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## Prevention and treatment of overweight and obesity in children and adolescents

**Abstract** Increasing numbers of obese children and adolescents all over the world demand an investment in the primary and secondary prevention of obesity and overweight in this age group. The goal of preventive measures in children is to avoid the negative short- and long-term health problems associated with obesity. Primary prevention aims at establishing a healthy, active lifestyle and keeping children and adolescents within a range of body weight which is considered to be healthy. Constant availability and affordability of palatable and energy-dense food in the affluent society of the western world demands preventive strategies. Universal or public health prevention seems to be the most suitable form because several other cofactors of morbidity and mortality of affluent societies can also be prevented. However, in most European countries there is a lack of awareness of the necessity of prevention programmes, not only among the general population but also among the medical society. More awareness and consciousness to the problem of obesity must be generated in order to lead to effective therapeutic programmes. For those children and adolescents who are already obese, secondary prevention is mandatory. Therapeutic intervention programmes for the obese aim at long-term weight maintenance and normalisation of body weight and body fat. They have to modify eating and exercise behaviour of the obese child and establish new, healthier behaviour and lifestyle. Treatments programmes must include behavioural components in order to permanently change nutrition and physical exercise of the obese children and adolescents. However, long-term results of treatment programmes in European countries are scarce and the reported results, even of multidisciplinary regimens, are not impressive.

**Conclusion** In most European countries there is an urgent need not only for a growing awareness of the problem of obesity in children and adolescents but also for development of new comprehensive approaches in treating this group.

**Key words** Childhood obesity · Primary prevention · Secondary prevention · Treatment · Behavioural programmes · Physical activity · Dietary treatment · Pharmacological therapy · Surgical treatment · Public health

**Abbreviations** *BMI* body mass index · *PSMF* protein-sparing modified fast · *VLCD* very low calorie diet

### Introduction

Never before in man's history was childhood obesity a general health problem, but during the last decades not

only obesity in adults but obesity in infants and youngsters has reached epidemic proportions. Obesity accounts for substantial morbidity and mortality in industrialised and developing countries, thus representing the leading cause of preventable death [12, 15]. The

increasing prevalence of obese children and adolescents will aggravate the problem because many of the obese children will become obese adults in addition to the relative constant number of adults who gain weight during ageing. The long-term consequences of the growing number of obese children and adolescents will lead to a considerable burden for the health systems. In view of this trend, treatment and prevention of childhood obesity have gained more and more interest and importance. The passive and waiting approach of many physicians and health care professionals must give way to more aggressive attempts to prevent obesity and earlier treatment measures have to be considered.

The major objective of primary and secondary prevention is to avoid the negative, short-term and long-term, health effects of obesity. Primary and secondary prevention and treatment do not differ in their aims and in the rational background; however, they do vary in their time frame and the target population. Both aim at health promotion to achieve permanent changes in energy intake and energy expenditure and rely on strategies to implement and facilitate in establishing these lifestyle changes e.g. by behaviour modification. Primary prevention of obesity may be the best way to avoid the negative health consequences, however, it is an erroneous assumption that prevention is an easier task than treatment. Both are very similar in their approaches and consequently face similar problems regarding compliance, success or failure. In recent years it has become evident that obesity management covers a wide spectrum of strategies, which include prevention, weight maintenance, managing obesity co-morbidities and weight loss. These different parts of obesity management are independent and, particularly in children and adolescents, each one is of distinct importance.

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### **Primary prevention of childhood obesity**

Prevention of childhood obesity is a rather new area that has attracted recent attention for several reasons, particularly because of the drastic increase in the prevalence of obesity and the persistent failure of treatment to achieve long-term success. There are several reasons why strategies aimed at prevention of weight gain and obesity should be easier, less expensive and more effective than treating obesity after it has fully developed. A number of studies have documented the failure of many obesity treatments to achieve long-term success in adults as well as in children [40, 54, 70]. Moreover, the health consequences associated with obesity over a long period may not be fully reversible by weight loss [75] and the proportion of the population that is either overweight or obese is now so large that there are no longer sufficient health care resources to offer treatment. In spite of the strong rationale behind the prevention of obesity there has been little comprehensive research addressing the question whether such strategies are effective. Furthermore, the fact that obesity rates in almost all areas of the

world are rapidly increasing casts doubt whether it is possible to prevent excessive gains in body weight in the long-term. There is only indirect evidence that prevention strategies can play an effective role. In adults in Finland there was a lower rate of increase in mean body mass index (BMI) from 1972 to 1992 in the most highly educated groups [50, 77]. In some areas of Finland, the average BMI has actually fallen after 1987 in men in the groups of highest education and the rates of increase in mean BMI in women of the high and medium education groups appear to be levelling off. These data suggest that it may be possible to prevent increases in the average weight and to prevent obesity in certain population groups. However, the most convincing evidence of the effectiveness of prevention strategies comes from studies which demonstrate that effective management and support of overweight and obese children can significantly reduce the number of children who carry this weight problem into adulthood [22, 23, 28, 34]. The long-term prevention of obesity in these studies was achieved during difficult transition periods of childhood and adolescence when weight gain can be a major problem.

