Influence of nutritional variables and obesity on health and metabolism

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Summary

Obesity is a recurring theme in current scientific literature. This can easily be explained by its exponential increase in all layers of society. The popularity of this subject has also given rise to associated questions, which have achieved greater prominence in health-related publications. In order to assess what has been studied in the field of obesity and nutrition, an overview of all articles published on these subjects in some of the main Brazilian scientific journals over the past two years was performed. Among the sub-themes selected for this study, those related to childhood obesity attracted attention due to their greater frequency. These were subdivided into: prevalence, intrauterine and breastfeeding influences that may lead to the development of this condition, impact on quality of life, cardiovascular system and metabolism, and possible prevention strategies. Furthermore, issues related to obesity in adults were explored, such as risk factors and new strategies for prevention, with special attention given to the many studies evaluating different aspects of bariatric surgery. Finally, the subject of malnutrition and the impact of the deficiency of specific micronutrients such as selenium, vitamin D, and vitamin B12 were assessed. Based on the results, it was possible to assess the actual importance of obesity and nutrition in health maintenance, and also the several lines of research regarding these issues. Thus, it is essential to create new methods, which must be quick and efficient, to update health professionals involved in the treatment of obesity.

Keywords: Obesity; nutrition; cardiovascular disease; childhood obesity; update; bariatric surgery.

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Introduction

Obesity is a recurring theme in the current scientific literature; this fact is mainly due to the exponential increase in its prevalence in all strata of society. The increasing popularity of this theme has also resulted in increased incidence and prominence of associated issues in health-related publications. In order to assess what has been studied in the field of obesity, nutrition, and its consequences, this review summarizes everything that has been published in some of the major Brazilian scientific journals over the last two years (2010/2011).

The selected journals were: "Revista da Associação de Medicina Brasileira", "Jornal de Pediatria", "São Paulo Medical Journal", and "Genetic and Molecular Biology". Articles were selected by searching the SciELO database using keywords such as "obesity", "nutrition", "diet", "overweight", and "dyslipidemia".

Childhood obesity

The impact of childhood obesity was the most extensively studied theme in this period in the selected journals. It is already known that obesity rates in the younger strata of society are progressively increasing; however, the greatest concern regarding this finding is the high frequency of overweight children who become obese adults. Furthermore, childhood obesity has early effects on the cardiovascular and metabolic health of the individual[1].

Silva et al. compared the scores obtained from 41,000 Brazilian children and adolescents with international growth reference values (WHO and CDC) to classify height, weight, and body mass index (BMI)[2]. The authors observed lower values in Brazilian children when compared to the percentile that identifies BMI (P85) by WHO in all ages observed. In another study, Jesus et al. found a high prevalence of obesity in even younger children, up to four years old, in the municipality of Feira de Santana[3].

Although the results are still paradoxical, they are justified by the fact that Brazil is going through a process called "nutrition transition", characterized by an inversion in the distribution patterns of nutritional problems, consisting of a change from malnutrition to overweight. Thus, the authors emphasize that strategies to prevent obesity should be maintained, and that new approaches must be employed, mainly in populations where overweight has never been considered a public health problem, such as in the city of Feira de Santana[2-4].

Nutritional influences in the intrauterine period

The nutrition transition has demonstrated a rapid pace of increase, both in Brazil and in other countries where it occurs. This increased pace may have very serious consequences, such as malnutrition and obesity coexisting in the same individual, which greatly enhances the risk of both chronic and infectious diseases. The study by Clemente et al. correlated short stature in adolescent and prepubertal individuals, as a possible consequence of mild malnutrition, to a higher percentage of body fat, especially in the abdominal region[5]. The author's hypothesis to explain this phenomenon was a possible nutritional deprivation during the fetal and early childhood period that may lead to adaptations, resulting in the development of obesity in the subsequent phases[5].

