Fizyoterapi Rehabilitasyon. 2008; 19(1):30-36

Static back endurance in apparently healthy Nigerian adults

Chidozie Emmanuel Mbada, Olusola Ayanniyi

[Mbada CE, Ayanniyi O. Static back endurance in apparently healthy Nigerian adults. Fizyoter Rehabil. 19(1):30-36.]

Research Report

Purpose: The Biering-Sørensen Test of Static Muscular Endurance (BSME) has been used to evaluate back extensor endurance holding times in overseas populations in both patients and healthy subjects. Data from Africa on back extensor endurance are scant; the aim of this study was to collect mean data on back extensor endurance holding times and also investigate the back endurance pattern among apparently healthy adult Nigerians. **Materials and methods:** 376 apparently healthy consecutive adults aged 38.9±13.5 years participated in this study. The participants performed the BSME and their height and weight were measured using standard procedures. Percentage body fat was estimated using bioelectrical impedance analysis. Body Mass Index (BMI) and Lean Body Mass (LBM) and Body Fat Mass (BFM) were calculated. **Results:** The mean endurance time of all the participants was 113±49 seconds. Majority of the participants had good endurance performance (49.5%) with the back endurance pattern in the ratio 5:4:1. The correlation matrix shows a significant inverse correlation between endurance time and each of age, and the measures of adiposity. **Conclusion:** From the outcome of this study we conclude that the endurance capacity of the back extensor muscles among apparently healthy Adult Nigerians is lower than normal Biering-Sørensen holding times.

Key words: Physical endurance, Sørensen Test, Back extensor muscles, Endurance time, Nigerian adults.

CE Mbada
Obafemi Awolowo University Teaching Hospital Complex, Ile-Ife, Nigeria
PT, MSc

O Ayanniyi
Physiotherapy Department, College of Medicine, University of Ibadan, Nigeria
PhD, FMII

Address Correspondence to:
Chidozie Emmanuel Mbada
Resident Physiotherapist
Obafemi Awolowo University Teaching Hospital Complex,
Ile-Ife, Nigeria
Email: doziembada@yahoo.com

Sağlıklı Nijeryalı erişkinlerde statik sırt enduransı

Amaç: Statik kassal enduransın Biering-Sørensen Testi (BSME) denizaşırı toplumlarda hem hastaların hem de sağlıklı olguların sırt ekstansör enduransı tutma zamanını değerlendirmede kullanılır. Sırt ekstansör enduransı üzerine Afrika'dan veri yetersizdir. Bu çalışmanın amacı sırt ekstansör enduransı tutma zamanının ortalama verilerini toplamak ve ayrıca görünüşe göre sağlıklı erişkin Nijeryalılarda sırt endurans paternini belirlemekti. **Gereç-yöntem:** 38.9±13.5 yaşlarında görünüşe göre sağlıklı ardı ardına 376 erişkin bu çalışmaya katıldı. Katılımcılar BSME'yi uyguladı ve boy ve kiloları standart yöntemlerle ölçüldü. Vücut yağ yüzdesi bioelektriksel impedans analizi kullanılarak belirlendi. Vücut kütle indeksi (VKİ) ve yağsız vücut kütlesi (YVK) ve vücut yağ kütlesi (VYK) hesaplandı. **Sonuçlar:** Tüm katılımcıların ortalama endurans zamanı 113±49 sn idi. Katılımcıların çoğu 5:4:1 oranı içindeki sırt endurans paterni ile iyi performansa sahipti (%49.5). Korelasyon matriksi endurans zamanı ve her yaş ve yağ ölçümleri ile doğru yönde anlamlı korelasyon gösterdi. **Tartışma:** Bu çalışmanın çıktılarından görünüşe göre sağlıklı erişkin Nijeryalılar arasındaki sırt ekstansör kaslarının endurans kapasitesinin normal Bierin-Sorensen tutma zamanından daha düşük olduğu sonucuna vardık.

Anahtar kelimeler: Fiziksel endurans, Sørensen Test, Sırt ekstansör kasları, Endurans zamanı, Nijeryalı erişkinler.

