Comparative assessment of back extensor muscles' endurance between nulliparous and parous women

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Abstract. *Background and objective:* Poor endurance of the back extensor muscles has been reported among more women than men. There are several reported reasons for its predilection but the influence of parity has not been investigated. The objective of this study was to investigate the influence of parity on back extensor muscles' endurance between nulliparous and parous women.
Methods and Results: 146 women whose ages ranged between 21 to 60 years were recruited into the study using sampling of convenience. This consisted of 77 nulliparous women group (21–42 years) with a mean age of 32.7 $\pm$ 5.7 years and the parous women group (26–60 years) with a mean age of 41.2 $\pm$ 9.9 years. The participants performed the Biering-Sørenson test of Static Muscular Endurance (BSME) and their height, weight and percentage body fat were measured using standard procedures. Body Mass Index (BMI) and lean body mass (LBM) and body fat mass (BFM) were calculated. Data were summarized using the descriptive statistics of mean and standard deviation, Pearson's Chi-square, Independent t-test, and Analysis of Variance were used as applicable. The α level was set at 0.05. The finding of this study showed that parous women were significantly older, heavier and had greater level of adiposity than their nulliparous counterparts. The result indicated a significant association between parity and endurance time ($X^2 = 88.05$; $P = 0.020$), nulliparous women have significantly greater back extensor muscles' endurance ($t = 4.902$; $P = 0.000$) when compared to parous women. The results suggested that the significant age and anthropometric difference between the nulliparous and parous women could contribute to the endurance differences. Number of parity is much related to back extensor muscle endurance ($F = 22.32$; $P = 0.000$). Back extensor muscles' endurance decreases as the number of parity increases.
Conclusion: Our results suggest that parity is an important factor in the aetiology of low back extensor muscles endurance among women.

Keywords: Back extensor muscles' endurance, nulliparous, parous, women

1. Introduction

Back extensor muscles are classified as postural muscles [30] that aid in maintaining the upright standing posture and controlling lumbar forward bending [15] and are suited to support low levels of activity for long periods of time [52]. The endurance of these back extensor muscles have been reported to be related to low back health [9,29,39]. Low levels of static endurance in the back extensor muscles are associated with higher rates of low back pain (LBP) [22,63], decreased proprioceptive awareness [25], and decreased productivity in the workplace [53]. The Biering-Sørensen test of Static Muscular Endurance (BSME) is a clinical tool

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for assessment of low back muscular endurance and it has been reported to be valid, reliable, safe, practical, responsive, easily administered and inexpensive [3,65].

A number of factors have been shown to influence isometric back extensor endurance test results. This include environmental factors; such as physical activity and lifestyle [8,43]. Constitutional factors; such as age [2,31] and different anthropometric parameters [23,31]. Others are behavioural factors; such as motivation [20,36], the presence of back pain [2, 23,32], health [23,44], profession and education [2, 13]. Numerous studies on the back extensor muscles have demonstrated an association between gender and endurance capacity reporting lower endurance among women than men [1,34,49] but denied in the findings of some other studies that reported that healthy (i.e. free of LBP) women are less fatigable than men [31,41]. However, lack of back extensor muscles' endurance has frequently been cited as a suspected factor in the aetiology of LBP [54] and it has also been associated with prolonged or recurrent back pain [29]. On the other hand, back pain in itself has been reported to precipitate decreased muscle endurance resulting from increased muscle metabolite from prolonged muscle tension and spasm [4], muscle deconditioning [59] and inhibition of the paraspinal muscles [59] in response to pain and decreased activity.

McKenzie [50] stated that both during and after pregnancy, women are subjected to altered mechanical stresses, which affect the back and frequently result in back impairment. There are many musculoskeletal changes associated with pregnancy [18,57]. These musculoskeletal changes include back and pelvic pain, postural changes, joint laxity, reduction in muscle strength, and poor endurance of the trunk muscles [11, 56]. Indications for possible causes of back pain in pregnancy include both hormonal and mechanical factors [50]. Back pain is widely recognised as a major problem in pregnancy [48,55] which is often experienced by up to 50% of all pregnant women lasting up to 6 months after delivery [17] but the pain usually ameliorates once the child is delivered [19]. Also, it has been shown that parous women have significantly greater muscle laxity than nulliparous women but after the first pregnancy, laxity does not change with the number of pregnancies [14] but it is not known whether decreased back muscle endurance resulting from pregnancy resolves in like manner as the other musculoskeletal changes in pregnancy.