The impact of maternal diet on the health of children and adolescents was another theme that has been the subject of study in recent years. Silveira et al. studied the associations between nutritional status of children and maternal nutritional status with environmental factors in the slums of Maceió (state of Alagoas, Brazil)[6]. The high rate of malnutrition observed in children was associated with the presence of short-stature mothers, probably due to their state of chronic malnutrition. The high rate of overweight also observed in these children shows the consequences of the increased pace through of the nutrition transition process, especially in low-income populations[6].

Another study by Monteiro et al. evaluated, in an animal model, the consequences of physical activity in pregnant and lactating women with and without adequate protein intake, and the development and growth of the offspring's femur[7]. Protein malnutrition was associated with worsening bone mass development in puppies, causing permanent damage to the bone structure of this population. Light physical activity with adequate protein diet did not influence the development of the bone structure in these animals[7].

Nutritional influences in the lactation period

Breastfeeding also has a strong influence on body composition during childhood, as observed by Ferreira et al.[8]. In their study, breastfeeding for more than 30 days was an important protective factor against overweight in children aged 1 to 5 years. The protective effect was even stronger when breastfeeding occurred in the first weeks after birth.

The high prevalence of infants with vitamin A deficiency and anemia is another matter of concern in Brazil. A study by Pereira Neto et al. investigated the factors possibly responsible for the occurrence of these serious deficiencies[9]. The first item observed was inadequacy associated to breastfeeding, as the mean total and exclusive time of breastfeeding were below the recommendations proposed by the World Health Organization. Moreover, there were also errors in relation to the introduction of complementary foods, usually related to insufficient

amount, associated with the maintenance of breastfeeding as a priority. The use of iron supplementation up to two years after birth was associated with a lower rate of anemia. These results once again demonstrate the importance of maternal nutritional supervision during pregnancy and lactation[9].

One possible explanation for the high rates of vitamin-A deficiency among infants was assessed by Lira and Dimenstein. The authors investigated the reason why women with diabetes have higher chances of developing vitamin A deficiency[10]. The direct consequence of this deficiency is impairment in the supply of vitamin A to the fetus, making it more vulnerable to suffer from a limited supply of vitamin A. Some studies suggest that hyperglycemia is a causal factor for the imbalance in the levels of retinol and retinol-binding protein (RBP), but the mechanism responsible for these alterations in vitamin A levels remains unknown. It is currently known that glycemic control normalizes vitamin A levels, and that its supplementation is not effective in this population, as the levels remain reduced.

It is important to be aware that vitamin A supplementation in this population, besides not providing normal plasma concentrations of the vitamin, can lead to hepatotoxicity[10].

Nutritional errors in the first year of life may also compromise other aspects of child health and development of diseases such as asthma and allergies. Strassburger, assessed the association between diet during this period and respiratory outcomes and allergy markers at 3 and 4 years of age. The author observed a three-fold increase in the chance of developing asthma in children who consumed cow's milk before 4 months old. This is justified by the interruption in the cycle of exclusive breastfeeding and therefore, it may influence the development of intestinal flora and interfere with the allergic response. These data show that the correction of simple nutritional errors can contribute to prevent the development of asthma in childhood[11].

Epidemiology of obesity in schools

As obesity has been increasing in infants and children at the pre-school age, an increase of this worrisome condition can also be observed in the subsequent phases, in addition to its early health impacts in these individuals.

Mendonça et al. carried out an epidemiological study to assess the prevalence of obesity and overweight among schoolchildren and adolescents in a Brazilian capital[12]. The prevalence found in this population was lower than the results of studies with similar populations. Despite these results, the authors were able to estimate that the risk of obesity was five times higher in individuals from private schools, when compared those who attend public schools. Obesity was most common between the ages of 7 and 9 years, showing the need for monitoring these individuals in the long-term to prevent future complications[12].

Nascimento et al.[13] also compared the prevalence of overweight and obesity in private and philanthropic schools, and observed a higher percentage of overweight children even in the wealthiest strata of society, represented by private schools. However, the risk for overweight was considered similar in both groups, suggesting that the trend in the poorer strata of society goes in the same direction.