Two major facts suggest childhood and adolescence to be the best age for primary preventive measures: (1) susceptibility to obesity is most striking in those with a family history and (2) persistence of childhood obesity increases with age. Thus, research on obesity prevention in childhood and preadolescent age groups seems considerably promising and population-oriented strategies, including school-based programmes and individual risk prevention programmes could be an effective measure to fight the emerging epidemic. There exists ample evidence for individual differences in susceptibility to obesity, but obesity is not innate but develops over time. The question therefore is whether and how the development can be stopped or influenced. The primary prevention aspect in particular is highlighted by the fact that once obesity has developed, it is difficult to treat and it tends to persist. Very few of the different forms of treatment have good long-term prognosis and consequently it seems to be easier, less frustrating, less expensive and more effective to prevent development of obesity than treat it [71]. Moreover, many of the negative health effects, which develop over time in obese patients, can be prevented and thereby health costs saved. Obesity prevention could be the best way to address health problems it causes.

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### **Individual risk factors**

Childhood obesity can develop at any time between early infancy and late adolescence. In a recently published paper Unger and co-workers [96] tried to focus on the period, when obesity first developed. They found that most of the children who were obese (120% ideal body weight/height) at the age of 7 had become overweight by the age of 4 and obese at 5 years of age [96]. Similar results were found in the prospective part of the

Bogalusa Heart Study, thus underlining the importance of the age group of kindergarten children [37]. The importance of this age group was also stressed by the investigations of Rolland-Cachera et al. [84]. They demonstrated that an “early adiposity rebound” between the 2nd to 5th year was associated with the development of obesity. Physiologically BMI and fatness decline after a sharp increase during the 1st year of life and start to increase again after the age of 6 and 7. By monitoring BMI curves of children who are at risk becoming obese, onset of obesity can be easily detected. Approximately 15%–20% of all obese people become obese in childhood and an additional 10%–15% during adolescence. Preventive efforts therefore must clearly begin at an early age, and persist during adolescence into adulthood.

During the last decade it has become evident that not all individuals are equally susceptible to develop obesity. Familial obesity, however, appears to be the single strongest predisposing factor, probably mediated by genetic predisposition and promoted by a shared environment. Depending whether none, one or both parents were obese, it could be shown that obese parents more frequently also have obese children. If both parents are obese, there is an 80% probability that their children are obese too. The probability declines to 40% if there is only one obese parent [38, 39]. Another important risk factor for the development of obesity is early development of lesser degrees of fatness. Children and adolescents who are at the upper end of weight percentiles are at a much higher risk to become truly obese later in life compared to those who are leaner [102]. Moreover, individuals who develop the most extreme degrees of obesity are often those who suffer earliest in life from obesity [78]. Consequently, particular attention has to be given to these individuals and they are primary targets for preventive efforts.

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### Population risk factors

The single most important inter-population risk factor for developing obesity seems to be affluence. In the latter half of the century changes in social and economic conditions in industrialised western, but also developing, countries have typically been accompanied by an increasing prevalence of obesity. Factors like increased availability and affordability of highly palatable, energy-dense foods to the general population and low levels of education on the consequences of high caloric intake have contributed to population obesity. The increases in obesity rates, particularly in lower socioeconomic groups during the last decades, are paralleled with the trends in the availability of fast foods, loss of cultural eating tradition and traditional cooking. The problem is aggravated by a decline in active occupations and increases in inactive leisure time pursuits. During this time the gene pool has remained rather constant, suggesting that the combination of all these factors has contributed

to the drastic increase in the problem of obesity in European countries.

Treating obese children in many respects is the secondary prevention of adult obesity. Effective treatment in children may prevent or delay adult obesity and several studies give reason for optimism about the potential for multifaceted integrative treatments [28, 34]. However, primary prevention strategies aim at preventing obesity even in children and adolescents. For primary, as for secondary prevention of obesity, two approaches are possible: increase of physical activity and energy expenditure and modification of energy intake.

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### Levels of preventive action

High-risk group (selective prevention, targeted prevention) prevention versus universal or public health prevention

Preventive measures can aim at the high-risk individual or the high-risk group or the whole population without defined risk. An individual, targeted approach deals with children or adolescents who are already overweight or obese (secondary prevention) but also those who are at risk of becoming obese (primary prevention) and show biological markers associated with excessive fat stores. The primary objectives of targeted prevention of obesity are restricted to the prevention of further weight gain and to the reduction in the number of children and adolescents who will develop obesity-related co-morbidities in adulthood. These individuals will already suffer some weight-related problems and require intensive individual or small group preventive intervention.

Selective prevention measures are aimed at subgroups of the population that are at risk of developing obesity. High-risk groups possess genetic, biological or other factors (e.g. eating habits), which have been associated with increased risk for obesity. Selective prevention strategies may be initiated through kindergarten, schools, colleges, community centres or through any appropriate setting which allows access to high-risk groups. Selective prevention is concerned with improving the knowledge and skills of groups of people to allow them to deal more effectively with factors which put them at a risk of developing obesity. For the high-risk-group strategy, knowledge of risk factors and risk behaviour is of essential importance to target the efforts. To determine the risk for obesity several factors, e.g. history of the family and the child, social, metabolic and genetic background must be included and taken into account. The great metabolic variance between individuals aggravates a clear definition of high-risk groups on an individual basis. Inter-individual variance of human metabolism (energy requirement, fat oxidation or insulin sensitivity) which is genetically determined, explains the different effects of our affluent society on the individual. Predisposed children and adolescents become obese more easily than those who can adapt to the affluent

environment because of high-energy requirement and energy expenditure.

