

An update in prevention and treatment of pediatric obesity

Manuel Moya

Alicante, Spain

Background: Obesity prevalence is growing as well as its severity with increasing morbidity and mortality. This "globesity" also affects developing countries where under nutrition and stunting frequently coexist with overweight and obesity. One third of obese adults began to be so in the pediatric ages. There are two main types of prevention: general one representing greater actions from health authorities and the individual one carried out by the pediatrician and the patient at risk. Once the state of obesity is reached (relative body mass index, rBMI >121%) the longer lasting care becomes more complex and frequently unsuccessful. The treatment of obesity is aimed to care for the present and silent disorders and for preventing its further tracking to adulthood.

Data sources: Identification of pediatric population at risk which is the one with an rBMI of 111%-120% plus other risk factors. Specific individual actions include reduction of food intake, increase of energy expenditure, involvement of parents, and the child-adolescent himself in the prevention. Therapy is based on some principles plus the important medical and emotional approach.

Results: A Cochrane study based on only 10 appropriate studies showed a predominant poor efficacy of the undergone preventive action. Treatment guides are presented after our own experience with a group of 400 kids with an average follow-up of 7 years and other individual prevention studies.

Conclusions: Involving motivated pediatricians with a minimum of time for visits and better follow-up in the frame of a general national preventive programme could be a rational outcome. Treatment of obesity should never be postponed whatever the clinical care is.

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Author Affiliations: Hospital Universitario S. Juan/ Universidad M. Hernández, Alicante, Spain (Moya M)

Corresponding Author: Manuel Moya, Pediatric Department, Carretera Valencia s/n, 03550 San Juan, Alicante, Spain (Tel: +34 965 938 24; Fax: +34 965 91 94 29; Email: manuel.moya@umh.es)

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There are many studies, evidence-based studies, and projects or programmes for the prevention of pediatric (and adult) obesity without a clear positive and general result. Obesity prevalence is growing as well as its severity with an increased morbidity and earlier mortality.^[1] It is a recent idea that an efficient prevention issue is one which starts in pediatric ages. The main reason for this is that 30% of obese adults began to be so before adolescence.^[2] If we consider that there is one billion of overweight or obese people in the world then this 30% early start represents an important quota for prevention. According to the International Obesity Task Force (IOTF),^[3] 10% of children and youngsters between 5-7 years are overweight and 2%-3% obese, making an estimation in absolute numbers for this decade of 155 and 45 million children respectively for both these conditions. These estimated figures have global representation not impending that in some parts of America or Southern Europe the frequency is greater, or even in some Indo-Asian areas^[4] there is the coexistence in the general population of overweight and obesity around 5% alongside underweight and stunting around 28%. In China^[5] in the decade of 1989-2000, an increase in the number of overweight adults (BMI ≥ 25 kg/m²) occurred involving men (14%) more than women (8%). This growing situation began after the Second World War due to some conditioning factors such as changes in food consumption, lesser physical activity both at work and home, greater purchasing power and marked urbanism even in rural areas. This trend is still rocketing with an expectation for this curving in only two decades.^[6] Another reason for this early prevention attitude is that the obese child, despite his/her chubby aspect is already sick and the treatment they should have will almost certainly be unsuccessful.

In this review to assess the degree of over nutrition, the relative body mass index (rBMI) has been chosen from an analysis of other current methods.^[7,8] The BMI percentiles for age and gender, if available for the population to be assessed should be used mostly for screening. To its less quantifiable information given we should also consider that 95 percentile has risen nowadays in the charts particularly from the fourth year of life.^[9,10] Therefore the only slightly overweight

(85-90 percentiles) in the general population will not be identified as such. As prevention implies a prolonged follow-up, a more precise method is desirable: z score or rBMI.

Relative body mass index is obtained by dividing the classic BMI (kg/m^2) by the same parameters corresponding to the 50 percentile of the growth charts in use for children of the same age and gender multiplied by 100. This index is easy to use and does not require the use of a computer and allows a tighter follow-up of weight excess and clearer comprehension by adolescents and the children's families. Its main advantage is that it avoids the general problems of classical BMI in reality the Quetelet Index, because this Belgian mathematician was the one who described it in 1869 and which applies to adults with a fixed height. The normal early sinusoidal curve and regular ascending pattern from 7 years onwards may advise against its use during the growth periods, thus giving way to BMI percentile curves. BMI z-scores have the same advantages (comparison with a reference population) as rBMI, but their calculation can be more complicated needing a suitable software programme. This method is the most commonly used for research or epidemiological studies. Finally abdominal circumference and its derived waist to height ratio (WHtR) are very useful parameters when accurately obtained not only for the indirect estimation of abdominal fat but also for evaluation of further cardiovascular diseases.^[11] Waist circumference reflects subcutaneous and perivisceral fat whereas dual energy X-ray absorptiometry (DEXA) can better quantify this trunk fat.

All these measurements, particularly the ones related to BMI are intended to provide quantifiable and measurable criteria for differentiating normal weight, overweight and obese children. In case of rBMI normal weight corresponding to 90%-110%, overweight to 111%-120% and obesity to $\geq 121\%$.

Prevention

General approach for obesity prevention

If pediatric obesity prevalence is increasing almost everywhere, a *general approach* is probably required. It is a competence of the National Health Authorities normally advised by scientific organizations whether national or supranational. WHO, through the Global Alliance^[12,13] which gathers international scientific societies, is giving advice at least in one instance to the European Commission on Public Health. The consequence of this is a general prevention programme^[14] with three types of action: primary care (health professionals, barriers, efficacy), school and

community (education, diet, physical activity) and administrative (play yards, safe walks, food regulation, TV regulation, etc). There are a great deal of reports in the prevention in certain spots. However, the Cochrane study on clinical studies for obesity prevention^[15] gives real information about the state-of-art of the varied ways. Only ten studies have the required quality in terms of design and duration. The results were varied but shown a predominance of poor efficacy of the undergone action.^[16]

In this context^[17] a new issue has been launched to involve the primary care physicians in the obesity prevention actions.^[14,18,19] This *Individual approach* of prevention is more specific because it involves simultaneously the pediatrician or the health team and the child and family. Individual prevention should be done on every child attending the clinic or health supervision programmes for overweight or any other reasons. Pediatricians for this type of prevention must be motivated and also have a minimum knowledge of obesity prevention, otherwise there will be no headway. In addition to clear guidelines they also need accurate methods for body measurements, and simple and routine ways for assessing dietary patterns and physical activity.^[20] We will return to these aspects while showing our experience.

The next question is to whom individual prevention is addressed. The pediatrician must have a clear idea about the target population: the first category includes undoubtedly the overweight children (rBMI: 111%-120%; zs: 1-2; percentiles 84%-98%) older than 4 years and specially if adolescent, due to the fact that 80% of them will go on to be obese adults. Before the age of 2 years prevention is not stressed, the only action at this age is to recommend a healthy eating pattern because this would last longer.^[21] Between the ages of 2 to 3 years, prevention should be individualized and started if one of the following recognised risk circumstances appears. Other circumstances deserving prevention include longer gestational age, particularly if the birth weight is greater than 4.0 kg; obese parents with or without co-morbidities (intractable obesity, type 2 diabetes, dyslipemia, cardiovascular disease, etc) and if there is an early obesity rebound (<5 years), this estimated by rBMI, zs, or waist circumference and WHtR greater than 0.5 if available. In case of an obese mother the association with obese offspring is greater than the father, and this is more evident as the child grows.^[22,23] There are other determinant factors, some of which are easily evaluated in primary care, such as poverty, reduced hours of sleep,^[24] non-Caucasian children living in occidentalised areas^[25] or infants of diabetic mothers having normalised weight before the first year of life.^[26] Another much more important point is alteration of the FTO gene in

which a single nucleotide polymorphism (VS 9939609) is associated with an increase in BMI^[27] This alteration may occur with some other genetic predisposing factors. This section dealing with target children does not end with an exclusion but with an individualized approach to children with physical or mental disabilities.

