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Comparison of abdominal muscle strength in post-parous and nil parous subjects

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Summary
This study investigated the relationship between parity and abdominal muscle strength using the Kraus-Weber test. Female volunteers (700) comprising 350 post-parous and 350 nil-parous subjects participated in the study. Physical characteristics of the subjects (age, body weight, height and ponderal index) were measured while the abdominal muscle strength was assessed using three of the six-item Kraus-Weber tests. Results were analysed using descriptive and inferential statistics. Independent t-test showed a significant difference in values of the abdominal muscle strength of the post-parous and nil-parous subjects ($P<0.05$). Pearson's correlation's matrix showed an inverse relationship between parity and scores on the Kraus-Weber test in the post-parous subjects. A significant difference was observed across the parity groups in age, Ponderal index and scores on the Kraus-Weber tests. It was concluded that the abdominal muscle strength of the post-parous subjects was low compared to nil-parous subjects. Due to the ease of application and its non-dependence on the use of sophisticated equipment, it was recommended that the Kraus-Weber test should be used for both subjective assessment and training of abdominal muscle strengths.

Keywords: *Parity, Abdominal Muscle Strength*

Résumé
Cette etude a investigué la relation entre la partie et la force des muscles abdominaux en utilisant le Kraus-Weber test. Sept-cents femmes volontiaires incluants 350 post-pare et 350 nuli-pare ont participés a l'etude. Les characeteristiques physique des sujets (age, prids, taille et l'indexe ponderate) avaient été mesures, alorsque que la force des muscles abdominaux avaient été evalues en utilisant les testes des six-choses de Krasn-Weber. Les resultats ont ete analyses en utilisant la statistique descriptive et differentielle. Le test-t independent a montré une difference significative dans les valeurs des forces des muscles abdominaux des sujets post-pare et muli-pare (P 0.05). La matrix de correlation de peason a montré une relation inverse entre la parite et les scores du test de Kraus-Weber chez les sujets post-pare. Une difference dignificative a ete observé à travers les groupes de parite egale, l'index ponderale et les scores dans les test de Kraus-Weber. II a ete conclut que la force des muscles abdominaux des sujets post-pare etaient faible compare a celle des nu-pares. Due à sa facilite a être applique et à sa non-dependance des equipments statistique, il à été recommende que le test de Kraus-Weber devrait etre utilise pour les evaluations subjectives et la formation pour l'evaluation de la force des muscles abdominaux.

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Introduction

Muscle strength can be defined as the capacity of a muscle to produce the tension necessary for maintaining posture, initiating movement or control of movement during the condition of loading on the musculoskeletal system [1,2]. Abdominal muscles are involved in various activities of the trunk most notable of which are the trunk flexion and rotation movements. The different segments of the abdominal musculature combine for various trunk movement rather than isolated muscle contractions and movements [3]. The upper abdominal muscle fibres are concerned mainly with trunk flexion movement while the lower abdominal segment muscles are concerned with stabilization of the pelvis when the legs are moved [4,5]. Abdominal muscle strength can be defined as the measure of the maximum intramuscular tensions that can be generated by the abdominal muscles against a resistance [6,7].

Parity is one of the several factors that can compromise the strength of the abdominal muscles. In order to accommodate the increasing size of the uterus, the abdominal muscles permit an enormous degree of stretching. This stretching of the skin and abdominal muscle is evident by the superficial stretch marks seen on the abdominal wall during pregnancy [4]. Evaluation of abdominal muscle strength has been used by various clinicians in identifying individuals with severe weakness and muscular imbalance. Knowledge of abdominal muscle strength is used to prevent abnormal posture and detecting individuals who are at risk of developing low back pain [8].

The Kraus-Weber strength test involves active flexion and extension of the trunk. The active range of trunk motion is said to be dependent on the abdominal muscle strength, among other factors [8]. The Kraus-Weber strength test as a form of manual muscle strength test is a 6-item test of the abdominal muscles and the trunk extensor muscles. Three of the 6 items of the test assess the abdominal muscles strength while the other 3 items test the strength of the trunk extensor [8]. The items for the abdominal muscle strength test various parts of the abdominal wall. These tests are quick, equipment-free clinical muscle strength tests which can serve as an assessment tool and can later be taught to train abdominal muscle strength to the patient. The aim of this study was to evaluate the possible relationship between parity and abdominal muscle strength using Kraus-Weber test.

Materials and methods

Subjects

Seven hundred healthy female volunteers between the ages of 18 and 35 years participated in this study. A total of 350 volunteer 6 weeks post-natal patients attending the post-natal clinic of Adeoyo Maternity Hospital, Ibadan, Nigeria, served as the post-parous (experimental) subjects. The control subjects were nil-parous volunteer female undergraduate clinical students of the University

College of Ibadan Hospital, (UCH), Ibadan, Nigeria. Informed consent of the post-parous and nil-parous subjects were sought and obtained while the professional consent of the obstetricians in charge of the post-natal patients was also sought and obtained.

