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Body Changes Resulting from Pregnancy Period

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ABSTRACT

The objective of this study was to analyze the corporal modifications in the pregnant women due to the pregnancy period, as SOUZA *et al.* (2012) reported, gestation is a period of intense changes for women, both physical and psychological. Metabolic changes were studied, which according to Guyton (1919) increase significantly during gestation. In the cardiovascular system, Cunningham *et al.* (2012) reported an increase in cardiac output shortly after the fifth week of gestation, thus generating an increase in the heart rate. Barreto *et al.* (2009) informs that in the respiratory system due to the acceleration of metabolism, an increase in the oxygen requirement changes are caused, leading the pregnant woman to breathe more deeply and frequently. Skinner (1991) points out hormonal changes, arguing that pregnancy generates an increase in hormone production and several endocrine glands, the author points out studies which indirectly evidence that because of the increase in the size of the pituitary there is an increase in the secretion of some trophic hormones.

1. INTRODUCTION

According to the Basic Care Information System of Brazil (SIABBR), the Gross Birth Rate in Brazil in 2015 was 5,660,211, the lowest pregnancy rate per year since 2000. It can still be verified observing the graph of the Brazilian Institute of Geography and Statistics (IBGE) a constant drop in the Brazilian fertility rate from 2000 to 2015. Gestation generates a significant transformation in the maternal body in a period of approximately 42 weeks, considered by COSTA *et al.* (2010) one of the biggest changes that the human body can suffer. These modifications are anatomical, biochemical and physiological, occur in the reproductive system, cardiovascular, renal, respiratory, tegumentary, skeletal muscle, gastrointestinal, liver, pancreas, enzymes, neurological system, organs of sense among others.

2. LITERATURE REVIEW

2.1 CHANGES ARISING FROM THE GESTATION PERIOD

Gestation is a period of intense changes for women, both physical and psychological SOUZA *et al.* (2012). According to Barreto *et al.* (2009), for an average period of 42 weeks the mothers organism undergoes through great anatomical, biochemical and physiological changes, which occur in the reproductive system, cardiovascular, renal, respiratory, tegumentary, gastrointestinal system, liver, pancreas, enzymes, neurological system, in the skeletal muscle, sense organs among others, besides psychic modifications. According to Andrade and Lopes (2008), the main changes during pregnancy are alterations in the circulatory, respiratory and support tissues, such as connective and muscular tissues.

The physiological changes that occur during pregnancy can be subtle or striking and are considered the biggest changes that the human body can suffer, generating fears, doubts, anguish, fantasies or just curiosity about the transformations occurring in the body. (Costa *et al.*, Pp. 87, 2010).

Even with all these changes, the Brazilian Ministry of Health (2001) informs that pregnancy is neither a pathological nor an unhealthy state, where the pregnant woman must remain inactive, but rather a phase where there are several physiological, hormonal and anatomical modifications so that the fetus may develop in this period.

2.1.1 METABOLIC CHANGES

The metabolism undergoes through radical changes during pregnancy, according to Cunningham *et al*. (2012) because of the high demand of the placenta and the fast-growing fetus the pregnant woman suffers several metabolic changes, no other physiological changes after the birth can bring such great changes. According to Guyton (1919) all the metabolic functions of a pregnant women increase to give sufficient nutrition to the growing fetus, the author further states that the metabolism of the pregnant woman increases in general proportionally to the increase of the weight of the pregnant woman, and about 5 to 10% more, and that this increase is due to the greater demand of energy needed by the mother to carry the weight of her growing baby. He reports that the fast growth of the fetus demands a much increased activity of most maternal functions, such as fast metabolism, breathing, pumping of blood through the heart and also fast digestion.

The basal metabolic expenditure of the pregnant woman is considerably higher during pregnancy and maybe 120 to 130% higher than that of non-pregnant women, according to Skinner (1991). Thus the extra energy needed while the mother rests for 38 weeks gestation is estimated in average (113 kJ??) 27,000 kcal. The average increase in daily energy usage is 40 kJ (10 kcal) during the first three months, 350 kJ (215 kcal) during the third quarter. The extra energy seems to be predominantly derived from the catabolism of carbohydrates. (SKINNER, 1991).