Because of the high prevalence of obese children and adolescents in Europe, a universal population approach seems to be useful. Universal or public health prevention programmes are directed at the population or community as a whole regardless of their current level of risk. The aim is to stabilise the level of obesity in the population, to reduce the incidence of new cases and to reduce the prevalence of obesity within the population. The most important issue of a universal population approach is a reduction in the mean weight of the population. At the population level it is possible to reach large numbers of both obese and non-obese children and to do this in a cost-effective manner. An additional advantage is that other risk factors; e.g. blood pressure, diabetes, etc. can be positively influenced as well. For children and adolescents, a logical setting for pursuing these goals is the school system. School-based programmes should encourage an active school concept involving parents and governors to open school sport and recreational facilities for the use of pupils families and surrounding populations, safe walking and cycling to school and also to enable teachers to receive training in nutrition and physical activity. Nevertheless, such a mass approach to control and prevent life style diseases has been criticised for requiring those who may be a low risk to make changes similar to those at high risk. In the prevention of overweight and obesity, where the prevalence of the condition even in childhood and adolescence is already extremely high and a large proportion of the population is at high risk, universal approaches have the potential to be the most effective form of prevention. Whereas in the United States several school-based prevention projects have been published [19, 36, 91, 100], there could be found only one report on a primary prevention programme for school children in Europe [68, 69]. In Kiel, Germany, in 1996 a primary prevention programme "Kieler Adipositaspräventionsstudie, KOPS" was launched. Some 500 to 1000 children per year were recruited and investigated with respect to risk for obesity and several other risk factors, including cardiovascular risk, diabetes and hypertension. The programme includes a school-orientated intervention (primary prevention) and a family-based treatment programme for secondary prevention of obese children. Follow-up investigations after 6 to 7 years are planned, however so far, no results have been published. In spite of this singular model, the fact that primary prevention programmes are so scant in Europe underlines the sub-optimal situation regarding prevention of obesity on a population-oriented basis.

Independent of which prevention strategy will be chosen, the medical and social environment in most European countries has to be prepared to establish effective programmes. At the moment we are far away from initiating such programmes because there is a lack of awareness for the necessity of prevention programmes, not only among the general population but

also among the medical society. Obesity for many physicians is still rather a cosmetic problem without important implications for general health. The public as well as health care workers often have incomplete, confused, and occasionally incorrect knowledge of obesity and nutritional issues [82] and the WHO states in the Press Release WHO/46: "the problem of obesity has so far been largely ignored as a public health issue". Obesity is not a common subject in the pre-qualification training of health care workers and opportunities for update training are limited. Moreover, treatment of obesity very often is frustrating and prevention seems to be impossible. In many European societies much more awareness and consciousness for the problem of obesity must be created in order to come to effective therapeutic programmes. Then it will be possible to realise, that therapy and prevention in many aspects do not differ in regard to the problems we will face.

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### Treatment of childhood obesity

#### Aim of treatment

The primary goal of childhood obesity treatment is the regulation of body weight and body fat with nutrition, which nevertheless ensures normal growth and development. Moreover, ideally these interventions are associated with positive changes in the physiological and psychological sequelae of obesity. Therapeutic interventions aim at long-term weight maintenance and normalisation of body weight and body fat and therefore they have to modify eating and exercise behaviour of the obese child. The establishment of new, healthier behaviour and lifestyle is necessary to reduce and maintain normal body weight through adolescence into adulthood. The behavioural changes need time to be established and confirmed, furthermore they need reinforcement and positive feedback. Strong efforts are necessary to achieve long-term success. However, these strategies may be of only limited value in individuals who are prone to obesity because of low energy expenditure, children with familial obesity and a genetic background. These factors may help to explain the limited long-term success of treatment efforts in childhood and adolescent obesity. Nevertheless, behavioural treatment of obese children and adolescents focusing on reducing energy intake and increasing energy expenditure by active lifestyle and physical exercise are the foundations of treatment in children and adolescents. The behavioural approach grew out of the learning theory of the 1970s and is based on the assumption that eating and exercise behaviour affects body weight and vice versa. By changing eating and exercise behaviour it should be possible to change body weight. Eating and physical activity patterns are learned behaviours and can be modified and changed. In order to modify these behaviours it is necessary to change the environment that influences and determines it. This approach does not deny genetic background, which can

contribute to the development of obesity considerably, however, the environment which promotes the development of the genetic predisposed phenotype can be influenced. Despite a genetic predisposition for many centuries, the environmental factors (irregular food availability and heavy everyday physical exercise) prevented the development of obesity. Individual family and cultural background always influenced body weight by determining food preferences, choices and preferred level of physical activity.

Based on these assumptions it becomes clear that the behavioural approach influences the whole family. Aiming at changing behaviour within the family and shared very often results in conflicts. Therefore the family can emerge as a considerable risk factor for falling back into old behavioural mechanisms which causes or at least favour the development of obesity. Whereas the basic principles of the behavioural approach are valid for almost all individuals who try to reduce body weight, several individual factors have to be taken into account when treating children and adolescents, e.g. age of the patient, degree of overweight, risk factors, parental obesity, social aspects etc. These individual factors might contribute to the different treatment outcomes that are reported. Treating obesity as a homogeneous condition and not considering the individual background and aetiology is a reasonable factor which influences treatment results negatively. Individual and heterogeneous interventions suggest being more successful than those not taking into account these individual and personal aspects do.

