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Non-pharmacological approaches to obesity – a concise review

Luminita-Georgeta Confederat [1,2], Liliana Mihailov [1], Mariana Rotariu [1], Iustina Condurache [1]

1 Faculty of Medical Bioengineering, "University of Medicine and Pharmacy Grigore T Popa", Iasi, Romania;
2 "Sfântul Spiridon" County Emergency Clinical Hospital, 700111 Iasi, Romania

* Correspondence: Iustina Condurache, iustina.condurache@yahoo.com

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Abstract: Obesity has become a major public health problem due to its alarming increase in prevalence in recent years, both in children and adults. This medical condition is associated with increased morbidity and mortality rate, being the main risk factor for chronic diseases as type 2 diabetes, hypertension, cardiovascular diseases, dyslipidemia, non-alcoholic fatty liver disease and chronic kidney disease. Considering the fact that obesity is a multifactorial determined disease involving genetic, biological, behavioral and psychological factors, the approach to obesity should be performed in a multidisciplinary team. The management of obesity is complex and it includes non-pharmacological, pharmacological and, sometimes, surgical interventions. Nutrition interventions for obesity are focused not only on weight loss but also on long-term maintenance of the body weight achieved, including caloric restriction, macronutrient-based interventions, diatery fiber, meal replacements and intermittent fasting. For people living with obesity, the medical nutrition therapy shloud be in accordance with their individual values, preferences and treatment goals, in order to be maintained long term. In addition to diet, physical activity plays an important role in human health, contributing to the prevention of obesity and being part of its management, reducing metabolic risk factors and improving general condition.

Keywords: obesity, nutrition interventions, physical activity

Introduction

Obesity is a complex medical condition, with an alarming rising prevalence in recent decades, involving an enormous economic burden for healthcare systems, due to its frequent association with cardiovascular, metabolic, endocrine, renal, and psychological diseases [1]. Considering these aspects, obesity is now recognised as a growing and concerning public global health crisis, China being the most affected country. According to World Health Organizations (WHO) data, besides the fact that obesity is associated with an increased incidence rate, increased morbidity and mortality and shorter life expectancy, it also represents the main risk factor for prevalent chronic diseases as type 2 diabetes, hypertension, cardiovascular diseases, dyslipidemia, non-alcoholic fatty liver disease and chronic kidney disease [2].

Overweight and obesity are broadly defined as medical conditions characterized by the accumulation of excess adipose tissue, associated with increased health risks. As it is defined by excessive accumulation of adiposity, obesity is commonly estimated by the body mass index value (BMI). In accordance with WHO classification criteria, individuals with a BMI falling within the range of 25 to 29.9 kg/m^2 are categorized as overweight, while those surpassing a BMI threshold of 30 kg/m^2 are classified as obese. Further stratification of obesity is based on BMI cutoff points, which distinguish between Class I obesity (30-34.9 kg/m^2), Class II obesity (35-39.9 kg/m^2), and Class III obesity, also known as morbid obesity, which is characterized by a BMI exceeding 40 kg/m^2. In children and adolescents, BMI

ranges according to age- and sex-specific percentiles are used. Although BMI remains the primary parameter for assessing overweight and obesity, it is important to note that the distribution of adipose tissue in different body compartments, such as subcutaneous and intra-abdominal regions, may provide a more sensitive measure; thus, waistline and waist-to-hip ratio are important tools to assess fat distribution and risk stratification [3, 4].

In addition to fat accumulation, obesity is closely associated with an altered metabolic profile, with adipose tissue being recognized as a highly metabolically active tissue with an intense secretory profile. Excess adipose tissue exerts significant systemic activity, including multiorgan dysfunction, metabolic disorders (insulin resistance and dyslipidemia), chronic inflammation and a procoagulant state. In addition, obesity is a major contributor to the development of chronic diseases such as type 2 diabetes, hypertension, cardiovascular disease, dyslipidemia, non-alcoholic fatty liver disease, chronic and acute kidney disease, respiratory diseases (chronic obstructive pulmonary disease and sleep apnea syndrome) [3]. Besides the mentioned aspects, obesity has a strong psychological impact on social relationships, especially in adolescents and young adults [5, 6].

