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Symposium III: Metabolic health, weight management and obesity prevention in childhood and adolescence
Effectiveness of lifestyle intervention in overweight children

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Therapy of choice in obese children and adolescents is lifestyle intervention based on nutrition education, behavioural treatment and exercise treatment. Its efficacy even after the end of intervention has been proven by several randomised-controlled trials and meta-analyses including a recent Cochrane review. However, randomised-controlled trials are likely to overestimate the effectiveness. Studies under normal day-to-day circumstances demonstrated only a very moderate effect on weight loss (<10% success rate 2 years after the onset of intervention). A reduction of >0·5 SDS-BMI (which means a stable weight over 1 year in growing children) is associated with an improvement of cardiovascular risk factors, while improvements of quality of life seem independent of the degree of weight loss. Younger children and less overweight children particularly profit from lifestyle interventions in contrast to extremely obese adolescents. Recent studies demonstrated that involving parents is crucial for success, suggesting that parents and children and not children alone should be the primary target of interventions. Failures in weight reduction are attributed not only to a lack of motivation but also to other aspects particular to the genetic background. The techniques, more than the contents, of an intervention influence the treatment outcome. Besides behavioural therapy, systemic and solution-focused treatments are important. Future longitudinal research should focus on the identification of which children and adolescents profit from which kind of intervention, in order to be able to tailor specific treatment approaches. Studies under normal day-to-day circumstances are necessary to prove the benefit of this kind of intervention.

Lifestyle intervention: Behaviour therapy: Effectiveness: Children: Adolescents

The increasing prevalence of obesity in childhood poses an ever-increasing problem for our health systems[1,2], since a great proportion of overweight children tend to become obese adults[3]. Childhood obesity affects both the children's quality of life and social integration[1]. Obesity and its associated comorbidities such as hypertension, dyslipidemia and disturbed glucose metabolism – which also appear frequently in children[4,5] – are associated with premature death[6,7]. Early vascular changes have been demonstrated in obese children by increased intima-media thickness[8], a predictive factor for atherosclerosis, heart attack and stroke[9]. A large epidemiological study demonstrated the association between BMI in childhood (7–13 years of age) and CHD in adulthood (⩾25 years of age) in a cohort of >270 000 Danish[6]. Furthermore, in a cohort of about 5000 American Indian children without diabetes, obesity, glucose intolerance and hypertension in childhood were strongly associated with increased rates of premature death from endogenous causes[10]. In conclusion, both higher BMI during childhood and cardiovascular

Abbreviations: RCT, randomised-controlled trial; SDS-BMI, SD score of BMI.

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risk factors in obese children are associated with an increased risk of CHD in adulthood[7]. For these and other reasons, effective therapeutic approaches are urgently needed in childhood obesity. In obese children, lifestyle interventions are the predominant recommendation[11]. However, the long-term effectiveness of such kinds of interventions in clinical practice is often discussed critically, and outcomes vary widely between different studies[12]. The scope of this review is to present our current knowledge of lifestyle interventions for overweight children and adolescents, and to demonstrate some methods and outcomes of a long-term effective lifestyle intervention.

Aims of lifestyle intervention in overweight children

The effectiveness of a lifestyle intervention is determined not only by weight loss, and the following targets have been proposed[13–15]:

1) Reduction of overweight.
2) Improving comorbidity.
3) Improving health behaviour.
4) Minimising adverse side effects (e.g. eating disorders such as bulimia).
5) Improving quality of life.

Interestingly, the great majority of randomised-controlled trials (RCT) in childhood obesity are focused on target 1 (weight loss), while analyses of other targets listed are scarce. This may be attributed to the difficulties there are to measure health behaviours objectively. There are no relevant reports of adverse side effects of interventions in the literature. This may be attributed at least in part to the fact that only few studies have searched for side effects. However, lack of success in a lifestyle intervention may reduce self-confidence.

How much weight loss should be achieved?

There are no studies analysing what amount of weight loss needs to be reached to improve quality of life in overweight children. A very rapid weight loss is frequently associated with weight gain in follow-up[1,16] (yo-yo effect) due to a reduction of the BMR[17] and an unfavourable change of satiety and anorexic hormones[17,18].