How can prevention be carried out at an individual level? Some points should be incorporated into the natural preventive attitude when pediatricians are confronted with a case of a plump child. Before taking specific actions a few appropriate and feasible points should be included for this new preventive action.

Without clinical knowledge, it will be difficult to give children and their families the basic information about the grim future of the process and also the precise behaviour on measures for diet, physical activity and leisure. All of these in the context of the advantage given by the frequent and valued point of primary care.^[28,29] The basic knowledge for pediatricians and health professionals, teachers, mothers, families of the first principles of thermodynamic equilibrium is advisable. According to this if the energy intake through food exceeds expended by means of oxidation, a storage of this excess will proceed but in the only way the human can, as fat deposits. It would be advisable to show a simple cartoon easily understood by children and their parents ending with the message "if you overeat it, you must burn it; if not it will be stored as fat". Therefore it can be possible to reduce the weight excess more efficiently by simultaneously decreasing food intake and increasing energy expenditure through physical activity.

The information of body measurements for health professionals should include the use of rBMI (or

BMI zs if available) for the above quoted advantages. Seinaptracker^[30] is an easy-to-run software programme that calculates every quoted parameter including other standards such as percentile charts for arm, waist and hip contours and even growth velocity. In addition not all countries have the BMI percentile graphs and the use of the well-known and easily downloaded North American ones will lead to an under-estimation of this problem.^[10] The basic information of risk factors should include the added risk factor for obesity such as parental obesity (BMI >30 kg/m²), neonatal status and the rest of the above quoted items. Pediatricians and health professionals should have the capacity to note the family's food patterns which should be simpler than the usual nutritional questionnaires. This specific form can be added with new data at the follow-up visits. A section of this form is reserved for physical activity during the weekend days.

The next notion for the pediatrician/health professionals is accuracy. Although it is simple to obtain height, weight and contours, the lack of precision will lead to a confounding evolution and the collected data would be of no use for clinical or epidemiological studies whether individual or multi-centred.

Specific individual actions for preventing further growth of fat deposits or reducing them to the range of healthy weight

Reduction of food intake

This reduction should be adapted to the family's (and dining halls) diets picked up from the questionnaire. A guide for not reducing excessively the energy

Table. Daily energy requirements according to age and gender in normal children and adolescents^[55]

Age (y)	Boys		Girls	
	Weight (kg)	Energy requirements Kcal/d	Weight (kg)	Energy requirements Kcal/d
1-2	11.4	948	10.8	865
2-3	13.5	1129	13.0	1047
3-4	15.7	1252	15.1	1156
4-5	17.7	1360	16.8	1241
5-6	19.7	1467	18.6	1330
6-7	21.7	1573	20.6	1428
7-8	24.0	1692	23.3	1554
8-9	26.7	1830	26.6	1698
9-10	29.7	1978	30.5	1854
10-11	33.3	2150	34.7	2006
11-12	37.5	2341	39.2	2149
12-13	42.3	2548	43.8	2276
13-14	47.8	2770	48.3	2379
14-15	53.8	2990	52.1	2449
15-16	59.5	3178	55.0	2491
16-17	64.4	3322	56.4	2503
17-18	67.8	3410	56.7	2503

intake is in the Table. The next six points provide an uncomplicated way to accomplish this. A) It is necessary to diminish food rich in fat, use lean meats and low fat fish, and switch to skimmed milk and dairy products. B) Carbohydrates should provide around 60% of total energy. The present criterion is to change "low for slow carbohydrates".^[31] For this it is advisable to know the glycemic index (GI) which in some countries already appears on food labels.^[32] C) Soft drinks should be reduced. They normally have caloric sweeteners. One wide substitution used in the industry is sucrose by corn syrup which is rich in fructose,^[33] indicating a caloric increase although the carbohydrate quality could be better. Consistent evidence shows how this habit is associated with weight gain.^[34,35] Fruit juice is used in younger ages and probably if not consumed in large amounts will not be associated with a greater adiposity. D) Do not eat between the main meals. Snacks, normally energy dense in fats and sugars, are associated with overweight.^[36,37] E) The portion sizes (also diameter of dishes) should be diminished.^[38] F) The importance of a regular diet (food pattern) should be stressed.^[39]

Simultaneous increase of energy expenditure through physical activity (PA)

Mechanization is an incontrovertible fact inherent to our social milieu, especially in developed countries with the consequent reduction of possibilities for maintaining the thermodynamic balance. This can be summarized^[40] as follows. The generalization of motorized transport affects almost all kids of all social levels due to longer distances and risks of accidents when walking or cycling even in rural areas. This together with the difficulties of playing in the fresh air reduces the opportunities for energy expenditure having been replaced by sedentary leisure activities. Another question with PA is the difficulty for measuring it with certain exactitude, it would be chimerical to provide accelerometers for every kid subject to prevention or even to a more restricted overweight population. So PA can be assessed by means of its duration and its intensity (LMV or light, moderate, vigorous). The first two levels of intensity are estimated if the child reports feeling tired at the end of the session and is transpiring or not. Vigorous level is easy to find out because it implies formal training. It should be kept in mind how PA in general becomes lesser in older youngsters, in girls and in children from lower social levels.^[41]

To counteract this situation the following actions can be adopted. Walking and using stairs (lift only for disabled) whenever possible. Formal physical education at school should be regulated with the same rigour as other subjects, therefore children must be encouraged

to take this seriously. In some European countries there are only two hours per week and weakly controlled. It is well known that three sessions of 30 minutes per week of moderate-vigorous exercise can compensate mechanisation-safety consequences,^[42] more recently this quota has been raised to 60 minutes throughout the day of moderate-vigorous exercise.^[43] It is advisable to plan PA for after school hours and weekends. Aerobic, walking or running do not require special equipment or facilities. Family understanding is basic for the sustainability of these activities particularly in the case of overweights. At the same time, sedentary attitudes should be regulated also.^[44] Screen time refers to the time before TV, computer, computer games or video games. TV watching probably gives the most concern, the accessibility to a wide array of specific TV channels around the clock is a proved fact for inducing overweight particularly when TV sets are in the bedroom.^[45] Moreover the nutritional composition of foods announced on TV is of low quality in terms of fat types, sodium or fibre content.^[46] In 2001 the *American Academy of Pediatrics*^[47] recommended no more than two hours viewing TV per day and none for kids younger than two years. Thus a total of two hours for screen time can be the maximum allowed on week days. The negative effect of TV for developing and maintaining obesity has been recognized for a long time^[48] for its probable capacity to reduce energy expenditure. Getting the kid involved in some domestic tasks can do away with some sedentary habits.

Involvement of parents and families

First, parents should know and be aware of the present and future risks of obesity. The present risk must be discussed such as silent hyperinsulinism, hypertension, sleep disorders or final height among other facts and the future risks as newer data for life expectancy or co-morbidities.^[49] Second, the measures to be taken at home even if they are intractable or indulgent parents. Their commitment will lead to healthy habits for meals, PA and lifestyle. Positively the family habits discovered after the questionnaire can contribute to the healthy behaviour rather than weight control alone, this leads to a better emotional state of the kid. This information to parents has some additional aspects according to different ages. For preschoolers, it is necessary to limit use of stroller, play with them or bring them to play yards, avoid the no fruit desserts and respect the kid's feeling of satiety.^[50] For children of school ages, particularly girls, it must be taken into account that the parental energy intake and high BMI can be a determinant of overweight.^[51] This together with parental PA should be improved or at least to try. For adolescents advantage should be taken of his/her attitude for self involvement and motivation

besides that of the family.^[36] Because of the sedentary attitudes in adolescence along with the parental ones^[52] it is advisable to stimulate such changes in all of them. Finally, there are two notions in relation to this approach to the family. The first is to go deeper in factors sometimes unnoticed but responsible for weight gain or re-gain once they are in the honeymoon period after the initial improvements in the rBMI. The second is not to make them feel guilty in case of non-positive results in this long lasting process.^[53]

Involvement of the kid himself

The older the better to understand the physical consequences of obesity, but particularly the progressive isolation to which he or she is headed soon.^[54] In general bullying is better accepted than isolation. This information should be given in a private atmosphere and in no way should be recriminated whatever the results.