The management of obesity is very important for all specialists involved in the complex care of obese patients. The approach to obesity should be performed in a multidisciplinary team including doctors, dieticians, physical therapists and psychologists, and it should include both pharmacological and non-pharmacological interventions. This review will be focused on non-pharmacological approaches to obesity, including dietary interventions and physical activity.

2. Obesity – epidemiological data

The global prevalence of obesity continues to rise, especially after the COVID-19 pandemic, where the number of people with weight gain increased significantly due to the lockdown in several countries [7]. But this alarming increase in prevalence of obesity and overweight is not only related to COVID-19 pandemic; since the second half of the last century, the prevalence of obesity has also tripled worldwide, reaching about 30% in the global population, with a significant increase in children and adolescents [3].

Obesity is particularly prevalent in developed countries, where the obese population continues to grow, while rates are relatively lower in low- and middle-income countries. The prevalence of obesity and overweight individuals in developing countries can be attributed to the widespread availability and accessibility of processed foods high in calories but low in nutritional value, leading to an increased number of obese and overweight people in these regions [8]. Between 2005 and 2015, the obesity rate in the US was around 30-34% and the prevalence of obesity in UK was 23-24% [9]. Recent global data suggest that in 2020, 988 million people were living with obesity and the predictions for 2030 estimate that 1.5 million people will have a BMI over 30 kg/m^2 [10].

According to WHO data, in 2016, over 1.9 billion adults were obese and nearly 39% of them were overweight. In recent years, the prevalence of childhood obesity also increased, and nearly 38 million children under the age of five were obese and over 340 million children and adolescents between 5 and 19 years old were found as obese worldwide. Also, it is estimated that by the year 2030, more than 50% of the population from USA will be obese [11].

3. Obesity – risk factors

The increasing prevalence of obesity is strongly linked to a number of risk factors and is mainly due to many aspects of modern society, often characterized by urbanization, where the demand for both high-calorie and junk food exceeds the need for healthy food. [12]. In addition to this, it is widely accepted that unhealthy lifestyles, sedentarism and

little physical activity are strongly correlated with an increase in the number of obese and overweight people. In addition, there are many psychological factors, including depression and stress, which are involved in the consolidation and unfavorable evolution of obesity. In this regard, there are numerous clinical studies suggesting that stress promotes weight gain, due to stress-induced cortisol secretion, which alters energy balance, leading to fat deposition and increasing circulating glucose and insulin levels. [3]. In addition to unhealthy lifestyle and behavioral conditions, there are some biological factors associated with overweight and obesity. For example, several clinical studies suggested that the alterations in leptine expression was associated with severe forms of obesity [13]. Further, some changes in normal gut microbiota were correlated to increased permeability and inflammation of the gastrointestinal tract, resulting in systemic inflammation and contributing to the development of obesity [14]. Of major importance is the large amount of data supporting the genetic background of obesity, which is represented by mendelian syndromic obesity, mendelian non-syndromic obesity and polygenic obesity, depending on the gene mutation associated with the severity of the phenotype [3]. The risk factors involved in the development of obesity are summarized in Figure 1.