Studies analysing quality of life in overweight children have demonstrated an improvement even without weight loss in children participating in lifestyle interventions[19,20]. Therefore, a direct link between amount of weight loss and quality of life seems unlikely.

A reduction of cardiovascular risk factors and insulin resistance as well as an improvement of intima-media thickness have been reported in a reduction of SD score of BMI (SDS-BMI)>0.5[21–23]. This amount of weight reduction is similar to a reduction of BMI 1–2 kg/m^2. However, a smaller reduction of overweight may also be associated with an improvement of health[23] since, for example, increasing physical activity even without weight loss is associated with an improvement of cardiovascular risk factors[24].

From a practical point of view, it is important to inform the parents and children that a stable weight over 1 year in growing children is similar to a BMI reduction of 1–2 kg/m^2. Therefore, the aim of lifestyle interventions should be a stable weight in overweight children who are growing.

Components of intervention

Usually, lifestyle interventions for obese children are based on physical activity and nutrition education using behaviour therapy and other techniques.

Physical activity

Most lifestyle interventions include sports sessions to improve physical activity[12]. The hypothesis behind this intervention is that increasing physical activity improves aerobic and anaerobic fitness as well as muscle strength, and therefore reducing body weight without loss of lean body mass. However, obese children do not differ significantly in the amount of physical activity they undertake compared to normal weight children[25] questioning this treatment approach. Furthermore, there is a limit to the time available for sports training. There appears to be no study in the literature demonstrating an increase of physical activity by sport training alone leading to long-term weight loss[12,26].

However, sports activities have several benefits. Usually, these sessions are well accepted by obese children and adolescents if they are performed in closed groups excluding normal-weight children[27]. They can lead to an improvement in self-confidence, a new positive body image and help to build up motivation if children have success in a training tailored for their abilities. Most importantly, increased physical activity is associated with an improvement of cardiovascular risk factors in obese children even without weight loss[24].

Another approach is to increase physical activity in everyday life such as walking to school or kindergarten instead of using cars or buses. However, these approaches were not associated with a significant weight loss in recent studies[24,28].

Reducing sedentary behaviour

Since sedentary behaviour such as television viewing or the use of computer games is strongly associated with childhood obesity, it is not surprising that reducing time spent watching television or playing consoles games is associated with weight loss, also in young children[29]. Therefore, a reduction of TV and computer time is one of the most promising strategies to reduce body weight. However, there are no well-established and evaluated methods to reach this goal. Interestingly, paying parents money to reduce TV viewing by their children was shown to be a successful approach[29].

Diet

The ‘classical’ way of weight reduction is dieting by reducing energy intake, for example, by reduction of fat and sugar intakes. Many lifestyle interventions include nutrition courses. Strict dietary concepts (e.g. energy

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intakes limited to 4200 or 6000 kJ/d) are not always helpful as they cannot be adhered to for longer periods of time, and the families do not learn to change their dietary intakes under day-to-day circumstances[1,14]. Furthermore, a hypoenergetic diet in children jeopardises growth and development[14]. Additionally, energy needs differ widely, even between children of the same age and gender, and is influenced by many factors including physical activity and genetic background[1,14]. A reduction of energy intakes by about 30 %, mainly by reducing fat and sugar intakes is recommended[14] even if studies proving these approaches are still lacking.

RCT have demonstrated two effective strategies to reduce body weight: a reduction of intakes of sweetened drinks was associated with reduced overweight in children and adolescents in two independent studies[30–32]. Furthermore, a reduction of fast food intakes also seems promising, since consumption of fast food is a well-known predictor of weight gain[33].

Some observations question the impact of a traditional nutrition education course on weight loss in obese children. Dietary records do not differ in respect of energy intake, and amounts of fat and sugar consumption between obese and normal weight children[34,35]. This surprising finding may be attributed to underreporting, but maybe also to different genetic background. Additionally differences in physical activity explain this finding in part. Furthermore and most importantly, levels of knowledge concerning 'healthy' nutrition are not different between obese and normal-weight children[36]. This suggests that the problem is not the lack of knowledge concerning adequate nutrition but to realise this knowledge in everyday life.

