

Maternal behavioral factors influencing postpartum weight retention. Clinical and metabolic implications

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Abstract

Objectives: to describe some factors of maternal behavior such as breastfeeding, diet, physical activity, sleep and clinical-metabolic disorders associated with retention and/or weight gain during postpartum.

Methods: specific articles on the subject were searched in LILACS, MEDLINE/PubMed and SciELO databases.

Results: the literature review suggests that breastfeeding or physical activity alone are not enough to return to the pre-pregnancy weight, if they are not combined with restrictions of energy intake. Reduced sleep affects both eating habits and activity patterns resulting in lower energy expenditure, in addition to altering the glycemetic metabolism.

Conclusions: maternal obesity increases the risk of metabolic syndrome. Interventions during postpartum are critical for maternal health and could be the key in reducing the risk of transgenerational maternal/childhood obesity.

Key words *Postpartum period, Maternal behavior, Obesity, Metabolic syndrome X, Sleep deprivation, Insulin resistance*

Introduction

In the last decades concerns on maternal health has been widely concentrated on the access and quality of care during pregnancy and childbirth. In contrast the post-partum period has not been receiving the same importance. During this period women undergo deep modifications involving the recovery of the genital apparatus as well as endocrine and nutritional functions.¹ One of the most evident physical changes is the weight loss, averaging 0.6 and 0.8 kilograms/month for the first six months.² However, many women may retain or even gain weight one year after delivery. This additional weight gain may have a cumulative effect in subsequent pregnancies,³ increasing the risk of maternal obesity and related morbidities in all the reproductive cycle.⁴ Therefore, weight loss is relevant for women who gained excessive weight during pregnancy and critical in those who were overweight or obese at the beginning of pregnancy.⁵

Homeostasis of postpartum maternal weight depends on the balance of energy resources, whose basic components of expenditure are primarily associated with breastfeeding and physical activity patterns. During this period there are also changes in the sleeping patterns,⁶ with reduced sleeping hours as a result of taking care of the child, which may persist for weeks or even months.⁷ It is thought that in the Western societies obesity has increased in parallel with decreased sleep, so this could be a relevant component in weight homeostasis and postpartum metabolism.⁸

The factors that modify maternal postpartum weight - both pre-pregnancy weight and weight gained during pregnancy, as well as those involved in energy balance - are highly variable among women. In general, during the postpartum period there is an increase in energy intake and a reduction in physical activities. As a result, approximately 20% of the mothers keep or even gain weight with the consequent development of obesity.⁸⁻¹⁰

According to Kac¹¹ weight gain during pregnancy and lactation are the main factors involved in the postpartum weight retention. He also noted the need for analyzing physical activities, food consumption and other lifestyle factors sparsely researched. This article describes some factors of maternal behavior related to lactation, diet, physical activities and sleep time involved in the postpartum weight homeostasis. We also examined the clinical and metabolic implications of weight retention and/or weight gain in this period. For this review we searched information in medical textbooks and arti-

cles from LILACS, MEDLINE/PubMed, and SciELO databases, using the postpartum weight retention, breastfeeding, dietary intake, sleep deprivation, insulin resistance as main key words.

Breastfeeding

Breastfeeding has important health benefits both for the child and the mother, including its preventive role in the development of maternal and child obesity.¹² During the postpartum period, the mother should lose weight to return to the pre-pregnancy weight, while maintaining nutritional requirements for adequate breastfeeding. This lactation pattern appears to have a protective effect against postpartum weight retention, particularly when it lasts for at least 6 months.¹³ The mechanisms underlying this phenomenon involve changes in the endocrine environment favoring lipolysis in liver and peripheral tissues and mammary lipogenesis due to the combined action of prolactin and insulin.¹⁴ These neuroendocrine changes would preserve the substrates necessary for the milk synthesis facilitating the supply of nutrients to the mammary gland.¹⁴

It has been estimated that lactating women lose around 0.6 and 0.8 kilograms/month in the first six postpartum months, but this figure is a very variable to be suggested that there is nonlinear association between breastfeeding and weight loss.^{10,15} Rather, this relationship would be conditioned by the duration of breastfeeding and maternal nutritional status, to which we could add cultural factors, psychological and activity patterns and among others. This complexity of factors probably explains the variability of maternal weight trajectories during the postpartum period. Indeed, some studies have found that breastfeeding promotes postpartum weight reduction^{15,16} but also it is evident that a similar weight loss pattern has been observed in both lactating and non-lactating women, showing a lack of association between breastfeeding and maternal weight.^{17,18}