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## Treatment components

### Behavioural approach

The major principal of the behavioural approach to obesity is the recognition of the association between eating and exercise behaviour and environmental events e.g. food stimuli, social activities, mood etc. [14]. The first step in changing behaviour is self-monitoring and recognition of the patients individual lifestyle regarding eating practices and physical activity. Monitoring allows the patient and therapist to identify typical patterns which can be potentially changed. The fact that self-monitoring needs a certain degree of intellectual and rational capability limits the behavioural approach to individuals who are able to analyse their behaviour and attitude to nutrition and exercise. Due to these limitations the behavioural therapy very often is not the optimal approach for pre-school children and youngsters. Self-monitoring is considered to be the most important factor in behavioural programmes and effective self-monitoring is found to be a good predictor of long-term success [43, 99].

The next step in changing behaviour is goal setting. It is often necessary to break down the targets into intermediate goals and components in order not to overload

the individual and to frustrate him/her with an unrealistic goal (total weight loss as well as behaviour changes). The goal setting must be realistic and achievable within a time frame; it must be easily comprehensible and not cause frustration because it seems to be unreachable. In regard to weight loss, the goal is a weight reduction of approximately 0.5 kg per week. However, depending on the phase of treatment, it also could be to maintain weight at a certain level. Short-term goals that children and adolescents reasonable can expect to achieve are emphasised [7]. The hallmark of behavioural treatment programmes is the stimulus control technique. Changes in the environment of the children and adolescents result in changes of their behaviour and favour appropriate lifestyles. Lifestyle modifications aim to reduce caloric intake and increase energy expenditure via physical exercise and active behaviour. Introduction of new behaviour is stepwise and carefully planned in order not to make an excessive demand on the individual. A designated, decorated eating-place helps to restrict eating to that place and to separate eating from other activities (e.g. TV, video, reading). It also helps to avoid between-meals eating and eating "out of mood". Stop signs at the refrigerator and places where food is stored can remind the child of his newly learned behaviour [87, 112].

During the treatment sessions the participating children and adolescents identify individual situations that pose a problem for their eating and exercise behaviour. They discuss and generate possible solutions to the problems and evaluate the success of their attempt. During the training sessions individual experiences are exchanged and strategies are adapted to the participants. Managing risk situations and elaboration of strategies for problem solving is essential for long-term success. Together with relapse prevention, these components make up a great deal of work of the behavioural modification in children and adolescents. It is generally accepted that lapses are a natural part of the weight loss process, nevertheless, relapse prevention is an essential part of management of lapses. Children are taught to anticipate situations that might cause them to lapse and to plan strategies for coping with these situations. A major goal is to prevent permanent relapse into old, inappropriate behaviour. The primary goal of reinforcement strategies is to compensate for frustrations due to changed behaviour and to establish the new appropriate living style. It is important for children and adolescents to positively motivate them and reward them for their efforts and their obtained modifications and weight loss. Thus a structured rewarding system has shown to positively affect motivations and general attitude to the programme [112]. The rewards must be achievable within a definite period, which is easily comprehensible and motivates the children. In our behaviour programmes we offer "point" for positive behaviour (diet and exercise) and after reaching a certain number of points a reward, which was defined with the parents in a written contract, is offered and handed over.

In contrast to behaviour treatment in adults, in children and young adolescents behaviour control is applied externally by parents or/and other adults in charge of them. This poses a serious challenge and self-monitoring, goal setting and stimulus control is problematic if the caretakers are not convinced of the new behaviour. Thus motivation and careful introduction of modifications of behaviour are essential for success. Opposition and refusal of therapeutic measures may result when it is not possible to convince the child that he/she is self-responsible for the treatment and behaviour. Particularly in children it is therefore necessary to involve parents and to engage them in the treatment of their children. Optimally, obese parents join the treatment efforts of their children and thereby support each other. In adolescents, particularly in the phase of separation during puberty, sometimes it is not necessarily optimal if parents supervise the treatment. Opposition against the parents and the emerging individual personality of the adolescent motivate and stimulate self-control and responsibility. Aggression and rejection of parental opinions and attitudes to nutrition and exercise on the one hand can interfere with the therapeutic process or can be used as additional motivation for the accompanying therapist. A sensitive and empathic approach to the adolescent's problem is necessary to find out the individual optimum strategy.

#### Diet and nutrition

The basis for dietary modification in the treatment of obesity is the hypothesis that obese individuals consume too much energy in relation to their energy expenditure. Considerable individual variations in energy expenditure are well-documented [11], however, these variations have to be taken into account and do not contradict this principle. As a consequence, dietary modification is a "conditio sine qua non" in treating obese children and adolescents, independent of whether the goal is weight maintenance or weight loss. Diet and eating behaviour are two different components which must be influenced and changed by behaviour modification treatment in order to result in permanent weight stabilisation. The necessity of permanent treatment of the obese is now more widely recognised and short-term weight changes are no longer the goal of treatment.

