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ORIGINAL RESEARCH

Is there any change in the function of the pelvic floor and abdominal muscles of primigravidae in the second and third trimester of pregnancy?

Existe alteração na função dos músculos do assoalho pélvico e abdominais de primigestas no segundo e terceiro trimestre gestacional?

¿Hay alteraciones en la función de los músculos de la pelvis y del abdomen en el segundo y tercer trimestre de embarazo en primíparas?

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ABSTRACT | The purpose was to compare the function of the pelvic floor muscles in the second and third trimester of pregnancy of primigravidae. The study was carried out in two Family Health Units of the municipality of Aracaju, state of Sergipe, Brazil. Pregnant women have undergone three evaluations of the function of the pelvic floor muscles, through surface electromyography: until 16 weeks of pregnancy, between the 24th-28th and 34th-36th week of pregnancy. We recorded resting values, maximum voluntary contractions and sustained contractions. Data was tabulated in Excel and analyzed statistically in the *Statistica* program. A 5% significance level ($p \leq 0.05$) was adopted. Nineteen primigravidae participated in this study, with an average age of 21.74 ± 3.65 years. There was an increase in body mass in the third trimester of pregnancy compared with the pre-pregnancy period, decrease in the average of the pelvic floor muscle signal during rest, along the three assessments and, in relation to the abdominal muscles, there was a decrease in the average signal at rest and during the sustained contraction in assessments 2 and 3 when compared with assessment 1. We concluded that other factors, besides those related to increased maternal body mass, may be associated with overload on PFMs during pregnancy in the first trimester. This overload can cause pregnant women to have muscle tone near the upper reference limit, thus changing the pattern of electromyographic activity, especially at rest, to maintain its support function of the continence and pelvic organs.

Keywords | Pregnancy; Pelvic Floor; Electromyography/methods.

RESUMO | O objetivo deste estudo é comparar a função dos músculos do assoalho pélvico no segundo e terceiro trimestre gestacional de primigestas. Foi desenvolvido em duas unidades de Saúde da Família do município de Aracaju (SE). As gestantes foram submetidas a três avaliações da função dos músculos do assoalho pélvico por meio da eletromiografia de superfície: até 16 semanas gestacionais, entre a 24ª-28ª e 34ª-36ª semanas gestacionais. Foram registrados valores de repouso, contrações voluntárias máximas e contrações sustentadas. Os dados foram tabulados no Microsoft Excel e analisados estatisticamente no programa *Statistica*. Adotou-se um nível de significância de 5% ($p \leq 0,05$). Participaram do estudo 19 primigestas, com média de idade de 21,74±3,65 anos. Houve aumento da massa corporal no 3º trimestre gestacional em relação ao período pré-gestacional e diminuição da média do sinal dos músculos do assoalho pélvico durante o repouso ao longo das três avaliações. A musculatura abdominal diminuiu a média do sinal no repouso e durante a contração sustentada nas avaliações 2 e 3 comparadas à avaliação 1. Pode-se concluir que outros fatores, além dos relacionados ao aumento da massa corporal materna, podem estar associados à sobrecarga nos MAP durante a gestação logo no primeiro trimestre. Essa sobrecarga pode fazer que as gestantes apresentem um tônus muscular próximo

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ao limite superior de referência, alterando o padrão de atividade eletromiográfica principalmente no repouso, a fim de manter a função de sustentação dos órgãos pélvicos e de continência.
Descritores | Gravidez; Diafragma da Pelve; Eletromiografia/Métodos.

RESUMEN | Este estudio compara la función de los músculos del suelo pélvico en el segundo y tercer trimestre de embarazo en primíparas. Se ha llevado a cabo en dos unidades de salud de la familia en la municipalidad de Aracaju (SE, Brasil). Las embarazadas fueron sometidas a tres evaluaciones de la función del músculo del suelo pélvico, a través de la electromiografía de superficie: hasta 16 semanas de embarazo, entre la 24ª-28ª y la 34ª-36ª semana. Se observaron valores de reposo, contracciones voluntarias máximas y contracciones sostenidas. Se analizaron los datos estadísticamente en el programa Statistica de Excel, empleando un nivel de significancia de 5% (p≤0,05). Participaron 19 primíparas, con promedio de edad de 21,74±3,65 años. Los resultados mostraron un aumento de la masa corpórea en el tercer trimestre de embarazo comparado al período antes del embarazo, disminución de la media del signo de los músculos del suelo pélvico durante el reposo al largo de las tres evaluaciones, y en cuanto al músculo abdominal disminuyó la media del signo en reposo y durante la contracción sostenida en las evaluaciones 2 y 3 al compararla con la 1. Se concluye que otros factores, además de los relacionados con el aumento de la masa corpórea materna, pueden asociarse con la sobrecarga en los MAP durante el embarazo, tan pronto en el primer trimestre. Esta sobrecarga le implica a la embarazada un tono muscular cerca al límite de referencia, lo que le altera el estándar de actividad electromiográfica, en especial en el reposo, para mantener sostenible los órganos pélvicos y de continencia.
Palabras clave | Embarazo; Diafragma Pélvico; Electromiografía/métodos.

