle ergometer (B600 model, UK) was used for muscles warm up. The participants warmed up with the bicycle ergometer unloaded for two minutes at self determined speed five minutes prior the test as recommended by Alaranta.[11] During the test, two non-elastic straps were lightly fastened around the participants' gluteus maximus and ankles (just superior to the medial and lateral malleoli) for stability on the plinth, a pillow was positioned beneath the ankle straps to reduce the strain on the distal aspect of the tendo calcaneus (Achilles tendon) and thereby ensure comfort of the participants (Figure). The participants were asked to maintain the horizontal position until they can no longer control the posture or tolerate the procedure by asking them to maintain contact between their back and a weight hanging from the ceiling. The total time from the onset of the test to trunk flexion and loss of the static neutral position is recorded as the endurance time or the isometric holding time (in seconds) with the stop watch (Quartz U.S.A). The test was conducted only once and thereafter the participants were discharged.[11]

DATA ANALYSIS

Data were summarized using the descriptive statistics of mean and standard deviation. Inferential statistics involving Independent t-test Pearson's and Product moment correlation analysis were also used. The á level was set at 0.05. The data analysis was carried out using SPSS 13.0 version software (SPSS Inc., Chicago, Illinois, USA).

RESULTS

The participants ranged in age from 21-62 years with a mean of 38.9 ± 13.5 years. The male (38.9 ± 13.9 years) and the female (38.9 ± 10.6 years) participants were age matched. The physical characteristics, measures of adiposity and the mean endurance time for both males and females are presented in Table 1. The results showed that the males were significantly taller than their female counterparts. However, the females had significantly higher levels of adiposity (BMI, PBF, BFM) than the males. Males exhibited significantly greater static endurance (p =

0.014) of the back extensor muscles than females (119 ± 49.8 seconds vs. 106 ± 47.6 seconds) (Table 1). Pearson's product moment correlation matrix shows an inverse but significant correlation between endurance time and each of age, weight, BMI, PBF, LBM and BFM among the male and female participants respectively as presented in Table 2. The following descriptive terms for correlation were used:

.00 - .25 little, if any
.26 - .49 low correlation
.50 - .69 moderate correlation
.70 89 high correlation
.90 1.00 very high correlation.[26]

DISCUSSION

There is general agreement that differences exist between muscular endurance capacity of the back extensor of males and females in literature. With a few exceptions [22, 23, 27, 28], studies found significantly longer position-holding times in healthy female subjects [4, 15-20], and in female patients with LBP.[18, 29] However, the finding from this present study revealed that males demonstrated better muscular endurance of the back extensor muscles than females during static contractions as the mean endurance time of male participants was significantly higher than that of the female participants. The result of this study disagrees with previous reports that found higher muscle endurance in healthy adult women than in men. It is important to note that the few studies that reported greater timed muscle endurance among men than women were among LBP population and cannot be used to compare the finding of this study. However, spectral analysis of electromyography signals recorded during the test of endurance of the back extensor muscles indicated greater muscle fatigability in males.[15, 17, 19, 30, 31]

Several hypotheses have been put forward to explain the gender-related difference in muscular endurance of the back extensor muscles. Gatzke [25] noted that the substantial anatomical, physiological, and morphological differences that exist between men and women may affect their exercise capacity and influence the magnitude of response to exercise. Marras et al [32] reported that the geometry of the trunk of females and males differs. Specifically, due to the gender dependent differences in body segment proportions (females generally have shorter legs and longer torsos than men); hence the forces differ between males and females.[33] Such factors can significantly impact variables such as spine loading [32], mechanical efficiency, and predisposition to injury.[33, 34]

Although the Sorensen test has been extensively studied, the better performance among females remains partly unexplained [35] Different explanations have been postulated for the longer isometric holding time in women than men from previous studies. In females, the weight of the upper body is less and the center of gravity of the trunk lowers, as compared to males. [18, 36] However, the position-holding time remained longer in females wearing weights attached to the upper body [37] or performing isometric trunk muscle endurance tests in the standing position.[36] Clark et al [37] therefore submitted that the sex difference observed during isometric contraction was not influenced by torso length, as there was no significant relationship between torso length and endurance time. The greater degrees of lumbar lordosis in females have been implicated to afford a mechanical advantage by lengthening the lever arm of the spinal erector muscles.[38, 39] These differences in muscular endurance capacity of the back extensor of males and females have been reported to be influenced by sex-linked biologic factors (hormones or physiology).[16, 36] Furthermore, differences in muscle composition have been suggested as the most compelling hypothesis in sex differences in muscular endurance capacity. Mannion et al [19] suggested that the spinal muscles may show better adaptation to aerobic exercise in females as a result of a larger proportion of slow Type I fibers in the cross-sectional muscle area.[40, 41] There is no clear consensus on whether a racial difference in skeletal muscle fibre type exists.[42]

This present study was carried out among indigent Africans; however, it is not known whether certain ethnic and racial groups appear to be particularly predisposed to poor low back endurance. No previous study has evaluated gender differences in static muscular endurance of the back extensors among Nigerians; there is also a dearth of studies evaluating the static endurance of back extensor muscles from SSA. Our finding is inconsistent with previous reports on the pattern of endurance of the back extensor muscles from oversea populations; it therefore becomes necessary that further studies be carried out among African populations to establish the pattern of static endurance of the back extensor compared with studies from other populations.