The dietary intervention involves reduction or stabilisation of total calorie intake, fat intake, modification of the composition of macronutrient intake, as well as reconstruction of eating habits, which aim at avoiding between-meals, uncontrolled caloric intake and preference for energy dense nutrients. Virtually all behavioural programmes include nutritional aspects, e.g. recording what individuals eat, calorie and fat content of food, specific situation when they eat, etc. During behavioural programmes for children and adolescents, basic knowledge and teaching lessons on healthy eating, dietary

principles, and calories are provided. Interventions aim at increasing intake of complex carbohydrates and dietary fibre and decreasing energy-dense foods with a high fat content. Depending on the degree of overweight and obesity, different dietary interventions are necessary: ranging from minor modifications (substitution of high caloric sweet drinks and energy dense foods, e.g. sausages and typical traditional fat food) to profound change of dietary habits with drastic restriction of caloric intake. Age is another variable which determines the degree of dietary intervention. Generally in young children drastic caloric restriction is not so often necessary because overweight is not as profound as in older age groups. Moderate dietary restriction of the caloric intake and maintenance of body weight over a longer period often results in "growing into the body height" and thus normalising body weight. However, this approach on the other hand must not prevent efficient dietary treatment or delay of necessary therapeutic intervention. The whole social and individual situation of the family must be taken into account in order to evaluate the suitable approach regarding optimal time and intervention as well [87].

In moderate overweight children and adolescents, caloric restriction of 30% to maximum 40% of their caloric requirements results in efficient weight reduction. The energy intake must be adjusted to factors such as heavy physical activities in special situations. Generally a mixed hypocaloric balanced diet with consisting of 25%–30% fat, 50% to 55% preferentially as complex carbohydrates and 15%–20% protein is prescribed. Usually a fixed number of meals are recommended (e.g. five meal times) in order to avoid between-meals and snacking. Moreover, sufficient fluid intake should be provided (1.5 to 2.0 l/day). With diets of this or similar composition, weight loss of approximately 0.5 kg/week can be achieved even over longer periods. Adverse effects of such diets are rarely described [86] and appropriate growth without metabolic abnormalities is found. More drastic caloric restrictions have been associated with impaired velocity of growth and lean tissue accretion [1].

In grossly obese children and adolescents under strict indications the use of very low calorie diets (VLCD) and/or protein-sparing modified fast (PSMF) is possible. These diets have been used to treat severely obese adolescents and usually consist of 600 to 900 kcal and provide 1.5 to 2.0 g high-biological-quality protein per kilogram reference body weight per day. Most diets are provided as lean meat (PSMF), however, there are some reports with liquid formulas (VLCD) [101, 113]. These diets are designed to maximise rapid weight loss, to preserve mineral balance, achieve positive nitrogen balance within the shortest possible time (1 to 2 weeks), and to minimise lean body mass loss. These modern PSMF and VLCD diets contain adequate quantities of carbohydrates and other nutrients, especially potassium, magnesium and vitamins and are considered to be safe. They usually are of limited duration (3–10 weeks), need

strict indication and should not be used without close medical supervision [31, 101, 110, 113]. It must be emphasised that under certain conditions VLCD provide a safe and efficient treatment of obesity but emphasis has to be put on continuous weight control and behavioural training as well as follow-up care otherwise long-term results in patients treated with VLCD are weak and frustrating for both therapist and patient [70]. In our experience VLCD/PSMF treatment can be useful in superobese adolescent patients, who tried several times to lose weight with conventional diets and failed, as well as in patients with Prader-Willi syndrome. In these patients considerable weight loss can be achieved and patients are motivated to hold on to a diet. However, it must be underlined that these diets are useful only in the initial period of treatment and they do not lead to long-term changes of lifestyle which are necessary for weight stabilisation. In our experience it is absolutely necessary to start lifestyle modification already during VLCD treatment. Stepwise behavioural changes in diet and physical exercise are absolutely necessary and more promising for continuous long-term weight loss. The new lifestyle must become a part of daily life and not a cumbersome routine for periods when body weight has increased again.

Very little is known about specific components of dietary recommendations, e.g. macro-nutrient content of the diet, use of sweeteners, dietary fibre or studies on the pattern of eating in obese children, distribution of food in meals, number of meals per day, rigid or flexible meals. The question whether sweets should be totally removed from the diet, or allowed to certain degrees, is open. Little is known about the effects of dietary modification on food preferences and long-term effects of modifications on food habits in children and adolescents.

#### Potential dangers and negative side-effects of dietary manipulation

The potential negative effect of dietary intervention in children and adolescents is the possibility of impairment of linear body growth. Growing children and adolescents who are undergoing dietary manipulations are sensitive to growth disturbances. Any dietary intervention, particularly those involving macronutrient composition and energy supply during a period of growth, can negatively affect growth [1, 61]. Thus close medical supervision of growth data in children and adolescents must be guaranteed. Weight reduction in obese children and adolescents is associated with significant changes in the electrocardiographic pattern [76]. These changes may only be detected by intra-individual comparison, however, reduction of heart rate and shortening of QT interval in the course of weight reduction may be of clinical relevance. Consequently, massive weight loss in obese children and adolescents should be medically supervised.

#### Exercise and physical activity

Besides restriction of energy intake, promotion of energy expenditure, physical exercise and activity is the other choice to modify body weight. The health benefits of physical exercise are clear and there are many reports which demonstrate the very substantial gains [8, 97]. However, it is important to distinguish the value of modest increases in physical activity from that of more vigorous exercise. Even light activity can provide a valuable addition to energy expenditure as long as the activity is sustained for substantial parts of the day. Thus transferring from a sitting to a standing position to undertake a variety of tasks enhances energy output and any activity which involves being upright and moving can contribute appreciably to energy expenditure. Moreover, there is increasing evidence that physical inactivity makes an extremely important contribution to the development and persistence of childhood obesity [24, 42, 55, 73]. Consequently, it seems reasonable to conclude that individuals who are particularly inactive are much more likely to gain weight in childhood and adolescence.