Although the epidemic of obesity in childhood and adolescence is a relatively recent theme, the literature includes a guideline that was published in 2005, which focused on the prevention of atherosclerosis in this population. Grosso et al. assessed the level of knowledge on this guideline among pediatricians[14]. Most evaluated physicians were not familiar with the guideline; in fact, more than two thirds of these physicians had never even heard of it. The highest percentage of errors occurred with those professionals who were not academically engaged, who worked only in private clinics/hospitals, and who had graduated long ago. These results show the need for a more adequate disclosure of this material, which is essential to guide the conduct of medical professionals.

School environment has a great influence on children's health, not only due to the time they spend at school, but also as the place where they meet their peers and exchange health information. For all these reasons, school is considered the ideal environment to implement strategies for prevention and control of health issues such as obesity. Silveira et al. article aims to bring an updated review of health interventions to reduce obesity and overweight carried out in schools and of data on the effectiveness of these nutrition education and weight reduction actions[15]. Twenty-four articles that presented data on different strategies used around the world were selected. Interventions with the following characteristics were shown to be effective: over one year of duration, introduction as a regular school activity, parent involvement, introduction of nutrition education in the curriculum, and regular supply of fruits and vegetables in the school food services. This result emphasizes the value of simple, but well executed interventions in this population[15].

Childhood obesity prevention measures

In order to achieve an early diagnosis and prevent weight gain in this population, some simple measures can be used in medical consultations and even in sporadic physical assessment at school. The evaluation of abdominal obesity is an important measure, as its impact on

cardiovascular health is even greater than general obesity. Although there is no consensus or standardization of values of waist circumference for this young population, several studies have shown an increase in prevalence of this condition in children and adolescents. In their study, which evaluated different cutoffs for waist circumference, Pereira et al[16]. concluded that the most appropriate value as an indicator of metabolic disorders in an outpatient sample was that proposed by Freedman.

Consequences of childhood obesity

The consequences of childhood obesity can be observed in several aspects of these individuals' health status, whether in childhood or adulthood. The subsequent topics summarize different aspects of children' and adolescents' health that are compromised by obesity.

Several studies have demonstrated a decline in the quality of life of obese young individuals when compared to their normal weight peers. This worsening is also related to the worsening in the general clinical condition of these individuals, and even to the earlier onset of chronic diseases in this population. Poeta et al. evaluated the association between quality of life and health in a population of obese young individuals[17]. The results showed that obese children had a poorer quality of life in all studied areas. These data are important in order to develop strategies that will also have an impact on the improvement of this important health parameter.

Alongside childhood obesity, metabolic syndrome (MS) has also shown an increased prevalence among young individuals. The main challenge in dealing with MS in children and adolescents lies in the diagnosis. There are no specific criteria or definitions for MS in children, and adaptations of the criteria used for adults in this population hinder the identification of the presence or absence of the disease. Pergher et al. surveyed the main classifications for MS found in children[18]. Although there is currently no standard for accurate waist circumference measurement in children, this measure is considered essential to determine the syndrome in this population.

Regarding diabetes mellitus, the classification of children and adolescents has been established and it is the same used in adults; as for the insulin resistance classification, it is still based on percentile curves, and the cutoff used in this population is 110 mg/mL. Body composition is the major blood pressure determinant in children and adolescents. Therefore, blood pressure values are adjusted for height, gender, and age. The Third Report of the National Cholesterol Education Program (NCEPIII) has already developed a classification that is specific for this population, as did the International Diabetes Federation (IDF); however, the classifications differ in several points and must be adjusted and validated, so that they can be applied to large samples to help reduce the risk of future complications in this population[18].

