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(REVIEW ARTICLE)

The importance of studying metabolism in pregnancy

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Abstract

The gestational period is marked by an intense anabolic process. Weeks after conception, the placenta is already formed and begins to secrete important hormones related to the metabolism of various nutrients. These alter maternal metabolism, promote fetal growth, and prepare the mother for labor and lactation (HARREITER J. et al.,2006).

Keywords: Pregnancy; Metabolism; Nutrients; Development Fetus

1. Metabolism in Pregnancy

Metabolic adaptations resulting from pregnancy are essential to ensure the growth and proper development of the fetus, provide sufficient energy and nutrients until its birth and control maternal stocks of nutrients and energy during pregnancy, delivery and lactation (VITOLO, 2008).

Of the maternal physiological changes, what stands out most is the hem dilution, which increases its total blood volume by 40 to 50%. Such adaptation is due to the supply to protect the mother and baby when in supine position, in addition to preventing blood loss during childbirth.

In pregnancy, a reduction in the plasma level of amino acids is observed due to the high fetal demand. The pregnant woman saves this type of substrate for fetal synthesis and there is an adjustment in lipid metabolism. The baby uses about 80% glucose for energy production, not using circulating fatty acids.

The hormones involved are growth hormone (GH) - mainly placental, epinephrine, placental lactogen hormone (hPL), and others that increase to lipolysis and use of pregnant women as energy, raising plasma levels of cholesterol, fatty acids, TG and phospholipids. As the mother preserves plasma glucose for the fetus, her fasting glucose is 15 to 20 mg lower than in the pre-gestational period. For this to be possible, during this period, a peripheral resistance to insulin is observed. During feeding, maternal hyperinsulinemia suppresses lipolysis and ketogenesis and increases amino acid uptake. Promoting an adjustment in fat storage and tissue protein synthesis. The hormones involved in this mechanism are progesterone, placental GH, lactogenic hormones, glucagon, cortisone and estrogen (VITOLO, 2008; Guimarães; SILVA, 2015). Some hormones affect a woman's quality of life during pregnancy. Thus, progesterone increases appetite in the first half of pregnancy, reducing uterine contractility and intestinal motility. Estrogen plays hydroscopic action on tissues, favoring its elasticity and edema. It also dilutes serum proteins and favors skin hyperpigmentation and can reduce appetite in the second half of pregnancy. Human placental lactogen (hPL) has mammogenic action and reduces insulin sensitivity during pregnancy (VITOLO, 2008; Guimarães; SILVA, 2015).

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Due to all these changes, the mother's nutritional and energy demand becomes very high. Thus, the two second quarters are marked by the increase in the caloric requirement in order to meet all this demand. It is also worth mentioning that gene expression is dependent on nutrients such as omega-3, zinc, chromium, vitamin D, magnesium and others (DIAS; CATALANI, 2011; Guimarães; SILVA, 2015).

At the beginning of pregnancy, there is virtually no increase in the caloric need. There is then, from the second trimester, an increase in the mother's metabolic rate until the third trimester of approximately 300 kcal/day, increasing the risk of ketosis when food deprivation occurs in the mother (VITOLO, 2008; BLUMFIELD *et al.*, 2012; EMOND *et al*., 2018; HARREITER *et al.*, 2019).

Table 1 Summary of physiological changes during pregnancy

	First quarter	**Second quarter**	**Third quarter**
Physiological changes	• 10-25% physiological increase in functions and metabolism. Increased heart rate. • Thickening of the muscle fibers of the uterus, causing pressure on the bladder on the right side. • Loss of concentration and increased drowsiness caused by progesterone.	• Relaxation of the Muscles of the TGI causes lower secretion of digestive enzymes, leading to delay in gastric emptying and constipation. • 50% increase in blood volume. • Increased respiratory rate. • Baby growth pushes the ribs and pelvis. • Insulin resistance.	• Progesterone causes hypotonia of the esophane inferior sphincter • Increased pressure of the uterus on the stomach. • Changes already listed in the second quarter, but it is observed more markedly.
Common symptoms	Heartburn, nausea and vomiting, eructation and bloating.	Breast paraesthesia and Mastalgia, colostrum production, gum sensitivity, gastroesophageal reflux and heartburn, dyspnea, frequency and urgency to urinate, need for rest and drowsiness, mmss edema and LLLl, discomfort to walk, increased hunger.	All related in the second quarter, and may be more pronounced at this stage.