These four points are not complex, neither excessively time-consuming for pediatricians practising at the individual level. It is worth noting that no special equipment, special tests or even other professionals are required apart from a regular follow-up. Nevertheless the present situation shows a tenacious mediocrity in positive preventive results.

Out of a general pediatric clinic in our hospital we were able to identify 320 overweight children and adolescents and it was accepted by them and their families to be additionally followed at the Nutrition Unit for prevention of obesity. At that moment it was based mainly on dietary intervention. After a period of 4.21 ± 2.7 years of monitoring of data, the results (Fig. 1) were: one third did properly with a final rBMI below 111, another third remained in the range of overweight, and the last third evolved to obesity. We reckoned what would happen if the overweight third were re-evaluated four years later. It is necessary at this point to consider that the preventive actions on a small scale only give small scale results but until a general prevention programme is carried out widely in efficient practice, this is one way to act and should not be underrated because if the phase of treatment for obesity is reached, then results can be more ominous.^[19]

Treatment

To overview the treatment of pediatric obesity, it is worth noting the experience in the Nutrition Unit of this hospital^[55] which has followed 439 obese children and adolescents in a period of 11 years, the minimum study time in all of them being 14 months. None of them was premature, and birth weight in 7 of them

was above 4.0 kg. Thirteen of them were diagnosed as having syndromic obesity, and, therefore, were excluded from the on-going study (Fig. 2).

There was a group with favourable evolution ($n=88$) where the skew in the representation towards weight excess showed the difficulty and effort to keep the rBMI below 121% during the seven years of follow-up. Favourable progress can be considered due to the fact that at the end the average rBMI was 117%. The second group with unfavourable evolution ($n=260$) only exceptionally reached this 121% barrier, not even in the

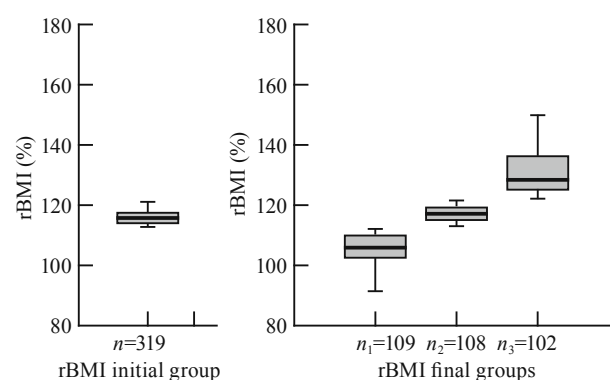


Fig. 1. Evolution of overweight children and adolescents after a 4 years programme for obesity prevention. rBMI: relative body mass index.

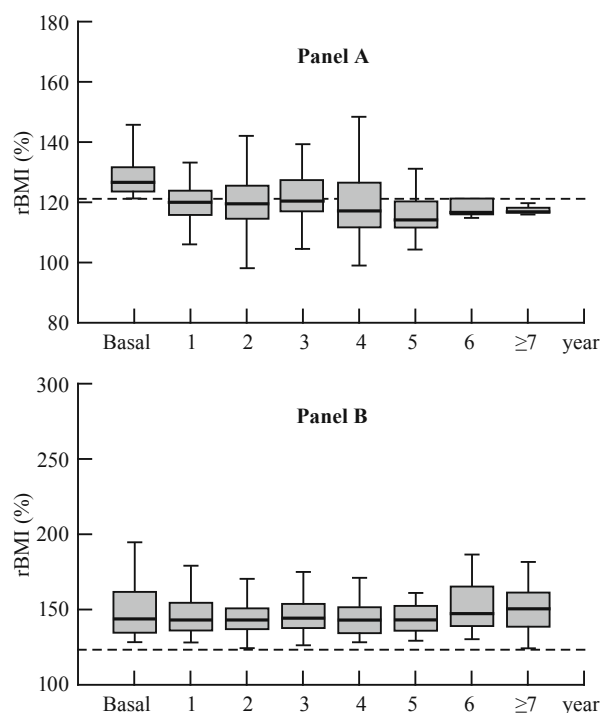


Fig. 2. Obesity evolution after a programmed therapy scheme. **Panel A:** the group of 88 children with favourable evolution; **Panel B:** the group of 260 children with unfavourable evolution. rBMI: relative body mass index.

"honeymoon period" which usually happens in the first few months of treatment. After the same long period the rBMI was exactly the same as at the beginning.

There was also a third group, termed as "bad" or not known evolution ($n=78$) because they never returned after the initial visit, their rBMI averaged 135%. From a direct analysis we can see that the favourable progress group came to an obesity consultation at an average age of 4 years and with an initial rBMI of 130.0 ± 12.1 ; whereas the unfavourable group came later, at an average age of 8.7 years and with an rBMI of 143.1 ± 21.2 . Treatment for both groups was identical and, in spite of having covered medical and dietary aspects, exercise, psychological support, an absence of drug treatment, and with free access to consultation, the results, taken as a whole, have not been very satisfactory. These results are at the same non-convincing level of therapeutic success of the Cochrane analysis.^[56]

The present bases of obesity treatment once they have been established in the child or adolescent are going to be analysed below. These require a team, although minimum, has to be well coordinated.

Medical approach

The medical approach aims firstly at weight control which must be channelled and unified. If the child is still growing,^[57] the most useful and tolerable policy is that of not gaining any weight while increasing in height. Rapid weight loss through a strict diet is not appropriate as growth rate diminishes. If the degree of obesity is severe and there are complications, a weight loss of 0.5 kg/month can be considered. If we are dealing with adolescents who have completed growth, weight loss can be up to 0.5 kg/week but with a very close follow-up in both cases. Other medical aspects, although less important (mammary fat deposits, red or white stretch marks, etc) should not be ignored owing to the impact they have on young people. Finally, right from the beginning the aims to be achieved should be pointed out and agreed upon along with their estimated time. This is particularly important when parents show a certain lack of concern^[58] in keeping weight gain under control.

The second task is to discover and deal with the co-morbidities. Within these, the most important is, probably, a precise diagnosis (and handling) of the insulin resistance syndrome (IRS), preferably by means of glucose tolerance tests (oral or iv). It is better to do these tests after the age of 5 years as those done at an earlier age usually show normal results whatever the degree of obesity. Perhaps, in the future new applications of the classical homeostasis model assessment (HOMA) index could substitute the

lengthy oral tolerance test and offer a real estimation of the problem.^[59,60] It must not be forgotten that the insulin resistance syndrome includes hypertension and dyslipemia as well as homeostatic alteration of glucose.^[61-63] Some predisposing factors should be taken into account here, the fact of prematurity,^[64,65] regardless of the degree of appropriateness to gestational age when this is found as an antecedent in obese youths, implies a higher risk of developing this resistance. Neither can we forget the monogenic obesity, in which some gene mutations occur,^[66] and in this case PPAR- $\gamma 2$ that codifies a nuclear receptor of the adipocyte can have a protective effect against insulin resistance. In the future this field will certainly be more developed. The interest for IRS lies in the frequency of the consequent development of type 2 diabetes mellitus^[67] and cardiovascular diseases. To contain this resistance it is obvious that the reduction of adiposity is fundamental but physical exercise is also very important as has been shown by means of a good cardiovascular condition estimated from oxygen consumption and the variation of cardiac frequency with progressive physical exercise. To summarize these predisposing factors, it should be considered that the progress in obesity genetics^[68] will give some opportunities to start the treatment at an earlier moment.^[69]