Also considering the lack of solid criteria to determine MS in children and adolescents, Cavali et al.[19] aimed, through a cross-sectional study with young Brazilians, to propose new diagnostic criteria and to compare with that proposed at the IDF by Jolliffe and Jansen. The authors used the same parameters of the previous criteria, but different cutoffs, and obtained a higher prevalence of MS in the same population. This increase can be explained by the substitution of insulin resistance for glycemia, which was justified in an attempt to mask the physiological insulin resistance present in adolescence. The cutoffs proposed for hypertension were also lower, contributing to this increase. The last divergence responsible for the overestimation observed with the new criteria was given by analyzing the presence of hepatic steatosis, unpublished to date. The authors believe that the new test may be more sensitive to detect this condition in young individuals[19].

The impact of different cardiovascular risk factors on the health of adults when compared to children and adolescents is different. Feliciano-Alfonso et al. estimated the prevalence of MS in individuals between 15 and 20 years and its main risk factors[20]. There was a high prevalence of modifiable risk factors, especially smoking, followed by pre-diabetes and overweight, which suggests the need for preventive measures specific for this age group. The prevalence of MS differed greatly between the different classifications (REGODICI, IDF, American Heart Association [AHA]) used, suggesting the need for greater harmonization between the existing criteria for this population[20].

A high prevalence of obesity and cardiovascular risk factors was also found by Mazaro et al. in children aged 7 to 12 years in schools in the city of Sorocaba, state of São Paulo, Brazil[21]. The authors found a high prevalence of overweight and obesity in the sample, as well as increased waist circumference, increased blood pressure, and acanthosis nigricans, a skin alteration associated with MS, but at lower frequencies. It was concluded that simple preventive measures, such as blood pressure and waist circumference measurement, as well as assessing skin alterations, should be taken in order to prevent even worse consequences for these individuals' health[21].

The association between obesity and alterations in glucose metabolism has been well described in the literature in adults, but there are still some doubts regarding its behavior in children. Mieldazis et al. found a strong association between insulin resistance and BMI in this age group (prepubertal)[22]. Thus, it is believed that specific health policies to reduce weight in this age group

would have a direct impact on the prevalence of diabetes and MS in the adult population.

Nonalcoholic fatty liver disease (NAFLD) is one of the consequences of obesity in the liver. Its prevalence is also associated with MS and has been increasing in children and adolescents. Duarte et al. observed a high prevalence of NAFLD in a population of children and adolescents undergoing abdominal ultrasounds[23]. As it is a disease with few symptoms and slow progression, its consequences in a young population can be disastrous, such as evolution to cirrhosis followed by death. The results also showed a low correlation between the presence of NAFLD and high levels of aminotransferases, suggesting that, for this population, only the ultrasonographic examination is considered sensitive. The authors concluded that the diagnosis of MS should be performed as soon as possible to determine the presence of NAFLD, in order to prevent permanent damage[23].

Lira et al. observed a strong correlation between the presence of NAFLD and other metabolic disorders in individuals with overweight and obesity[24]. The odds ratio for the development of NAFLD in this group was 10.77 compared to individuals with normal weight. A low correlation between the presence of HS and liver enzymes was also observed, probably because the injuries are at an early stage. This study reinforces the findings of Duarte et al.[23] and the need for attention in all strata of society.

Camilo et al. analyzed the possible contribution of obesity to the development of asthma in children and adolescents[25]. Possible mechanisms for this association are caused by the release of inflammatory chemokines due to excess adipose tissue, in addition to mechanical limitations due to obesity that compromise the volume and functional capacity. The authors concluded, however, that there are no sufficient data in the literature yet to characterize a possible cause-effect association between these two conditions, whose prevalences are growing in parallel. Further studies are needed in order to establish the reliability of the association between these two conditions[25].

There are data in the literature that suggest a greater presence of bone mass in obese individuals, acting as a protective factor against osteoporosis and fractures. In a cross-sectional study, Carvalho et al. established a strong association between body composition and bone mass in children and adolescents[26]; however, significant differences were found between genders. In males, bone mass was associated with the amount of lean mass, whereas in females, bone mass was associated with the amount of fat mass.