Table 2 Recommended weight gain according to gestational trimesters

Nutritional status Pre-Gestational	**Total weight gain in the 1st quarter (kg)**	**Weekly weight gain rate in the second and third trimesters of pregnancy (kg)**	**Total weight gain (kg)**
Pre-gestational BMI or in the first trimester of <20	2.3	0.521 (0.453 – 0.589)	12.5 to 18 kg
Pre-gestational BMI between 20 and 24.9	1.6	0.406 (0.362 – 0.453)	11.5 to 16 kg
Pre-gestational BMI between 25 and 29.9	0.3 to 0.9	0.272 (0.226 – 0.317)	7 to 11.5 kg
Pre-gestational BMI > 30	0	0.226 (0.181 – 0.272)	6 to 7 kg

It is important to identify whether the pregnant woman is underweight or overweight at the beginning of pregnancy, to enable appropriate interventions to correct nutritional imbalances. The low weight of the pregnant woman increases the risk of preterm and low birth weight and maternal anemia. Overweight and maternal obesity increase the risk of

cesarean section, difficulty in losing weight after childbirth, having overweight children, gestational diabetes and hypertension that can compromise the life of the baby and the mother (HARREITER *et al.*, 2019).

Regarding satisfactory weight gain, eutrophic pregnant women are expected to increase from 15 to 20% of her pre-gestational weight. According to the Institute of Medicine (IOM, 2009).

In twin pregnancies, individualized evaluation is necessary. In any case, a weight gain of around 2.7 kg per month is recommended from the twentieth gestational week (VITOLO, 2008).

2. Pregnant Woman's Food

From conception to breastfeeding, the baby is totally dependent on the feeding of the pregnant woman. This is because during pregnancy, the baby feeds on nutrients absorbed and metabolized by the mother. In addition, the pregnant woman's eating habits still directly influence the baby's variety, quality and even taste, because the placenta can interfere with the baby's taste and smell (VITOLO, 2008; BLUMFIELD *et al.,* 2012; HARREITER *et al.,* 2019).

It is important to note that during pregnancy, women should not diet restrictively or lose weight during this period. Researchers have demonstrated that this type of conduct can generate smaller babies with metabolic alterations. Thus the diet should be as healthy and varied as possible, including fresh vegetables and fruits, grains and seeds, as well as whole grains, lean protein sources and healthy fats. It is important to consume meals every 2 and a half to 3 hours, in smaller amounts and chew the food very well to facilitate digestion and avoid gastric discomforts such as reflux, heartburn, eructation and gases, in addition to constipation (VITOLO, 2008; CARREIRO; CORREA, 2010; EMOND *et al.,* 2018).

Meals should include all food groups, such as complex or integral carbohydrate, legumes, vegetables and fruits, high biological value proteins (AVB) and mono and polyunsaturated fats. This care makes it possible to intake different nutrients that complement each other and provide sufficient substrate for the nutrition of the mother and baby to be adequate (GOMES *et al*., 2019).

Regarding the distribution of macronutrients, calculated under the total energy value (VET), it is recommended 45 to 65% of carbohydrates, 15 to 20% of proteins (adjusting to 10 g or 1.1 g/ kg of pre-gestational weight/day, not exceeding the intake of 71 g per day) and 20 to 35% lipids (ADA, 2008).

