

Full Length Research Paper

The role of health care assistance in pregnant women exposed to malnutrition

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Abstract

The process of malnutrition during pregnancy that leads to dysfunction of the fetus' endocrine system is denominated metabolic programming. The mother's nutritional status can greatly influence the development of the child. We sought to evaluate the performance of health professionals working at the family health strategy regarding a group of pregnant women in a disadvantaged community in Rio de Janeiro. Sixty health professionals working answered a questionnaire with objective questions. Descriptive analyses were performed using Statistical Package for Social Sciences (SPSS, Inco, IL, USA). Of the respondents, 78% were Community Health Agents, nurses and nursing technician, 70% were female, 67% had completed high school and 25% had an University degree, 63% had less than three year experience in primary care. Among them, 43% were unaware and 45% had no opinion about the metabolic programming, 47% declared reading only eventually magazines and scientific articles about health. Regarding continuing education activities, 52% rarely participate in health care courses, 45% have the habit of participating in conferences. When asked about the most effective health information technology for community-based educational activities, the most cited were: women's culinary workshops, informational folders, multimedia lectures and educational videos. We conclude that it is necessary to stimulate continuing education in primary care health unites due to the turnover of health care professionals.

Keywords: Continuing education, pregnant women, primary health care, health professionals, metabolic programming.

INTRODUCTION

The metabolic programming is a concept defined by a process in which an insult (imprinting), occurred at a critical period of development - such as pregnancy or lactation - results in permanent changes in the structure and / or function of an organ or metabolic action (Barker, 1995; Lucas, 1999; Moura and Passos, 2005; De Moura et al., 2008). Epidemiological, clinical and experimental studies have shown that dietary changes, hormonal and environmental factors during critical periods of development could permanently affect the structure and

physiology of organs and tissues (Walker and Courtin, 1985; Dorner and Plagemann, 1994; Passos et al., 2000; Correa et al., 2011; Lloyd et al., 2012). In most cases, the inducing stimulus of programming is the lack of nutrients to the developing fetus, which amends the provision of nutrients to the tissues with preferential diversion of supply to the brain at the expense of other organs such as liver (Barker, 1997).

Several published studies show that changes in intrauterine life and during the early puerperium, may favor the emergence of Non-communicable diseases (NCDs), such as diabetes mellitus, hypertension, atherosclerosis and cardiovascular disease in adulthood (Barker et al., 1993; Godfrey and Barker, 2000; Passos et al., 2000; Passos et al., 2002; Phillips, 2002; Dutra et al.,

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Table 1. Frequency of health professional ages evaluated.

Variable		Frequency	(%)
Age	18 ---34	39	65
	35---51	20	33
	52---68	1	2
Total	-	60	100

Table 2. Gender of health professionals evaluated.

Variable		Frequency	(%)
Sex	Male	18	30
	Female	42	70
Total	-	60	100

2003; Passos et al., 2004; Vicente et al., 2004; Yura and Fuji, 2006 Fagundes et al., 2007; Moura et al., 2007; Lisboa et al., 2008, Fagundes et al., 2009; Correa et al., 2011). These studies demonstrate a significant association between future programming and endocrine-metabolic disorders, especially obesity and disorders of endocrine function.

Reorient models of health care requires an understanding of the health situation of a certain place in order to act based on that specific reality. In the case of NCD, they have their specificity, especially with regard to quality of life of people and their families (BRASIL, 2008).

Primary care should consider the subject in its uniqueness, complexity, comprehensiveness and socio-cultural dimensions, and seek to promote their health, prevent and treat diseases as well as reduce damage or suffering that may compromise their ability to live healthily (BRASIL, 2006). The Family Health Program, created in 1994 in Brazil, approaches health promotion respecting the guidelines of the Unified Health System (Sistema Único de Saúde) SUS, the Brazilian Public National Health System. SUS proposes a model of comprehensive care emphasizing primary care and the promotion of family health (Costa and Menezes, 2000). An innovative feature of PSF is its emphasis on the reorganization of primary health care units to focus on families and communities and integrate medical care with health promotion and preventive actions (MS, 2010).