The author also reports that during pregnancy, until the time of delivery, it is normal for the woman to fatten, on average, 12.5 kilograms and around 3.35 the maternal energy reserve (fat) and the rest due to the fetus: placenta, Amniotic fluid, uterus, blood breasts and extravascular fluid. The abrupt change of weight by itself is already a great indication of the metabolic changes that are happening. According to Cunningham *et al.* (2012) apud. Hytten and Thomson (1968), the fat reserve occurs more in the middle of the gestation staying, usually accumulated in the most central parts of the body. For the author, it is possible that the progesterone hormone acts by regulating liposomal and hypothalamic mechanisms, and that at the end of gestation, the lipostatic levels return to the same values that they had before gestation and the added fat is lost. These mechanisms of energy storage theoretically protect the mother and the fetus from prolonged fasts or intense physical exertion. For Cunningham *et al.* (2012) leptin plays a key role in the regulation of body fat and in energy expenditure,

they affirm that in pregnancy leptin levels increase from two to four times, reaching its maximum level during the second trimester and remaining in the End of gestation.

Guyton (1919) discusses human chorionic somatomammotropin that has one of its main functions linked to the metabolism of glucose and the fats of the mother. It decreases the glucose utilization performed by the mother allowing her to be more available for the fetus and at the same time increases the mobilization of fatty acids in the maternal adipose tissue so that the mother can use this fat to generate her own energy instead of glucose. The author emphasizes that glucose is the main substrate that the fetus needs for its energy, in this way it can be said that these hormones play a fundamental role for proper nutrition of the fetus.

Much of the metabolic increase is related to the enlargement of the thyroid gland according to Skinner (1991). The author reports that with the increase of the gland and the thyroid hormone occurs a higher plasma concentration of proteins bound to iodine, causing a high metabolic expenditure of the body cells and this favors an increase in the oxygen consumption at rest, elevation of the heart rate and a lower heat tolerance. The author further emphasizes that high heat production is evidence of increased basal metabolism during gestation and occurs because of it, so for balancing the body raises the temperature and eliminates heat by radiation and convection. Also because of the heat, there is an increase of the blood flow to the skin, providing a greater loss of heat, but the feeling of heat increases, for this reason, pregnant women have less tolerance for warmer environments.

Insulin sensitivity is another major landmark of gestation, Cunningham *et al.* (2012) state that during the period of pregnancy, pregnant women commonly have a mild hypoglycemia when they are fasting, hyperglycemia shortly after eating and hyperinsulinemia. The highest plasma insulin level during pregnancy is normal and is directly linked with the various responses peculiar to glucose ingestion. Pregnant women have a state of peripheral resistance to insulin that is generated by the pregnancy itself in order to make sure that after the meal the fetus will have the necessary supply of glucose, leaving the pregnant women with 45 to 70% more insulin sensitivity than not pregnant ladies.

Cunningham *et al.* (2012) report that the amount of total serum calcium decreases during pregnancy, causing a decrease in the plasma concentration of albumin, which consequently decreases the amount of calcium bound to this protein, but the amount of ionic calcium doesn’t change. They report that the development of the fetus generates a significant demand

on the maternal homeostasis of calcium, needing it also to prevent the excessive reduction of the pregnant woman. They continue to say that during all the gestation approximately 1,000 mg of iron is needed, of which 300 mg is directly transferred to the fetus and 200 mg lost in the different types of excretion, these losses always occur, even if the pregnant woman is lacking iron. Most iron is used in the final half of pregnancy, averaging 6 to 7 mg per day, but usually, the body cannot provide this amount and it is necessary to ingest iron supplementation. If this supplementation does not occur, the hemoglobin and hematocrit concentration will drop causing the blood volume to increase. The fetus is not impaired because the placenta transfers iron to itself even if the mother is in deficit of it.

Cunningham *et al.* (2012) says that the increase in cutaneous blood flow during gestation is useful to remove the excess heat generated by the accelerated metabolism, states that the volume expansion varies greatly through each pregnant women, in some cases only a slight increase occurs, and in others the volume functions, such as responding to the metabolic demands of the uterus, providing nutrients to support placental and fetal growth, protecting both mother and fetus from the effects of supine and upright positions on venous return, and also protects pregnant women from excessive blood loss at delivery.