Butte and Hopkinson¹⁵ reported that a strongest predictor of postpartum weight change is the weight gained during pregnancy. However, it has also been observed that women who started their pregnancy overweight or obese are more likely to not breastfeed compared to women with normal or low pregestational weight. Thus, maternal obesity, before or during gestation, has been associated with delayed onset and shorter duration of lactation.^{19,20} Obese mothers are at increased risk for prolonged labor, excessive stress at delivery and present a higher prevalence of cesarean section than non-obese ones,

factors that delay lactogenesis II, when a greater milk secretion is stimulated by prolactin.¹² Regarding this, Rasmussen and Kjolhede²¹ observed that prior to lactogenesis II, overweight or obese women had lower levels of prolactin in response to suction, suggesting that the onset, and not only the duration of breastfeeding, is negatively affected by the maternal body mass index (BMI). Overweight and obese women show elevated levels of hormones produced or stored in the adipose tissue. This tissue is a large reservoir of progesterone, which has known inhibitory effects on prolactin.²² Leptin could be another endocrine factor associated with breastfeeding. This hormone, produced by adipose tissue and the placenta, is elevated in obese women. In vitro studies have found that leptin inhibits the myometrial contractions induced by the oxytocin,²³ so high levels of leptin in obese women may also inhibit milk ejection.¹²

In addition to the hormonal mechanisms that favor weight retention in obese mothers, psychological and sociocultural factors should also be mentioned. At present, studies on maternal behavioral factors related to breastfeeding are scarce.²⁰⁻²³ The available evidence defies the statement that breastfeeding promotes weight loss, but more robust studies are needed to assess its real impact on postpartum weight by adjusting different confounding factors. At the same time, it marks the greater risk of late onset and early cessation of breastfeeding in overweight and obese women.

Diet

Lactating women must increase the energy consumption through a varied diet, in order to satisfy the nutritional demands that require the breast milk synthesis. An additional 500 Kcal/day is recommended during the first six postpartum months and 400 Kcal/day for the following months.²⁴ Several epidemiological studies have shown that women who breastfeed increase their caloric intake but decrease their energy expenditure.^{25,26} Antonakou *et al.*²⁷ found that energy intake during the first trimester of postpartum was 2000 Kcal and the energy expenditure was 1870 Kcal. Even with this positive energy balance, the weight loss was 0.7 kilograms/month. The authors referred that weight loss could be part of a natural energetic process that involves breastfeeding.

Clearly, the maintenance of the energy balance depends not only on the energy expenditure produced by breastfeeding, but also on women's energy consumption during postpartum.^{25,26,28} In a prospective study, Castro *et al.*²⁹ evaluated the effect

of the food pattern on the change in body weight during this period. They found that women showed less weight change by eating a mixed diet than those who ate a healthy one. However, these women had higher income and schooling, so their socioeconomic status and eating habits could have had an important role on the dietary pattern beyond pregnancy and postpartum periods.

Regardless to the diet composition, the total energy intake plays an important role in weight retention.^{2,29} In this sense, the additional calories recommended for lactating women may be excessive for those who are overweight or obese, since this weight gain can be used during breastfeeding, exempting the daily intake to cover all nutritional needs.^{2,29,30} Nevertheless, it is unclear whether a clinically relevant weight loss can be achieved in this group of women and what type of treatment would be optimal. In a follow-up of overweight and obese lactating women subjected to 500 Kcal/day restriction and moderate physical activities for ten weeks, the weight loss averaged 4.8 kilograms.³¹ Another intervention study performed between the third and sixth postpartum months found only that a diet restriction promoted a significant weight loss (9%), which was sustained for nine months after the intervention.²⁵ This weight loss implied a caloric reduction as well as changes in the diet composition, with lower proportions of fat and sucrose intake and higher content of carbohydrates and fibers complexes.²⁸ Huseinovic *et al.*³² observed that reducing and/or replacing high-calorie food such as snacks and soft drinks for vegetable consumption significantly reduced postpartum weight. Increased protein intake has also been associated with postpartum weight loss.³³ Furthermore, it has been postulated that diets with low glycemic index could be effective to control overweight and obesity as reported in a follow-up from pregnancy through postpartum, during which women lost weight and improved their nutritional behaviors that continued over time.³⁴

The meals frequency is another aspect of the maternal diet, but the association between the number of daily meals and the control of body weight is still discussed.³⁵ A prospective trial in overweight and obese women however, reported a positive association between food frequency and energy intake at the beginning of this study. The reduced food frequency resulted in lower intake and weight loss,³⁶ suggesting the importance of food frequency on postpartum weight retention.