A point often overlooked in the literature concerns the effect of childhood obesity on the musculoskeletal system. The prevalence of chronic pain, shortenings, and even localized orthopedic alterations are far higher in obese children and adolescents when compared with those with normal weight. Jannini et al. compared the prevalence of skeletal muscle colors in a population of obese *versus* healthy adolescents exposed to the same stimulus: use of computer and videogames[27]. Both groups of adolescents reported high incidence of musculoskeletal pain; however, the obese group had a higher percentage of orthopedic alterations, especially in the lower limbs.

Metabolic disorders can affect the synthesis, secretion, and composition of saliva. Obesity implies a severe alteration of the individual's nutritional status and thus, the composition of saliva is altered, resulting in major consequences such as demineralization of teeth and alteration of the protective structures of the mouth. In order to study this innovative topic, Pannunzio et al. published an article in an attempt to correlate BMI with saliva composition and its consequences[28]. Analysis of saliva demonstrated that overweight and obese individuals had alterations in the chemical composition of saliva, which can influence protection against cavities.

Bad eating habits adopted by children and adolescents have consequences that go beyond obesity. The choice of nutritionally poor foods, in addition to causing weight gain, implies in a severe picture of nutritional deficiencies in this population. Steluti et al. investigated the prevalence of deficiency of vitamins B6 and B12 and folate in Brazilian adolescents[29]. Surprisingly, the prevalence of nutritional inadequacy in the sample was considered low, which can be explained by supplementation program of these nutrients in processed foods and flours and greater access to foods rich in these nutrients. Beans were considered the food that contributed the most to the adequacy of consumption of these nutrients[29].

Physical exercise is involved in the prevention and treatment of obesity and its related comorbidities. In this scenario, physical fitness is determinant and low rates can characterize metabolic alterations. The study by Andreasi et al. correlates the level of physical fitness and anthropometric measurements in schoolchildren aged between 7 and 15 years[30]. The results showed a significant correlation between lack of physical fitness, female gender, obesity, and abdominal hyperadiposity[31].

Obesity in adults

Far from being considered a new theme, obesity in adults has been extensively explored in previous years in Brazilian literature. Currently, studies seek to increase the knowledge of the association mechanisms of this condition with metabolic alterations whose prevalence increase simultaneously.

In their review, Ikeoka et al. address the close association between obesity, insulin resistance, inflammation, and atherosclerosis[31]. The authors report that after exploring all possible pathophysiological mechanisms involving these conditions, the association between these conditions has finally been established. It is very likely that excess adipose tissue induces dysregulation in the production of adipokines, metabolically active substances produced by adipocytes. There is an excess of inflammatory adipokine production, such as IL-6 and TNF-alpha, resulting in a chronic inflammatory state of the body, as well as insulin resistance and endothelial dysfunction. Simultaneously, there is a decrease in the production of beneficial adipokines, such as adiponectin and leptin, which can exacerbate its characteristics and stimulate appetite, leading to further weight gain. Thus, weight loss appears to be an essential goal for cardiovascular risk reduction in obese individuals.

Classic strategies, such as physical exercise and diet should be maintained in the treatment of these individuals, but new strategies are needed, which combined with classic ones, can result in greater efficiency[30].

Arterial hypertension is an important cardiovascular risk factor associated with obesity. Previous studies have found a high prevalence of this condition in Brazilian individuals. Nascente et al. aimed to verify not only the prevalence of this condition in a small Brazilian town, but also its association with BMI and waist circumference[32]. Their results showed a similar prevalence to that found in larger cities, and a positive association with BMI and waist circumference. It can be concluded that public policies aimed at weight reduction can prevent a large number of deaths caused by this risk factor[32].

Another important emerging cardiovascular risk factor is the presence of diabetes mellitus. Rodrigues et al. investigated other specific risk factors associated with diabetes mellitus type 1[33]. Despite the low prevalence of coronary heart disease, which can be explained by the young age of the participants, most of the individuals had dyslipidemia, hypertension, and poor glycemic control. These results suggest that greater control of metabolic abnormalities is necessary to reduce the cardiovascular risk and the high rates of microvascular lesions in the population observed in this study.