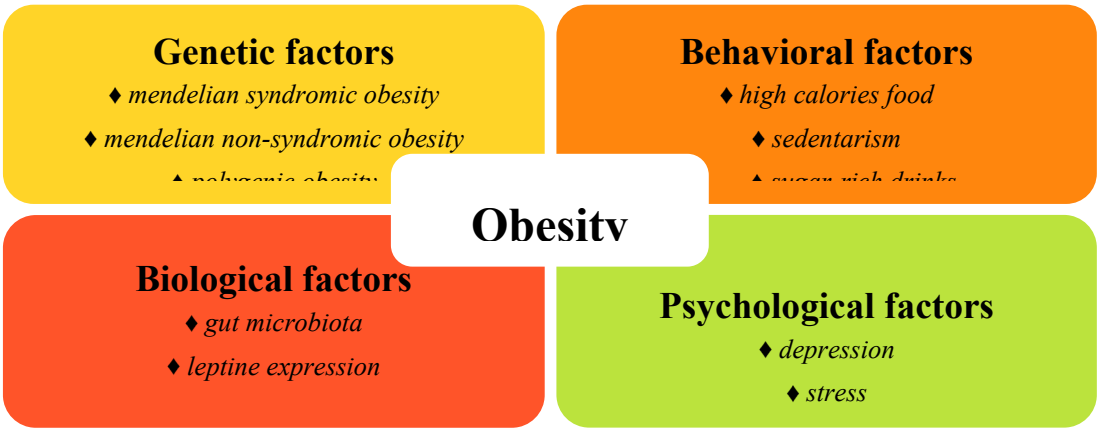

Fig. 1. Risk factors for the development of obesity

4. Management of obesity

Obesity is a complex disease developed under the influence of several factors as genetic determinism, unhealthy diet, lack of physical activity, as well as biological and psychological factors. Additionally, obesity is strongly correlated and it represents a risk factor for the onset and unfavorable prognosis of some chronic disease such as type 2 diabetes, cardiovascular diseases, dyslipidemias, kidney and respiratory diseases. Considering these aspects, the management of obesity should be multifactorial, including both pharmacological and non-pharmacological interventions, and it should be performed in a multidisciplinary team. The multifactorial management of obesity is represented in Figure 2.

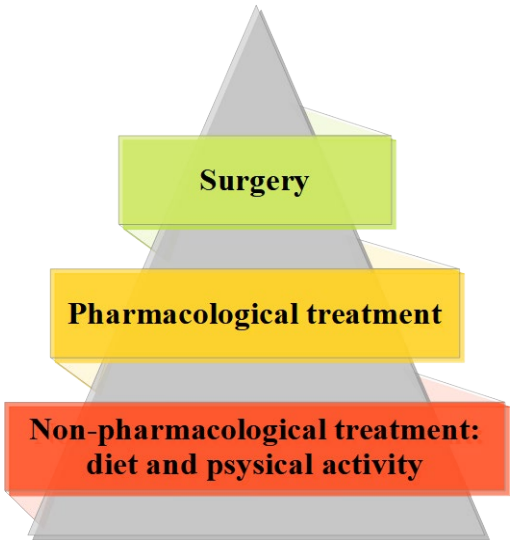

Fig. 2. Management of obesity

4.1. Nutrition interventions

As it can be observed in Figure 2, the non-pharmacological approaches of obesity, including dietary intervention and physical activity, are at the base of the pyramid that represents the complex management of this disease, highlighting the importance of these interventions. Nutrition and healthy eating is important for everyone, regardless of body size, weight or health status, but it is crucial in people living with obesity and obesity-related diseases [15]. Traditionally, nutrition interventions for obesity were focused on promoting weight loss based on dietary restrictions. It is widely accepted that a caloric deficit is necessary to initiate weight loss, but achieving this target for long-term could be difficult due to compensatory mechanisms that promote excessive calorie intake by increasing the sensation on hunger [16, 17]. According to Canadian Adult Obesity Clinical Practice Guidelines, nutrition interventions for obesity management should be focused on achieving health-outcomes in order to reduce the risk for chronic diseases and to improve the quality of life, not just focused on weight changes [15]. In addition, dietary interventions affect people in different ways, and there is no single best dietary approach, no one-size-fits-all diet for obesity management, and adults with obesity should consider a range of dietary intervention options that meet their individual values, preferences and treatment goals and can be maintained over the long term [18, 19].

4.1.1. Caloric restriction

Dietary interventions based on caloric restriction are most commonly recommended, being generally classified in moderate calorie (1300-1500 kcal/day), low-calorie (900-1200 kcal/day) and very low-calorie diet (< 900 kcal/day), depending on the caloric intake [15].