The following motive for concern^[70] within the medical task is hepatic esteatosis or the most severe non-alcoholic esteatohepatitis which is being increasingly diagnosed and always implies more uncertainty in this prolonged clinical course.^[71,72] It is very important to carry out the diagnosis of esteatosis in the first stage before this progresses to the second stage which can lead to non-alcoholic esteatohepatitis, cirrhosis, and lastly, liver failure. The development of hepatic esteatosis^[73] is the consequence of an imbalance between the levels of fat entry and synthesis and elimination, being then stored in the macro- or micro-vesicular form of diffuse esteatosis in hepatocytes of the periportal and middle zones. There is a murine model in which the administration of docosahexanoic and eicosapentaenoic acids prevent the apparition of esteatosis.^[74,75] This is probably due to interference with the proinflammatory metabolic way of arachidonic acid, thus diminishing the production of α -TNF by means of macrophages, IL-6 and other proinflammatory cytokines. It is probable that this recent experimental finding may be applied to the obese child in a near future.^[76] The only way to counteract this deposit is decreasing the level of obesity.

Other important aspects which require medical attention are accelerated puberty, hypertension and sleep apnea. Early puberty must be evaluated by means

of bone age, sex steroid levels, dehydroepiandrosterone sulphate (DHEAS), gonadotropins as well as secondary sexual characters. The best control is taken through weight loss as the luteinizing hormone releasing hormone (LHRH) analogues are less indicated for this acceleration.^[77] The negative consequences of sleep apnea or respiratory alteration during sleep have been revealed after a generalisation of polysomnographic studies or more simply through nocturnal pulsoxymetry.^[78,79] Apart from the direct repercussion on the quality of sleep, there are also intellectual and cognitive deficit and the classically known cardiovascular complications. Treatment for this situation is principally weight reduction, and if this is not achieved, continual positive nasal pressure is very efficient for improving the exchange of oxygen during sleep. Very rarely is adenoidectomy indicated here. Finally, in the medical duty height variations have to be studied and evaluated to disclose an eventual obesity syndromic case, especially if in case of short height or there are dysmorphic findings or a lesser learning capacity. When the presence of monogenic obesity is suspected it makes a hereditary pattern study and enzyme and/or gene assessment necessary.^[68,80] An endocrinological study should always be carried out on consolidated obesity or even on overweight when a WHtR is greater than 0.5.^[81]

Dietary approach

The therapeutic dietary approach is based on the thermodynamic balance^[82] mentioned in prevention. It has been considered the most important and has brought about a multitude of diets varying both in composition and energy intake; however, when assessed for a long-term they have not proved very effective or unriskey particularly those altering the macronutrient ratio.^[83,84] The outcome of the diets in adults has precluded their use in children.^[85] Strict diets have led to a series of negative consequences, a loss of lean body mass, a reduction in growth velocity, binge-eating and anorexia. For this reason there is more of a tendency to change eating habits and eliminate negative factors from the diet as we will see later on. From a quality point of view the diet should be balanced, avoiding the typical and peculiar diets of obese adults. In spite of some positive results from diets low in carbohydrates in pediatrics, the known risks resulting from ketogenic diets used in certain types of epilepsy, imply resistance to insulin, edema, renal lithiasis, hyperuricemia, acidosis, and hypercalcuria,^[86] and therefore need some well controlled studies.^[87] It is worth mentioning how some food companies are making an effort to improve and reduce caloric density in certain foods; how labelling is more informative,

with the possibility of the glycemic index appearing on the label. However, the traffic light system on the labels of green, go ahead, amber, cut down and red, cut out is not well accepted by manufacturers.^[88] Dietary recommendations are the same as those mentioned in prevention, perhaps we can add here that a balanced and low caloric diet (Table shows the guide for normal energy intake) should be accepted by the whole family, and there should be regular meal times, avoidance of snacks and eating between meals, smaller portions, snacks substituted by fresh fruit and to use foods that take time to eat (brown bread, fruit that needs peeling). Food should be prepared in the oven, grilled or boiled without adding oil instead of frying. In fact diets with a balanced low energy density from vegetables, pulses, fruit and minimally elaborated cereals, all with the lower GI,^[32,89] can be the main target. But it must be well understood that changes in the diet alone have very little long-term effect in rBMI reduction.

Emotional support

From the moment that a patient is included in a weight reduction programme there are two very clear notions: first, the long duration of the treatment and second, for however many ups and downs the patient suffers neither he nor his family should be recriminated.

The family, especially the parents, should involve themselves in the treatment to lose weight and so create an anti-obesity climate, it is fundamental that at least one of them collaborates. During childhood parents have an important influence on food habits and physical exercise; this has been shown by studies^[90] on long-term weight control. When there is family cooperation, weight reduction during the first year is more intense, and even if the rBMI will slightly increase, the reduction is always significantly lower for a longer time than when there is no family support.^[91]

Another aspect worth mentioning is how the child cannot stay always in the family atmosphere, he must have an adequate social life and know how to control his intake when out of the family environment, or, at least, to be able to compensate at the next meal for previous unusual excess.

Behavioural interventions for the parents to join and stick with the programme are not easy especially if they imply separate sessions, either individual or with other parents so perhaps, sessions should be simultaneous with those of the child. Normally these are provided in specialized treatment units, and again it can be considered as part of treatment. In our experience,^[55] patients and families showed a certain reluctance to attend the session mainly because of its duration (≥ 60 minutes) and frequency (every two weeks). The existence of cultural and personal

aspects or family stability as already mentioned in the prevention section are other factors which make this more difficult. When dealing with adolescents they must be motivated to change dietary habits and lifestyle themselves probably by means of individual sessions giving them freedom to attend or even phone when they wish. At this age it is more important for them to be slim and have a better image than to be healthy and so this should be taken advantage of. Probably the most decisive part of the treatment for the adolescent is his changes in behaviour whether this results from group or individual sessions.^[92] To modify food habits, our team uses the following pattern: an analysis (described by the child himself), the act of eating and circumstances around it; an analysis of the rhythm and frequency of meals and an analysis of the sensorial issues of eating (that is, if he feels hungry or enjoys what he eats). All this has the aim of changing obesogenic behaviour, and will also include physical exercise as described later. In both age groups it is important to recognize the signs which come before weight regain. The role of the family is completed with firm agreements as to achieving an aim and verbal support. We must not forget that neglected children have a risk nine times higher of becoming obese adults.^[93] If there is low self-esteem or bullying (39% of European kids^[94]) from peers, this requires specific psychiatric treatment.^[95] Probably more studies are required to adjust the emotional support to the family, assuring an absence of complications (anorexia).^[96]

Physical activity

This has become more important in the treatment of an obese person and presently is found in less empirical bases than before. The scientific and quantifiable bases which the FAO provides for human energy requirements^[97] at different ages offer a reference point for considering an increase in physical activity. In the Table, the daily energy requirements according to age and gender can be seen and will serve as a crude guide, for pediatric patients due to the fact that it is easier to decrease 500 kcal in a menu than to know how to quantify the same amount of energy expenditure in normal situations and activities. Some modern fitness devices can count the energy produced in kcal after a session, assuming an energetic yield of 20%-22% for humans, roughly one could assess the expenditure for this PA session. This can also be evaluated by other means such as lists of activities.^[98] Various governments and health organizations in Occidentalised countries^[99] have promoted a series of PA activities clearly stipulated in the actions for general prevention (NAOS, movimento sport organizzato, Trim and Fit) and perhaps are also useful in treatment. At an

individual level physical exercise must be regarded very positively as, even if it does not reduce the BMI, at least it lowers the co-morbidities, one of these being the rise in blood pressure. PA alone, can reduce the perivisceral adipose tissue and improve insulin resistance and blood lipid profile.^[100]