INTRODUCTION

During pregnancy, the maternal body mass and gravid uterus increments increase the pressure on the pelvic floor muscles (PFM). In addition, hormonal changes, occurred mainly from the second trimester of pregnancy, may cause changes in the connective tissues, influencing the support and continence mechanism[1].

As a result of these changes, there may be a reduction in support of the bladder neck and proximal urethra, predisposing pelvic floor (PF) dysfunctions[2,3], which may become more prevalent as the pregnancy progresses and are associated with the pressure exerted by the fetal head on the bladder[4,5].

O'Boyle et al.[6] observed a significant increase in urethral mobility in primigravidae, suggesting that physiological changes occur in the pelvic floor (PF) during pregnancy. However, little is known about the changes that occur in the pattern of electromyographic activity of PFMs during pregnancy, and there are no studies in the literature comparing the pattern of electromyographic activity between the different gestational trimesters of primigravidae. This information is extremely important for the clinical practice of physical therapists, allowing the adoption of strategic behaviors for the prevention of these changes during the prenatal period, such as the practice of exercises for strengthening PFMs and guidelines regarding the signs and symptoms of possible PF dysfunctions.

Therefore, the purpose of this study was to compare the function of PFMs in the second and third trimester of primigravidae.

METHODOLOGY

This is a cross-sectional observational study conducted from July/2012 to October/2013. The study was approved by the Ethics in Human Research Committee at the Federal University of Sergipe, in compliance with Resolution 466/12 of the National Council of Health, according to opinion 76308-2012 (CAAE: 06190112.9.0000.5546).

The sample calculation was carried out using the G*Power 3.1.3 program. The values found in the study of Batista et al.[7] and Botelho et al.[8] for the electromyographic activity of PFMs in pregnant women were used as the parameter. For a test power of 0.90 and alpha error of 5%, a sample of 12 pregnant women was suggested. In this way, considering a possible sample loss of 40%, 20 primigravidae who were in the second trimester were selected.

The study was conducted in two Family Health Units of the municipality of Aracaju, state of Sergipe, Brazil.

For this, contact was established with the City's Health Department, and Family Health Units serving pregnant women were selected. During the prenatal consultation, the pregnant woman was invited to participate in the study by the responsible researcher. Being aware of the study and voluntarily agreeing to participate, the first assessment was scheduled.

Primigravidae aged between 18 and 40 years, pre-pregnancy body mass index (BMI) considered normal, based on the definition of the World Health Organization (WHO)[9], gestational age up to 16 weeks, normal risk pregnancy and single fetus and who were in prenatal care, were included in the study. The study exclusion criteria were: risk of miscarriage, uterine bleeding, urinary tract infection and/or inflammation, cognitive impairment that would prevent the understanding of the study, illicit drug use, smoking and alcoholism.

Pregnant women were subjected to assessments of the function of PFMs, through EMG, in three periods: up to 16 weeks of pregnancy, between the 24th-28th and 34th-36th week of pregnancy, according to the date of the last period[10] and/or the first ultrasound performed during pregnancy[11].The BMI was assessed in three stages based on the Atalah Table[12].

For assessing the function of PFMs, we used the surface electromyography system called MyoTrac Infinit™, with the following specifications: conversion of the original signal into the root mean square (RMS) value, band pass filter of 20-500 Hz, common-mode rejection ratio (CMRR) > 130 dB and active electrode impedance of 1012 GΩ. Data were normalized by the maximum peak value among the three maximal voluntary contractions performed[13,14]. This device records the sum of the electrical potentials generated by the depolarization of muscle fibers at rest and during voluntary contraction, of which its amplitude is recorded in microvolts (μV). It is the most accurate method for measuring the integrity for neuromuscular electromyography, and can be regarded as an indirect measure of muscle strength and the level of pressure of PFMs when performing their contraction[15,16].

Pregnant women were positioned in supine position with hip and knee flexed, and feet on the stretcher. Then, the examiner introduced a vaginal sensor (model AS 9572, brand Thought Technology Ltd.®, with stainless steel capture surface measuring 27 mm in diameter and 69 mm in length), lubricated with a water soluble gel spoon in the vaginal opening. Two reference electrodes were placed in the right anterior superior iliac crest and in the right lateral malleolus. In addition, self-adhesive electrodes were placed in the rectus abdominis for simultaneous measurements of the activity of PFMs and abdominal muscles.