Muscular endurance is the ability of an isolated muscle group to perform repeated contraction over a period of time.[1] Endurance testing of back extensor muscles examines the localized capability of the extensor muscles of the back to sustain activity. This endurance of the back extensor muscles can be assessed electrically by analyzing the electromyographic (EMG) signal of the neural activity during given postures or movements and also mechanically 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.[3,4] There is some evidence that decreased muscular endurance could be a cause, as well as a consequence, of certain musculoskeletal disorders.[5] Decreased muscular endurance is considered a characteristic dysfunction[6] and an impairment leading to disability[7] and musculoskeletal disorders.[5] Specifically, low levels of static endurance in the back extensor muscles are associated with higher rates of low back pain (LBP),[6] decreased proprioceptive awareness,[7] poor balance,[8] and decreased productivity in the workplace.[9]

Muscular endurance of the back extensors has been reported to be assessed less frequently than muscular strength,[10] although the endurance capabilities of these muscles may be as important or even more important than strength in the prevention and treatment of LBP.[11] 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] Also, endurance testing of the back extensors and antecedent rehabilitation were considered as important aspects of obtaining resolution for many individuals struggling with LBP.[12]

The Biering-Sørensen test of static muscular endurance (BSME) otherwise known as the Sørensen test is a clinical tool for diagnosis of low back muscular endurance and it has been reported to be valid, reliable, safe, practical, responsive, easily administered, inexpensive, and there is a substantial quantity of compiled data.[11-13] This test has been used in many studies, either in its original version or as variants.[14] The test has been studied for how well it detect associations of back function and LBP,[15] e.g. for monitoring the effects of intervention or rehabilitation,[16] pre-employment[17] or return to work physical evaluations.[18] The Sørensen test gained considerable popularity as a tool reported to predict low back pain within the next year in males.[14, 19]

The BSME has been used to evaluate back extensor endurance holding times in overseas populations in both patients and healthy subjects, as well as in assessment of work ability and rehabilitation.[19-21] with substantial compiled mean values.[12,22,23] The Sørensen test has become the tool of reference for evaluating muscle performance in patients with LBP, most notably before and after rehabilitation programs.[14] It is believed that a large individual variation exists in the relationship between muscle performance capacity and musculoskeletal disorders.[12] However, it is not known whether certain ethnic and racial groups appear to be particularly predisposed to poor low back endurance. To our knowledge, studies on low back endurance among Nigerians evaluating back extensor endurance holding times appear not available. This study aimed to collect mean data on back extensor endurance holding times and also investigate the back endurance performance pattern and the relationship of anthropometric variables with endurance time among apparently healthy adult Nigerians using the BSME.

MATERIALS AND METHODS

Subjects

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. 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 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 CE, 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 CE, 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. CE, 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).

BFM was calculated from the BIA estimate of the Percentage Body Fat (PBF) using the formula: BFM = (PBF X total body weight)/100. LBM (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.[19] 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 hands held by their sides. Prior the test, A Sportop bicycle ergometer (B600 model) 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.[12] 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 towel 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. The participants were asked to maintain the horizontal position until they can no longer control the posture or tolerate the procedure. 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.[12]

The participants were categorized into three groups based on their endurance pattern according to Alaranta et al[24] as (1) Good performance (2) Medium performance and (3) Poor performance categories. Participants with endurance time of less than 58 seconds were classified as having poor performance, an endurance time of between 58 – 104 seconds was considered medium performance while an endurance time ranging between 104 – 240 seconds was classified as good performance.

Data analysis

Data were summarized using the descriptive statistics of mean, ranges, percentages and standard deviation. Inferential statistics involving Pearson's Product Moment correlation analysis was also used. The α level was set at 0.05. The data analysis was carried out using SPSS 13.0 version software (SPSS Inc., Chicago, Illinois, U.S.A).

RESULTS

The physical characteristics of the participants are presented in Table 1. The mean age of the participants was 38.9±13.5 years. The mean height, weight and BMI were 1.65±0.81m, 63.8±12.0Kg, 23.5±4.35Kg/m^2 respectively. The mean endurance time of all the participants was 113±49 seconds as shown in Table 1.