2.1.2 CHANGES IN THE CARDIOVASCULAR SYSTEM

Andrade and Lopes (2008) reported that around the 10th week of gestation an increase in the pregnant women's plasma volume due to hydrosaline retention begins, they report that this increase in blood volume leads to an increase in cardiac output, also increasing the volume of systolic ejection. Guyton (1919) reports that the addition of female sex hormones and hormones of the adrenal cortex during gestation causes the pregnant woman to gain about 3 liters of fluid, according to the author, on average 0.5 liters of this liquid is found in the plasma and 0.5 liters is represented by the red blood cells, so in this way it can be concluded that 1 liter of additional fluid is gain of blood volume. He reports that on average one third of this blood is used to fill the placental sinuses, the rest is collected in the circulation making the blood flow more easily to the heart. Thus, maternal cardiac output is on average 30% higher than normal.

The postural changes that occur in pregnant women are responsible for the change in their pressure. Between 24 and 26 weeks of gestation, the blood pressure of the pregnant women usually gets to its lowest value and can increase again right after, Cunningham *et al.* (2012).

For Wright *et al*. (1950) there is a deceleration in venous blood flow in the lower limbs of pregnant women, it happens because there is a blood stagnation because of the enlargement of the uterus that blocks the pelvic veins and the inferior vena cava, preventing the blood from the usually circulation for the legs, but the author informs that this situation can return to normal when the pregnant women lie down on the side or immediately after the childbirth. These changes according to Cunningham *et al.* (2012) can cause the development of varicose veins in the lower limbs and vulva, hemorrhoids and even deep venous thrombosis emphasize that hemorrhoids can also be caused by constipation and increased pressure of veins below the uterus, which is in an increased size.

For Cunningham *et al.* (2012) the extravagant increase in the blood volume of pregnant women, since hypervolemia has important functions during pregnancy, such as: respond to the metabolic diligences of the uterus that is enlarged with its vascular system rather hypertrophied, provide the nutrients needed for accelerated growth of the placenta and the fetus, protect the mother and fetus from the effects of the standing position and lying belly upwards regarding venous return and also protect the pregnant woman from excessive blood loss at the time of delivery. According to Barreto *et al.* (2009) together with increased blood volume one of the main changes is the increase in heart rate, which according to Andrade and Lopes (2008) occurs especially from the sixth month of gestation, with an average of 10 to 15 beats per minute, occurring due to the decrease in peripheral resistance. According to Barreto *et al.* (2009) for this reason, it is common the appearance of tachycardia and palpitations in pregnant women even with them at rest, causing a high index of morbidity and mortality.

Cunningham *et al.* (2012) states that the volume of blood being pumped by the heart per minute, Heart Rate, already begins to increase from the fifth week of gestation, leading to a decrease in peripheral vascular resistance and increased heart rate, Weineck (1941) states that the cardiac output increases because of the increase in systolic volume and heart rate, also reports that between the sixth and eighth week of pregnancy the blood volume and the cardiac output of the pregnant woman begin to increase, reaching their maximum value at the end of the second trimester with an increase of 40 to 50%. He states that the increase in blood volume occurs because of the increase in plasma volume by 50% and the volume of erythrocytes by up to 20%, stating that during the first stage of delivery, the cardiac output of pregnant women increases moderately, different from the second stage where, due to the

great effort of the pregnant woman to expel the fetus, the cardiac output increases considerably.

The heart rate fluctuates during gestation and "Normal pregnancy is not a high-throughput state", says Cunningham *et al.* (2012). The author explains this comment stating that at the end of pregnancy there are expected increases in cardiac output, heart rate and systolic volume, but the systemic and pulmonary vascular resistance is reduced considerably while pulmonary capillary pressure and central venous pressure do not change considerably between the end of gestation and the puerperium, then, although there is an increase in cardiac output, the ventricular function remains the same as that of non-pregnant women. For Skinner (1991) the higher blood volume decreases the oxygen carrying capacity of the blood additionally with the enlargement of the fetus, there is an increase of blood flow to the uterus in consequence of placenta's tissues.