Physical activity

Regular physical activity have important benefits for cardiovascular health and the lipid profile in lactating women, as well as facilitating a faster return to the pre-gestational weight.³⁷ Additionally, some epidemiological studies have reported the inverse relationship between prenatal physical activity and maternal postpartum depression.^{38,39} The maternal-fetal benefits in maternal physical activity have encouraged some institutions to promote the practice of physical exercises during pregnancy, establishing general guidelines that propose the gradual restart of postpartum routines. Despite such benefits, both pregnancy and postpartum are associated with lower levels of physical activity. Ainsworth *et al.*⁴⁰ analyzed activity patterns in overweight or obese women enrolled in a physical activity program. They observed that more than 50% of the women remained sedentary for about 9 hours a day, 37% performed light activities and 11% moderate activities. Even those women who were physically active before their pregnancy tended to reduce their activity level during this period.

The role of physical activity in postpartum weight loss has been examined both in observational studies and clinical trials. The differences in the study designs, duration, population, methods, instruments used and among others, make it difficult to compare them all. However, the results in both types of the studies have been summarized in several review articles and meta-analyses. One of them, published by Amorim Adegboye and Linne,⁴¹ evaluated the impact of physical activity with or without caloric restriction on weight, body composition, cardio-respiratory fitness and breastfeeding. The dietary restriction was associated with weight loss and the reduction of fat-free mass, but it did not affect the fat mass. In contrast, physical exercises did not promote a significant weight loss, although the cardio-respiratory capacity of women who performed physical activities has increased.

The combination of physical activities and dietary restriction was associated with significant weight loss and reduced fat mass. Fat-free mass, plasma prolactin, milk volume, as well as linear and ponderal growth of the baby did not show differences in any of the cases. The authors concluded that physical activity does not modify postpartum weight but improves the cardio-respiratory health. The lack of impact of physical activity on postpartum weight loss could be caused by an increase of energy intake. In this respect, Larson-Meyer³⁷ referred that the studies are not conclusive regarding the role of exercise as a major promoter of weight

loss and body fat in postpartum. Women with exclusive breastfeeding, the "inefficiency" of regular physical activity for weight reduction can be attributed to increased energy intake. Dewey *et al.*⁴² suggested that women who performed physical activity compensated their energy expenditure by reducing other daily activities, but not their energy intake.

Another meta-analysis by Nascimento *et al.*⁴³ reported that although interventions in physical activity promotes postpartum weight loss, the impact is much intense when physical exercise is combined with dietary interventions. They concluded that the interventions that combine physical activities with changes in energy intake cause greater weight loss than those that consider exercise alone or combined with nutritional counseling. Accordingly, Van der Pligt *et al.*⁴ pointed out that the most effective interventions are those that include the components of dieting and physical activity. On the other hand, the mentioned studies did not report any adverse effect of physical activity on breastfeeding.^{41,42} Moreover, several guidelines on physical activity during postpartum encourage to perform both physical activity and breastfeeding.⁴³ Despite these observations, many women do not follow such recommendations.³⁸ Some studies, including qualitative approaches suggest the existence of barriers such as maternity and family responsibilities, lack of time, lack of family and/or social support and fatigue among others.^{45,46}

The current evidence suggests that mothers who combine physical activity with changes in the dietary intake are most likely to return to their pre-pregnancy weight, but further researches should be done about the influence of breastfeeding and other factors that may intermediate this relationship, such as socioeconomic level.