The American Dietetic Association (ADA) does not guide diets that have amounts of less than 130 g/day of carbohydrates, harming maternal and child health. As for proteins, high biological value (AVB) should be prioritized and their distribution between 10% and 35% of VET should be maintain. In addition, the intake of saturated fats should be less than 7% of total lipids and cholesterol, less than 200 mg/day. The recommendations of vitamins, minerals and fibers (20-35 g/day or 14 g for every 1000 kcal) are similar for pregnant women who have gestational diabetes *mellitus* (MGD) or not. It is important to note that the energy recommendation should promote adequate weight gain and restrictive diets are discouraged and may lead to ketonuria (FRANZ *et al.,* 2002; ADA, 2004; ADA, 2008).

The RDA recommends a daily intake of 175 g/day of carbohydrates for pregnant women and 210 g/day for lactating women. Protein consumption of 1 g/ kg/day (calculated on pre-gestational or acceptable weight) is recommended with an additional 1 g/day in the first half, 9 g/day in the second trimester and 31 g/day in the third trimester. Of these, it was recommended to intake at least 50% of protein of high biological value (IOM, 2005).

Good quality proteins or AVB are those from animal origin such as meat and poultry, dairy products, eggs and fish. According to the Institute of Medicine (IOM), these proteins are the source of the nine essential amino acids (phenylalanine, histidine, isoleucine, leucine, lysine, methionine, threonine, tryptophan and valine) and, for this reason, are called AVB or "complete proteins". Plant proteins such as those present in legumes, grains, nuts, seeds and some vegetables do not include all essential amino acids, so they are called "incomplete proteins" (IOM, 2005).

To the so-called simple or complex carbohydrates, such nomenclature was related to the speed of digestion and availability of seeric glucose. Being the simple carbohydrates of rapid digestion and elevation of glycemia and complex, being of slower digestion and gradual elevation of glycemia. Currently, it is known that the structure of the molecule influences digestion time and glucose elevation (SHENK, S. et al., 2003).

However, postprandial glycemia is influenced by the time of metabolization of carbohydrates, the availability of serum glucose, insulin secretion and its peripheral tissue sensitivity. So, the glycemic response depends on the amount and glycemic index of the carbohydrate ingested (PUJOL, 2017).

The intrinsic factors that influence the glycemic response of carbohydrates may be their physical form (juice or fruit), the type of starch, maturation, the type of preparation (fried, cooked, roasted), among others (FANI, 2016).

There are other factors that contribute to the glycemic response and that prevent the accuracy of this calculation such as age, body composition, meal times, chewing, existence of peripheral resistance to insulin, intestinal microbiota and genetic individuality, among others (DODD, 2011; QIN, 2012).

In any case, two mechanisms can impact to reduce the glycemic response in meals as modulating the absorption speed of carbohydrates including more viscous fibers and mono or polyunsaturated fats, and increase insulin secretion through protein intake (AUGUSTIN, 2016).

The concentration and distribution of carbohydrates throughout the day can contribute to better glycemic control. However, this strategy should be individualized, taking into account the eating habits, tests and tolerance of the pregnant woman. Thus, to control the glycemic load of the diet, fractionation and reduction of carbohydrate volume are guided, maintaining fixed schedules for meals (ADA, 2004; ADA, 2008).

The fractionation of meals allows the pregnant woman not to present hypoglycemia, nausea and even emesis, besides regulating the hunger-satiety axis. Establishing meal times allows the body to organize itself to provide digestive enzymes and hormones, optimizing the digestive process and avoiding discomfort (VITOLO, 2008).

Due to the increase in free fatty acids resulting from pregnancy, one should consider an intake of up to 30% of the VET of total fats, limiting the intake of saturated fats to 10% and discourage the intake of *Tran's fats*. In dyslipidemia, it is recommended to limit the intake of cholesterol to 200 mg/day. However, fat restriction is not recommended due to the fetal process of myelinization, which may compromise its neurological development (GUIMARÃES; SILVA, 2003).