Genetic influences of obesity

Genetic influences in the development of obesity

Some studies have evaluated the influence of gene expression in the development of obesity. The main role of butyrylcholinesterase (BChE) in the body is to hydrolyze choline and other esters in the liver before distributing these nutrients throughout the body. Previous findings, however, indicated an association of this substance with obesity, dyslipidemia, and weight gain, due to its link with ghrelin hydrolysis and inactivation. Data also show that obese patients have high levels of BChE. To prove this theory, Boberg et al. evaluated the intensity and activity of this substance in obese and normal weight individuals[34]. Although the results showed similar intensity values between the two groups, it is believed that the activity of this substance in the obese is more intense than in individuals with normal weight, which demonstrates the capacity to control the extent of action of this substance.

Other data available in the literature showed that individuals with high innate BChE activity tend to be leaner, and that BChE synthesis is increased in individuals prone to weight gain, suggesting that BChE activity is important for energy balance, BMI, and the use of fat. This is supported by the fact that ghrelin deacylation is a BChE activity. Dantas et al. evaluated the role of BChE and ghrelin genes, and their association with the use of fat in individuals[35]. The results were inconclusive, but indicated a regulatory role of the ghrelin gene in BChE gene expression, suggesting a possible correlation in the process of using fat.

The hypothalamic control of hunger has also been the object of obesity-related research. Serotonin is a neurotransmitter responsible for regulating functions such as mood, sleep, appetite, and others. Alterations in its release or its receptors are associated with increased desire for sweets and carbohydrates, and with lower satiety. Feijó et al. reviewed the role of serotonin in the control of hunger and satiety[36]. The reviewed studies demonstrated that the main receptor associated with food intake and energy balance is the 5-HT2C and its synergetic interaction with POMC and MC4 receptors. More studies are needed in order to better understand these mechanisms, which are so important in weight control.

New preventive strategies

New strategies have been investigated in the treatment of obesity. Classic interventions such as diet and exercise have been explored in new ways, while new strategies, such as bariatric surgery, are being approved due to the better long-term outcomes and the lower risks associated with the procedures.

Regarding a preventive diet for atherosclerosis, much is said about specific foods that should be avoided and those whose consumption should be encouraged. This selection of "beneficial and harmful" foods is based on their chemical composition, which is described in tables made specifically for this purpose. The major drawback is that there are many differences regarding

the values of important nutrients, such as saturated fat and cholesterol for the same food in different tables. In an attempt to overcome these differences and to establish actual values, Scherr et al. analyzed the chemical composition of the main foods that constitute the Brazilian diet and compared it with values obtained from the most commonly used tables[37]. The results showed that there are significant differences between the actual values and the values described in the tables; this may impair the nutritional guidelines that are currently given to patients. The authors concluded that it is necessary to update and standardize the existing tables by performing new analyses of composition.

Physical exercise also plays an essential role in improving cardiovascular health and in the prevention and control of obesity; however, some points should be taken into account in this specific population. Obesity has a major impact on respiratory system function; this is partly due to the decreased expansion of the chest, which compromises diaphragmatic mobility and reduces lung capacity and volume. Spirometry is an important measure to evaluate pulmonary function, and its impairment is associated with increased morbidity and mortality. Melo et al. evaluated the progression of pulmonary function with increasing BMI through spirometry and other lung function measurements[38]. The results showed a trend towards worsening of lung function with the progression of BMI, which becomes significant when BMI > 45 kg/m². The study, however, did not evaluate the impact of obesity on long-term lung function, leaving an open question as to whether there is progression and evolution of this disability even with lower BMI levels.

The study by Gontijo et al. also evaluated pulmonary function in obese and non-obese individuals through spirometry after the six-minute walk test. The results showed a negative correlation between increased BMI and distance walked during the test, which demonstrates the progression of damage over the years caused by long-term obesity[39].