Materials

The materials used in this study included:

- A firm, sturdy plinth for the Kraus-Weber test
- A researcher-administered questionnaire was used to obtain relevant history from the subjects with respect to pregnancy, childbirth, mode and number of previous deliveries and child spacing, history of low back pain, vocation and other relevant history. (Only information on the number of deliveries was utilized in statistical analysis in this report).
- A non-elastic tape measure was used to measure the distance through which the subject could lift the leg off the plinth.
- A stop-watch for timing exercise performance during the exercise test.
- A height and weighing scale to measure the height and weight in meters and kilograms, respectively.

Procedure

The procedure of the exercise tests was adequately explained to the subjects. A structured interview was conducted by the researcher to obtain relevant history from the subjects with respect to pregnancy, childbirth and mode of past deliveries. Age was recorded in years to the nearest whole number for consistence. Height was measured and recorded in meters using a height meter while weight of subjects was obtained using a Hanson model (England) portable weighing scale. For height measurement, the subject stood erect, bare-footed with heels placed against the height meter placed vertically on the wall. The distance between the vertex of the head and the sole of the feet was recorded as the subject's height. Body weight was measured with the subject standing erect on the weighing scale, barefooted and with minimal clothing. Ponderal index was calculated from obtained height and weight measurements. The abdominal muscle strength tests were carried out using 3 of the six-item Kraus-Weber test as follows:

Test 1 (T_1): This was to test the strength of the abdominal and psoas muscle.

Position of subjects: The subjects was in supine position with the hands behind the neck, the knees fully extended. The researcher held the feet of the subject firmly on the plinth while the subject was instructed to curl up into sitting position, clasping the hands behind the neck. Stiff back sit-up was discouraged [8].

Grading: If the subject could not raise the shoulder from the plinth, the score was zero. If the subject could reach sitting position unaided the score was 10. If the subject was given some assistance halfway to the sitting position, the score was 5.

Test 2 (T_2): This was a test of strength of the upper abdominal muscle.

Position of subjects: The subjects was in supine-position with the clasped hands behind the neck the hips and knees in flexed position with the sole of the feet on the plinth. The subject's feet were held down on the plinth while she was instructed to roll up into sitting. She was prevented from making stiff back, sit-up and also disallowed from using the elbows to assist sit-up.

Grading: Grading was done as in Test 1 above

Test 3 (T3) : This test was for lower abdominal muscles (Ilio-psoas)

Position of subjects: The subject was in supine-position with hands clasped at the back of the neck and legs extended at hips and knee. The subject was instructed to raise the two legs at the same time off the plinth to a height of 10 inches. Arching of the back by the subject while carrying out this test was disallowed.

Grading: If the subjects could hold the legs in position for ten seconds, the score was 10. The time in seconds for which subject could maintain the straight leg raising (not more than ten seconds) was assigned as grade to the subject, if the subject could not raise the legs to a height of 10 inches or if she could not hold the raised leg, the score was zero.

Treatment of data

Mean and standard deviation were calculated on all the measured parameters. The independent t-test was used to compare the age, height, weight, Ponderal index and abdominal test of the post-parous and nil-parous subjects. The relationship between parity, Ponderal index, weight of subjects and abdominal muscles strength was obtained using the Pearson's matrix. Analysis of variance was carried out to compare the Kraus-Weber test scores of the post-parous subjects across the parity group to see the effect of number of pregnancies on abdominal strength. Also Duncan's post hoc analysis was done across paired groups to see which of the paired groups had actual significant difference for age, T_1, T_2 and Ponderal index.

Results

Seven hundred (350 post-parous and 350 nil-parous) subjects participated in this study. Their ages ranged between 18 and 35 years. The physical characteristics of the subjects are shown in Table 1.

Table 1: Subjects' Physical and Anthropometric Parameters.

	Post-Parous (n = 350) X ± S.D.	Nil-Parous (n – 350) X ± S.D.	Calcu Lated	*P* - level
Age (yrs)	24.93 ± 4.18	22.91 ± 1.98	8.168	*P* < 0.05
Weight (kg)	54.64 ± 7.17	54.07 ± 0.56	1.168	*P* > 0.05
Height (m)	1.57 ± 0.05	1.58 ± 0.06	1.59	*P* > 0 05
Ponderal Index (W/H^3)	258.03 ± 38.54	256.19 ± 30.55	0.698	*P* > 0.05

The mean age of the post-parous subjects was significantly higher than that of the nil-parous *($P<0.05$)*. There was no significant difference in the weight, height and Ponderal index of the post-parous and nil-parous subjects *($P > 0.05$)*. The abdominal muscle strength tests

T_1 and T_2 were significantly lower in the post-parous group compared to the nil-parous subjects ($P < 0.05$) while no significant difference was seen in the abdominal test T_3 for the two groups ($P > 0.05$) as shown in Table 2.