Techniques of intervention

Behaviour therapy and negotiation

Most lifestyle interventions are based on behaviour therapy including behaviour contracts, booster systems (which means reward of desired behaviour), self-reflection curves, impulse control techniques, self-instruction, cognitive restructuring, development of problem-solving strategies and model learning via parents[37–39]. The effectiveness of behaviour therapy approaches have been proven in several studies[38,39].

However, in recent years, interventions for overweight children have moved on to systemic and solution-focused theories[37]. Based on these theories, techniques were developed to create concrete solutions, and to change family health behaviour consistently, by methods tailored to the individual family situation. Instead of focusing on unfavourable behaviour habits, the strengths of the overweight children are encouraged, avoiding prohibitions. Useful techniques are summarised in Table 1.

One major challenge in lifestyle intervention is the attendance rate, which very much depends on a positive, confiding relationship between patient and therapists. In an RCT, an attendance rate greater than 75 % was associated with a significant better outcome after the end of the intervention[40]. Although further work is needed to understand the association between attendance rates and the relationships between therapists and the family, this study suggests the potential importance of strategies to promote and to facilitate programme attendance by using adequate techniques in lifestyle interventions.

Target group

The great majority of lifestyle interventions focus on children and adolescents[12,26,41,42]. However, in recent years, several studies have demonstrated that interventions with parents are more effective than interventions with children alone. Involving parents is a major predictor of success. Recent RCT clearly demonstrated that integrating parents in the interventions is more effective than treating children alone[12,43,44].

Parents have an important model function for the eating and exercise behaviour of their children. Furthermore, they control the health behaviour of their children. Some parents attempt to control the health behaviours of their children by penalising. However, encouraging the strengths of their children can be more effective and helps to build a positive family atmosphere, which is also useful to support the challenge of overweight[37]. Booster systems and contracts are helpful to provide incentives for new health behaviours. All initiatives should be addressed to the behaviour of the child, and not his/her weight[37]. To be consistent is frequently difficult for parents, but essential to support a change in the behaviour of their children.

Duration of intervention

Since overweight and obesity are chronic conditions, long-term interventions are necessary. Accordingly, short-term in-patient interventions over 2–8 weeks are very unlikely to offer long-term success[20,45–47]. The successful interventions required periods of 6–12 months[26,41,42]. However, there are no studies analysing the relationship between the duration of interventions and long-term outcomes.

Effectiveness of intervention

A recent Cochrane review[12] looking at treatment in obese children including sixty-four RCT with 5230 participants, identified lifestyle interventions focused on physical activity and sedentary behaviour in twelve studies, diet in six studies and thirty-six studies concentrated on behaviourally orientated treatment programmes. The studies included varied greatly in intervention design, outcome measurements and methodological quality. Meta-analyses indicated a reduction in overweight at 6 and 12 months of follow-up in lifestyle interventions. While there are limited quality data to recommend one treatment programme to be favoured over another, this review shows that combined behavioural lifestyle interventions, compared to standard care or self-help, can produce a significant and clinically meaningful reduction in overweight or obesity in children and adolescents.

A meta-analysis calculated the mean reduction of BMI in nutrition and physical activity interventions compared

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Table 1. Techniques for lifestyle intervention in obese children (adapted from[42])