The practice of physical exercise results in an exacerbated production of free radicals, which damage cells. Miranda-Vilela investigated the impact of supplementation with pequi oil, a Brazilian fruit rich in carotenoids, in runners. The results were positive and showed the protective potential of this oil supplementation against anisocytosis, also improving the capacity to transport oxygen in the blood[40].

The postmenopausal period in women is a time of increased cardiovascular risk and possible weight gain. Trevisan et al. investigated the effects of exercise or no exercise together with isoflavone-enriched soy supplementation on basal energy expenditure in women in this life phase[41]. The results showed a significant increase in the resting energy expenditure (REE) in the groups that performed physical exercise, and even higher in the group that received soy supplementation combined with exercise. This strategy should be considered in order to improve the quality of life of this population.

Bariatric surgery

As mentioned before, the search for new treatment strategies for obesity continues, as available therapies have limited results that are often not long-lasting. In this scenario, bariatric surgery has emerged as an effective treatment with lasting results. In addition to providing unprecedented weight loss, significant and permanent metabolic improvements are achieved in most cases.

Ilias assessed the impact of three surgical techniques (vertical-banded gastroplasty, biliopancreatic diversion, and Roux-en-Y gastric bypass) to improve MS and reduce complications[42]. The surgery that showed the best results was the metabolic biliopancreatic diversion, which may be associated with a higher percentage of maintenance of weight lost postoperatively. Vertical gastroplasty showed high rates of weight regain and higher rates of MS after surgery (40%). The Roux-en-Y gastric bypass showed weight regain in the fifth year after surgery, and also maintained a 30% prevalence of individuals with MS. The morbimortality was similar in all groups, but the biliopancreatic diversion showed the highest incidence of later nutritional complications. This result suggests that each surgery has advantages for a specific group of individuals and the choice should be based on careful assessment and the individual's personal characteristics[42].

Bariatric surgery, exactly because it provides a long-lasting weight loss, can help to prevent other diseases associated with obesity, such as cancer. In his review, Ilia shows great reduction in the number of deaths due to cancer in patients submitted to the surgery in relation to those who did not undergo the treatment. The author points out, however, that the surgery should not be seen as a treatment for cancer; its reduction is merely a consequence of weight loss. These data reinforce the idea that bariatric surgery helps in preventing serious diseases, not only in the short term such as diabetes, but in the long term as well[43].

Some of the most common side effects of bariatric surgery are nutritional deficiencies; these are often inherent to the structural changes that occur in the gastrointestinal tract resulting from the chosen procedure. Bordalo et al. performed an updated review with all the recommendations in the literature regarding supplementation in patients after bariatric surgery[44].

One of the main recommendations concerns the prescription of polyvitamins and minerals on an individual basis, according to the needs of the patient and the type of procedure performed. Special attention should also be paid to disabsorptive surgeries, whose resulting deficiencies are often more severe. The authors also state that the key micronutrients that must be supplemented are: thiamine, iron, calcium, and vitamins A, D, E, and B12. Regarding disabsorptive and mixed surgeries, there may be the need for supplemental protein, due to the decreased rate of absorption. The conclusion of the authors is that it is necessary to establish protocols to guide preventive supplementation in these patients, possibly with megadoses, to ensure good bioavailability[44].

Some data indicate that 80% of bariatric surgeries are performed in women, mostly at fertile age. This means that more and more women with a history of bariatric surgery will become pregnant, and there are limited studies that assess the implications of surgery in pregnancy. Despite the nutritional deficiencies arising from the absorptive problems, some studies indicate a better prognosis in pregnant women who were submitted to the surgery than in overweight ones[45]. In their study, Nomura et al. evaluated fetal vitality, as well as maternal and fetal complications in women who underwent Roux-en-Y gastric bypass. Among the deficiencies, anemia was the most commonly found during pregnancy; there was a decrease in rates of pregnancy complications such as diabetes and hypertension[46].