Sleep deprivation

The obesity epidemic has been associated with chronic sleep deprivation.⁴⁷ The postpartum is a period particularly associated with sleep worsening, which may persist for several weeks or even months,⁶ that is why maternal sleep is considered a new risk factor for weight gain and obesity during the postpartum.^{8,47} In fact, it has been reported that women with less than 5 sleeping hours/day at 6 months postpartum can retain 5 or more kilograms at 12 postpartum months.⁷

In Figure 1 some possible explanatory pathways to develop diabetes and obesity are shown. Sleep restriction seems to be associated with an increase in the activity of the sympathetic nervous system,

which can lead to reduced insulin secretion, along with an increased diurnal release of growth hormone and nocturnal cortisol, resulting in increased insulin resistance and glucose intolerance.^{8,9} Glucose tolerance is a term that describes how the body controls glycemia for the tissues and brain. In fasting conditions, the high blood levels of glucose and insulin indicates an inadequate administration of glucose. There is evidence that impaired glucose tolerance is a risk factor for type 2 diabetes.⁴⁸

A short duration of sleep could also affect the appetite regulatory hormones. There are several hormones acting with opposite functions in this mechanism, but two of them are keys: leptin and ghrelin.⁴⁹ Leptin is a hormone derived from adipocytes that suppresses the appetite, while ghrelin is a peptide produced in the stomach that stimulates the appetite. Sleeping less than 8 hours has been found to be associated with low levels of leptin and high levels of ghrelin.⁴⁹ This suggests that sleep deprivation is a risk factor for obesity.

An inadequate sleep may also modify eating and drinking patterns.⁵⁰ Individuals who sleep fewer

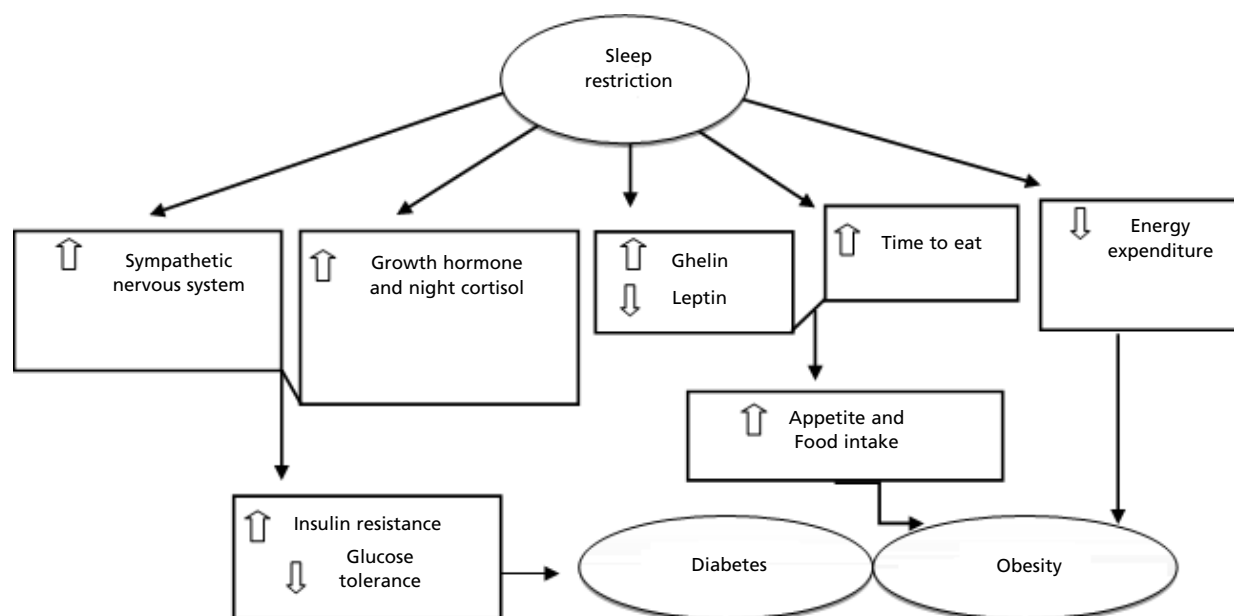
hours consume foods with high energy content. This could occur through an alteration of the neural pathways that regulate rewarding behaviors, which would stimulate the consumption of caloric food.⁵¹ It was also found that staying awake at night would lead to physiological changes that promote hunger. In a controlled trial, individuals who went to bed late were shown to have lower concentrations of leptin than those who went to bed earlier.⁵²

Similarly, women with short sleep duration tend to get up early and eat more snacks throughout the day, changing their eating pattern.⁵² Generally, snacks are food rich in carbohydrates and poor in proteins (may lead to micronutrients deficiency). They also eat more calories and fat with higher LDL cholesterol levels than people who regularly have breakfast.⁵³ The kind of food intake affects quality of sleep. St-Onge *et al.*⁵³ found that individuals who ate more saturated fats and sugars had lighter, less restful, and more disturbed sleep.