Technique	Example	Rationale
Be neutral and adopt a normalising, non-blaming position	'Obesity is like being allergic to energies. If you are allergic to fur, you need to stay away from cats and dogs. Similarly, if you are 'allergic' to energies, you need to be more careful than your friends about what you eat and your activity level. It is not your fault and it may seem unfair' instead of 'Congratulations, you are not ill, you just have to eat less and be more active to reduce your body weight'.	This approach is not adversarial and honours possible treatment approach of the family.
Assume motivation	'What has your son been trying to do in the past that has been helpful to him?' or 'How did you notice that? Who else in the family has noticed that?'	These questions show that team members assume that the family members have been trying to solve the problem and are motivated to continue doing so.
Intervene with questions (observe-analyse-intervene)	'If you compare yourself with your mother, do you eat less, as much or more?'	The form of this question is guided by an assumption that a child should not consume more than an average sedentary middle age female. The question is formulated in a circular way that requires comparison with other family members and automatically involves other members of the family. Such circulating questions allow some analysis of the relationships in the family.
Use scaling questions	'I would like to ask you a scale question, if it's okay with you? On a scale of 1–10, where 10 represents the highest possible level of satisfaction and 1 as the lowest, where would you say you are today with respect to how satisfied you are with your progress toward a healthy weight?' The adolescent answers six. 'OK. And how about you, Mom?' The mother of the adolescent answers seven. 'That's interesting. So – (turns back to the adolescent) – what do you think about the fact that your mother chooses a higher number than you do?'	Scaling questions allows an estimate, for example, of the motivation to change a lifestyle habit. Circulating questions allow some analysis of the relationships in the family.
Use contextual markers and avoid direct advices	'Some studies show that by decreasing television viewing time, children are able to increase physical activity and decrease weight. That is why we encourage children to limit television and computer time to a maximum of 2 h/d. What is your opinion about this?' or 'Many families say that it is easier to keep hunger under control during the day, if children eat breakfast, but what do you, as parents, think about this?'	This technique avoids resistance of the family to direct advice and is less adversarial.
Reframe to create a positive relationship	'I don't know how to help my daughter. I nag all the time. Sometimes I sound like a tape recorder from morning to night,' a mother of a teenage patient complains during a session. 'So you have been wondering if reminding your daughter is helpful', the therapist asks.	A new narrow perspective of behaviour helps the family to develop solutions.
Focusing on strengths and not on shortcomings and use them as a source to solve the problem	Instead of a common question: 'Do you eat breakfast?' The team member can ask: 'How many days a week do you eat breakfast?' The child answers: 'Three'. The therapist follows: 'So what's different about the days when you eat breakfast?'	The therapist has a possibility to explore the difference between the days when breakfast occurs and different circumstances when breakfast is not eaten. In this way the therapist highlights the positive exception to the problem (not eating breakfast).
Focus on small changes	'What would be the smallest change that you could make before our next meeting that you feel would be easy to carry out?'	The likelihood of changes is increased if choosing small steps of behaviour changes.
Identify family resources	'How can your mother help you accomplish this change?' or 'What can your father do to help?'	The children disclose their wishes from their parents and the parents changed their role from someone who forbids to someone who fulfil a desire.

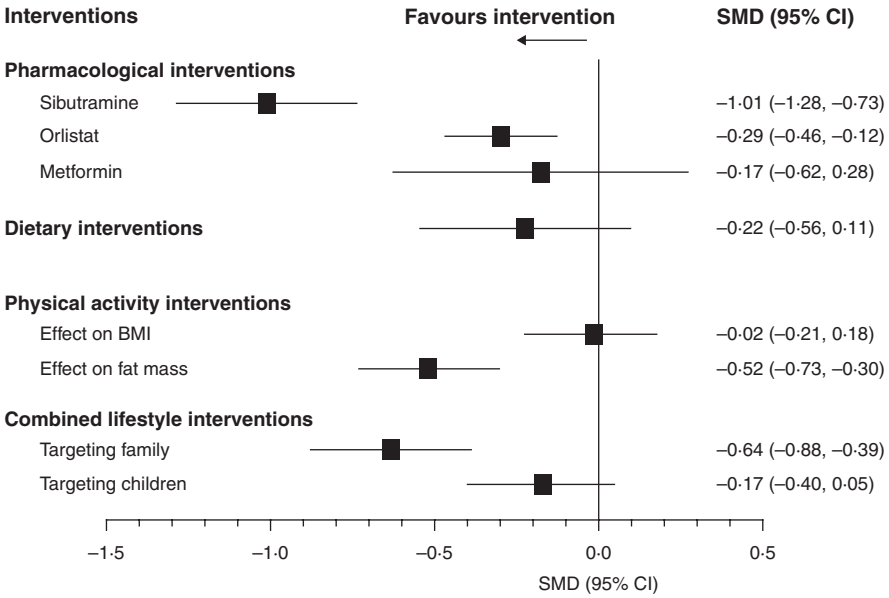

Fig. 1. Effect of lifestyle intervention in obese children, findings from the meta-analyses of McGovern *et al.*[42]. SMD, standardised mean differences.

with controls[41,42]: Interventions resulted in significant reductions of −0·29 SDS-BMI (95% CI −0·45, −0·14)[41] up to −0·63 (95% CI −0·90, −0·43)[42]. The effects of lifestyle interventions were higher in combined lifestyle interventions (diet + physical activity) and when targeting families (see Fig. 1)[42].