Thus, the health professional acting in the Family Health Program becomes an intermediate element between the individual and his family and the basic health unit. All professionals involved in caring for pregnant women should join efforts in order to sensitize pregnant women for nutritional deficiencies in order to minimize the future effects of undesired metabolic programming. It is important to develop, among other skills, the ability to act as a multiplier of knowledge and facilitate habit changes to improve health. The present study sought to evaluate the perceptions and knowledge of health care workers about metabolic changes in pregnant women in a family clinic in the city of Rio de Janeiro.

METHODS

This study was approved by the Ethics in Human Research Committee of Gama Filho University – RJ (protocol 170/2011). Data collection was performed by applying a questionnaire containing objective questions to health professionals in a busy Family Clinic in a poor area of Rio de Janeiro city, selected on a convenience basis. It is a large unit with approximately 80 health professionals. The survey was conducted in January and February 2012. Health professionals with at least senior high school schooling assisting pregnant women were eligible and were invited to sign the informed consent. The questionnaire contained information on their sociodemographic characteristics, their continuing education activities, their knowledge and perceptions about metabolic programming and their opinions about community-based health education materials.

Data were gathered and analyzed using the descriptive statistics module of the *Statistical Package for Social Sciences* (SPSS Inc, IL, USA).

RESULTS

We included 60 health professionals, including physicians, nurses, nutritionists, nursing technicians and Community Health Agents (CHA). Their characteristics are displayed in Table 1. Most were young (18-34 years age), female and approximately half were married. Most were CHA, 67% had senior high school as their highest degree.

Profile of health professionals

Among health professionals aged between 18-66 years. The highest prevalence was for the range of 18 to 34 (65%) (Table 1).

A higher prevalence of female health professional (+288% vs. men) (Table 2). Regarding marital status, 52% of health professionals are married (Table 3).

Table 3. Marital Status of health professionals evaluated.

Variable		Frequency	(%)
Marital Status	Married	31	52
	Single	25	42
	Other	4	6
Total	-	60	100

Table 4. Occupation of respondents.

Variable		Frequency	(%)
Profession	Doctor	1	2
	Nurse	9	15
	Pharmaceutical	1	2
	Dentist	4	6
	Physiotherapist	2	3
	Practical Nursing	6	10
	CHA	34	57
	Other	3	5
Total	-	60	100

Table 5. Update of health professionals with readings of articles, courses and participate in meetings.

Variable	Regularity						
	Doctor	Nurse	Pharmaceutical	Dentist	Physiotherapist	Nursing technician	CHA
Reading magazines in the area of health /scientific articles	0/1(0%)	5/9(55%)	0/1(0%)	2/4(50%)	1/2(50%)	1/6(16%)	3/34(8%)
Participation in health care courses	1/1(100%)	8/9(89%)	0/1(0%)	2/4(75%)	0/2(50%)	3/6(50%)	4/34(11%)
Participation in Congresses	0/1(0%)	5/9(55%)	0/1(0%)	2/4(50%)	0/2(0%)	1/6(16%)	0/34(0%)

Table 6. Assessment of prior knowledge of health professionals on the subject of metabolic programming.

Variable	Without knowledge of metabolic programming						
	Doctor	Nurse	Pharmaceutical	Dentist	Physiotherapist	Nursing technician	CHA
Metabolic programming(do not know what that is)	1/1(100%)	6/9(67%)	1/1(100%)	3/4(75%)	0/2(0%)	4/6(67%)	31/34(91%)
Causes of metabolic programming(Unable to respond)	1/1(100%)	6/9(67%)	1/1(100%)	2/4(50%)	1/2(50%)	5/6(86%)	32/34(94%)

The survey of health professionals showed that 82% of health professionals were interviewed CHA, nurses and nursing, respectively, and 67% with secondary education (Table 4).

Assessment of professional updating

Overall evaluation of health professionals as the technical investment professional, 47% said they only

sometimes read scientific journals eventually, 52% eventually attend health courses and 45% attend conferences (Table 5).

Regarding their self-evaluated knowledge on the subject metabolic programming, 80% declared they knew nothing and 83% answered incorrectly the main causes and stimuli that induce metabolic programming (Table 6).

