ABDOMINAL MUSCLE STRENGTH AND SOME RESPIRATORY FUNCTION INDICES IN SUBJECTS OF VARYING PARITY STATUS

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SUMMARY

This clinical evaluation study was carried out to compare the strength of abdominal muscles and some respiratory function indices in volunteer women of childbearing age.

The population for this study comprised: volunteer female staff of the University College Hospital (UCH) Ibadan; female students of the College of Medicine, University of Ibadan and post-natal patients of UCH, Ibadan, Nigeria. One hundred women of childbearing age volunteered to participate in the study; they comprised 50 post-parous and 50 nulliparous subjects who were recruited as they became available. Data were collected over a period of 8 weeks. The vital capacity (VC), peak expiratory flow rate (PEFR) and strength of the abdominal muscles were measured. The data were analyzed using descriptive statistics of mean, standard deviation and inferential statistics of t-test at 0.05 alpha level of significance.

The results showed that while PEFR and abdominal muscle strength were significantly higher in the nulliparous group ($p < 0.05$), vital capacity, a ventilatory parameter, was not significantly different in the two groups. The study concluded that the significantly lower abdominal muscle strength and PEFR in the post-parous subjects can be attributed to restrictive anatomical features of the rib cage.

The study therefore recommended that there is a need for obstetricians in charge of ante and post-natal women to refer them for physiotherapy for abdominal muscle strengthening programmes. This will strengthen their abdominal muscles and promote respiratory efficiency.

Key words: parity, respiratory function indices, abdominal muscle strength

INTRODUCTION

The diaphragm is man's main respiratory muscle.[1, 2] The motion of the rib cage can almost be completely attributed either to the direct action of the diaphragm through its insertion at the lower ribs or its indirect action on the reduction of intra-thoracic pressure through the abdominal musculature.[3] There have been many studies on the role of the abdominal muscles in both quiet and forceful breathing.[2, 4, 5] It is believed that when the ventilatory capacity of the lungs are compromised, the respiratory functions are affected, and the individual would utilize the abdominal muscles to effect forced expiration, thus giving room for improved inspiration action. It is also believed that the abdominal muscles could be strengthened in order to assist the ventilatory process, especially in patients with obstructive respiratory disorders, and that the strength of the abdominal muscles can assist prolonged and forced expiration.[5]

Pregnancy and post-natal muscle weakness as well as frequent successive pregnancies have been implicated as factors that could compromise abdominal muscle strength.[6] It is known that after the

20th week of pregnancy, the anterior abdominal wall enlarges by stretching.[7] The stretch is obvious in both the upper and lower abdominal walls. A continuous stretch of this nature on muscle fibres puts them at a physiological disadvantage with respect to muscle strength. This is because the continuous stretch causes the muscles to become less elastic and to sag.[8]

The aims of this study were to find out the effect of parity on abdominal muscle strength in selected women of childbearing age and to find out the effect of abdominal muscle strength on each vital capacity (VC) and peak expiratory flow rate (PEFR) in the selected women.

MATERIALS AND METHODS

Subjects

The populations for this study were volunteers from the female staff of the University College Hospital (UCH), Ibadan, Nigeria; female students of the College of Medicine, University of Ibadan; and post-natal patients of the UCH Ibadan.

A total of 100 non-smoking female volunteers between the ages of 18 and 40 years took part in the study. Subjects were apparently healthy and reported no history of acute or chronic respiratory disorders at the time of the study.

The subjects were assigned into two main groups - the nulliparous group and the post-parous group (post-natal subjects); each group had 50 subjects. The 50 post-natal subjects who participated in this study were patients who came for the six weeks post-natal check-up at the outpatient post-natal clinic of UCH Ibadan. They had completed their post-natal routine and were adjudged free of post-natal complications by their obstetricians. Data were collected over a period of 8 weeks. The consent of the subjects in both groups was sought and obtained before participation in the study.

METHODS

The subjects in each group were appropriately instructed about the aims and procedures of the tests. The height of each subject was measured in centimeters to the nearest one decimal point using a height meter. The subject stood erect, barefooted, with heels against the height meter placed vertically against a wall; subject's height was the distance between the vertex of the head and the side of the heel. Body weight was measured with the subject standing barefoot on the weighing scale and wearing minimal clothing. Weight was recorded in kilogrammes to the nearest decimal place. The following respiratory function measurements were taken before the abdominal strength was assessed.