Interestingly, there are many more reviews and meta-analyses in the literature than original papers, indicating that we are discussing lifestyle interventions rather than performing clinical studies to improve our knowledge. Furthermore, RCT are likely to overestimate the effectiveness of lifestyle interventions. For example, the success rate in an RCT at our institution evaluating a lifestyle intervention for overweight children was 94%[48]. However, in clinical practice outside the RCT, the same kind of intervention performed by the same therapists resulted in a success rate of 79%[49] suggesting that the participants differ between RCT and normal clinical practice. Perhaps, more motivated families participate in RCT.

Since the effects of lifestyle interventions in clinical practice under 'real-life' conditions and not under the umbrella of an RCT are largely unknown, we performed the following study[47]: One hundred and twenty-nine centres in central Europe specialising in outpatient paediatric obesity care participated in the following quality assessment; all patients presenting before the year 2006 for lifestyle intervention of at least 6 months duration in these institutions were analysed in a 2-year follow-up. A total of 21 784 (45% male) overweight children and adolescents aged 2–20 years (mean BMI 30·4 kg/m^2, mean SDS-BMI 2·51, mean age 12·6 years) were included in the analysis. Based on an intention-to-treat analysis, 20% of the children reduced their SDS-BMI after 6 months, 14% after 12 months and 7% after 24 months, but complete data were only available in 24, 17 and 8% of children, respectively (see Fig. 2(A)).

In conclusion, under real-life conditions, most treatment centres cannot prove the long-term efficacy of their interventions due to high drop-out rates or a lack of documentation. The disappointing findings in most treatment centres are in line with a much smaller multi-centre study of overweight children in Italy[50] or observations in overweight adolescents suffering from type 2 diabetes mellitus, in whom interventions were initiated but most patients were lost to follow-up[51,52]. It can be speculated that the high drop-out rate is caused by certain characteristics of overweight patients and their families (e.g. lack of psychosocial support and parenting skills), by a decline in the motivation for lifestyle changes[53], by inadvertent constraints to therapy adherence, by insufficient efficacy and/or quality of lifestyle interventions in real life or by incomplete documentation due to lack of financial reimbursement to clinicians for follow-up visits.

Conversely, in our previously cited study, single institutions had much better results with sustained weight reduction in up to 51% of the children after 2 years (see Fig. 2(B)) demonstrating the great heterogeneity of follow-up quality under real-life conditions: in the five treatment centres with the best outcome (518 patients), 83% of the children reduced their overweight after 6 months, 67% after 12 months and 51% after 24 months (see Fig. 2(B)). Nearly 25% of the children reduced their overweight >0·5 SDS-BMI, which has been demonstrated to be clinically relevant[21,22,54]. These findings under real-life conditions are in line with the RCT[26,41,42]. The much higher success rate in the five best treatment centres can be explained in part with the much lower drop-out rate (43% versus >90% in the other treatment centres) suggesting that weight loss is achievable if patients can be motivated for regular treatment, keeping in mind that it is likely that the most successful children tend to continue treatment.