When asked to assess the quality of life around the family clinic, 47% of respondents viewed as bad (Table 7).

Table 7. Classification of quality of life around the family clinic that performs like a professional.

Variable	Frequency	(%)
Good	5	8
Regular	20	33
Bad	28	47
Rubbish	7	12
Total	60	100

Table 8. Evaluation of the choice of information technology in health for working with pregnant women with the metabolic programming theme.

Variable	Frequency	(%)
Individual consultation with nutrition	12	20
Group of women with culinary workshop	32	53
Referral to nutrition	16	27
Total	60	100

Table 9. Evaluation of the choice of health information technology for development work in NASF themed metabolic programming.

Variable	Yes		Not	
	Frequency	%	Frequency	%
Printed booklet	28	47	32	53
Folder information	34	57	26	43
Flipchart	14	23	46	77
<i>Datashow</i>	35	58	25	42
Educational video	32	53	28	47
Primer-Magnetic Magnet	17	28	43	72

When asked about information technology in health care, offered by NASF, to contribute to the improvement in the acquisition of knowledge related to metabolic programming, 53% chose the group of women with cooking classes (Table 8).

In evaluating information technology in health, such as subsidies for development work in NASF, were chosen: informational folders, use of equipment Data show with slides and educational videos (over 50% choice on each topic) (Table 9).

As for length of service in primary care, 63% of respondents had up to three years of work, supporting the importance of investment in continuing education in primary care due to the arrival of new professionals.

DISCUSSION

In the present paper, we reviewed the previous

knowledge on metabolic programming among health professionals who work directly with pregnant women in a primary care setting in a poor region in Rio de Janeiro on issues related to the neglect of power and relations with future consequences for the fetus, increasing the prevalence of Chronic Non Communicable Diseases (NCDs) such as obesity, hypothyroidism, cardiovascular disease and type II diabetes, all caused by metabolic programming.

The term "programming" refers to a permanent change for a particular function, consequent to a stimulus or aggression (imprinting) occurred at a critical period of life, such as pregnancy or lactation (Barker, 1995; Lucas, 1999; Moura and Passos, 2005, De Moura et al., 2008). Several epidemiological studies, clinical and experimental studies have shown that dietary changes, hormonal and environmental factors during critical periods of development could permanently affect the structure and physiology of organs and tissues (Walker and Courtin,

1985; Pracyck et al., 1992; Dorner and Plagemann, 1994; Passos et al., 2000, Godfrey & Robinson, 1998, Correa et al., 2011), predisposing the genesis, in adulthood, cardiovascular disease and metabolic syndrome (obesity, dyslipidemia, hypertension and diabetes mellitus type 2) (Barker et al., 1993, Godfrey and Barker, 2000; Phillips, 2002; Yura and Fuji, 2006).

Corroborating the epidemiological and clinical studies, which require a more careful interpretation of interference and involve many variables, experimental models have shown the influence of various factors on the prevalence of diseases in adulthood (maternal malnutrition during pregnancy and / or lactation exposure to environmental factors or hormones) (Desai et al., 1995; Pires et al., 2006; Hoppe et al., 2007).

In most cases, the inducing stimulus of programming is the lack of nutrients to the developing fetus, which amends the provision of nutrients to the tissues with preferential diversion of supply to the brain at the expense of other organs such as liver (Barker and Clark, 1997).

Ravelli et al., (1976) were among the first researchers to link obesity in adulthood with malnutrition in early life. In this epidemiological study, there was a higher incidence of obesity in adult offspring whose mothers suffered food restriction in the first two trimesters of pregnancy. Subsequently, experimental studies have also shown that association (Steps et al., 2000; Costa et al., 2011).

Several studies have assessed the possible association between fetal malnutrition and hypertension and / or heart failure. It was shown that patients with nutritional deficiency during fetal life are more prone to hypertension (Langley-Evans and Jackson, 1996; Lisboa et al., 2012). These concepts were reinforced by studies indicating that maternal diet during pregnancy and inadequate perinatal affect organogenesis and, consequently, the functionality at maturity. Such changes would make the adult problems such as hypertension, cardiovascular and renal disease (Ingelfinger and Woods, 2002). Fernandez-Twinn et al., (2006) showed that maternal protein restriction during gestation and lactation program the heart's response to β -adrenergic stimulation, suggesting a higher risk of heart failure.