The biggest problem is getting the child to practise physical exercise but if this is overcome he will maintain his weight for a longer term. The usual sports such as swimming, cycling, etc, if they are accepted, they have a more long-lasting effect than aerobic.^[101] This does not imply that initially aerobic does not have a clear indication due to the fact that it can be practised with certain privacy and is well accepted, especially by girls. Competitive team sports are not the most indicated, since a poor performance or changing in the locker rooms leads to the abandonment of these activities. Family collaboration supporting the practise of sport and allowing the child to choose the sport is essential despite the effort this may suppose.^[102] Another aspect to take into account is how obese persons tire very easily with physical exercise as they probably double the amount of energy than their slim peers. It is necessary to organise physical activity in such a way that the seriously obese (rBMI >180%) is limited to walking, swimming or gentle static bicycle, while the moderately obese can do aerobic or gymnastics. The final goal, and the sooner the better, is to achieve the 60 minutes per day of moderate-vigorous exercise, as is recommended by the Centre for Disease Control and Prevention.^[103] However, in short, flexibility and personalisation are the key words.^[104]

At the same time that these activities are being programmed it is necessary to establish an anti-sedentary attitude. A child who is not sedentary takes more interest in things and his activities are usually more progressive.^[97,105] Perhaps watching television for hours on end can be highly criticised not only for the lack of activity that this implies but also for the publicity spots which tempt into eating snacks that almost always have a high content of refined sugar and fats.^[46] A more active lifestyle with less video games has shown favourable results.^[106] Being sedentary must be substituted by a lifestyle in which any physical activity is taken up because it will really help for assuming domestic tasks, walking, cycling, using the stairs, etc not only during the week, for example, walking or cycling to school, but also during the weekend. Hence it is important for the rest of the family to adopt this new lifestyle. There are questionnaires^[107] to measure physical activity during leisure time by means of metabolic equivalences. This is tedious to calculate and has some bias, when this is gauged by the obese person himself it tends to be over estimated.^[108]

In order to get more accurate values of PA in obesity, adults^[109] start to use pedometers and even with a cut-off point (12000 steps/day). Probably this could be used too in adolescents or older children.^[110]

The results of increased physical exercise must be known beforehand so as not to create false illusions. These usually take several months to be seen and for this need at least three sessions of 30 minutes a week. Although nowadays as we mentioned above and in the prevention section of this paper longer sessions (60 minutes) give better result, but always with a medium intensity. School sports and gymnastics must be taken seriously if the activity programme loses its value. It is also a mistake to think that with the exercise that an obese person may do, this could counteract the calories of a large portion of fast food (≈ 700 kcal). For this you would need to do 2 hours of vigorous exercise (elite).

Drug and surgical treatment

This section is almost exclusively applicable for adult obesity treatment, and in some countries^[111] medical treatment is regulated to be used only in those with BMI >30 kg/m². This gives us an idea of how careful one must be when prescribing in pediatrics the four groups of drugs used in non syndromic obesity: appetite suppressors, thermogenesis stimulants, nutrient absorption inhibitors and inhibitors of cannabinoid receptor.^[112] Amphetamines and other adrenergic drugs have been advised against even in adult use due to important side effects such as hypertension, tachycardia, dryness in the mouth, and risk of abuse. Sibutamine is an inhibitor of the reuptake of epinephrine and serotonin which produces a reduction in the appetite as part of its adrenergic properties thus bettering weight control in the adult at least during the first year.^[113] In a study by Berkowitz et al^[114] carried out on adolescents, acceptable results appear. Nevertheless its use is not really clear in routine treatment, until long-term safety (hypertension, tachycardia) and efficacy have been demonstrated.

In reduction of nutrient absorption, the only drug approved of by the different agencies or national bodies of medicine is Xenical.^[115] This bonds with the pancreatic lipase colipase dependent diminishing the hydrolysis of fatty acids in Sn-1 (-3) position of the triglyceride and cholesterol esters. As it is not a total union, fecal loss is at least 30% fat in the form of triglycerides, also carrying with liposoluble vitamins and cholesterol at the same time. Conceptually its use is not indicated in phases of growth due to malabsorption effect. Results of the drug in adults^[112] have also not been so positive owing to its poor contribution to weight control, the loss of liposoluble vitamins which have to be supplemented, especially for its side effects

ranging from simple flatulence to oily fecal loss or fecal incontinence. In adolescents^[116] the weight reduction was small although significant but with the frequent side effects mentioned. In this same line of non-use, olestra, which is an indigestible artificial fat with similar side effects, could be included. The use of inhibitors of cannabinoid receptors especially the one known as CBI is a new class of drug acting on the food intake regulation mechanisms. It has been used in adults but probably not in pediatrics.

In the group of medicines and/or products to be avoided, dietary supplements and herbal preparations must be included because of a lack of reliable studies and the risk of using them in conjunction with co-existing products like alkaloids.^[117]

Other medicines which can be considered apart from the specific ones for syndromic obesity in the treatment of child obesity are metformin and conjugated linoleic acid (CLA). Lack of effectiveness of the general treatment has probably justified its use. Metformin has been used because of its weight, lowering action and protection against a later development of type 2 diabetes.^[118] However its administration in children without high levels of insulinemia and no family risk of type 2 diabetes seems not to be justified. The situation may be different when considering the administration of CLA. This is based on its antiadipocyte action, by which weight reduction does not present greater obstacles, but it is still in a preliminary phase.^[119] As a general rule, drug treatment should be prescribed in a specialized unit and for trials with a duration of 6-12 months with a close follow-up for assessing weight regain and adverse effects.

Bariatric surgery is not an option for pediatric obesity. In the adult, certain clinical conditions are needed and failure of conventional treatment before is included in the surgery programme. Also included are clinical and psychological assessment and the decision about the appropriate technique suited to each individual with a strict follow-up.^[120] The results from the Goteborg group,^[121] after 10 years, could not be more encouraging, maintaining a weight loss which fluctuates between 20% (banding) and 30% (gastric bypass). The idea which prevails at present is not to practise any type of surgery on the child or adolescent until their growth period is over.^[122] In the few cases when adolescents have been operated on these have not proved successful.

Obesity treatment comes as consequence of a failure or absence of prevention programmes and entails a long and complex process. A while ago^[123] we pointed out the necessity of a multidisciplinary team to have even a minimum success. Now is a good moment to reflect how this team can be effective with only

pediatric professionals, an expert nurse, and, perhaps a health visitor, a role which is now beginning to appear in some countries. This could be enriched with dietitians, psychiatrists, etc. All this is desirable but in no way must be an impediment so as not to attend to these patients or follow them in their hard task of maintaining appropriate weight.