At the extreme of the energy equation, people with poor sleep are probably less physically active, resulting in lower caloric expenditure. If there is an

Figure 1

Possible explanatory pathways relating to sleep and the metabolism.



Adapted from Knutson and Van Cauter⁹

increase in the appetite and eating desire are combined in reducing physical activity, then it is evident the importance of sleeping to regulate body weight.

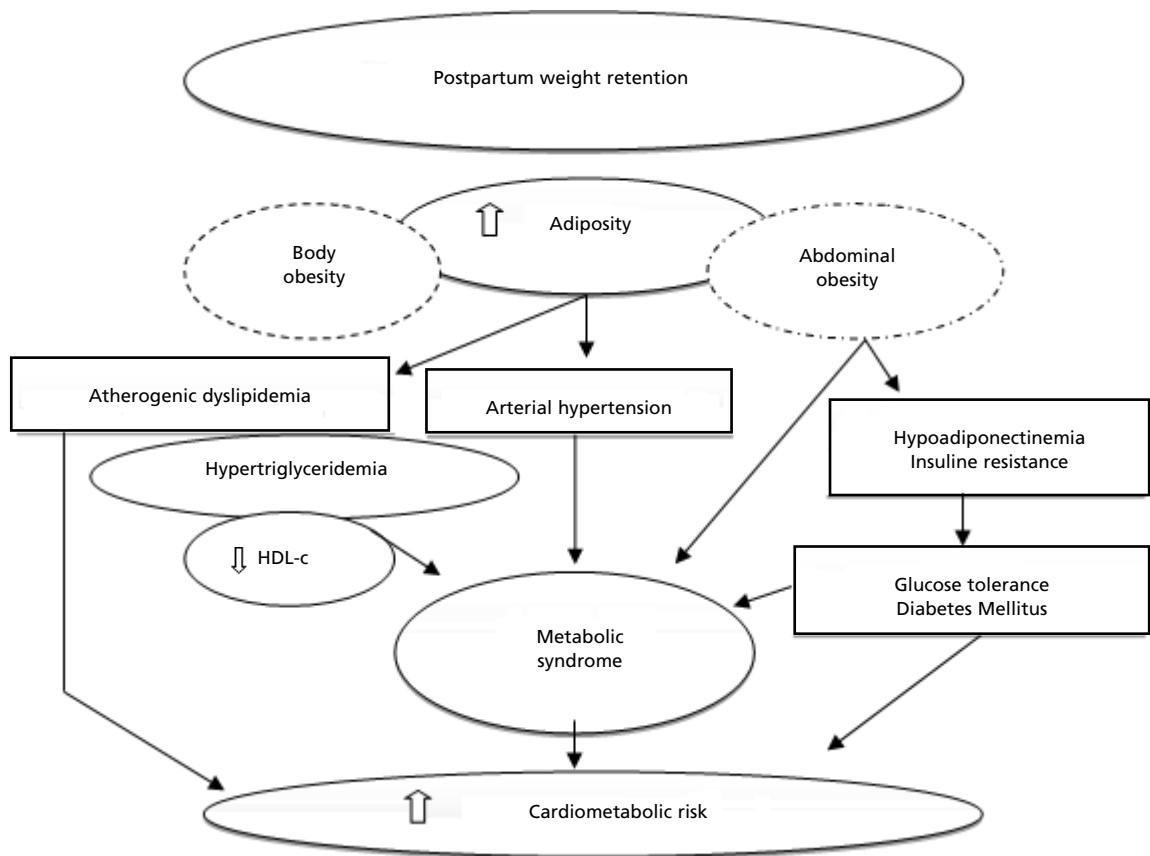
Clinical and metabolic implications

Figure 2 represents a flowchart describing the relationships among postpartum weight retention and clinical and metabolic disorders. One year after delivery, approximately 42% of the mothers returned to their pregestational weigh,¹⁰ 10% retained 5 to 10 kilograms and nearly 3% retained more than 10 kilograms.⁵⁴ Both gestational weight retention and/or weight gain during postpartum are risk factors for obesity and alterations in the cardio-metabolic profile, including insulin resistance (IR), hypo-