Pires et al. (2006) showed that the protein restriction (5% protein) or calories (50%) during pregnancy and lactation alters the renal structure of the offspring, increasing the chance presenting hypertension in adult life. Also in this context, Marcelino et al. (2004) demonstrated hypertension and decreased nitric oxide synthase in the offspring of mothers submitted to diet with 0% protein in early lactation.

It has been shown increase of catecholamines in adult rats whose mothers received low protein diet during pregnancy and lactation (Petry et al., 2001).

The protein malnutrition and / or caloric, during pregnancy or lactation, several program changes in

glucose homeostasis in adulthood, such as hyperinsulinemia and insulin resistance (Fernandez-Twinn et al., 2003; Lisboa et al., 2012).

During pregnancy, calorie restriction of 30% is associated with hyperleptinemia, hyperphagia, hyperinsulinemia and obesity in female adult offspring (Vickers et al. 2001a, Vickers et al., 2001b). In lactation, maternal severe protein malnutrition (0% protein) increases serum leptin (Moura et al., 2002; Lisboa et al., 2012).

Despite the many studies definitely showing the risks of malnutrition during pregnancy, we have demonstrated that health care workers dealing with poor pregnant women are largely unaware of these risks. There is an urgent need for improving their awareness so that they can transmit knowledge and help pregnant women to incorporate healthy nutritional habits, especially during this gestational period. Constant training to health professionals, providing the multiplication of information generated by scientific research, with continuous production of knowledge, which should arrive as soon as possible the population served in order to minimize damage health and contribute to the improvement in quality of life.

Shares of Nutrition part of the commitment of the health sector with respect to the components of the System of Food and Nutritional Security created by Law No. 11346 of September 15, 2006, with a view to the human right to adequate food. In primary care these actions and Nutrition are the responsibility of the NASF (Centers for Family Health Support) created by the Ministry of Health in order to emphasize the inclusion of the Family Health Strategy in the service network and expand the coverage, resolution, territorialization, regionalization, and the expansion of the shares of NAPS in Brazil. Nutrition is inserted in this context with actions to promote healthy eating habits at all stages of the life cycle and responses to major health care demands regarding eating disorders, nutritional deficiencies and malnutrition.

Among the respondents 47% said they only sometimes read magazines in the area of health and scientific articles and 52% participate sometimes courses in health and 45% did not have the habit of attending conferences, relatively high number of health professionals remote access to professional development, 63% of professionals with up to three years of work in primary health care. As already highlighted by the Ministry of Health, the continuing education of health professionals is fundamental to the transformation of the labor process, which includes the learning needs of the multidisciplinary team, based on community values, knowledge, habits and attitudes (Ministry Health, 2005; WHO, 2005; Fortuna et al., 2011).

When asked about the theme metabolic programming 80% did not know about it and 83% had no opinion on the stimulus of metabolic programming. These findings

highlight the importance of continuing education for health professionals, as the NASF represents the first contact in the health care network within the health system, characterized mainly by the continuity and comprehensiveness of care, and the coordination of assistance within the system itself, the family-centered care, guidance and community involvement and cultural competence of professionals.

In this scenario, the challenges are many. The health systems of different countries are suffering the impact caused by a scenario of high spending and resource constraints in health and the consequent restructuring of services. Thus, managers are demanding reliable information about the benefits of technology and financial impact on the public sphere in order to support policy formulation and effective decision making. The Health Technology Assessment (HTA) is a comprehensive research of clinical consequences, economic and social use of health technologies, existing or emerging from research and development to obsolescence. Presented as sources of research: efficacy, effectiveness, safety, risks, costs, cost-effectiveness ratios, cost-benefit, cost-utility, equity, ethics, economic and environmental implications of technology, among other variables involved in the decision making of health administrators (BRAZIL, 2006).

Interestingly, health care workers pointed audiovisual educational materials as their preferred method. Previous studies of pregnant women described positive experiences with the use of health information technologies as tools for upgrading and acquisition of healthy behaviors (Delfino et al., 2004; Duarte and Andrade, 2006).