2.1.3 CHANGES IN THE RESPIRATORY SYSTEM

Due to the acceleration of metabolism, the oxygen requirement is increased, causing changes in the respiratory system inducing the pregnant woman to breathe more deeply and more frequently, occurring in many cases hyperventilation, Barreto *et al*. (2009). Andrade and Lopes (2008) point out that changes in ventilation capacity per minute are due to increased tidal volume and respiratory rate, these modifications can lead to hypocapnia and respiratory alkalosis, which are compensated by a greater excretion of bicarbonate, besides this, the fetus sends the mother CO_2 through the placenta.

For Souza *et al.* (2012) breathing is also affected by the large modifications of the abdominal wall that occur because the uterus has its vertical axis and therefore requires of this muscle a total support, causing the pregnant woman to begin breathing by increasing the volume of the chest and Abdomen at the end of their gestation, but emphasizes the training of abdominal breathing so that the muscles strengthen, oxygenating the baby and doing the work of relaxation. Andrade and Lopes (2008) report that the changes that occur in the chest of the pregnant woman generate a need for the use of a differentiated musculature for breathing and that, with the displacement of the diaphragm due to the growth of the uterus, a requirement of the use of the High costal musculature, thus the vital capacity remains the same, but the residual volume decreases, generating a decrease in the oxygen reserve, especially in the last trimester of pregnancy.

According to Skinner (1991) because of the continuous increase of the fetus and the placenta, there is a displacement of the viscera and diaphragm upward, which, according to Cunningham *et al.* (2012), an elevation of approximately four centimeters during pregnancy. According to Skinner (1991), all these changes may result in an increase in vital capacity, but at the same time, no changes in total lung capacity are noticed. The author further states that in this way there is a noticeable decrease in the amount of air that remains in the lungs of the pregnant women when they reach the end of their expiration. Skinner (1991) reports that at the beginning of pregnancy hyperpnea occurs, which is increased ventilation, this happens because it is a natural physiological response to the gestation period.

2.1.4. HORMONAL CHANGES AND THEIR CONSEQUENCES

According to Skinner (1991), pregnancy generates an increase in several endocrine glands and raises the hormone production. The author emphasizes studies that indirectly evidence that, due to the increase in the size of the pituitary gland, there is an increase in the secretion of some trophic hormones.

During gestation, the production of parathyroid hormones increases, generating the absorption of maternal bone calcium and raising the amount of calcium in the plasma, in the proportion of the fetus needs (Skinner 1991).

Cunningham *et al.* (2012) argue that women suffer during pregnancy an increase in fluid retention, which according to Skinner (1991) is due to an increase in the production of aldosterone by the adrenal cortex, generating a tendency in the renal tubules to reabsorb sodium. The same author believes that pregnancy can lead to a decrease in various hormonal immune functions, a lack of lymphocytes may perhaps explain some autoimmune disorders during pregnancy, such as rheumatoid arthritis, multiple sclerosis and autoimmune thyroiditis. However, not all immune functions are diminished, such as lymphocytes, immunoglobulins, among others.

Changes in the body of the pregnant woman such as an increase in the size of the uterus, sinuses, maternal external genitalia and relaxation of various pelvic ligaments are related to the increase of estrogen and progesterone (Skinner 1991). According to Guyton (1919), this large production of progesterone and estrogen by the corpus luteum, which is two to three times more, is small compared to the amount of these two hormones that are secreted by the placenta, these being 30 times more for estrogen and ten times more for progesterone. It

reports that the secretion of these two hormones begins within a few weeks after the onset of pregnancy and increases rapidly after the sixteenth week of gestation, peaking just before birth. Skinner (1991) reports that these changes have the function of bringing, to leadm to cause greater mobility of the sacroiliac joints and also an increase in the elasticity of the pubic symphysis, extremely necessary for the moment of delivery.