The results of the studies performed with nutrition interventions based on caloric restriction are contradictory; even if these interventions that achieve a caloric deficit can result in short-term weight loss (6-12 months), the weight achieved cannot be maintained over time. A randomized clinical trial including women with BMI between 35 and 40 kg/m^2 evidenced that recommending 1000 kcal/day versus 1500 kcal/day determined greater weight loss after 6 months, but it was associated with significant weight regain after 12 months [20]. Although a greater percentage of participants on a 1000 kcal/day diet achieved a weight loss of 5% or more at 12 months, this type of diet may be more difficult to maintain over the long term, especially for people with a high calorie intake before the intervention. Another randomized clinical trial in participants over 65 years of age who

followed a diet with a deficit of 500 kcal/day compared with their previous intake, but with a minimum intake of 1000 kcal/day, showed a significant reduction in body weight (4%) at 12 months, together with a significant improvement in glycemic and lipid profile control [21]. Related to the fact that weight loss achieved by caloric restriction interventions is difficult to maintain, Polidori et al. investigated the amount of caloric intake to compensate for weight changes in free-living humans and estimated that appetite increased by 100 kcal/day for each kilogram of weight loss, explaining weight regain over time. This could be explained by the fact that caloric restriction may lead to pathophysiological drivers that promote weight gain by stimulating hunger and appetite and decreasing satiety. Furthermore, caloric restriction could have negative consequences for skeletal and muscle health, reinforcing the idea that recommendations should be individualized and that interventions should be not only effective but also safe for the patient [22, 23].

4.1.2. Macronutrient-based interventions

Macronutrients are the main source of dietary calories, and the dietary reference intakes allow for a wide acceptable distribution of macronutrients in caloric intake, ranging between 45% to 65% for carbohydrates, 10% to 20% for proteins and 20% to 35% for fats [15]. There are several studies concerning macronutrient-based approaches, highlighting the important role of individualized nutritional interventions and the greater importance of the quality of macronutrients than of their proportions from the caloric intake.

Some studies evaluated low carbohydrate diets (<40% of calories from carbohydrates) and extremely low carbohydrate diets (<10% of calories from carbohydrates), in which carbohydrates were replaced with fats and/or proteins; the results showed no meaningful advantages of one macronutrient distribution over another, neither in terms of weight control, nor regarding other cardiometabolic risk factors [15]. A meta-analysis of 48 clinical randomized controlled trials including more than 7000 participants that followed dietary recommendations varying macronutrient distribution under free-living conditions, showed no significant differences in weight loss at 6 and at 12 months and no significant improvements in glycemic control or lipid profile [24, 25]. Furthermore, a systematic review revealed a U-shaped relationship between the proportion of carbohydrates in the diet and mortality rates. Diets with lower carbohydrate intake (<40%) and those with higher intake (>70%) were associated with increased mortality, while the intermediate range, spanning from 40% to 70% carbohydrate intake, was linked to lower mortality rates [26].

The quality of macronutrients substituted seems to be more important than the quantity of macronutrients and their proportions in the caloric intake. The Eco-Atkins trial showed that a lower carbohydrate intervention in which high-glycemic index carbohydrates were replaced with high-quality unsaturated fat from nuts and canola oil and proteins from soy and pulses, reduced LDL-cholesterol in participants with BMI over 27 kg/m^2 [15]. Other studies investigated the isocaloric replacement of refined carbohydrate sources with high quality monounsaturated fatty acids and animal proteins with vegetal sources; the results showed significant improvements in multiple cardiometabolic risk factors in people with diabetes and overweight including reduction in body weight and fat mass, blood pressure, blood glucose and lipids [27]. In addition to this, some analyses suggest that the replacement of saturated fatty acids with monounsaturated fatty acids (from olive oil, avocado, nuts and seeds) and the replacement of high-glycemic index carbohydrate sources with low-glycemic index ones is associated with decreased incidence of coronary heart disease [15].