Table 2: Subjects' performance on Kraus-Weber test.

	Post-Parous (n = 350) X ± S.D.	Nil-Parous (n = 350) X ± S.D.	Calculated t	*P* – Level
T_1	7.46 ± 4.31	9.81 ± 1.33	9.77	$P < 0.05$
T_2	4.27 ± 4.77	9.11 ± 2.79	16.39	$P < 0.05$
T_3	9.84 ± 1.16	9.90 ± 0.96	0.71	$P > 0.05$

The relationship between parity, weight, Ponderal index and Kraus-Weber abdominal tests are shown in table 3. There was positive but low correlation between parity, weight and Ponderal index while negative and low correlation was seen between parity and abdominal muscle strength tests in the parous subjects as shown in Table 3. Table 4 shows the age, Ponderal index and the Kraus-Weber abdominal strength test across the 7 parity group.

Table 3: Correlation between parity and each of weight, ponderal index and abdominal strength tests.

Variables	Correlation Coefficient (r)	z-Coeff	*P* - level
Weight	0.169	0.169	$P < 0.05$
Ponderal index (P.I)	0.167	0.167	$P < 0.05$
Abdominal test (T_1)	-0.359	0.33	$P < 0.05$
Abdominal test (T_2)	-0.326	0.34	$P < 0.05$
Abdominal test (T_3)	-0.087	0.087	$P > 0.05$

Table 4: Analysis of variance between anthropometric variables and scores on Kraus-Weber tests across parity groups.

		P_0 (n = 350)	P_1 (n = 169)	P_2 (n = 81)	P_3 (n = 50)	P_4 (n = 1)	P_5 (n = 14)	P_6 (n = 5)	Calculated F-Ratio	*P*-Level
Age	X	22.91	22.22	25.68	27.50	30.10	31.43	28.60	100.49	$P < 0.05$
	S.D.	1.98	2.69	2.89	2.96	3.71	3.96	4.10		
Ponderal	X	256.19	251.35	259.16	268.77	268.22	274.02	250.06	2.96	$P < 0.05$
index	S.D.	30.55	31.76	40.59	42.98	51.21	34.35	55.35		
Abdominal	X	9.81	9.05	6.54	6.00	5.65	4.29	3.00	36.01	$P < 0.05$
test (T_1)	S.D.	1.32	2.94	4.72	4.95	4.96	4.75	4.47		
Abdominal	X	9.11	6.30	2.25	2.30	3.06	1.43	2.00	64.14	$P < 0.05$
test (T_2)	S.D.	22.79	4.70	3.96	3.94	4.41	3.63	4.47		
Abdominal	X	9.90	9.94	10.00	9.20	40.00	9.64	10.00		$P < 0.05$
test (T_3)	S.D.	0.96	7.69	0.00	2.55	0.00	1.34	0.00		

Age, Ponderal index and abdominal muscle test T_1 and T_2 showed significant difference across the 7 parity groups ($P < 0.05$) while the abdominal tests T_3 did not show any significant difference ($P>0.05$) Duncan's post hoc analysis done across paired groups for age, Ponderal index (Table 5) and T_1 and T_2 is as shown in Table 6.

Table 5: Duncan Post-HOC analysis of age and Ponderal index across groups.

Parity Pair	Age Group range	Age Actual Difference	Ponderal index Group range	Ponderal index Actual Difference
P_0 & P_1	0.697	0.690	9.556	4.845
P_0 & P_2	0.733	2.770	10.061	2.968
P_0 & P_3	0.758	4.591	11.400	12.581*
P_0 & P_4	0.776	7.156	10.649	12.027*
P_0 & P_5	0.791	8.520	10.847	17.825*
P_0 & P_6	0.802	5.691	11.007	6.129
P_1 & P_2	0.697	3.460	9.556	7.813
P_1 & P_3	0.733	5.291	10.061	17.426*
P_1 & P_4	0.758	7.846	10.400	16.872*
P_1 & P_5	0.776	9.210	10.649	22.670*
P_1 & P_6	0.791	6.381	11.847	1.284
P_2 & P_3	0.697	1.821	9.556	9.613*
P_2 & P_4	0.733	4.386	10.06	9.059
P_2 & P_5	0.758	5.750	10.400	14.857*
P_2 & P_6	0.976	2.921	10.649	9.097
P_3 & P_4	0.697	2.565	9.556	0.554
P_3 & P_5	0.733	3.929	10.061	5.244
P_3 & P_6	0.758	1.100	10.400	18.710*
P_4 & P_5	0.697	1.364	9.556	5.798
P_4 & P_6	0.733	1.465	10.061	18.156*
P_5 & P_6	0.697	2.829	9.556	23.954*