Guyton (1919) discusses the various functions of estrogen during gestation. In the mother estrogen causes a rapid proliferation of the muscles of the uterus, an increase of the vascular system to the uterus, a dilation of the external sexual organs and of the vaginal orifice, thus facilitating the passage of the baby at the moment of the birth and probably a certain degree of relaxation in the ligaments of the pelvis to also facilitate the passage of the fetus. In addition to these functions performed by the estrogen in the reproductive organs, this also generates the rapid growth of the breasts. The same author reports progesterone during pregnancy has the function of making available to the fetus the extra quantities of nutrients located in the endometrium, the author further informs that progesterone also exerts an inhibitory effect on the muscles of the uterus, making it relax throughout pregnancy. Guyton reports that this hormone complements estrogen in its effect on the breasts, generating the withdrawal of the nutrients in the glandular cells, making all the necessary elements for the milk production to be available in the necessary moment.

Andrade and Lopes (2008) report that one of the primordial corporal modifications is the enlargement of the uterus, until around the tenth week it is still restricted in the pelvic cavity, but gradually its growth is evident on the abdominal wall. They inform that during the gestation its volume grows up to thousand times and its weight an average of 6 Kg. The uterus according to Cunningham *et al.* (2012) is a nearly solid structure that weighs 70 grams with a cavity of 10 ml or less, during pregnancy it is able to accommodate the fetus, placenta and amniotic fluid (an average of 5 liters, up to 20 or more). Being at the end of the gestation 500 to 1000 times greater than before, being with approximately 1.1 kg. All these changes in the uterus are caused by estrogen and progesterone, resulting in stretching and hypertrophy of muscle cells, with limited production of myocytes, increasing the elastic tissue, giving strength to the walls of the uterus, which are thicker at the beginning of the pregnancy and decreases along. For Andrade and Lopes (2008), these changes in the size of the uterus leading to a change in abdominal shape and a thoracic expansion, through relaxation of the

intercostal ligaments and elevation of the diaphragm that generate an increase in inspiratory capacity during pregnancy up to 300 mL.

Cunningham *et al.* (2012) discuss relaxin that relaxing helps the pubic ligament to stretch, cervical softening, vaginal relaxations, and inhibition of myometrial contractions, all of which are necessary for gestation and delivery. The authors continue to argue that the hormone plays a key role in the second phase of labor, remodeling the extracellular matrix of the breasts, vagina, pubic symphysis, uterus and cervix. For Cunningham *et al.* (2012) the vaginal walls undergo major modifications as they need to accompany the distentions that occur at the time of delivery, causing a considerable increase in mucosal thickness, loosening of connective tissue and hypertrophy of smooth muscle cells.

According to Weineck (1941) at the beginning of gestation, there is an increase in the secretion of relaxin and estrogen, this increase causes relaxation of connective tissue, tendons, ligaments and joints. The cartilage becomes softer and because of the greater circulation of the synovial fluid, the pelvic girdle joints move away. As a consequence of all this the flexibility of the pregnant woman is increased, increasing the capacity of stretching of the tissues. This extra stretching of the tissues in conjunction with the new body weight distribution may lead to a compensatory overload of some specific muscle groups, such as the spinal extensor muscles, and thereby cause back pain.

Still, with regard to back pain, Barreto et al. (2009) point out that, as a consequence of hormonal changes, the joints also suffer from changes in mobility during gestation, especially sacroiliac and pubic symphysis, thus increasing pelvic capacity (Foti *et al.*, 2000). Joint and ligament relaxation make the joints more flexible thus making the hip region more unstable. According to the author, this mobility also causes changes in the posture of the pregnant woman and may cause discomfort in the lower part of the spine. Because of the pronounced lordosis and constant neck flexion in the last trimester of pregnancy, pregnant women may experience pain, numbness, and weakness.

3. CONCLUSION

It is concluded that gestation is an average period of 40 weeks in which the woman's organism undergoes intense changes, being these anatomical, biochemical and physiological, occurring modifications in the reproductive system, cardiovascular, renal, respiratory, tegumentary, skeletal muscle, gastrointestinal system, liver, pancreas, enzymes, neurological

system, in the sense organs among others, besides psychic modifications, being able to vary their intensity and quantity among the women. The physiological changes that occur during this period are among the most pronounced that the human body can suffer and for this reason can generate fears, doubts, anguish and curiosity, often leading women to a state of greater fragility and tendency to injury. Even with all these changes, the Ministry of Health of (2001) informs that gestation is not a pathological state nor sickly where the pregnant woman must remain inactive.

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