DISCUSSION

There is a growing support for the quantification of endurance and normative data on endurance tests of the back extensor muscles are being compiled from previous studies and from various populations. Though healthy young men and women possesses different endurance profiles for the spine stabilizing musculature, data of endurance times in normal subjects are useful for patient evaluation and for providing clinical rehabilitation targets.[22] This study employed the use of the BSME in the mechanical quantification of back extensor muscles' endurance in apparently healthy adult Nigerians. A mean endurance time of 113±49 seconds was found in this study. The mean endurance time found in this study was comparable with the endurance holding times reported by Stewart et al[25] (113 seconds.) in a study among Australian coal miners. However, the mean endurance value in this study was lower than normal Biering-Sørensen holding times (138 seconds.).

Normative holding time has been reported for apparently healthy participants in various studies, 180 seconds in a study involving 101 women,[26] and 196 seconds in a study from the U.S.A.[27] Normative holding time for healthy participants therefore has been reported to be approximately 3 minutes.[26,27] However, mean endurance time among patients with LBP has been reported to be significantly lower than that of the healthy subjects from previous studies[4,28] but denied in other studies that reported no significant difference.[17,25]

Table 1. Physical characteristics and the endurance time of the participants (N=376).

	X±SD
Age (years)	38.9±13.5
Height (m)	1.65±0.81
Body weight (kg)	63.8±12.0
Body mass index (kg/m^2)	23.5±4.35
Percentage body fat	26.5±9.43
Lean body mass (kg)	46.2±7.58
Body fat mass (kg)	17.4±8.77
Endurance time (sec)	113±49.0

Table 2. Pearson's Product Moment Correlation between IHT and the dependent variables of the participants.

Dependent variables	r (p)
Age (years)	- 0.562* (0.000)
Height (m)	0. 013 (0.799)
Body weight (kg)	- 0.391* (0.000)
Body mass index (kg/m^2)	- 0. 430* (0.000)
Percentage body fat	- 0.489* (0.000)
Lean body mass (kg)	- 0.029 (0.570)
Body fat mass (kg)	- 0.514* (0.000)

r: Pearson's Product Moment Correlation coefficient. * p<0.01.

Pearson's product moment correlation matrix shows an inverse correlation between endurance time and each of age, weight, BMI, PBF, and BFM among the participants as presented in Table 2. The pattern of the endurance performance of all the participants is presented in Table 3. About half of the participants (49.5%) were within the good endurance performance category. The pattern of performance of isometric back endurance as good, medium or poor respectively, as seen in this study was in the ratio 5:4:1.

Table 3. Pattern of the endurance performance of all the participants.

Endurance time classification	Description	Number	Percentages (%)
>104 - 240 seconds	Good	186	49.5
58 - 104 seconds	Medium	146	38.8
<58 seconds	Poor	44	11.7

The correlation matrix revealed a significant inverse relationship between endurance time and age of the participants. This finding is consistent with previous investigations which confirmed the presence of age influence in isometric endurance time.[29] Most studies have shown that muscle endurance declines with advancing age.[3,20,30] However, our finding 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.[31] From this current study, weight and each of the studied measures of adiposity (BMI, PBF and BFM) showed an inverse relationship with endurance time respectively. This is consistent with studies that reported correlation among anthropometric measures and endurance time among healthy subjects.[31,32] These findings corroborate the reports that several anthropometric measures such as BMI, body weight, height, and body fat have been considered to be related to back function and these have led to a wide range of reported correlation coefficients for the association from -0.04 to 0.68.[31,32] Ropponen et al,[33] reported that anthropometric factors are important in low back muscle performance. The association between the different factors and back function can also be influenced by the fact that certain factors may exhibit mutual associations e.g. anthropometrics and physical activity.[34,35] On the other hand Gibbons et al,[31] reported that anthropometric factors had a comparatively minor role, to increase and sustain back muscle function in healthy adults as regards static back extensors endurance test.