In summary, our data underlie the importance of investment in continuing education in primary care due to the arrival of new professionals.

REFERENCES

- Barker DJ (1995). The fetal and infant origins of disease. *Eur. J. Clin. Invest.* 25: 457-463.
- Barker DJ (2003). The developmental origins of adult disease. *Eur. J. Epidemiol.*, 18 (8): 733-736.
- Barker DJ, Clark PM (1997). Fetal undernutrition and disease in later life. *Rev. Reprod.* 2(2):105-112.
- Barker DJ, Martyn CN, Osmond C, Hales CN, Fall CH (1993). Growth in utero and serum cholesterol concentrations in adult life. *BMJ.* 307:1524-1527.
- BRAZIL. Ministry of Health Bureau of Health Care Department of Primary Care. National policy for primary care / Ministry of Health, Bureau of Health Care, Department of Health Care - Brasília: Ministry of Health, 2006. 60 wt. - (Series A. Technical Standards and Manuals) (Series Pacts for Health 2006, vol. 4).
- BRAZIL. Ministry of Health Secretariat of Health Surveillance Secretariat of Health Care Guidelines and recommendations for the comprehensive care of chronic non-communicable diseases, health promotion, surveillance, prevention and care / Ministry of Health, Secretariat of Health Surveillance, Department of Health Care - Brasília: Ministry of Health, 2008. 72 p. - (Series B. Basic Texts of Health Care) (Series Pacts for Health 2006; v. 8).
- Ceballos LT (2007). Síndrome metabólico en la infancia. *An Pediatr (Barc)*. 66:159-66.
- Correa CL, Lisboa PC, Oliveira E, Moura EG, Oliveira RMF, Gomes AC, Machado-Silva JR (2011). The outcome of acute schistosomiasis infection in adult mice with postnatal exposure to maternal malnutrition. *Mem. Inst. Oswaldo Cruz.*, 106(5): 584-593.
- Costa N, Menezes M (2000). The implementation of the Family Health Unit. Department of health policies. Department of Primary Care. Ministry of Health.
- Costa RR, Villela NR, Souza MG, Boa BC, Cyrino FZ, Silva SV, Lisboa PC, Moura EG, Barja-Fidalgo TC, Bouskela E (2011). High fat diet induces central obesity, insulin resistance and microvascular dysfunction in hamsters. *Microvasc Res.* 82(3):416-22.
- De Moura EG, Lisboa PC, Passos MCF (2008). Neonatal programming of neuroimmunomodulation - role of adipocytokines and neuropeptides. *Neuroimmunomodulation.* 15: 176-188.
- Delfino MRR, Patrício ZM, Martins AS, Silvério MR (2004). The participant caring process with a group of pregnant: impact on overall health and individual and collective. *Bull World Health coletiva.* 9 (4):1057-66.
- Desai M, Crowther N, Ozanne SE, Lucas A, Hales CN (1995). Adult glucose and lipid metabolism may be programmed during fetal life. *Biochem Soc Trans.* 23: 331-335.
- Dorner G, Plagemann A (1994). Perinatal hyperinsulinism as possible predisposing factor for diabetes mellitus, obesity and enhanced cardiovascular risk in later life. *Horm Metab Res.* 26: 216-221.