Regarding, polyunsaturated long-chain n-3 (omega-3) fatty acids (LCPUFA) are essential in mammalian health. These facts are present in fish oil and flaxseed oil, and fish oil has the most efficient form of LCPUFA (BORDELEAU et al., 2020).

LCPUFA measures physiological processes such as angiogenesis, immunity, inflammatory response, among other cellular and molecular functions that impact health and disease. Eicosapentaenoic acid, 22: 5n-3 (EPA) and Docosaexaenoic acid, 22: 6n-3 (DHA) comprise part of cellular signaling. DHA is part of the structure and function of the cell membrane (CUNHA et al. 2015)

Researchers report that the diet rich in refined foods has a low pufas n-3 content, leading individuals to an increased risk of disease

Thus, inadequate maternal intake of DHA and EPA can impair the baby's growth, exposing it to risks of cognitive decline, inflammatory processes, cardiovascular disease, behavioral changes and mental stress in adulthood (KABARAN; BESLER, 2015).

The study conducted by Helland *et al* (2003) suggested that maternal supplementation of omega-3 polyunsaturated fatty acids, such as DHA and AA during pregnancy and lactation, influenced children's intelligence. Although there are positive results of omega-3 supplementation during pregnancy, we must remember that adequate and individualized feeding is essential in this period, directly influencing the effects of supplementation.

An observational study (*N* = 11,875) conducted by Hibbeln *et al* (2007) showed that the higher maternal consumption of seafood during the gestational period influenced the fine motor skills, behavior, verbal intelligence and social development of children up to 8 years of age.

It is already clear the importance of the consumption of omega-3 fatty acids during pregnancy – both for the health of the mother and baby. Several well-delineated research proves these benefits.

Thus, a study conducted by Bisgaard *et al* (2016) with 736 pregnant women related omega-3 supplementation to reduced risk of allergies, asthma and respiratory tract infections in infants. The researchers administered 2.4 g of omega

3 (55% EPA and 37% DHA) per day from the third trimester of pregnancy, suspending its administration in the last gestational week.

These results reinforce the importance of the quality of fats that will be part of the diet of pregnant women.

Therefore, the data cited here reinforce the importance of the quality of diet fats in the gestational period. In addition, the other nutrients that will be part of the feeding of pregnant women should be taken into account in order to provide synergy and nutritional balance.

The food sources of LCPUFA (n-3) are cold and deep water fish, seafood and seeds. Some fish have higher amounts of omega-3 (n-3) per portion. Assim, in 60 g we have approximately anchovy with 1,200 mg, wild salmon with 590 mg, sardines with 556 mg, trout with 550 mg and tuna with 488 mg. Similarly, for seafood, mussels have 443 mg, oysters 390 mg, crab 234 mg, scallops 206 mg and shrimps 178 mg (MOZAFFARIAN; RIMM, 2006).

3. Conclusion

The alert is mainly for pregnant women, because the methyl mercurium exceeds the placenta, exposing the fetus to the risk of neurodevelopmental changes. It is noteworthy that fish and seafood suffer contamination of methyl merychurio related to environmental contamination, predatory nature and longevity of the species. For example, swordfish and sharks are larger animals that live longer, have higher concentrations of mercury, while smaller animals such as molluscs and salmon have lower concentrations of this metal (DULEY L. et al, 2010).

The recommendation for fish consumption for pregnant or lactating women according to the https://health.gov/dietaryguidelines/2015/guidelines/chapter-1/a-closer-look-inside-healthy-eating-patterns/ -callout-seafoodDiethic Guidelines for Americanos (2015-2020) is 2 to 3 parts per week, choosing fish with low mercury content. Another orientation is to prefer fresh fish to canned, avoid fried foods and prefer healthier preparations, such as grilled or stewed.

Compliance with ethical standards

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Disclosure of conflict of interest

All authors contributed to the realization of this review article.