**Indicates significant actual differences in groups*

Table 6: Duncans post-hoc analysis for abdominal tests T_1 and T_2 (across the group)

Parity Pair	Test T_1 Group Range	Test T_1 Actual Difference	Test T_2 Group Range	Test T_2 Actual Difference
P_0 & P_1	0.826	0.761	1.015	2.812*
P_0 & P_2	0.870	3.291*	1.069	6.768*
P_0 & P_3	0.899	1.814*	1.104	6.814*
P_0 & P_4	0.921	4.169*	1.131	6.049*
P_0 & P_5	0.938	0.761	1.152	7.685*
P_0 & P_6	0.951	6.814*	1.169	7.114*
P_1 & P_2	0.826	2.510*	1.015	3.965*
P_1 & P_3	0.870	3.053*	1.069	4.002*
P_1 & P_4	0.899	3.408*	1.104	3.237*
P_1 & P_5	0.921	4.767*	1.131	4.873*
P_1 & P_6	0.938	6.053*	1.152	4.302
P_2 & P_3	0.826	0.543	1.015	0.046
P_2 & P_4	0.870	0.898*	1.069	0.719
P_2 & P_5	0.899	2.257*	1.104	0.917
P_2 & P_6	0.921	3.543	1.310	0.346
P_3 & P_4	0.826	0.355	1.015	0.765
P_3 & P_5	0.870	1.714*	1.069	0.871
P_3 & P_6	0.899	3.000*	1.104	0.300
P_4 & P_5	0.826	1.359	1.015	1.816*
P_4 & P_6	0.870	2.645*	1.069	1.065
P_5 & P_6	0.826	1.286*	1.015	0.751

* *Indicates significant actual difference in groups*

Discussion

Statistical analysis revealed that the post-parous subjects were older than the nil-parous subjects. The difference in age could be attributed to the fact that the nil-parous subjects in this study were undergraduate clinical and nursing students who were single. The age difference can also be a reflection of the childbearing age in this study environment.

The post-parous and nil-parous subjects were however matched in weight, height and Ponderal index. This implies that parity did not significantly affect the weight of the subjects. This is in contrast to expectations as women are known to become fatter after child bearing. The comparable height of the subjects irrespective of parity status implies that parity does not affect the height of the female subjects. The age difference is a serious limitation of this study because it would have been ideal for the subjects in the two groups to be age matched.

The nil-parous subjects performed better in the Kraus-Weber upper abdominal muscle strength test than the post-parous subjects. This is an indication of weaker abdominal muscles in the parous subjects. During pregnancy, the abdominal muscle fibres stretch and lengthen and may return to near pre-pregnancy level after delivery. Repeated lengthening and recoil of abdominal muscles during and post-pregnancy, respectively, can result in weakened abdominal muscles. This agrees with the observation of previous studies [4,9] that there is reduced intramuscular tension generated by the abdominal muscle due to laxity of the muscle post-pregnancy.

Whereas age is a factor that determines man's ability to exhibit strength, the non-significant difference in T_3 for the two groups in spite of the significant difference in their age shows that age cannot be considered as a contributory factor to the significantly lower muscle strength score in T_1 and T_3 for the post-parous subjects.

The Pearson's correlation matrix showed a low, but positive relationship between parity and each of body weight and Ponderal index. This implies that adiposity level and total body weight increased significantly as number of pregnancies increased. A significant increase in Ponderal index and decrease in abdominal muscle strength as number of parity increased indicated that the subject's adiposity level increased as parity increased while abdominal muscles are weakened further by subsequent pregnancies. This is confirmed by negative but significant correlation between parity and T_1 and T_2.

The lower abdominal muscle strength (T_3) did not show any significant difference between the post-parous and nil-parous subjects. This can be attributed to the function of lower abdominal muscles as stabilizers of the hip and pelvis during bilateral straight leg raising [10]. This implies that pregnancy has little effect on the strength of the lower abdominal muscles by their anatomical location and functions.

Conclusion

Based on the findings of this study, it was concluded that parity significantly reduced the strength of the upper abdominal muscles of the post-natal subject. Parity did not significantly affect Ponderal index of the post-natal subjects when compared with the nil-parous subjects. However, as parity increased in the post-natal subjects, Ponderal index also increased.

Recommendation

Based on the findings of this study, it is recommended that routine exercise therapy programme be administered by the physiotherapist to pre-and post-natal women in order to maintain and restore the integrity of their abdominal muscles, respectively. The Kraus-Weber abdominal strength test could be used to assess abdominal muscle strength clinically because of ease of administration and its ready clinical affordability as it is an equipment-free test. The test items could also be used to train abdominal muscle strength in patients with weak abdominal muscles.

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