Peak Expiratory Flow Rate (PEFR). The subject assumed a normal sitting position. The mouthpiece on the peak flow meter was placed in the subject's mouth and held tightly by her lips. She was instructed to inhale as deeply as possible and then exhale as rapidly and forcefully as possible into the mouthpiece. The reading on the peak flow meter was recorded in litres per minutes. Values were recorded from three attempts, the best of the three values was used in the statistical computation of data.

Vital Capacity. The subject was in a normal sitting position. The mouthpiece, fitted to the pocket spirometer was placed in the subject's mouth and held firmly by her lips. The subject was instructed to inhale as deeply as possible and then to exhale fully into the spirometer. The procedure was performed three times and the best reading (recorded in litres) was used for statistical analysis.

Abdominal Muscle Strength

According to Nobel, the abdominal musculature can be divided into two main regions - upper and lower abdominal muscles. The abdominal musculature was assessed separately for the upper and lower abdominal region using exercise tests[9, 10] as follows:

Upper Abdominal Muscle Strength (UAMS)

The subject assumed a supine position on a firm plinth, with the extended legs stabilized at the knees and ankles by the investigator. The subject was instructed to flex the trunk with the scapular cleared from the plinth and with the hands on the thigh. If the subject was able to do this, she was given a grade 3 score. A higher test was performed (grade 4) until the maximum possible grade (grade 5) which the subject could reach was obtained. For grade 4, the subject flexed the trunk with scapular clearance and hands folded across the chest. For grade 5, the subject flexed the trunk with scapular clearance and hands behind neck. For subjects who were not able to pass the initial test they were tested for lower grades (grade 1 and 2) and the best possible lower grade was recorded. For grade 1, with hands still on the thigh, the subject tried to flex the cervical spine with head clearance, if however the tip of the shoulder and the cranial tip of the scapular are off the plinth, the grade is 2. For grade 0, the subject was unable to flex the cervical spine and raise the head from the plinth. At the highest grade attained by a subject she was instructed to hold the position for as long as possible and was scored 1/10 unit for every second she was able to maintain the position in addition to the grade scored initially. A score of 3.4 meant that the subject had grade 3 and maintained the grade for four seconds before fatigue set in. The timing for maintaining the highest possible grade was stopped immediately the subject changed position no matter how small the change was, provided it was observable. The final value obtained was recorded as a measure for upper abdominal muscle strength.

Lower Abdominal Muscle Strength (LAMS)

The exercise test started with the subject in supine position, with the head and shoulders supported and stabilized. The subject was instructed to raise both legs as high as possible without bending the knees (bilateral straight leg raising) and without raising the head and the shoulders off the plinth. If the subject could raise the leg to 90° of hip flexion, she was instructed to flex the hip to 50° and hold this position for as long as possible. Subjects who could not maintain the bilateral straight leg raising position at 50° were told to hold any position attainable for as long as possible. The range of motion attained was measured and this served as the criterion for grading. The possible grades ranged from 0 to 10. One point was given to every 10° of flexion attainable by the subject up to a maximum of 5 points for 50° hip flexion. No point was given for 0° hip flexion. Time measurement was also incorporated and was scored to the maximum possible grade obtained, such that a 3.4 score meant grade 3 held for 4 seconds. The lower abdominal wall was palpated during the test to affirm that the muscles were contracting.

The values obtained from the upper and lower abdominal muscle tests were summed up for each subject to get the overall score for total abdominal muscle strength (TAMS).

DATA ANALYSIS

Descriptive statistics of mean and standard deviation were calculated for upper, lower and total abdominal muscle strength as well as peak expiratory flow rate and vital capacity of the post-parous and nulliparous groups.

The independent t-test was used for equal sample size at 0.05 level of significance to determine if there was any significant difference between the abdominal muscle strength, vital capacity and peak expiratory flow rate of the two groups.