Exercise programmes therefore are designed to increase energy expenditure and produce or increase negative energy balance. Almost all multi-faceted treatment programmes for obesity combine dietary interventions with exercise programmes to accelerate weight loss and help to maintain long-term weight loss. In behavioural weight loss programmes, a great deal of attention is given to exercise because this is the single best indicator for long-term weight maintenance in adults. The association between exercise and successful long-term weight loss has been observed in men, women and also in children and adolescents in different treatment programmes [26, 104]. Comparing successful and unsuccessful adult patients consistently showed that successful weight losers are those who reported adherence to the exercise programme [20, 51, 54]. Randomised trials have consistently shown that the combination of diet plus exercise was superior to diet alone or exercise alone [6]. Exercise programmes include lifestyle exercise, e.g. walking instead of driving with the bus or using stairs instead of lifts, as well as exercise in a planned and structured manner, e.g. participating in sport or gymnastic groups. Treatment programmes should encourage both types of activity for children and adolescents.

Another aspect is that inactive phases (sedentary activities, TV and video viewing etc.) during the day should be exchanged as much as possible for active behaviour. Recent studies suggest that decreasing sedentary activity is very effective in promoting weight loss. Many programmes now include lessons on this topic [29, 112]. A goal of exercise programmes therefore is to promote an active lifestyle for the obese children and adolescents and to implement this in their everyday life. Whereas children under the age of 10 are rather active by their nature, during the teenage period a more

sedentary lifestyle becomes more evident. Specific attention thus must be paid to this age group to facilitate physical activities and sport. Both exercise and active lifestyle must be encouraged, including physical activity at home, in school and during leisure time. Obese children and adolescents, because of their fear to participate in sports which are dominated by lean and normal weight peers, very often refuse sporting activities. Physical activity therefore should be made a family event and parents should take responsibility for providing motivation and support for children's physical activity. Daily physical activity should be given a priority and the best case is when parents are physically active with their children. They very often are lacking self-confidence and suffer from their distorted body image. Joining regular sport training programmes is often a major problem for them. Nevertheless, children and adolescents should be encouraged to aim at least for one period of at least 30 min of moderate activity on a daily basis.

### Treatment options

A vast variety of treatment programmes are offered for obese children and adolescents in Europe, some of them published in international and national journals [16, 30, 34, 35, 41, 52, 53, 56, 57, 58, 62, 72, 74, 81, 83, 87, 88, 94, 98, 103]. Table 1 summarises some of the published data on therapeutic regimens, the list, however, is probably incomplete. There are only very few data on randomised treatment trials and even less data on long-term results.

#### *Outpatient treatment*

Outpatient clinics of major paediatric departments offer different therapeutic approaches for different age groups of obese patients. Individual treatment or group treatment is offered, some of the programmes including the family, others offering specific family orientated programmes. These programmes do not differ in their major components to those in other countries, particularly in the United States.

#### *Dietary camps*

During the last century, starting in the German-speaking countries so called "dietary camps" were founded, offering complex and effective treatment for various age groups [5, 47, 48, 92, 112]. These camps are typically characterised by three phases of treatment: (1) pre-camp phase: recruiting motivated patients on an outpatient basis, dietary counselling, self-monitoring and goal setting as well as starting with treatment (dietary and exercise programme). During phase (2), all participants take part in a structured multidisciplinary behavioural treatment programme which takes place during the summer holidays. During a period of 2–5-weeks, chil-

dren and adolescents aged 9 to 16 years learn specific skills of a behavioural programme aiming at weight loss and stabilising reduced body weight. During this period all children and adolescents are admitted to a camp, supervised by physicians, dieticians and personal trained in behavioural therapy (5–7 children/trainer). In daily regular training sessions, the behavioural programme is taught and regular exercise programmes are performed. Modification of eating habits, induction of lifestyle change, discussion of alternative behaviour and prospective control is aimed during these sessions. During the camp, a self-monitoring and confirmation system is institutionalised. Rewarding new eating habits and active participation in physical training and sport activities, as well as achieving a prospected weight loss, are goals of the treatment programme. Basic dietary knowledge is taught and nutritional aspects of weight loss are discussed during the daily group sessions. Besides the training programme, leisure activities are offered to the participants e.g. sport activities: tennis, basketball, badminton as well as a variety of other activities including horse riding, swimming etc. but also creative activities and relaxing techniques are available. The major success of these programmes is based on the appropriate way for children and adolescents to learn effective treatment procedures in a very pleasant way together with peers who share the same problems. During phase (3), a follow-up treatment is included which lasts between 6 months and 1 year. Trainers and medical personal who treated the participants during the active dietary camp organise meetings on a regular basis every 2 to 3 weeks where experiences are interchanged and problems can be discussed. A financial deposit is paid back after completing the follow-up treatment. The acceptance of one of these programmes, organised for more than 10 years, is excellent. More than 90% of boys and girls who participated in the dietary camps quoted after 1 year the programme as effective and motivating. One-year follow up data show that 27.4% of all participants could reduce their body weight after the dietary camp and 33.9% maintained and stabilised the weight reached during the camp and 38.7% regained weight (unpublished data).