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References

- 1 Olshansky SJ, Passaro DJ, Hershow RC, Layden J, Carnes BA, Brody J, et al. A potential decline in life expectancy in the United States in the 21st century. *N Eng J Med* 2005; 352:1138-1145.
- 2 Bouchard C. Obesity in adulthood. The importance of childhood and parental obesity. *N Eng J Med* 1997;337: 926-927.
- 3 Lobstein T, Baur L, Uauy R. Obesity in children and young people. A crisis in Public Health. *Obes Rev* 2004;5(Suppl 1):4-104.
- 4 Jafar TH, Qadri Z, Islam M, Hatcher J, Bhutta ZA, Chaturvedi N. Rise in childhood obesity with persistently high rates of undernutrition among urban school-aged Indo-Asian children. *Arch Dis Child* 2008;93:373-378.
- 5 Nguyen TT, Adair LS, He K, Popkin BM. Optimal cutoff values for overweight: using body mass index to predict incidence of hypertension in 18- to 65-year-old Chinese adults. *J Nutr* 2008;138:1377-1382.
- 6 Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes estimates for the year 2000 and projections for 2030. *Diabetes Care* 2004;27:1047-1053.
- 7 Poskitt EME. *Practical Pediatric Nutrition*. London: Butherworths, 1988.
- 8 Poskitt EM. Defining childhood obesity: the relative body mass index (BMI). European Childhood Obesity group. *Acta Pediatr* 1995;84:961-963.
- 9 World Health Organization. Obesity and overweight. World Health Organization through Global Strategy on diet, physical activity and health-chronic disease information sheet. Geneva: WHO 2003.
- 10 Dietz WH. Overweight in childhood and adolescence. *N Eng J Med* 2004;350:855-857.
- 11 Freedman DS, Kahn HS, Mei Z, Grummer-Strawn LM, Dietz WH, Srinivasan SR, et al. Relation of body mass index and waist-to-height ratio to cardiovascular disease risk factors in children and adolescent: the Bogalusa Hearth Study. *Am J Clin Nutr* 2007;86:33-40.
- 12 Rigby N, Baillie K. Challenging the future: The Global Prevention Alliance. *Lancet* 2006;368:1628-1631.
- 13 Chan CW. Childhood obesity and advise health effects in Hong Kong. *Obes Rev* 2008;9(Suppl 1):87-90.
- 14 European Commission on Public Health. Obesity Round table—Workshop on Best Practice. Brussels, 29 October 2004. http://ec.europa.eu/health/ph_determinants/life_style.
- 15 Campbell K, Waters E, O'Meara S, Kelly S, Summerbell C. Intervention for prevention obesity in children. *Cochrane Database Syst Rev* 2002;(2):CD001871.
- 16 WHO. Health impact assessment methods and strategies. World Health Organization Regional Office for Europe. Copenhagen. March 2004. www.euro.who.int/health_impact.
- 17 Wofford LG. Systematic review of childhood obesity prevention. *J Pediatr Nurs* 2008;23:5-19.
- 18 AAP. Expert Committee. Assessment at child and adolescent overweight and obesity. *Pediatrics* 2007;120(Suppl 4)(dic 07): S163-288.
- 19 Moya M. Pediatricians primary actions for obesity prevention. *Asian J Pediatr Prac* 2006;10:25-29.
- 20 Bowdoin JJ. A response to the Expert Committee's recommendations on the assessment, prevention and treatment of child and adolescent overweight and obesity. *Pediatrics* 2008;121:833-834.
- 21 Forestell CA, Mennella JA. Early determinants of fruit and vegetable acceptance. *Pediatrics* 2007;120:1247-1254.
- 22 Kaplowitz HJ, Wild KA, Mueller WH, Decker M, Tanner JM. Serial and parent-child changes in components of body fat distribution and fitness in children from the London Longitudinal Growth Study, ages two to eighteen years. *Hum Biol* 1988;60:739-758.
- 23 Parsons TJ, Power C, Logan S, Summerbell CD. Childhood predictors of adult obesity: a systematic review. *Int J Obes Relat Metab Disord* 1999;23 Suppl 8:S1-107.
- 24 Lumeng JC, Chervin RD. Epidemiology of pediatric obstructive sleep apnea. *Proc Am Thorac Soc* 2008;5: 242-252.
- 25 Brussaard JH, van Erp-Baart MA, Brants HA, Hulshof KF, Löwik MR. Nutrition and health among migrants in The Netherlands. *Public Health Nutr* 2001;4:659-664.
- 26 Dabelea D, Hanson RL, Lindsay RS, Pettitt DJ, Imperatore G, Gabir MM, et al. Intrauterine exposure to diabetes conveys risk for type 2 diabetes and obesity: a study of discordant sibships. *Diabetes* 2000;49:2208-2211.
- 27 Frayling TM, Timpson NJ, Weedon MN, Zeggini E, Freathy RM, Lindgren CM, et al. A common variant in the FTO gene is associated with body mass index and predisposes to childhood and adult obesity. *Science* 2007;316:889-894.
- 28 Crooks DL. Child growth and nutritional status in a high poverty community in eastern Kentucky. *Am J Phys Anthropol* 1999;109:129-142.
- 29 Dietz WH, Gortmaker SL. Preventing obesity in children and adolescents. *Annu Rev Public Health* 2001;22:337-353.
- 30 Argemi J, Moya M. Seinaptracker. An easy-to-run computer software programme for assessing growth and nutrition in Pediatrics. www.seinap.org.
- 31 de Jong L. From low to slow-carb. *Food Eng Ingredients* 2004; Sept: 46-49.
- 32 Moya M. Glycemic index. Practical issues of this growing information. *Invest Nutr Alim Pediatr (Rev on-line)* 2003;1: #002. <http://www.seinap.org>.
- 33 Raben A, Vasilaras TH, Moller AC. Sucrose compared with artificial sweeteners: different effects on ad libitum food intake and body weight after 10 wk of supplementation in overweight subjects. *Am J Clin Nutr* 2002;76:721-729.
- 34 Bray GA, Nielsen SJ, Popkin BM. Consumption of high-