- Duarte SJHD, Andrade SMO (2006). Assistência pré-natal no Programa Saúde da Família. *Esc. Anna Nery.* 10(1):121-25.
- Dutra SCP, Passos MCF, Lisboa PC, Santos R, Cabanelas AP, Pazos-Moura CC, Moura EG (2003). Liver deiodinase activity is increased in adult rats whose mothers were submitted to malnutrition during lactation. *Horm Metab Res.* 35: 268-270.
- Fagundes A T S, Moura E G, Passos M C F, Santos-Silva A P, Oliveira E, Trevenzoli I H, Casimiro-Lopes G, Nogueira-Neto JF, Lisboa PC (2009). Temporal evaluation of body composition, glucose homeostasis and lipid profile of male rats programmed by maternal protein restriction during lactation. *Horm Metabol Res.* 41,866-873.
- Fagundes AT, Moura EG, Passos MC, Oliveira E, Toste FP, Bonomo IT, Trevenzoli IH, Garcia RM, Lisboa PC (2007). Maternal low-protein diet during lactation programmers' body composition and glucose homeostasis in the adult rat offspring. *Br J Nutr.* 98, 922-928.
- Fernandez-Twinn DS, Ekizoglou S, Wayman A, Petry CJ, Ozanne SE (2006). Maternal low-protein diet programs cardiac beta-adrenergic response and signaling in 3-mo-old male offspring. *Am. J. Physiol. Regul. Integr. Comp. Physiol.* 291(2): R429-436.
- Fortuna CM, Franceschini TR, Mishima SM, Matumoto S, Pereira MJ (2011). Movements of permanent health education triggered by the training of facilitators. *Rev Lat Am Enfermagem.* 19(2):411-20.
- Godfrey KM, Barker DJ (2000). Fetal nutrition and adult disease. *Am. J. Clin. Nutr.* 71(5): 1344-1352.
- Hoppe CC, Evans RG, Moritz KM, Cullen-McEwen LA, Fitzgerald SM, Dowling J, Bertram JF (2007). Combined prenatal and postnatal protein restriction influences adult kidney structure, function, and arterial pressure. *Am J Physiol Regul Integr Comp Physiol.* 292: 462-469.
- Ingelfinger JR, Woods LL (2002). Perinatal programming, renal development, and adult renal function. *Am. J. Hypertens.* 15: 46-49.
- Langley-Evans SC, Gardner DS, Jackson AA (1996). Association of disproportionate growth of fetal rats in late gestation with raised systolic blood pressure in later life. *J Reprod Fertil.* 106: 307-312.
- Lisboa PC, Fagundes AT, Denolato AT, Oliveira E, Bonomo IT, Alves SB, Curty FH, Passos MC, Moura EG (2008). Neonatal low-protein diet changes deiodinase activities and pituitary TSH response to TRH in adult rats. *Exp. Biol. Med.* 233(1): 57-63.
- Lisboa PC, Oliveira E, Fagundes AT, Santos-Silva AP, Conceição EP, Passos MC, Moura EG (2012). Postnatal low protein diet programs leptin signaling in the hypothalamic-pituitary-thyroid axis and pituitary TSH response to leptin in adult male rats. *Horm Metab Res.* 44(2):114-22.
- Lloyd LJ, Foster T, Rhodes P, Rhind SM, Gardner DS (2012). Protein energy malnutrition during early gestation in sheep blunts fetal renal