Studies on parity is inconclusive with some studies showing a link between parity and back pain [28,47,56] while findings of other studies disputed any relationship between parity and back pain in pregnancy [6,21]. To our knowledge, parity has not been studied as a factor in low back endurance among women and it appears there are no data on the mean back muscle endurance for nulliparous or parous women. This study aimed to investigate the hypothesis that no significant difference would be found between the back extensor muscles' endurance of nulliparous and parous women.

2. Materials and methods

2.1. Sample

This study recruited by sample of convenience two groups of women aged 21–60 years. All participants were recruited from University of Ibadan, University College Hospital, Ibadan and the surrounding metropolis. Participants were screened via interview to ensure that they satisfied the selection criteria for the study. The criteria included that the participants in both groups be asymptomatic of LBP for a minimum of one year as at the time of the study; be without any obvious spinal deformity or neurological disease; participants must not have be involved in competitive sport or athletics or with a reported history of cardiovascular diseases.

The first group consisted of 77 nulliparous females with a mean age of 32.7 ± 5.7 years; who were nulligravida as at the time of the study and had never had a spontaneous or elective abortion past their first trimester. The second group consisted of 69 parous women with a mean age of 41.2 ± 9.9 years; who had had one or more childbirths at least within a twelve month period prior to this study.

2.2. 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 Biering-Sørensen test of Static Muscular Endurance (BSME) was used in the assessment of back extensor muscles endurance [10]. 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 with their hands held by their sides. During the test, straps were fastened around the pelvis and ankles for stability in the test position. 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. The test was conducted only once and thereafter the participants were discharged [3]. The participants' height, weight and percentage body fat were measured using standard procedures. Body Mass Index (BMI) and lean body mass (LBM) and body fat mass (BFM) were calculated.

2.3. Data analysis

Data were summarized using the descriptive statistics of mean and standard deviation. Inferential statistics involving Pearson's Chi-square, Independent t-test and Analysis of Variance (ANOVA) were 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, USA).

3. Results

The participants ranged in age from 21–60 years. For the nulliparous women, ages ranged from 21 to 42 with a mean age of 32.7 $\pm$ 5.70 years. The parous women were between the ages of 26 and 60 with an average of 41.2 $\pm$ 9.9 years. The physical characteristics and the mean endurance time for both nulliparous and parous groups are presented in Table 1. The Independent t – test analysis showed a significant difference in age, weight and in the measures of adiposity (BMI, PBF, BFM) between the parous and nulliparous women (Table 1). The mean endurance time was found to be significantly different (t = 4.902; P = 0.000) with the nulliparous women demonstrating a greater endurance time than the parous women. Chi-square test revealed a significant association between parity and endurance time (X^2 = 88.05; P = 0. 020).

The parous participants were grouped based on the number of parity; the one-way ANOVA was used to compare their ages, physical characteristics and endurance time. Significant F-ratios were found for both mean age and mean endurance time (F = 123.9; P = 0.000; F = 22.32; P = 0.000) respectively. Post-hoc LSD was used to elucidate where the differences found in the F-ratio lies (Table 2).