The participants in this study were categorized into three groups based on their endurance pattern according to Alaranta et al[24] as good, medium or poor performance categories respectively. The pattern of back endurance seen in this current study was in the ratio 5:4:1. However, the pattern of endurance performance reported by Alaranta et al[24] in a study among 126 persons without LBP was in ratio 3:3:3. Alaranta et al [24] found good performance in 43 subjects, medium performance in 40 subjects and poor performance in 43 subjects. It therefore showed that majority of the population of this study on apparently healthy adult Nigerians had good back extensor muscles' endurance. From this study, one out of every ten participants had poor back extensors endurance while one out of every three in the study by Luoto et al[24] had poor endurance.

The BSME gained considerable popularity as a tool reported to predict LBP within the next year in males, however, debate continues to surround its ability to predict LBP.[14] Nevertheless, previous investigations have used the BSME as a predictor of low-back health, based on endurance time.[3,19] Poor static back endurance has been found to be linked to an increased risk of LBP during a follow up of 1-year.[24] Subjects with less than 58 seconds' endurance have been reported to have a 3.4 times greater likehood of developing LBP when comparing those with poor static back endurance performance to those with good performance.[19]

From the outcome of this study we conclude that the endurance capacity of the back extensor muscles among apparently healthy adult Nigerians is lower than normal Biering-Sørensen holding times. This is also lower than the normative data reported in previous studies emanating from western populations. However, the pattern of endurance performance revealed that majority of the studied population had good endurance. Though the mean endurance times in this study were lower than the normal Biering-Sørensen

holding times, nonetheless, fewer participants had poor back extensor endurance when compared with the pattern reported in a previous study.

This present study is limited in its external validity because of the lack of randomization of the participants recruited for the study. The result of this study can serve as a preliminary mean data for back extensor muscles endurance among apparently healthy adult Nigerians. Though most previous studies that reported normative data did not take care of this problem. It is our view that a simple randomized cross-sectional studies in which each member of the population has an equal chance of being selected for sample be carried out by future researchers as it will enhance generalisability of findings and be more representative of the general population.

REFERENCES

1. Burnett CN, Glenn TM. Principles of aerobic exercise. In: Kisner C, Colby LA, eds. Therapeutic Exercise: Foundations and Techniques. 3rd ed. Philadelphia: F. A. Davis Company; 1996:111-142.
2. Moffroid MT. Endurance of trunk muscles in persons with chronic low back pain: assessment, performance, training. J Rehab Res Dev. 1997;34:440-447.
3. Biering-Sørensen F. A prospective study of low back pain in a general population. II. Location, character, aggravating and relieveing factors. Scand J Rehabil Med. 1983;15:81-88.
4. Latimer J, Maher CG, Refshauge K, et al. The reliability and validity of the Biering-Sorensen test in asymptomatic subjects and subjects reporting current or previous nonspecific low back pain. Spine. 1999;24:2085-2089.
5. Alaranta H, Moffroid M, Elmqvist L-G, et al. Postural control of adults with musculoskeletal impairment. Clin Rev Phys Rehab Med. 1994;6:337-370.
6. Gandevia SC. Spinal and supraspinal factors in human muscle fatigue. Physiol Rev. 2001;81:1725-1789.
7. Gomer FE, Silverstein LD, Berg WK, et al. Changes in electromyographic activity associated with occupational stress and poor performance in the work place. Hum Factors. 1987;29:131–143.
8. Lee JH, Hoshino Y, Nakamura K, et al. Trunk muscle weakness as a risk factor for low back pain: a 5-year prospective study. Spine. 1999; 24:54-57.
9. Moffroid MT, Haugh LD, Haig AJ, et al. Endurance training of trunk extensor muscles. Phys Ther. 1993;73:10-17.
10. Pollock ML. Leggett SH. Graves JE. et al. Effect of resistance training on lumbar extension strength. Am J Sports Med. 1989;17:624-629.
11. Udermann BE, Mayer JM, Graves JE, et al. Quantitative assessment of lumbar paraspinal muscle endurance. J Athl Train. 2003;38:259-262.
12. Alaranta H. Strength and endurance testing. In: Yeoman SG, ed. The Clinical Application of Outcomes Assessment. Stamford: Appleton and Lange; 2000:158-162.
13. Moreau CE, Green BN, Johnson CD, et al. Isometric back endurance tests: a review of the literature. J Manipulative Physiol Ther. 2001;24:110-122.
14. Demoulin C, Vanderthommen M, Duysens C, et al. Spinal muscle evaluation using the Sorensen test: a critical appraisal of the literature. Joint Bone Spine. 2006;73:43-50.
15. Marras WS, Davis KG, Ferguson SA, et al. Spine loading characteristics of patients with low back pain compared with asymptomatic individuals. Spine. 2001;26:2566-2574.
16. Mannion AF, Taimela S, Müntener M, et al. Active therapy for chronic low back pain. Part 1. Effects on back muscle activation, fatigability, and strength. Spine. 2001;26: 897-908.
17. Ebrahimi I, Hosseini GR, Salavati SM, et al. Clinical trunk muscle endurance tests in subjects with and without low back pain. Medical Journal of the Islamic Republic of Iran. 2005;19:95-101.
18. Lemstra M, Olszynski WP, Enright W. The sensitivity and specificity of functional capacity evaluations in determining maximal effort: a randomized trial. Spine. 2004; 29:953-959.
19. Biering-Sørensen F. Physical measurements as risk indicators for low-back trouble over a one-year period. Spine. 1984;9:106-119.
20. Kankaanpää M, Laaksonen D, Taimela S, et al. Age, sex, and body mass index as determinants of back and hip extensor fatigue in the isometric Sorensen back endurance test. Arch Phys Med Rehabil. 1998;79:1069-1075.
21. Kaser L, Mannion AF, Rhyner A, et al. Active therapy for chronic low back pain: part 2. Effects on paraspinal muscle cross-sectional area, fiber type size, and distribution. Spine. 2001;26:909-919.
22. McGill SM, Childs A, Liebenson C. Endurance times for low back stabilization exercises: clinical targets for testing and training from a normal database. Arch Phys Med Rehabil. 1999;80:941-944.
23. Lee Y, Kuo C. Factor structure of trunk performance data for healthy subjects. Clin Biomech