- fructose corn syrup in beverages may play a role in the epidemic of obesity. *Am J Clin Nutr* 2004;79:537-543.
- 35 American Dietetic Association (ADA). Childhood overweight evidence analysis project: updated 2006. www.adaevidencelibrary.com/topic.cfm?cat=2721 (accessed 2007).
 - 36 Gibson P, Edmunds L, Haslam DW, Poskitt E. An approach to weight management in children and adolescents (2-18 y) in primary care. *J Fam Health Care* 2002;12:108-109.
 - 37 Jacobson MF. High-fructose corn syrup and the obesity epidemic. *Am J Clin Nutr* 2004;80:1081-1082.
 - 38 Jeffery RW, Hellerstedt WL, French SA, Baxter JE. A randomized trial of counseling for fat restriction versus calorie restriction in the treatment of obesity. *Int J Obes Relat Metab Disord* 1995;19:132-137.
 - 39 Francis LA, Lee Y, Birch LL. Parental weight status and girls' television viewing, snacking, and body mass indexes. *Obese Res* 2003;11:143-151.
 - 40 French SA, Story M, Jeffery RW. Environmental influences on eating and physical activity. *Annu Rev Public Health* 2001;22:309-335.
 - 41 Harris KM, Gordon-Larsen P, Chantala K, Udry JR. Longitudinal trends in race/ethnic disparities in leading health indicators from adolescence to young adulthood. *Arch Pediatr Adolesc Med* 2006;160:74-81.
 - 42 Deforche B, De Bourdeaudhuij I, Deboode P, Vinaimont F, Hills AP, Verstraete S, et al. Changes in fat mass, fat-free mass and aerobic fitness in severely obese children and adolescents following a residential treatment programme. *Eur J Pediatr* 2003;162:616-622.
 - 43 Strong WB, Malina RM, Blimkie CJ, Daniels SR, Dishman RK, Gutin B, et al. Evidence based physical activity for school-age youth. *J Pediatr* 2005;146:732-737.
 - 44 Matsudo V, Matsudo S, Andrade D, Araujo T, Andrade E, de Oliveira LC, et al. Promotion of physical activity in a developing country: the Agita São Paulo experience. *Public Health Nutr* 2002;5:253-261.
 - 45 Barr-Anderson DJ, van den Berg P, Neumark-Sztainer D, Story M. Characteristics associated with older adolescents who have television in their bedrooms. *Pediatrics* 2008;121:718-723.
 - 46 Powell LM, Szczypka G, Chaloupka FJ, Braunschweig CL. Nutritional content of television food advertisements seen by children and adolescents in the United States. *Pediatrics* 2007;120:576-583.
 - 47 American Academy of Pediatrics. Committee on Public Education. American Academy of Pediatrics: Children, adolescents, and television. *Pediatrics* 2001;107:423-426.
 - 48 Editorial. TV viewing linked to childhood obesity and violence. *Chicago Tribune* 17 April 1990, p.1.
 - 49 Preston SH. Dead weight?—The influence of obesity on longevity. *N Eng J Med* 2005;352:1135-1137.
 - 50 Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. *Med Sci Sports Exerc* 2000;32:963-975.
 - 51 Davison KK, Birch LL. Child and parent characteristics as predictors of change in girls body mass index. *Int J Obes Relat Metab Disord* 2001;25:1834-1842.
 - 52 Fogelholm M, Nuutinen O, Pasanen M, Myöhänen E, Säätelä T. Parent-child relationship of physical activity patterns and obesity. *Int J Obes Relat Metab Disord* 1999;23:1262-1268.
 - 53 Lederman SA, Akabas SR, Moore BJ. Preventing childhood obesity: A national conference focusing on pregnancy, infancy and early childhood factors. *Pediatrics* 2004; 116(Suppl 4):1139-1171.
 - 54 Boudailliez B, Fremaux MP, Jeanne F, Escoffier I, Bony H. Adolescent obesity: guidelines for the management. *Arch Pediatr* 2004;11:1274-1276.
 - 55 Moya M. New aspects for prevention and treatment of pediatric obesity. *Rev Esp Pediatr* 2007;63:123-133.
 - 56 Summerbell C, Ashton V, Campbell K, Edmunds L, Kelly S, Waters E. Interventions for treating obesity in children. *Cochrane Database Syst Rev* 2003;(3):CD001872.
 - 57 Rodden AM, Diaz VA, Mainous AG, Koopman RJ, Geesey ME. Insulin resistance in adolescents. *J Pediatr* 2007;151:275-279.
 - 58 Papandreou D, Rousso I, Makedou A, Arvanitidou M, Mavromichalis I. Association of blood pressure, obesity and serum homocysteine levels in healthy children. *Acta Paediatr* 2007;96:1819-1823.
 - 59 Sabin MA, Crowne E, Shield JHP. Outpatient-based paediatric obesity intervention clinic: simple advice and support are associated with significant reduction in weight in the first year. *Arch Dis Child* 2003;88(Suppl 1):A66-67.
 - 60 Wake M, Hardy P, Sawyer MG, Carlin JB. Comorbidities of overweight/obesity in Australian preschoolers: a cross-sectional population study. *Arch Dis Child* 2008;93:502-507.
 - 61 Viner RM, Segal TY, Lichtarowicz-Krynska E, Hindmarsh P. Prevalence of the insulin resistance syndrome in obesity. *Arch Dis Child* 2005;90:10-14.
 - 62 Levy JC, Matthews DR, Hermans MP. Correct homeostasis model assessment (HOMA) evaluation uses the computer program. *Diabetes Care* 1988;21:2191-2192.
 - 63 Katz A, Nambi SS, Mather K, Baron AD, Follmann DA, Sullivan G, et al. Quantitative insulin sensitivity check index: a simple, accurate method for assessing insulin sensitivity in humans. *J Clin Endocrinol Metab* 2000;85:2402-2410.
 - 64 Hofman PL, Regan F, Jackson WE, Jefferies C, Knight DB, Robinson EM, et al. Premature birth and later insulin resistance. *N Eng J Med* 2004;351:2179-2186.
 - 65 Rautanen A, Eriksson JG, Kere J, Andersson S, Osmond C, Tienari P, et al. Association of body size at birth with late life cortisol concentrations and glucose tolerance and modified by haplotypus of the glucocorticoid receptor gene. *J Clin Endocrinol Nutr* 2006;91:4544-4551.
 - 66 Buzzetti R, Petrone A, Caiazzo AM, Alemanno I, Zavarella S, Capizzi M, et al. PPAR-gamma2 Pro12Ala variant is associated with greater insulin sensitivity in childhood obesity. *Pediatr Res* 2005;57:138-140.
 - 67 Gutin B, Yin Z, Humphries MC, Hoffman WH, Gower B, Barbeau P. Relations of fatness and fitness to fasting insulin in black and white adolescents. *J Pediatr* 2004;145:737-743.
 - 68 Li S, Loos RJ. Progress in the genetics of common obesity: size matters. *Curr Opin Lipidol* 2008;19:113-121.
 - 69 Loos RJ, Bouchard C. FTO: The first gene contributing to common forms of human obesity. *Obes Rev* 2008;9:246-250.
 - 70 Marion AW, Baker AJ, Dhawan A. Fatty liver disease in children. *Arch Dis Child* 2004;89:648-652.
 - 71 Clark JM, Diehl AM. Defining nonalcoholic fatty liver disease: implications for epidemiologic studies. *Gastroenterology* 2003;124:248-250.
 - 72 Alwayn IP, Porte RJ. How to make steatotic livers suitable for transplantation. *Liver Transpl* 2007;13:497-505.
 - 73 Alwayn IP, Gura K, Nosé V, Zausche B, Javid P, Garza J, et al. Omega-3 fatty acid supplementation prevents hepatic

steatosis in a murine model of nonalcoholic fatty liver disease. *Pediatr Res* 2005;57:445-452.