Table 1
Comparison of the physical characteristics and the mean endurance time among the nulliparous and parous groups

Variables	Nulliparous (77) Mean $\pm$ S.D	Parous (69) Mean $\pm$ S.D	t value	P value
Age	32.7 $\pm$ 5.70	41.2 $\pm$ 9.90	−6.422	0.000
Height	1.62 $\pm$ 0.07	1.63 $\pm$ 0.08	−0.775	0.440
Weight	61.8 $\pm$ 13.1	66.4 $\pm$ 13.3	−2.116	0.036
BMI	23.6 $\pm$ 4.55	25.6 $\pm$ 4.93	−2.635	0.009
PBF	29.7 $\pm$ 6.85	36.2 $\pm$ 7.16	−5.623	0.000
LBM	42.8 $\pm$ 6.13	41.4 $\pm$ 6.27	1.359	0.176
BFM	19.0 $\pm$ 8.27	24.8 $\pm$ 9.12	−4.007	0.000
IHT	127.8 $\pm$ 46.3	96.3 $\pm$ 28.89	4.902	0.000

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

4. Discussion

The finding from this study showed that parous women were significantly older and heavier than their nulliparous counterparts. The measures of adiposity (as indicated by BMI, PBF and BFM) were significantly greater among parous women compared to nulliparous. The significant differences in weight and in the measures of adiposity found among the parous and nulliparous women in this study can be attributed to the effect of pregnancy. Pregnancy has been linked to the aetiology of overweight and increase level of adiposity among women [67]. Child bearing has been described as a natural physiologic event causing the body to undergoes tremendous physical, hormonal and physiological changes during pregnancy and the post-partum period which include maternal weight gain [27,33,66] and increase in body mass [11].

The finding from this study revealed a significant association between parity and muscle endurance of the back extensor muscles. The result indicated that nulliparous women have significantly greater back extensor muscle endurance when compared to parous women. However, based on our result, we failed to accept our original hypothesis that there will be no significant difference in the back extensor muscles' endurance of nulliparous women when compared to parous women.

This study also found a significant difference between the back extensor muscles' endurance of the primiparous and the multiparous women. The finding revealed that number of parity is much related to back extensor muscles' endurance, in that as the number of parity increases, endurance time decreases. There are many musculoskeletal changes associated with pregnancy [18,57]. Pregnancy has been reported to place extra mechanical stress on the lower back [68] resulting

Table 2
Summary of the One-way analysis of variance and LSD Post–Hoc multiple comparison of the physical characteristics and endurance time among the parous women based on the number of parity

	Number of parity					
	1	2	3	4		
	N = 14	N = 17	N = 19	N = 19		
Dependent variables	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	F ratio	P value
Age	28.21 ± 1.31^{a}	35.06 ± 5.30^{b}	45.11 ± 2.90^{c}	52.26 ± 4.47^{d}	123.9	0.000
Height	1.64 ± 0.10^{a}	1.63 ± 0.07^{a}	1.63 ± 0.10^{a}	1.61 ± 0.07^{a}	0.328	0.805
Weight	63.9 ± 16.8^{a}	71.5 ± 14.4^{a}	65.4 ± 12.0^{a}	64.7 ± 10.2^{a}	1.153	0.335
BMI	24.6 ± 6.24^{a}	26.9 ± 5.08^{a}	25.8 ± 4.32^{a}	25.0 ± 4.39^{a}	0.702	0.554
PBF	32.8 ± 8.16^{a}	37.7 ± 6.43^{a}	37.4 ± 7.07^{a}	36.1 ± 6.79^{a}	1.488	0.226
LBM	41.2 ± 8.79^{a}	43.2 ± 6.83^{a}	40.4 ± 5.53^{a}	40.9 ± 4.03^{a}	0.662	0.579
BFM	22.0 ± 11.2^{a}	27.8 ± 9.94^{a}	25.0 ± 7.86^{a}	23.8 ± 7.70^{a}	1.124	0.346
IHT	130.0 ± 35.7^{a}	103.8 ± 15.1^{b}	88.2 ± 14.5^{c}	72.6 ± 14.9^{d}	22.32	0.000

Superscripts (*a,b,c,d*).
For a particular variable, mode means with different superscript are significantly ($P < 0.05$) different. Mode means with same superscripts are not significantly ($P > 0.05$) different. When only one contrast is significant, one of the cell means has no superscript attached. The pair of cell means that is significant has different superscripts.
Key: BMI = Body Mass Index; PBF = Percentage Body Fat; LBM = Lean Body Mass; BFM = Body Fat Mass (Fat weight); IHT = (Isometric Holding Time); S.D = Standard Deviation.