4.1.3. Dietary fiber

High intake of dietary fiber is recommended for the general population; according to the dietary reference intakes, the adequate intake for total fiber coming from naturally or supplemental sources is between 25 g and 38 g daily for people aged from 19 to 50 years, and 20 g – 30 g daily for people over 50 years [15]. The evidence showed that higher intake of total dietary fiber was associated with decreased incidence of diabetes, coronary heart disease and its associated mortality, stroke and its associated mortality, colorectal cancer and mortality associated with all types of cancer, without differences between fiber type or fiber source [28]. On the contrary, the data from randomized controlled trials support that the benefit of dietary fiber on cardiometabolic risk factors are restricted to soluble fiber; the evidence for fiber from oats, barley (beta-glucan), psyllium (glucomannan), fruit and vegetables (pectin) showed improved glycemic control, lowering fasting blood glucose and postprandial glycemia, reduced insulin-resistance, blood pressure and blood lipids, including the established therapeutic targets for LDL, non-HDL, and apo-B [29, 30]. However, studies with mixed fiber interventions, meaning the intake of combined types and sources of dietary fiber, evidenced reductions in body weight, improvements in HbA1c and postprandial glycemia, blood pressure and lipids; the necessary quantities for these benefits are not well established but, the general recommendation supports optimal benefits at daily intakes of > 25 g of mixed fiber, providing 10 – 20 g/ day of soluble fiber [15].

4.1.4. Low-calorie sweeteners

Systematic reviews and meta-analysis of randomized controlled trials evaluated the effect of the substitution of sugars and other caloric sweeteners with low-calorie sweeteners; the results showed a modest weight loss and some improvements in cardiometabolic risk factors as blood glucose, blood pressure and liver fat in people with BMI over 25 kg/m^2 [31]. On the other hand, some large prospective cohort studies that have modelled baseline or prevalent intake of low calorie sweeteners showed and association with weight gain as well as an increased incidence of diabetes and cardiovascular disease [31].

4.1.5. Meal replacements

Partial meal replacement, as a part of a calorie-restricted intervention, is defined as the replacement of one or two meals per day with standard liquid meals having a rigorously controlled composition. This type of intervention proved to reduce body weight, waist circumference, and to improve blood pressure and glycemic control in patients with diabetes and overweight. A meta-analysis of 23 randomized trials concluded that nutrition interventions that include partial meal replacements achieved greater weight loss after one year compared with intervention programs without use of meals replacements [32]. Related to this, findings from the Look AHEAD trial, which aimed to achieve a reduction in body weight of over 7% using meal replacements, revealed that greater adherence to the recommendations was associated with a four-fold increase in the likelihood of reaching the weight loss target at one year compared to low-adherence participants. Additionally, higher adherence was linked to improved glycemic control and fewer health-related complications over a follow-up period of 9.6 years [15]. In addition to this, total liquid meal replacement for 12-20 weeks, as a part of intensive lifestyle intervention program for patients with obesity and diabetes, showed a 20-fold greater probability to achieve diabetes remission at 12 months [33]. Finally, it is important to mention that this type of intervention using meal replacements should be include medical supervision, extensive nutritional and psychological support as well as exercise counselling.

4.1.6. Intermittent fasting

Intermittent fasting, also described as time-restricted feeding or intermittent energy restriction, include different meal timing approaches that alternate periods of extended fasting (from no intake to intake less than 25% of needs) with periods of unrestricted intake. A systematic review of 11 trials found comparable outcomes between interventions using intermittent fasting compared with continuous energy restriction in terms of weight, fat mass, waist circumference, glycemic and lipid profile control [34]. In terms of adherence, there was a comparable level observed between the intermittent and continuous energy restriction groups. However, the intermittent fasting group experienced higher rates of attrition and reported more side effects [34].

4.2. Physical activity

Diet, physical exercise and behavior modification remain the cornerstones in the management of obesity both in children/adolescents and adults. However, an exclusive focus on weight loss has not been shown to be optimal, as cardiorespiratory fitness (CRF) which could mitigate the negative consequences of obesity on health regardless of BMI, is often not taken into account. Several studies highlight the fact that an improved physical condition neutralizes the negative effects of increased adiposity, as well as other specific risk factors for cardiovascular diseases [35].