(Bristol, Avon). 2000;15:221-227.
24. Alaranta H, Luoto S, Heliovaara M, et al. Static back endurance and the risk of low-back pain. Clin Biomech (Bristol, Avon). 1995;10:323-324.
25. Stewart M, Latimer J, Jamieson M. Back extensor muscle endurance test scores in coal miners in Australia. J Occup Rehabil. 2003;13:79-89.
26. Nordin M. Kahanovitz N. Verderame R. et al. Normal trunk muscle strength in women and the effect of exercises and electrical stimulation: Part I: Normal endurance and trunk muscle strength in 101 women. Spine. 1987;12:105-111.
27. Moffroid MT, Reid S, Henry SM, et al. Some endurance measures in persons with chronic low back pain. J Orthop Sports Phys Ther. 1994;20:81-87.
28. Nourbakhsh MR, Arab AM. Relationship between mechanical factors and incidence of low back pain. J Orthop Sports Phys Ther. 2002;32:447-460.
29. Chan KM, Raja AJ, Strohschein FJ, et al. Age-related changes in muscle fatigue resistance in humans. Can J Neurol Sci. 2000;27:220-228.
30. Hunter SK, Duchateau J, Enoka RM. Muscle fatigue and the mechanisms of task failure. Exerc Sport Sci Rev. 2004;32:44-49.
31. Gibbons LE, Videman T, Battié MC. Determinants of isokinetic and psychophysical lifting strength and static back muscle endurance: a study of male monozygotic twins. Spine. 1997;22:2983-2990.
32. Gross MT, Dailey ES, Dalton MD, et al. Relationship between lifting capacity and anthropometric measures. J Orthop Sports Phys Ther. 2000;30:237-247.
33. Ropponen A, Levälahti E, Videman T, et al. The role of genetics and environment in lifting force and isometric trunk extensor endurance. Phys Ther. 2004;84:608-621.
34. Kyle UG, Gremion G, Genton L, et al. Physical activity and fat-free and fat mass by bioelectrical impedance in 3853 adults. Med Sci Sports Exerc. 2001;33:576-584.
35. Maia JA, Thomis M, Beunen G. Genetic factors in physical activity levels: a twin study. Am J Prev Med. 2002;23(Suppl. 2):87-91.