Gender differences in back extensor endurance capacity during isometric contraction in this study could not be linked to age influence as the participants were age matched. However, females in this study have higher levels of adiposity. Increase in body fat levels has been implicated in the aetiology of decrease endurance of the back muscles from previous studies.[15, 40, 43] It is believed that a large individual variation exists in the relationship between muscle performance capacity and musculoskeletal disorders.[11] An influence of individual factors such as motivation, pain tolerance, smoking and competitiveness has been suggested.[2, 28, 44]

According to literature, the mean endurance time in healthy subjects for men is 84 to 195 seconds; for women, it is 142 to 220.4 seconds.[12] The mean endurance time of the males (119 ± 49.8 sec.) compared with females (106 ± 47sec.) from this study was lower than the Biering-Sorensen values (195 vs. 199 sec.) for males and females respectively. The mean value from this study was also lower than those reported by Kankaanpaa et al [15] (153.6 ± 47.9 vs.182.6 ± 47.3 sec.); Mannion and Dolan [16] (116 ± 40 vs. 142 ± 55 sec.); and Nicolaisen and Jorgensen [29] (184 ± 59 vs. 219 ± 33.0 sec.) for males and females respectively among other studies. However, the mean value among male subjects from this study was higher than those reported by Gibbons et al [40] (84 ± 45 sec.) and Latikka et al [45] (92 ± 46.0 sec.).

The endurance time age relationship as analyzed using the Pearson's moment correlation showed a moderate but inverse significant correlation among the male and female participants respectively. This finding is consistent with previous investigations which confirmed the presence of age influence in isometric endurance time,[46, 47] Most studies have shown that muscle endurance declines with advancing age.[14, 18, 47, 48] This present study's result of age influence in static endurance time is at variance with other findings that reported that age had either little or no influence at all on isometric endurance of back extensor muscles.[40] Also, from this study, each of the studied measures of adiposity (BMI, PBF and BFM) showed an inverse relationship with endurance time among the male and the female participants respectively with varying degree of strength of association. This result is consistent with studies that reported correlation among anthropometric measures and endurance time among healthy subjects of both genders.[49-52]

From the outcome of this study we conclude that there was significant gender-related difference in muscular endurance of the back extensor muscles in apparently healthy adult Nigerian with males having significantly greater timed back extensor muscles' endurance when compared with their female counterparts. The mean endurance times of the males and females from this study were lower than the original Biering-Sorensen values for males and females respectively. Age and the different measures of adiposity were inversely related with endurance capacity of the back extensor muscles in the apparently healthy adults with no gender bias. These findings may help to understand the determinants of back function in the testing of the trunk extensor musculature in clinical practice and could also have implications for exercise training and prescription. This eventually may lead to gender specific prevention and management of LBP.

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APPENDIX

Table I: Independent t-test Comparison of the physical characteristics and the mean endurance time among both male and female participants

Variables	Male (193) Mean ± S.D	Female (18) Mean ± S.D	t-value	P value
Age	38.9 ± 13.9	38.9 ± 3.16	-0.490	0.961
Height	1.68 ± 1.07	1.62 ± 1.07	7.981	0.000*
Weight	63.8 ± 11.1	63.8 ± 13.0	-0.020	0.984
BMI	22.6 ± 3.78	24.5 ± 4.69	-4.390	0.000*
PBF	20.5 ± 7.00	32.8 ± 7.37	-16.50	0.000*
LBM	50.2 ± 6.79	42.1 ± 6.00	12.2	0.000*
BFM	13.6 ± 6.75	21.6 ± 8.80	-9.93	0.000*
IHT	119 ± 49.8	106 ± 47.6	2.48	0.014*

* indicate significance

Key:

BMI = Body Mass Index
LBM = Lean Body Mass
IHT = (Isometric Holding Time)
PBF = Percentage Body Fat
BFM = Body Fat Mass (Fat weight)
S.D = Standard Deviation

Table 2: Pearson's Product Moment Correlation analysis between endurance time and the dependent variables of all the male and female participants

Dependent variables	Male participants (N = 193) Pearson Product Moment Correlation coefficient (r) (P value)	Female participants (N = 183) (P value)
Age	- 0.572** (0.000)	- 0.559** (0.000)
Height	0.140 (0.053)	- 0.234** (0.001)
Weight	- 0.326** (0.000)	- 0.461** (0.000)
BMI	- 0.432** (0.000)	- 0. 407** (0.000)
PBF	- 0.546** (0.000)	- 0.535** (0.000)
LBM	- 0.017 (0.814)	- 0.240** (0.001)
BFM	- 0.521** (0.000)	- 0.525** (0.000)

* P<0.05 ** P<0.01

Key:
BMI = Body Mass Index
PBF = Percentage Body Fat
LBM = Lean Body Mass
BFM = Body Fat Mass (Fat weight)
IHT = (Isometric Holding Time)