Initially, the volunteer was told to remain at rest for 15 seconds for recording the basal activity. After that, three maximum voluntary contractions (MVC), maintained by two seconds, with an interval of one minute between each, and three sustained contractions, maintained by six seconds, with an interval of one minute between each were recorded[17].

At each requested contraction, we observed the volunteer's abdomen and PFMs, to identify the completion of the Valsalva maneuver and/or simultaneous contraction of the adductor muscles of the hip and buttocks, instead of the isolated contraction of PFMs. When there was the contraction of accessory muscles, the contraction of PFMs was not recorded.

Data were tabulated in Excel and statistically analyzed in the *Statistica* program and through descriptive techniques (tables). Data were analyzed by means of nonparametric tests, after checking that some variables do not follow a normal distribution, through the Shapiro-Wilk test. The comparison among the three assessments was performed by the *Friedman* test and, in relevant cases, we used the Wilcoxon test with Bonferroni adjustment to identify the difference. A 5% significance level ($p \leq 0.05$) was adopted. Data are expressed as median ± interquartile deviation.

RESULTS

Nineteen primigravidae, with a median age of 20 years (18 to 30 years), participated in this study. Table 1 shows the anthropometric characteristics and the average gestational age in each assessment. There was a significant increase in body weight and BMI in the third trimester of pregnancy compared to pre-pregnancy period. In the three assessments, 31.6% of pregnant women (n=6) had BMI values above the limit considered appropriate for the gestational age.

Table 2 shows a significant decrease in the average of the PFM signal during rest, along the three assessments. As for the abdominal muscles, we found a significant decrease in the average signal at rest and during the sustained contraction in the assessments 2 and 3, when compared with the assessment 1.

Table 1. Anthropometric characteristics of primigravidae

Characteristics	Pre-pregnancy	Assessment 1	Assessment 2	Assessment 3	p-value
Gestational age (weeks)	-	16±2	25±2	35±2	-
Body mass (kg)	59±14	59±15.5[a]	63±15[a,b]	68±12[a,b,c]	<0.001
IMC (kg/m²)	23.3±14	24±15.6[a]	25.5±16.4[a,b]	27±19.5[a,b,c]	<0.001

[a]significant in relation to the pre-pregnancy period; [b]significant in relation to the assessment 1; [c]significant in relation to the assessment 2

Table 2. Functional assessment of PFMs and abdominal muscles of primigravidae

Variables (μV)	Assessment 1	Assessment 2	Assessment 3	p-value
Rest				
PFM average	8±4.3	7.6±3.8	6±3.4[a,b]	0.05
Abdominal average	7±3	4.8±1.8[a]	4.9±1.8[a]	0.006
CVM				
PFM average	54.5±12.8	51.2±11.9	53.8±14.3	0.69
Maximum PFM	91.4±7.5	90.9±10.9	92.8±6.4	0.50
Abdominal average	12.2±9.2	9.9±7.4	11.3±7.4	0.14
Sustained contraction				
PFM average	56.2±19.8	54.6±22.2	59.3±18.6	0.95
Maximum PFM	98.3±33	96.4±23.4	93.8±36	0.81
Abdominal average	16±15.3	11±6.3[a]	13±8.4[a]	0.04

[a]significant in relation to the assessment 1; [b]significant in relation to the assessment 2

DISCUSSION

The analysis of the electromyographic data indicates, at the end of the pregnancy, a significant reduction of the PFM signal during rest. In addition, there was a significant decrease of the electrical activity of the abdominal muscles at rest and during the sustained contraction in the last trimester of pregnancy.

Unlike other skeletal striated muscles, PFMs are characterized by maintaining a constant electromyographic activity, except during urination, defecation and Valsalva maneuver[18]. Thus, even during rest, PFMs maintain a constant electrical activity and low frequency. The motor units triggering low frequency potentials are the tonic activity of PFMs. When a stronger muscle activation or an increase in intra-abdominal pressure occurs, new motor units with large electrical signal amplitudes are requested, characterizing the phasic activity[19]. This suggests that the electrical signal of PFMs, found at rest for our study, is due to electrical activity of tonic motor units.

However, high values of electrical activity during rest are associated with an increased muscle tone by excessive tension, which may cause fatigue or muscle pain[19]. In our study, the mean values of the basal tone, especially in the assessments 1 and 2 are above 5 μV, considered the appropriate upper limit for the electrical activity of the muscle during rest[18]. According to Wehbe et al.[20], the muscle with high tone, despite being apparently in the maximum contractile capacity, may not have sufficient strength to withstand a minimum load, like gravity. So, this may indicate the presence of a high muscle tone, which can occur due to an overload and be associated with the reduced electrical activity during contraction, lower urinary tract symptoms or still urogenital symptoms such as pelvic pain and dyspareunia.