References

[1] CAI CQ. Et al. Association of neural tube defects with maternal alterations and genetic polymorphisms in one-carbon metabolic pathway. Ital. J Pediatr. 2019; 45(1): 37.

[2] CHAFFEE BW, KING JC. Effect of zinc supplementation on pregnancy and infant outcomes: a systematic review. Pediatric Perinat Epidemiol. Jul 2012; 26, 1: 118-37.

[3] CIOFFI J. et al. Physical activity in pregnancy: women's perceptions, practices, and influencing factors. J Midwifery Women's Health. 2010; 55(5): 455-61.

[4] CLARKE JHR, RATES SMK, BRIDI R. A warning about the use of plant products in pregnancy. Infarma. 2007; 19(1-2): 41-48.

[5] CLEMENTS SJ, CARDING SR. Diet, the intestinal microbiota, and immune health in aging, Critical Reviews in Food Science and Nutrition. 2018; 58(4): 651-661.

[6] CULLEN G, O'DONOGHUE D. Constipation and pregnancy. Best Pract Res Clin Gastroenterol. 2007; 21(5): 807-18.

[7] CUNHA AJLA, MILK AJM, ALMEIDA IS. The pediatrician's role in the first thousand days of the child: the pursuit of healthy nutrition and development. Jornal de Pediatria. November–December 2015; 91(6): S44-S51.

[8] DALL'ALBA V. et al. Health-related quality of life of pregnant women with heartburn and regurgitation. Arq. Gastroenterol, São Paulo. June 2015; 52(2): 100-104.

[9] DERBYSHIRE E. et al. Diet, physical inactivity and the prevalence of constipation throughout and after pregnancy. Maternal and Child Nutrition. 2006; 2: 127–134.

[10] DODD H. et al. Calculating meal glycemic index by using measured and published food values compared with directly measured meal glycemic index. J Clin Nutr. 2011; 94(4): 992-996.

[11] DULEY, L. et al. Magnesium sulphate versus diazepam for eclampsia. Cochrane Database Syst Rev. 8 Dec 2010; 2010(12): CD000127.

[12] DULEY L. et al. Magnesium sulfate and other anticonvulsants for women with preeclampsia. Cochrane Database Syst Rev. 2010; (11): CD000025.

[13] DULEY L. et al. Magnesium sulfate versus diazepam for eclampsia. Cochrane Database Syst Rev. 2010; (12): CD000127.

[14] DUNKER KLL. Et al. Eating disorders and pregnancy - A review. J Bras Psiquiatr. 2009; 58(1): 60-8.

[15] EBRAHIMY F. et al. Comparison of the therapeutic effects of Garcin (®) and fluconazole on Candida vaginitis. Singapore Medical Journal. 2015; 56(10): 567-572.

[16] ELZAYAT AM. et al. Prevalence of undiagnosed asymptomatic bacteriuria and associated risk factors during pregnancy: a cross-sectional study at two tertiary centres in Cairo, Egypt. BMJ Open. 2017; 7(3): e013198.

[17] EMOND JA. Et al. Better diet quality during Pregnancy Is Associated with a Reduced Likelihood of an Infant Born Small for Gestational Age: An Analysis of the Prospective New Hampshire Birth Cohort Study, The Journal of Nutrition. January 2018; 148(1): 22–30.

[18] ENOCH, D. A. et al. The Changing Epidemiology of Invasive Fungal Infections. Methods in Molecular Biology. 2017; 1508: 17-65.

[19] FESTIN M. Nausea and vomiting in early pregnancy. BMJ Clin Evid. 19 Mar 2014; 1405.

[20] STRONG RC, MUNIZ LB. Effects of dietary supplementation with fructooligosaccharides and inulin in the human body: evidence-based study. With. Health Sciences. 2009; 20(3): 241-25.