Physical activity plays an important role in human health, contributing to the prevention of obesity, reducing metabolic risk factors and improving general condition. Physical exercise can be subcategorized into two classes, acute and chronic exercise. Acute exercise refers to a single training session over a period of time, while chronic exercise/training includes repeated weekly or monthly exercise sessions. There are several studies that highlighted the short- and long-term effects of exercises on the human body; acute exercise interventions have been used to study the mechanisms of training adaptation, suggesting that an acute bout of exercise increases blood flow through adipose tissue, which leads to the delivery of fatty acids to skeletal muscle. In addition, during acute exercise, dietary fat stored in adipose tissue decreases as a result of the mobilization of fatty acids stimulated by β-adrenergic activation from adipose tissue to other tissues, such as skeletal muscle. Also, acute exercise alters adipose tissue physiology, leading to increased fat mobilization. However, it is not fully elucidated whether structural changes in adipose tissue are induced by physical exercise or by negative energy balance [36].

4.2.1. Recommendations and benefits of physical activity

Current guidelines recommend that exercise programs for weight loss shlould be focused on continuous aerobic exercises of moderate intensity; in addition, if possible, resistance exercises are recommended. The literature describes several types of exercises, of different intensities used in obese patients. Some studies have reported improvements in maximal oxygen uptake (VO2max), BMI and waist circumference (WC) with aerobic and/or combined training, while other studies have shown improvements in VO2max and, in some cases, decreases in BMI and blood pressure exclusively when performing resistance training.

An analysis of the benefits of physical activity in obese individuals highlights improvements in metabolic phenotype, cardiorespiratory and muscular fitness and improved quality of life. Physical activity is associated with specific benefits for brain health, including improving sleep and depressive symptoms, as well as emotional health and overall quality of life [37].

Fong et al. conducted a study that aimed to determine and compare the dose-response effects of exercise and caloric restriction on visceral adipose tissue in overweight

and obese adults; the results highlighted the fact that physical exercises had a grater dose-response effect on the reduction of visceral fat compared to caloric restriction [38].

There are several studies proving that regular physical exercise is associated with a lower risk of developing various types of cancer in the obese patients, and it could improve cancer prognosis and mortality. However, the nature of physical exercise responsible for these beneficial effects can not be clearly defined, so an optimal prescription of "anti-cancer" exercises is difficult to be achieved. In addition to this, it is not clear whether physical activity has direct biological effects that influence cancer initiation and progression, or whether it is only a marker of an overall health associated with a lower risk of cancer [39].

Spinal cord injuries are frequently associated with cardiometabolic diseases including obesity, due the the lack of activity. In these cases, obesity management should aim first inducing a negative energy balance and, secondly, increasing the use of fat as a fuel source. In people with spinal cord injuries, recruited muscle atrophy limits the ability of exercise and muscles have a low oxidative capacity, limiting the use of fat during exercise. These aspects must be considered when recommending exercise for the management of obesity in patients with spinal cord injuries [40, 41, 49].

Physical exercises are also recommended for obese patients diagnosed with osteoarthritis of the knee. Studies have shown the benefits of a recovery program combining intensive diet and exercise on knee joint loads, inflammation, and clinical outcomes among overweight and obese adults [42].

In children and adolescents, 60 minutes of moderate to intense physical activity, at least 5 days a week, are recommended to reduce the risk of obesity. For completely sedentary children, 20 minutes of physical activity daily or every 2 days are recommended at the beginning. It was found a linear relationship between the duration of physical activity and weight loss, each hour of physical exercise performed per week being associated with a decrease in BMI by 0.13 kg/m^2. The majority of physical activities in children and adolescents should be aerobic; resistance exercises that increase strength and muscle endurance should also be included at least three times a week. Daily activities such as the use of stairs, cycling and walking are also encouraged. Finally, schools and communities shloud play an important role in preventing obesity in children and adolescents by planning environments that demand and facilitate movement, pleasant activities such as dancing and various interactive games [43].