adiponectinemia and among others.⁵⁵

Insulin resistance is defined as a low ability of insulin to exert its biological actions in the target tissues, such as skeletal muscle, liver and adipose tissue.⁵⁶ Adiponectin -secreted by adipose cells- is an endogenous regulator of metabolic and cardiovascular homeostasis with insulin-sensitizing, anti-atherogenic and anti-inflammatory properties.^{55,56} Individuals with obesity, type 2 diabetes and coronary disease show reduced plasmatic levels of adiponectin.⁵⁶ Although the mechanisms are still not well understood, weight loss raises the plasmatic level of this hormone.⁵⁵ In contrast, low levels of adiponectin would be a predictor for IR and type 2 diabetes.⁵⁶ Retnakaran *et al.*⁵⁶ found that hypo-adiponectinemia during pregnancy predicts postpartum IR and beta cell dysfunction in puerperal

Figure 2
Postpartum weight retention and metabolic clinical implications.



women with a history of gestational diabetes.

Additionally, adiponectin levels are negatively correlated with BMI, body fat, triglyceride (TGL) and apolipoprotein concentrations.⁵⁵ Increased plasma levels of TGL, apolipoprotein B, low density lipoproteins (LDL-c) and reduced levels of high-density lipoproteins (HDL-c) are factors that characterize atherogenic dyslipidemia. This profile, also associated with higher blood pressure, has been observed in women who do not return to their pregestational weight⁵⁴ and those who have more fat on the adipose tissue.⁵⁷ This location of the body fat is one of the components of the metabolic syndrome (MS), along with dysglycemia, hypertension, hypertriglyceridemia and low HDL-c level. The prevalence of MS is increasing progressively during postpartum. It was found that women with impaired glucose tolerance and gestational diabetes have a higher risk of developing MS about 3 months after delivery.⁵⁷

Epidemiological studies have shown multiple connections between sleeping patterns, eating behavior, energy balance and breastfeeding with MS. Lactating women with and without history of gestational diabetes have a lower incidence of MS, and also healthier lipid profiles (increased HDL-c and LDL-c and LDL-c) than non-lactating ones.^{17,57} It has been estimated that each 1mg/dL HDL-c increase, the coronary risk decreases 2-3% in lactating women. This increase in the constituents of c-HDL would be generated in part by an increase in the catabolism of lipoproteins rich in triglycerides product of lactation. Conversely, short duration of lactation has been associated with subclinical atherosclerosis independent of pregestational cardiometabolic risk factors and usual risk factors.⁵⁸

It was also observed that women who are regularly active during postpartum improve both cholesterol levels and insulin sensitivity.^{57,58} Performing 150 minutes of moderate and vigorous physical activity per week (≥ 600 MET adjusted minutes) would reduce the risk of MS⁵⁹ by around 36%. The reduction of MS is associated with diets rich in fiber, fruits, vegetables and legumes.⁶⁰ It is important to highlight that both postpartum weight retention and

obesity have been attributed to suboptimal behaviors of maternal dieting and physical activities.

Conclusion

During the postpartum period, many women retain weight gain during pregnancy, so the reproductive cycle can become a risk factor for obesity. As such, this period may offer a window of opportunity for the primary prevention of chronic non-communicable diseases. This prevention should promote those maternal behaviors that favor the energy expenditure. In this review we analyzed the effects of breastfeeding, dieting, physical activities and sleeping duration.

Breastfeeding is considered as the focus of preventive actions of maternal obesity. However, elevated pregestational weight or excessive weight gain during pregnancy are factors that may alter breastfeeding, therefore studies should focus more on pre-pregnancy nutritional status and its evolution with reproductive events, particularly in women who have pregestational obesity.

The studies about postpartum diet suggest that the interventions should address not only caloric reduction of the diet but also to food quality and frequency of food consumption. The analyzed studies in the review suggest that dietary restriction per se do not promote an effective weight loss if it is not combined with physical activity. Physical activity as an intervention strategy would improve the cardio-respiratory fitness and preserve fat-free mass.

The shorter sleep would affect the energy balance with a negative effect on glucose metabolism, suggesting an association among sleep, obesity and insulin resistance.

Maternal overweight and obesity by excessive weight gain during pregnancy or weight retention in postpartum increase the risk of dyslipidemia and insulin resistance characterizing MS. Therefore, interventions during this period are essential for maternal health and may be the key for attenuating the transgenerational risk of maternal/child obesity.

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