[21] FRANZ MJ. Et al. Evidence based nutrition principles and recommendations for the treatment and prevention of diabetes and related complications (Technical Review). Diabetes Care. 2002; 25(1): 148-98.

[22] GARCIA-CASAL MN, LAYRISSE M. Absorción Del hierro de los Alimentos: papel de la vitamin A. Archivos Latino-Americanos de Nutrition, Caracas. Sept. 1998; 48(3): 191-195.

[23] GHOURI F, HOLLYWOOD A, RYAN K. A systematic review of non-antibiotic measures for the prevention of urinary tract infections in pregnancy. BMC Pregnancy Childbirth. 13 April 2018; 18(1): 99.

[24] GOMES CB. Et al. Ultra-processed Food Consumption by Pregnant Women: The Effect of an Educational Intervention with Health Professionals. Matern Child Health J. 2019; 23: 692–703.

[25] GORRIL L. et al. Risk of medicinal plants during pregnancy: a review of free access data in Portuguese. Arq. Cienc. Saúde UNIPAR, Umuarama. Jan. /Apr. 2016; 20(1): 67-72.

[26] GUI S. et al. Arginine supplementation for improving maternal and neonatal outcomes in hypertensive disorder of pregnancy: a systematic review. J Renin Angiotensin Aldosterone Syst. 2014; 15(1): 88-96.

[27] GUIMARÃES AF, SILVA SMC. Nutritional needs and recommendations during pregnancy. Cadernos' Centro Universitário S. Camilo, São Paulo. Apr. /Jun, 2003; 9(2): 36-49.

[28] HARREITER J. et al. Nutritional Lifestyle Intervention in Obese Pregnant Women, Including Lower Carbohydrate Intake, Is Associated with Increased Maternal Free Fatty Acids, 3-β-Hydroxybutyrate, and Fasting Glucose Concentrations: A Secondary Factorial Analysis of the European Multicenter, Randomized Controlled DALI Lifestyle Intervention Trial. Diabetes Care Aug 2019; 42(8): 1380-1389.

[29] HEITMANN K, NORDENG H, HOLST L. Pregnancy outcome after use of cranberry in pregnancy – the Norwegian mother and child cohort study. BMC Complement Altern Med. 2013; 13: 345.

[30] HELLAND IB. et al. Maternal Supplementation with Very-Long-Chain n-3 Fatty Acids During Pregnancy and Lactation Augments Children's IQ at 4 Years of Age. Pediatrics January. 2003; 111(1): e39-e44.

[31] HIBBELN JR. et al. Maternal seafood consumption in pregnancy and neurodevelopmental outcomes in childhood (ALSPAC study): An observational cohort study. Lancet al. 2007; 369: 578–585.

[32] JAMES A. et al. Folic Acid Supplementation and Pregnancy: More than Just Neural Tube Defect Prevention. Reviews in Obstetrics & Gynecology. 2011; 4(2).

[33] JEZIOREK M, FREJ-MĄDRZAK M, CHOROSZY-KRÓL I. The influence of diet on gastrointestinal Candida spp. Colonization. Rocz Panstw Zakl Hig. 2019; 70(2): 195-200.

[34] JUNIOR AG GRIGOLETO ARL, FREGONEZI PAG. Candidiasis Vaginal: a matter of health education/Vaginal Candidiasis: a matter of education in health. Brazilian Journal of Health. 2014; 2(2).

[35] KABARAN S, BESLER HT. Do fatty acids affect fetal programming? J. Popul Health. Nutr. 2015; 33: 14.

[36] KHALED K. et al. Perceived stress and diet quality in women of reproductive age: a systematic review and meta-analysis. Nutr J. 28 Aug 2020; 19(1): 92.

[37] KUMAMOTO CA, GRASNIGT MS. HUBE B. The gut, the bad and the harmless: Candida albicans as a commensal and opportunistic pathogen in the intestine. Current Opinion in Microbiology. 2020; (56): 7-15.