from the shift of the center of gravity more posteriorly and inferiorly from the increase lordosis of the lumbar spine, causing the paraspinal muscles to become strained and shortened [17]. According to Heckmann et al. [27] the normal physiological changes of pregnancy may induce mechanical and structural changes in the spine and neuraxis contributing to gestational and possibly postpartum back pain. It has been shown that parous women have significantly greater joint laxity than nulliparous women but after the first pregnancy, laxity does not change with the number of pregnancies [14]. However, there is some evidence that the generalized effect on joint relaxation may have long-term effects, persisting for years after delivery in some women [61]. Decreased endurance of the back muscles has been identified as one of the impairments resulting from pregnancy but there is a dearth of studies indicating whether it resolves in like manner as the other musculoskeletal changes resulting from pregnancy.

There was a significant age difference between the nulliparous women when compared to parous women from this study. This finding on age disagrees with previous study that back extension endurance time did not differ between young and old women [45]. However, some investigations confirmed the presence of age influence in isometric endurance time [16,38] but Gibbons et al. [24] reported that age had either little effect or no effect at all on isometric endurance of the back extensor muscles. Furthermore, there was a significant age difference among the parous women when they were classified based on the number of parity. The multiparous women were significantly older than their primiparous counterparts. The finding on age in our opinion could be a co-factor responsible for the outcome on the disparity in endurance capacity between the nulliparous and parous women in this study.

Moreover, weight, BMI, PBF and BFM of the parous women were significantly greater than that of the nulliparous women. The results suggested that the significant age and anthropometric difference between the nulliparous and parous women could contribute to the endurance differences between them. Ropponen et al. [58] reported that anthropometric factors appear to be of importance in low back muscle performance. Several anthropometric measures have been considered in relation to back endurance such as BMI, body weight, height, body fat and lean body mass [5,23,26, 46]. However, Gibbons et al. [23] opined 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. When the parous population were classified based on the number of parity, there was a significant difference in isometric endurance between them. Only age was significantly different among the parous women as the other anthropometric parameters were not significantly different. Previous investigators have reported that results of back extensors endurance test are attributable to an association between different factors such as physical activity [8,40,42] anthropometric measures [12,62] and genetic components [58]. 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 [35,37].

Lack of back extensor muscles' endurance has frequently been cited as a suspected factor in the aetiology of LBP [54] and it has also been associated with prolonged or recurrent back pain [29]. On the other hand, back pain in itself has been reported to precipitate decreased muscle endurance resulting from increased muscle metabolite from prolonged muscle tension and spasm [4], muscle deconditioning [59] and inhibition of the paraspinal muscles [59] in response to pain and decreased activity. However, studies on parity is inconclusive with some studies showing a link between parity and back pain [28,47,56] while findings of other studies disputed any relationship between parity and back pain in pregnancy [6,21]. Excessive straining during the expulsive phase of labour has been implicated as a possible cause of back pain [60]. The number of previous pregnancies has been reported to increase the risk of back pain [64]; this supported the earlier finding of Benson [7] who reported that backache occurs most frequently as a gynaecologic complaint during child bearing years, and is more common among women who have had several children.

From the outcome of this study we opined that decreased endurance of the back extensor muscles is a residual impairment precipitated by pregnancy and parturition among parous women. Decreased back muscles endurance secondary to pregnancy is much related with number of parity and it seems not to resolve like the other musculoskeletal changes in pregnancy. Also, decreased back muscle endurance among parous women may have resulted from possible influence of increased muscle metabolite from prolonged muscle tension and straining of child birth on the back muscles and may have been perpetuated by possible inhibition of the paraspinal muscles in response to pain. Further studies should investigate the reason for the difference in the endurance among nulliparous and parous women.

5. Clinical implications

Physical therapy has a widening role in the field of obstetrics and gynaecology which should include prenatal education on the importance of back muscles endurance and postpartum exercise program to retrain back muscles endurance. This may help reduce the effect of possible muscle inhibition of the back muscle which may lead to weakness of the back muscles and in turn precipitate LBP. This effort may help to decrease the risk of developing LBP among women.

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