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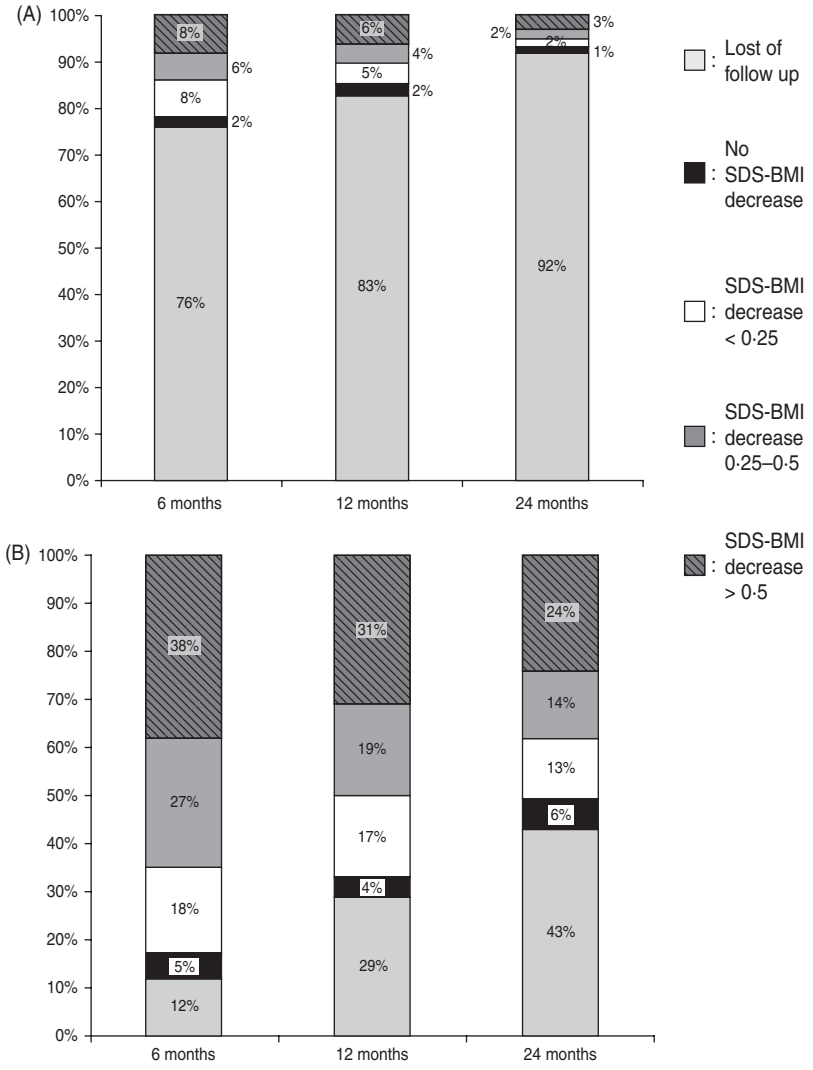

Fig. 2. Success rate at 6, 12 and 24 months after baseline in overweight children with lifestyle interventions under real-life conditions ((A) 21 784 children in 129 treatment centres; (B) 518 children in the five treatment centres with the highest success rate (defined as reduction of SD score of BMI (SDS-BMI)) at 2 years follow-up) adapted from[47].

Predictors of success

Apart from the quality of intervention, individual factors among participants influence the outcomes. For example, younger age and a lower degree of overweight were associated with greater success in many studies[20,45,47], underlining the benefits of an early intervention in childhood obesity.

Motivation

The motivation and willingness to change habitual dietary intakes and exercise habits are decisive for the success of lifestyle interventions[55]. However, a desire to decrease weight does not always correspond to the willingness to change behaviour. A simple and practical way to identify motivation in children and families are participation rates in sports groups for overweight children[27]. In our experience, an advantage of exercise groups for obese children before other interventions is that the families are confronted with the difficulties involved when attending training regularly (time, means of transport and care for other family members). Furthermore, the obese children can make contact with other obese children who have already finished their training and who can report on what they experienced. The children usually enjoy the exercise therapy, which is often not the case for them when doing school sports. Conventional sports clubs are often unsuitable for obese children since they strive to achieve challenging sporting results.