#### *Group therapy and individual therapy*

Many different types of therapy can be utilised within the context of a group. Group behaviour modification programmes in some studies gave better results than an individual contact programme [106]. However, another study compared individual dietetic counselling, group dietetic counselling and group dietetic counselling with behaviour modification. At 1 year follow-up, group dietetic counselling was not as effective as the other two regimens [63]. Both forms of therapy have advantages and bear problems: financial and time costs are to be considered as well as homogeneity of the group regarding age, gender and social background.



**Table 1** Published data on therapeutic regimens

Reference	Subjects, interventions, sample size	Key results
[30]	213 Obese children (aged 5–14 years); comparison of different treatments: group 1: nutritionist, group 2: nutritionist and dietician, group 3: nutritionist and psychiatry, group 4 nutritionist, dietician and psychiatry; duration of treatment: $1.0 \pm 0.8$ years	Good response (decrease in BMI $> 2.0$ /year) in 36.6% of all patients; different treatment regimens did not influence significantly success rates; group 4 tended to result in better success rates (41.3% versus 31.8%)
[34]	Swedish children (10–11 years old) identified in a school screening programme for obesity (BMI $> 23$ ; mean = 25.1); randomised controlled trial, 14–18 month intervention, group 1: family therapy – conventional treatment (diet counselling plus encouragement to exercise) and family therapy ( $n = 25$ ); group 2: conventional treatment ( $n = 19$ ); group 3: untreated control group ( $n = 50$ ); groups BMI comparable at baseline	1 Year post-intervention follow-up; family therapy group showed smaller increase in BMI than control group (5.1% versus 12%, $P = 0.02$ ) and fewer children with severe obesity (5% versus 29%, $P = 0.02$ ); no differences between conventional and control groups were statistically significant; no data on dropouts recorded; analysis carried out on an intention to treat basis
[35]	17 Obese children, aged 7 to 12 years; combined out-patient programme; 17 children (control group) receiving initial dietary instruction only	Obese group: decrease in percentage overweight – 11.5%; control group: increase of 2.8%
[52]	160 Obese children and adolescents aged $10.7 \pm 3$ years, percentage overweight $41.4 \pm 16.9\%$ ; individual consultations, behaviour modifications	3–6 Months: mean weight reduction 15.3%; 68% of the children had successfully reduced overweight below 20% after 3–5 years: 48 patients, initial weight reduction was 17.2%, after 3–5 years: 10.6%; 42% of the children had successfully reduced overweight below 20%
[56]	German children (9–12 years old) participating in outpatient programme for obesity. Dietary changes and behavioural treatment; 31 children (relative body weight $> 120\%$ ); 6 months intensive treatment (3 $\times$ per week sport, once per month dietary advice)	Follow-up 6 months, 12 months, 18 months: reduction of relative body weight; 6 months: 10/12 children successful; 12 months: 10/12 children successful; 18 months: 8/10 children successful
[62]	1620 Obese children and adolescents (806 boys and 814 girls, aged 2–20 years); treatment for a period of 3 months to 7 years with dietary modification and advice for exercise	No long-term results available
[64]	353 Obese Spanish children (176 boys, 177 girls) aged 7–15 years; multi-centre study; comparison of efficacy: medical advice versus cognitive-behavioural group therapy; group 1: medical advice; group 2: cognitive-behavioural group; group 3: rejected treatment	Significant, modest decrease in BMI in groups 1 and 2; no significant effect of groups 1, 2 after 2 years compared with any treatment
[72]	32 Obese children (age 6–15 years); two strategies, group 1: individual therapy; group 2: group therapy; 1 year follow-up, observation during 4 years	1 Year follow-up: group 1 reduction of body weight: 16.6%; group 2: reduction of body weight: 15.8%; 5 year follow-up: relative body weight 12.8% lower than at the beginning of the study
[74]	Czech children, 10–15 years, outpatient treatment, training camp (50 days); diet, exercise training programme and behavioural intervention	Body weight decreased by ca. 10% of initial value after treatment in the camp; no follow-up data available
[81]	25 Children and adolescents (15 girls, 10 boys, aged 3.9 to 16.4 years) outpatient clinic treatment; group 1: combined therapy: low calorie diet plus exercise; group 2: diet alone	After 4 months: group 1: overweight decreased by $25 \pm 13.5\%$ ; group 2: overweight decreased by $15.8 \pm 10.5\%$ (difference $P = 0.05$ ); treatment compliance better in group of combined treatment (group 1)
[83]	German children (mean age 12.7 years, mean relative body weight 155.5%); 6 weeks intensive in-patient rehabilitation programme, behavioural therapy (physical activity, dietary intervention by a multidisciplinary team)	Intensive treatment: reduction of percentile body weight (55.5% to 33% relative body weight); 1 year follow up: 30.9% of all patients further reduced body weight, 61% gained weight
[111]	68 Austrian children and adolescents (29 boys, 39 girls), aged $12.3 \pm 1.5$ years	Initial weight loss: $-11.8 \pm 3.5\%$ body weight
[94]	Multidisciplinary intervention model – 3-weeks dietary camp; dietary intervention, behavioural treatment	6 Months follow-up: $+1.3 \pm 11.9\%$ body weight; dropout rate: 8.8%