RESULTS

One hundred female subjects, from 18 to 40 years, with a mean age of 25.17±5.35 years took part in the study. Their mean age, weight and height are as shown in table 1. Results of the statistical analysis on abdominal muscle strength and respiratory function indices (PEFR and VC) for the subjects are shown in table 2. The t-test analysis showed significantly higher ($P<0.05$) abdominal muscle strength for subjects in the nulliparous group compared to the post-parous group. The nulliparous subjects had significantly higher ($P<0.05$) peak expiratory flow rates than the post-parous group (table 2). However the t-test did not show any significant difference ($P>0.05$) in the vital capacity of the two groups.

Table 1. Physical Characteristics of Subjects

Study Group	Age(yrs)	Height(m)	Weight (kg)
Nulliparous group (n=50)	21.16±2.02	1.63±2.05	52.96±7.38
Post-parous group (n=50)	29.118±4.57	1.59±0.06	57.95±8.50
Total subjects (n=100)	25.17±5.35	1.61±0.06	55.46±8.31
t-value (post VS nulliparous)	11.35	3.89	3.13
p-level	p<0.05	p<0.05	p<0.05

Table 2. Mean of Vital Capacity, Peak Expiratory Flow Rate and Abdominal Muscle Strength

Subject Group	Vital Capacity (liters)	Peak Flow Rate (Liters/Min)	Upper Abdominal Strength	Lower Abdominal Strength	Total Abdominal Strength
Post-parous (n=50)	2.49±0.31	274.6±48.41	4.54±0.69	4.89±0.68	9.41±1.21
Nulliparous (n=50)	2.46±0.05	375.2±71.77	5.34±0.14	5.34±0.32	10.85±0.22
t-value	0.26	6.75	7.45	5.93	8.98
p-level	>0.05	<0.05	<0.05	<0.05	<0.05

Table 3. Correlation between Abdominal Muscle Strength and Number of Pregnancies, Child Spacing, Vital Capacity and Peak Exploratory Flow Rate in the Post-parous Subject

	r	Z-coefficient	p-Level
Number of pregnancies	-0.171	0.171	$p>0.05$
Child spacing	-0.031	0.03	$p>0.05$
VC	-0.041	0.04	$p>0.05$
PEFR	-0.031	0.03	$p>0.05$
Abdominal muscle strength	0.041	0.04	$p>0.05$

At df = 98 and p = 0.05 Critical Value of r=0.194

Key
VC= Vital capacity
PEFR= Peak expiratory flow rate

DISCUSSION

In this study, the post-parous subjects had a higher mean age and weight than the nulliparous subjects. The difference in the mean age of the two groups could be due to the population from which the nulliparous sample was taken, they were university undergraduates who were unmarried and younger, compared to the ante-natal group who were older and married. Women have been observed to gain weight during pregnancy and after and the fact that the post-parous subjects in this study weighed more than the nulliparous subjects may be associated with childbearing weight gain.

Statistical analysis showed that the peak expiratory flow rate and total abdominal muscle strength of the nulliparous subjects were significantly higher than those of the post-parous subjects. This observed difference may be attributed to the effect of pregnancy on the abdominal muscles and the attendant post-natal weakness of these muscles.[6] The higher the intra-abdominal pressure the more forcefully air comes out of the lung cavity. Intra-abdominal pressure is aided by strong abdominal muscles. Overstretching of the muscles of the abdominal wall during pregnancy and relaxation of these muscles after childbirth weakens them.[5] This may account for the greater abdominal muscle strength seen in the nulliparous subjects. The progressive weakness of these muscles in the multi-parous subjects could also be a contributory factor to the breathlessness on little exertion experienced in the childbearing subjects.

The vital capacity of the post-parous and nulliparous subjects was not significantly different. Vital capacity is a ventilatory parameter which may be affected by restrictive anatomical features of the rib cage or the respiratory system. Post-partum anatomical status does not impose any restrictive effect on the respiratory system. This may explain the non-significant difference in the vital capacity of the two groups.

CONCLUSION

This study has shown that parity status affects the strength of the abdominal muscles of females. Also affected is the peak expiratory flow rate which is a forced expiratory index. The PEFR is affected by intra-abdominal pressure which is aided by strong abdominal muscles. The ventilatory parameter (vital capacity) is shown to be unaffected by the parity status of females as observed in this study.

A strengthening exercise programme will enable women to regain the pre-pregnant state of their abdominal muscles. This would in turn improve the peak expiratory flow rate and other forced expiratory indices of the post-natal programme.

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