Fetal vitality also remained unchanged in most cases, which does not dispense with monitoring during the intrapartum period. There was, however, a high prevalence of newborns with low-birth weight due to micronutrient deficiencies, which shows the need for individualized nutritional management focused on correcting specific deficiencies[46].

In addition to several positive effects on the individuals' health achieved through bariatric surgery, it is estimated that there was a significant reduction in costs related to the care of obesity and the control of metabolic diseases. Kelles et al. carried out the first study to assess the weight of the inclusion of bariatric surgery in the Brazilian health system[47]. Their results indicated a higher cost up to one year after the bariatric surgery; however, these results should not be interpreted yet, as only a long-term analysis can yield reliable results[47].

Malnutrition

In spite of the nutrition transition, and the consequent rise of obesity to its current status as main nutritional problem, the negative impact of malnutrition should not be ignored, especially in specific populations such as hospitalized patients. Malnutrition in hospital patients is extremely dangerous, as it greatly increases the risk of clinical complications and mortality in these individuals. In order to identify the main risk factors responsible for malnutrition in this population, Aquino et al. developed a cross-sectional study in a general hospital in the city of São Paulo[48]. The prevalence of malnutrition found by the study was high, but in accordance with values found in the literature. Its main predictors were, in ascending order: male gender, inadequate food intake, diarrhea, decreased appetite, clearly visible bones in the body's frame, and recent weight loss. The author concludes that all these factors are easily identifiable even at admission; early detection can decrease the incidence of comorbidities and consequently, reduce hospital mortality[48].

Influence of specific micronutrients on health

Similarly to malnutrition, deficiency of some specific micronutrients in the body can impair basic functions and also increase the risk of severe diseases. Due to its antioxidant properties, selenium has been studied as an anticarcinogenic agent. Almondes et al. concluded that selenium may reduce the risk of cancer by preventing the tumor cycle, stimulating apoptosis and inhibiting tumor cell migration and invasion, with high-dose supplementation, albeit not at toxic levels[49]. Animal studies have shown greater protective effect of selenium in liver, skin, breast, and colon cancers. In humans, the importance of selenium was evaluated in prostate and colorectal cancers; the least reported was bladder cancer[49].

Some medications can interfere with the absorption of nutrients that are essential for proper body function. Nervo et al. evaluated the prevalence of vitamin B12 deficiency in patients treated with metformin in Southern Brazil[50]. In the studied group, the prevalence of vitamin B12 deficiency was high, similar to that found in international studies. However, there is a limitation in the study due to the method used, the 24-hour recall, which does not assess intrapersonal variations and depends on the interviewee's memory. Another limitation is the self-reported dose and duration of metformin use and the use of serum vitamin B12 levels; although it is the most frequently used test for diagnosing deficiency of this vitamin, it has a high sensitivity, which may have altered the results[2]. The study concluded that patients using metformin for longer periods and with low intake of vitamin B12 are more likely to have a deficiency of this vitamin[50].

The vitamin D receptor (VDR) is deeply involved with bone metabolism in humans; their alleles, however, show a distribution that can vary depending on the

ethnic origin of the individual. Lins et al. evaluated the different haplotypes found in a group of Brazilian individuals of different ethnicities represented by diverse progeny (European, Asian, African etc.)[51]. The sample showed different haplotypes in the studied populations, which may explain the different responses obtained for each of these populations to alterations in bone metabolism, such as bone mineral density, vitamin D3 metabolism, and osteoporosis. The authors suggested that using this type of polymorphism analysis may help distinguish different ethnicities and their impact on bone metabolism[51].

The importance that has been given to the association between nutrition and obesity shows the profound influence of these conditions on individuals' health status. Lack of knowledge can have an adverse impact on the health of several subgroups of the population in many different ways. It is necessary for health professionals to keep up-to-date with scientific discoveries and develop new prevention strategies that are more effective and that address the specific needs of each population subgroup.

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