- vascular and nephron development and compromises adult renal function. *J. Physiol.* 590:377-393.
- Lottenberg S A, Glezer A, Turatti LA (2007). Síndrome metabólica: identificando fatores de risco. *J. Pediatr. (Rio J.)* [online]. 83 (5): 204-208.
- Lucas A, Eds Zieger EE, Moro GE (1999). Early nutrition and later outcome. Nutrition of the very low birthweight infant. In Nestlé Nutrition Workshop Series. 43:1-13.
- Marcelino AA, Moura AS, Barradas PC, Tenorio F (2004). Hypothalamic nuclei nitric oxide synthase expression in rats malnourished during early lactation period. *Nutr Neurosci.* 7(3):177-184.
- Ministry of Health (BR). Order no. 198/GM/MS of February 13, 2005 (BR). Establishing the National Education Policy as Permanent Health Strategy Health System for training and workforce development for the sector and other measures. 2005 [accessed 23 April 2012]. Available at: <http://www.saude.pb.gov.br/site/geab/portaria198.pdf>.
- Moura AS, Caldeira Filho JS, Mathias PC, Franco de Sá CCN (1997). Insulin secretion impairment and insulin sensitivity improvement in adult rats undernourished during early lactation. *Res. Commun. Mol. Pathol. Pharmacol.* 96: 180-192.
- Moura AS, Franco de Sá CCN, Cruz HG, Costa CL (2002). Malnutrition during lactation as a metabolic imprinting factor inducing the feeding pattern of offspring rats when adults. The role of insulin and leptin. *Braz. J. Med. Biol. Res.* 35: 617-622.
- Moura EG, Bonomo IT, Nogueira-Neto JF, Oliveira E, Trevenzoli IH, Reis AM, Passos MCF, Lisboa PC (2009). Maternal prolactin inhibition during lactation programs for metabolic syndrome in adult progeny. *J. Physiol.* 587: 4919-4929.
- Moura EG, Lisboa PC, Custódio CM, Nunes MT, Souza KP, Passos MCF (2007). Malnutrition during lactation changes growth hormone mRNA expression in offspring at weaning and adulthood. *J Nutr Biochem.* 18: 134-139.
- Moura EG, Passos MCF (2005). Neonatal programming of body weight regulation and energetic metabolism. *Biosci Rep.* 25 (3/4): 251-269.
- Moura EG, Santos RS, Lisboa PC, Alves SB, Bonomo IT, Fagundes AT, Oliveira E, Passos MC (2008). Thyroid function and body weight programming by neonatal hyperthyroidism in rats - the role of leptin and deiodinase activities. *Horm Metab Res.* 40(1):1-7.
- Passos MC, Lins MC, Lisboa PC, Toste FP, Bonomo IT, de Moura EG (2007). Maternal leptin
- Passos MC, Ramos CF, Dutra SC, Mouco T, Moura EG (2002). Long-term effects of malnutrition during lactation on the thyroid function of offspring. *Hormones Met Res.* 34: 40-43.
- Passos MCF, Ramos CF, Moura EG (2000). Short and long term effects of malnutrition in rats during lactation on the body weight of offspring. *Nutr. Res.* 20(11): 1603-1612.
- Passos MCF, Toste FP, Dutra SCP, Trotta PA, Pereira-Toste F, Lisboa PC, Moura EG (2009). Role of neonatal hyperleptinemia on serum adiponectin and suppressor of cytokine signalling-3 expression in young rats. *Brit. J. Nutri.* 101: 250-256.
- Passos MCF, Vicente LL, Lisboa PC, Moura EG (2004). Absence of anorectic effect to acute peripheral leptin treatment in adult animals whose mothers were malnourished during lactation. *Horm Metab Res.* 36: 625-629.
- Petry CJ, Ozanne SE (2001). Effects of maternal iron restriction in the rat on blood pressure, glucose tolerance, and serum lipids in the 3-month-old offspring. *Metabolism.* 50(5): 562-7.
- Phillips DIW (2002). Endocrine programming and fetal origins of adult disease. *Trends Endocrinol. Metabol.* 13: 363-364.
- Pires KM, Águila MB, Mandarim-de-Lacerda CA (2006). Early renal structure alteration in rat offspring from dams fed low protein diet. *Life Sci.* 79(22): 2128-2134.
- Ravelli GP, Stein Z, Susser M (1976). Obesity in young men after famine exposure in utero and early infancy. *N. Engl. J. Med.*, 295: 349-53.
- treatment during lactation programs the thyroid function of adult rats. *Life Sci.* 19: 1754-8.
- Vicente LL, Moura EG, Lisboa PC, Costa AMA, Amadeu T, Mandarim-de-Lacerda CA, Passos MCF (2004). Malnutrition during lactation is associated with higher expression of leptin receptor in pituitary of the adult offspring. *Nutri.* 20: 924-928.
- Vickers MH, Ikenasio BA, Breier BH (2001a). IGF-I treatment reduces hyperphagia, obesity, and hypertension in metabolic disorders induced by fetal programming. *Endocrinol.* 142(9): 3964-3973.
- Vickers MH, Reddy S, Ikenasio BA, Breier BH (2001b). Dysregulation of the adipoinular axis a mechanism for the pathogenesis of hyperleptinemia and adipogenesis diabetes induced by fetal programming. *J. Endocrinol.* 170(2): 323-332.
- Walker P, Courtin F (1985). Transient neonatal hyperthyroidism results in hypothyroidism in the adult rat. *Endocrinol.* 116: 2246-2250.
- WHO (2005). Preventing chronic diseases: a vital investment. Geneva: World Health Organization,
- Yura S, Fujii S (2006). Obesity in offspring with maternal undernutrition during pregnancy. *Nippon Rinsho.* 64(4): 795-780.