During pregnancy, PFMs suffer progressive overload by increased maternal body mass and gravid uterus[1,2]. Thus, although these muscles are made up of tonic contraction fibers[21], resistant to fatigue, it seems that their muscle fibers need to increase the tone to maintain their support and continence functions, and offset this progressive overload in PFMs.The results obtained in this study point to a significant increase in maternal body mass and BMI during pregnancy. Despite all the pregnant women in this study having normal pre-pregnancy BMI[9], it may be noted that, during pregnancy, 15.8% were overweight and 15.8% were obese. This becomes important, since obesity can increase the pressure on the PF[24], causing chronic stress and weakening of muscles and nerves, and may trigger PF dysfunctions[22,23], such as urinary incontinence.

However, even keeping values above 5 μV – considered the upper limit of the tonus at rest – in the third trimester, women had a basal tone less than in the first two trimesters. These data may suggest that the progressive increase of the maternal body mass and the gravid uterus are not the only ones responsible for the increased muscle tone during pregnancy, so that other factors may be associated with the high tone, especially in the first trimesters of pregnancy.

Wijma et al.[25] investigated the changes in the function of the PFM during pregnancy and found a significant increase in the mobility of the urethrovesical junction at rest and during the cough, right at the beginning of pregnancy, stressing that factors other than the increased pressure caused by the uterus can trigger the dysfunctions in the PF. The authors suggest that the hormonal action on PF connective tissue seems to contribute to the dysfunction of PFMs during pregnancy.

The hormone relaxin secreted in greater amounts in the second trimester of pregnancy, causes the connective tissue remodeling, reducing the tensile strength of these and other structures, such as the body and uterine cervix, pelvic joints and perineal tissues, further increasing the pressure on PF[26]. This can justify the higher values of electrical activity of PFMs, at rest, found in the first two assessments carried out at the beginning of the second and third trimesters of pregnancy. However, Tincello et al.[27] did not identify association between the concentration of the hormone relaxin in the second trimester of pregnancy and the presence of PF dysfunctions.

Another important result to be highlighted was the significant reduction in the average values of the abdominal muscle signal, at rest and during the sustained contraction. The increased waist circumference during pregnancy causes a change in the angle of insertion of the rectus abdominis, and the entire abdominal muscle group, causing a reduction in the ability to stabilize the pelvis and to sustain the PF[28,29].

Sapsford et al.[30] noted that, when the abdominal wall is relaxed or loose, there is a decrease in the electromyographic activity of PFMs, stressing that there is a synergy between PFMs and abdominal muscles. Thus, considering the muscle coactivation of PFMs with abdominal muscles, we expected to find a decrease in the electromyographic activity of PFMs during the sustained contraction, especially in the third trimester. However, our results had no significant difference of the electrical activity of PFMs during the MVC and the sustained contraction.

So, despite the synergistic action between PFMs and abdominal muscles are well defined in the literature, other factors may influence the pattern of electromyographic activity of PFMs during the contraction. Hodges et al.[31] showed an increase in the response of PFMs during the contraction of the deltoid muscle as part of anticipatory postural adjustment. In this study, each requested contraction, we observed the contraction of accessory muscles, such as the adductor muscles of the hip and buttocks, instead of the isolated contraction of PFMs. In cases where simultaneous contraction of these muscles occurred, the contraction of PFMs was not recorded.

Some methodological limitations should be considered for the results of this study. Since this is a cross-sectional observational study with assessments only during pregnancy, the accurate understanding of factors that can cause changes in the pattern of electrical activity of PFMs may be partly compromised. Studies assessing the PFMs of women before pregnancy and also in the postpartum period can contribute to the elucidation of these factors.

CONCLUSION

The basal tone of PFMs and abdominal muscles was lower in the third trimester, suggesting that factors other than those analyzed in this study related to increased maternal body mass may be associated with overload on PFMs during pregnancy in the first trimester. This overload can cause pregnant women to have high muscle tone, in relation to the upper limit shown in the literature, changing the pattern of electromyographic activity, especially at rest, to maintain its support function of the continence and pelvic organs. To prevent this change, it is essential that the physical therapist assesses the function of the PFM, especially during rest and sustained contraction, as well as guide the practice of muscle strengthening exercises of the PFM, in view of the importance of strengthening exercises in the neuromuscular function of PFMs, preventing fatigue and supplying the muscular deficit more effectively.

It is worth mentioning that, although there is a concern with actions related to Woman's Health, such as the *Rede Cegonha* [Stork Network], these programs do not include specific guidelines during prenatal and postpartum periods, concerning the care with PF[32]. Therefore, this requires teams of health professionals, including physical therapists, involved with prenatal care to be trained concerning such care, to enable effective actions to prevent urinary complaints and possible dysfunctions of the PF during pregnancy and postpartum period.

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