### Family-based therapy

Childhood obesity has always to be seen in the context of the family. The family is regarded a basis for every child's psychological development and a major factor influencing the child's behaviour and attitude to nutrition and exercise. Familial environments often contribute to the development of obesity. Parenting styles may

influence the development of food preferences and the ability of a child to regulate intake. Parents and other family members arrange a common, shared environment that may be conducive to overeating or a sedentary lifestyle. Family members serve as models and reinforce and support the acquisition and maintenance of eating and exercise behaviours. Family-based interventions are needed to modify these variables in treating obese chil-

dren [53]. Family therapy has been used for treatment of obese children and the effectiveness of family therapy has been shown in several studies [25, 27, 28]. Epstein and co-workers demonstrated that long-term results of family-based treatments in children were superior to other regimens. Using a prospective, randomised, controlled design, the authors examined the effects of behavioural family-based treatment on percentage overweight over 10 years in obese 6- to 12-year-old children. Their results show the importance of involving family and other sources of support for eating and activity change for long-term success. Today most integrative and multidisciplinary treatment programmes for obese children are family-based [5, 34, 95, 109a, 112]. However, there are no published reports on the long-term success of these programs.

#### *School-based programmes*

School health education programmes have a long tradition in the United States [14, 32]. In Europe, however, only a few local projects in different countries have been documented and published. Most of the school-based health programmes are not only directed at obese children but to all groups in order to promote healthy dieting and lifestyles. There are several reports on school-based investigations and programmes which aim at influencing traditional lifestyle and nutrition to a healthier status [2, 17, 67, 85, 105]. Long-term follow-up of these studies is difficult and results are not available. This area of intervention needs more research and should be seen more as health education provided by the society with the aspect of health promotion and prevention.

#### *Surgical treatment*

Surgery has been used in the treatment of obesity for more than 40 years in adults. Intestinal bypass surgery continued with the development of gastric bypass and in recent years gastric restriction (gastroplasty), vertical banded gastroplasty and adjustable gastric banding by laparoscopy are most frequently used. These techniques reduce food intake by reducing gastric volume and creating a small pouch where only a limited amount of food can be ingested. Whereas the former methods (jejuno-ileal bypass and gastric bypass) were more invasive and produced considerable negative side effects, particular for growing children and adolescents, the newer techniques seem to be more applicable, at least for adolescents, fulfilling the strict indications for anti-obesity surgery. It must be emphasised, however, that at the moment there are only case reports regarding surgical treatment for adolescents and no long-term results regarding side-effects and effectiveness exist [3, 9, 10, 46, 49, 59, 89]. Surgical treatment for obesity in children and adolescents should be considered only in selected cases,

e.g. Prader Willi syndrome or superobesity in adolescents which is refractory to conventional treatment.

#### *Pharmacological treatment*

The use of drugs in the treatment of obese children and adolescents is controversial and belongs to experimental therapeutic approaches in this age group. Thermogenic drugs and appetite suppressants should not be used routinely, even if there are some experimental data available [65, 66]. With the development of new anti-obesity drugs the interest in drug treatment in children and adolescents has resurfaced. However, at the moment there are no clinical trials published of pharmacological treatment with the lipase-inhibitor orlistat or sibutramine, a beta-phenethylamine that blocks re-uptake of norepinephrine and serotonin. There are some case reports on fenfluramine in the treatment of Prader Willi syndrome and excessive obesity [45, 90, 107] but these reports do not allow a general recommendation for pharmacological treatment of childhood obesity. In extremely obese adolescents with serious health problems and failure of conservative treatment, drug treatment could be individually considered. At the moment there is also not enough information available to give general advice on the use of growth hormone in the treatment of superobese patients or patients with Prader Willi syndrome [21, 60].

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#### **Future directions**

Further research into the treatment of obesity in children and adolescents should be directed towards development of successful primary prevention and treatment programmes, evaluating the effectiveness of treatment components (e.g. macronutrient composition or low fat diets etc.), devising successful family-orientated interventions and behavioural modifications. Furthermore it is necessary to establish clinical markers to identify individuals and populations at risk and to develop effective public health measures to increase participation in active rather than sedentary lifestyles in children and adolescents.

However, it must be emphasised that obesity is a public health problem and needs to be addressed from a population or community perspective. A health problem which affects the well being of a major proportion of the population is unlikely to be effectively controlled by strategies that focus on disparate individuals. Public action therefore is needed to promote and protect the health of the population. A public health approach to childhood obesity focuses on strategies dealing with the weight status of the population, particularly of the young population as a whole, in contrast to other interventions which deal primarily with factors influencing body weight of the individual. Public health action requires an integrated approach encompassing environ-

mental, educational, economic, technical, and legislative measures, together with a health care system oriented to the early detection and management of obesity in children and adolescents.

To date, in Europe there have not been any well-evaluated and truly concerted public health programmes aimed at the population-level management or prevention of obesity. Unfortunately public health programmes to manage (childhood) obesity will be unlikely to achieve the same spectacular rates of success as those associated with the control of infectious disease because it is not possible to totally remove the cause of obesity. Changes in life style and consequently in average body weight will not be spectacular within a few years. Efforts on producing an environment which supports improved eating and physical activity habits throughout the community will require a comprehensive and integrated range of strategies. The implementation of these measures will require general acceptance that the prevention and management of (childhood) obesity is not just the responsibility of the individuals, their families or health professionals but requires a commitment from all sectors of our societies.

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