Several studies have been performed aiming to evaluate different types of nutritional and exercise interventions aimed to improve body composition (fat/muscle mass), BMI and WC in people with obesity/overweight. Several groups of overweight or obese patients aged 55-70 were analyzed, the type of intervention being the following: no intervention, energy restriction (500–1000 kcal), energy restriction with high protein intake (1.1–1.7 g/kg/body weight), intermittent fasting, mixed exercise (aerobic and resistance), resistance training, aerobic training, energy restriction, physical exercise and high protein intake, energy restriction and resistance training, energy restriction and aerobic training and energy restriction with mixed exercise. The results showed that body fat was reduced with energy restriction associated with all types of exercise or associated with high protein intake. Energy restriction alone was less effective and tended to decrease muscle mass. Muscle mass increased significantly only with mixed exercises; all other interventions effectively preserved muscle mass. A decrease in BMI and/or WC was achieved with all interventions except aerobic training/resistance training alone or resistance training associated with protein intake. The results highlighted the fact that the combination of energy restriction with resistance training or mixed exercises and high protein intake had the most effective results [44].

4.2.2. Types of physical exercises

Childhood obesity is a multifactorial disease that affects both physical and mental health. The European Academy of Pediatrics and the European Childhood Obesity Group encourage health professionals, teachers, parents and guardians to promote physical exercise for all children, from birth to adolescence [45]. In the tables below are presented a series of exercises that can be approached in the management of obesity in children, adolescents and adults.

Table 1. Physical exercise programs that can be recommended for obese children and adolescents [46].

FITT	Cardiovascular (aerobic) program	Interval program	Muscle resistance program
Frequency	≥3/week	≥3/week	2–3/week
Intensity	Moderate-severe exercise	3–5 min. Mild-moderate Interrupting for 6–8 times 1–3 min high intensity exercise	High (50–70% MVC)
Time	20–60 min	Total 20–60 min	2–3 min. per muscle group (8–20 repetitions) Total ≥30
Type	Running, jumping, biking Swimming, soccer	Running, jumping, biking, Swimming	push-ups, climbing, paddle
Program duration	8–12 weeks	6–12 weeks	6–12 weeks

FITT: Frequency, intensity, time, and type
MVC: Maximum voluntary contraction

Table 2. Physical exercise programs that can be recommended for obese adults [47].

FITT	Aerobic vigorous intensity	Aerobic moderate intensity	Resistance high load	Resistance low-moderate load	Combined high intensity	Combined low-moderate intensity
Frequency	3–5/week	3–5/week	3/week	3/week	3/week	3/week
Intensity	>65% VO2max or >65% HRR or >75% HRmax	45–65% VO2max or >50–65% HRR or 65–75% HRmax	Average maximum load > 75% 1RM	Average maximum load 50–75% 1RM	-	-
Time	30–60 min	30–60 min	30–60 min	30–60 min	30–60 min	30–60 min
Type	walking, running, cycling and swimming	walking, running, cycling and swimming	free weights, weights machines and resistance bands	free weights, weights machines and resistance bands	A combination of aerobic; vigorous intensity and resistance; high load	A combination of aerobic; moderate intensity and resistance; low-moderate intensity
Program duration	8 weeks	8 weeks	8 weeks	8 weeks	8 weeks	8 weeks

Table 3. Types of moderate exercise that can burn 150 kcal [46].

Daily activities	Sports activities
Washing or polishing a car for 45–60 min	Playing volleyball for 45–60 min
Washing windows or the floor for 45–60 min	Playing with soccer ball for 45–60 min
Gardening for 30–45 min	Walking 1.5 km in 35 min
Using wheelchair for 30–40 min	Shooting a basketball for 30 min
Pushing a wheel for 30 min for 2 km	Biking 6 km in 30 min
Walking 2.5 km in 30 min	Dancing swiftly for 30 min
Climbing stairs for 15 min	Exercising in water for 30 min

5. Conclusions

Patients living with obesity should receive individualized medical nutrition therapy, aiming not only to improve weight outcomes, but also to reduce the risk of obesity-related disease as diabetes [48], dyslipidemia, hypertension, cardiovascular disease. In the management of obesity, it is essential to consider various medical nutrition therapies that meet specific criteria: they must be safe, effective, nutritionally adequate, culturally acceptable and affordable for long-term use. The importance of sustained adherence over time, regardless of the chosen intervention, is fundamental. In addition to nutrition interventions, physical activity is essential in maintaining health and preventing obesity, being associated with several benefits including improvements in metabolic profile, cardiorespiratory and muscular fitness and improved psychological and emotional status.

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