- 74 Mayer K, Meyer S, Reinholz-Muhly M, Maus U, Merfels M, Lohmeyer J, et al. Short-time infusion of fish oil-based lipid emulsions, approved for parenteral nutrition, reduces monocyte proinflammatory cytokine generation and adhesive interaction with endothelium in humans. *J Immunol* 2003;171:4837-4843.
- 75 Strijbosch RA, Lee S, Arsenault DA, Andersson C, Gura KM, Bistrrian BR, et al. Fish oil prevents essential fatty acid deficiency and enhances growth: clinical and biochemical implication. *Metabolism* 2008;57:698-707.
- 76 Alwayn IP, Andersson C, Lee S, Arsenault DA, Bistrrian BR, Gura KM, et al. Inhibition of matrix metalloproteinases increases PPAR-alpha and IL-6 and prevents dietary-induced hepatic steatosis and injury in a murine model. *Am J Physiol Gastrointest Liver Physiol* 2006;291:G1011-1019.
- 77 Jaruratanasirikul S, Mo-suwan L, Lebel L. Growth pattern and age at menarche of obese girls in a transitional society. *J Pediatr Endocrinol Metab* 1997;10:487-490.
- 78 Trang H. Sleep-disordered breathing in children with common obesity. In: Heinolzer U, L'Allemand D, Zipl WB, eds. *Prader-Willy syndrome as a model for obesity*. Basel: Karger, 2003.
- 79 Dworak M, Schierl T, Bruns T, Strüder HK. Impact of singular excessive computer game and television exposure on sleep patterns and memory performance of school-aged children. *Pediatrics* 2007;120:978-985.
- 80 Farooqi IS, Yeo GS, Keogh JM, Aminian S, Jebb SA, Butler G, et al. Dominant and recessive inheritance of morbid obesity associated with melanocortin 4 receptor deficiency. *J Clin Invest* 2000;106:271-279.
- 81 Maffei C, Banzato C, Talamini G, Obesity Study Group of the Italian Society of Pediatric Endocrinology and Diabetology. Waist-to-height ratio, a useful index to identify high metabolic risk in overweight children. *J Pediatr* 2008;152:207-213.
- 82 Caroli M, Burniat W. Dietary management. In: Burniat W, Cole T, Lessau I, Poskitt EME, eds. *Child and adolescent obesity. Causes and consequences, prevention and management*. Cambridge: Cambridge Univ Press, 2002.
- 83 Brehm BJ, Seeley RJ, Daniels SR, D'Alessio DA. A randomized trial comparing a very low carbohydrate diet and a caloric-restricted low fat diet on body weight and cardiovascular risk factors in healthy women. *J Clin Endocrinol Metab* 2003;88:1617-1623.
- 84 Foster GD, Wyatt HR, Hill JO, McGuckin BG, Brill C, Mohammed BS, et al. A randomized trial of a low-carbohydrate diet for obesity. *N Eng J Med* 2003;348:2082-2090.
- 85 Bravata DM, Sanders L, Huang J, Krumholz HM, Olkin I, Gardner CD, et al. Efficacy and safety of low-carbohydrate diets: a systematic review. *JAMA* 2003;289:1837-1850.
- 86 Willi SM, Oexmann MJ, Wright NM, Collop NA, Key LL Jr. The effects of a high-protein, low-fat, ketogenic diet on adolescents with morbid obesity: body composition, blood chemistries, and sleep abnormalities. *Pediatrics* 1998;101:61-67.
- 87 Sondike SB, Copperman N, Jacobson M. Effects of low-carbohydrate diet on weight loss and cardiovascular risk factors in overweight adolescents. *J Pediatr* 2003;142:253-258.
- 88 James P. Obesity bully: Industry has improved significantly. *Food Eng Ingredients* 2005; April 8-10.
- 89 Pawlak DB, Kushner JA, Ludwig DS. Effects of dietary glycaemic index on adiposity, glucose homeostasis, and plasma lipids in animals. *Lancet* 2004;364:778-785.
- 90 Nuutinen O, Knip M. Predictors of weight reduction in obese children. *Eur J Clin Nutr* 1992;46:785-794.
- 91 Epstein LH. Methodological issues and ten year outcomes for obese children. *Ann N Y Acad Sci* 1993;699:237-249.
- 92 Flodmark CE, Lissau I. *Psychotherapy*. In: Burniat NW, Cole T, Lissau I, Poskitt EME, eds. *Child and adolescent obesity. Causes and consequences; prevention and management*. Cambridge: Cambridge Univ Press, 2002.
- 93 Viner R, Nicholls D. Managing obesity in secondary care: a personal practice. *Arch Dis Child* 2005;40:385-390.
- 94 British Council. *Inclusion & Diversity in Education. European School Study 2008*. Brussels Conference. www.britishcouncil.org/indie (accessed 2007).
- 95 Braet C. Patient characteristics as predictors of weight loss after an obesity treatment for children. *Obesity (Silver Spring)* 2006;14:148-155.
- 96 Epstein LH, Valoski A, Wing RR, McCurley J. Ten year outcomes of behavioural family-based treatment for childhood obesity. *Health Psychol* 1994;13:373-383.
- 97 FAO/WHO/UNU Expert consultation. *Human energy requirements*. Rome: Food and nutrition technical report series 1. 17-24 October 2001.
- 98 Purizkova J, Matteiss C, Poskitt ME. Management though activity. In: Burniat W, Cole T, Lissau I, Poskitt EME, eds. *Child and Adolescent obesity. Causes and consequences. Prevention and management*. Cambridge: Cambridge Univ Press, 2002.
- 99 Lobstein T, Baur L, Uauy R. Prevention the only solution. *Obesity Rev* 2004;5:60-85.
- 100 Wilmore JH. The obesity epidemic. *Curr Sports Med Rep* 2007;6:345-346.
- 101 Epstein LH, Roemmich JN, Robinson JL, Paluch A, Winiewicz DD, Fuerch JH, et al. A randomized trial of effects of reducing television and computer use on body mass index in young children. *Arch Pediatr Adolesc Med* 2008;162:283-284.
- 102 Grilo CM, Brownell KD, Stunkard AS. The metabolic and psychological importance of exercise in weight control. In: Stunkard AJ, Wodden RA, eds. *Obesity Theory and Therapy*, 2nd ed. Philadelphia: Lippincott-Raven, 1996.
- 103 Centers for Disease Control and Prevention. *Physical activity for every one: recommendations*. www.cdc.gov/nccdphp/dnpa/physical/recommendations/young (accessed 2007).
- 104 Stahl T, Rutten A, Nutbeam D, Kannas L. The importance of the social environment for physically active lifestyle—results from an international study. *Soc Sci Med* 2001;52:1-10.
- 105 Robinson TN. Television viewing and childhood obesity. *Pediatr Clin North Am* 2001;48:1017-1025.
- 106 Kimm SY, Glynn NW, Kriska AM, Barton BA, Kronsberg SS, Daniels SR, et al. Decline in physical activity in black girls and white girls during adolescence. *N Eng J Med* 2002;347:709-715.
- 107 Styne DM. Obesity in childhood: what's activity got to do with it. *Am J Clin Nutr* 2005;81:337-338.
- 108 Yanowski SZ, Yanoski JA. Obesity. *N Engl J Med* 2002;346:591-602.
- 109 Tudor-Locke C, Bassett DR, Rutherford WJ, Ainsworth BE, Chan BC, Croteau K, et al. BMI-reference cut points for

- pedometers-determined steps per day in adults. *J Phys Act Health* 2008;5(Suppl 1):S126-139.
- 110 Ranstorp A, Ludvigsson J. Secular trends of pedometer-determined physical activity in Swedish school children. *Acta Paediatr* 2007;96:1824-1828.
- 111 James WP, Astrup A, Finer N, Hilsted J, Kopelman P, Rossner S, et al. Effect of sibutramine on weight maintenance after weight loss: a randomised trial. STORM Study Group. Sibutramine Trial of Obesity Reduction and Maintenance. *Lancet* 2000;356:2119-2125.
- 112 Eckel RH. Nonsurgical management of obesity in adults. *N Engl J Med* 2008;358:1941-1950.
- 113 Li Z, Maglione M, Tu W, Mojica W, Arterburn D, Shugarman LR, et al. Meta-analysis: pharmacologic treatment of obesity. *Ann Intern Med* 2005;142:532-546.
- 114 Berkowitz RI, Wadden TA, Tershakovec AM, Cronquist JL. Behavior therapy and sibutramine for the treatment of adolescent obesity: a randomized controlled trial. *JAMA* 2003;289:1805-1812.
- 115 Heck AM, Yanovski JA, Calis KA. Orlistat, a new lipase inhibitor for the management of obesity. *Pharmacotherapy* 2000;20:270-279.
- 116 McDuffie JR, Calis KA, Uwaifo GI, Sebring NG, Fallon EM, Hubbard VS, et al. Three month tolerability of orlistat in adolescent with obesity-related comorbid conditions. *Obes Res* 2002;10:642-650.
- 117 Allison DB, Fontaine KR, Heshka S, Mentore JL, Heymsfield SB. Alternative treatment for weight loss: a critical review. *Crit Rev Food Sci Nutr* 2001;41:1-28.
- 118 Freemark KM, Bursley D. The effects of metformin on body mass index and glucose tolerance in obese adolescents with fasting hyperinsulinemia and a family history of type 2 diabetes. *Pediatrics* 2001;107:E55.
- 119 Moya M, Juste M, Cortés E, Carratala F. Use of conjugate linoleic acid (CLA) in obese children and adolescent. *Rev Esp Paediatr* 2007;63:453-457.
- 120 Mechanick JI, Kushner RF, Sugerman HJ, Gonzalez-Campoy JM, Collazo-Clavell ML, Guven S, et al. Executive summary of the recommendations of the American Association of Clinical Endocrinologists, the Obesity Society, and American Society for Metabolic & Bariatric Surgery medical guidelines for clinical practice for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient. *Endocr Pract* 2008;14:318-336.
- 121 Sjöström L, Lindroos AK, Peltonen M, Torgerson J, Bouchard C, Carlsson B, et al. Lifestyle, diabetes and cardiovascular risk factors 10 years after bariatric surgery. *N Engl J Med* 2004;351:2683-2693.
- 122 Apovian CM, Baker C, Ludwig DS, Hoppin AG, Hsu G, Lenders C, et al. Best practice guidelines in pediatric/adolescent weight loss surgery. *Obes Res* 2005;13:274-282.
- 123 Moya M, Juste M, Durá T. Dietetic management of pediatric obesity. In: Del Pozo J, Morán J, eds. *Nutrition in Ambulatory Pediatrics*. Ediciones Ergon: Madrid, 1995.

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