Socio-economic status and minorities

Although assumed and frequently discussed, the family's socio-economic status (level of education of parents, family income and marital status) had no influence on the

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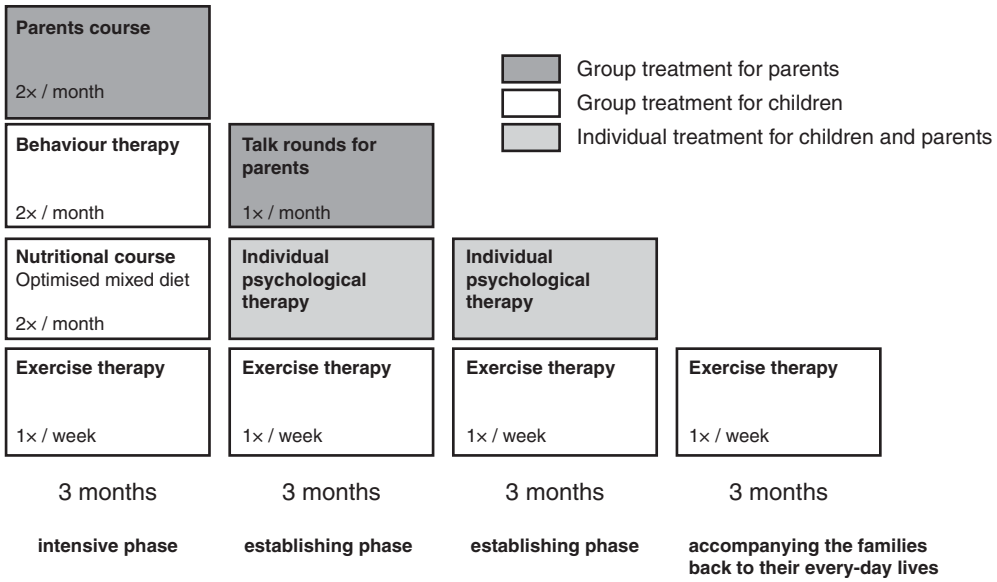

Fig. 3. Structure and components of the lifestyle intervention 'Obeldicks'[70].

success of treatment in a large study under real-life conditions[20]. However, some further studies showed that children from families in challenging social/economic circumstances had worse results[56]: If children regularly have meals elsewhere, other than in the family environment, the chances of success decrease. Consequences in nutrition, dietary and exercise rules are more difficult if different people like home helps, day care staff or grandparents all share responsibility for the child.

Some groups such as migrants or children of obese parents have an increased risk of obesity[57]. It seems meaningful to build tailored lifestyle interventions to consider differences in eating culture. Furthermore, intervention may be less successful in children with migration background[56,58,59]. One study demonstrated that a lifestyle intervention tailored for obese minority children (Afro-Americans) had success at the end of the intervention[60], but long-term follow-up data were disappointing[61,62].

Genetic background

Twin studies clearly demonstrated a genetic predisposition in obesity[63]. Accordingly we found an impact of melanocortin 4 receptor mutations that lead to a reduced receptor function of satiety in the leptin pathway on weight loss in lifestyle intervention[64]: While children with these melanocortin 4 receptor mutations were able to reduce their BMI during intervention, one year after the end of the lifestyle intervention, these children demonstrated a similar degree of overweight as at baseline, while children without these mutations had sustained their degree of weight loss. Furthermore, the polymorphisms *INSIG2* CC-genotype and *FTO* AA-genotype were associated with a lower degree of overweight reduction[65–67]. However, all these effects were small.

Apart from a potential influence of genetic markers on the degree of weight loss, genetic polymorphisms may influence the changes of cardiovascular risk factors in weight reduction. In our study population, the T-allele at rs7903146 in *TCF7L2* was associated with a significant negative dosage effect per allele on the improvement of insulin resistance and sensitivity indices such as HOMA-IR and QUICKI after the lifestyle intervention, independently of degree of weight loss, age and gender[68].

Furthermore, leptin resistance is suggested to be involved in the genesis of obesity. In our cohort, the reduction of SDS-BMI and body fat were significantly negatively associated with baseline leptin levels[69].

'Obeldicks': an example of a long-term successful lifestyle intervention

The lifestyle intervention 'Obeldicks' addresses obese (defined by BMI>97th percentile) children and adolescents aged 8–14 years. It is based on physical activity, nutrition education and behaviour therapy including the individual psychological care of the child and his/her family[70]. The costs are 1000 € per participant and are reimbursed completely by all German health insurances. An interdisciplinary team of paediatricians, diet-advisers, psychologists and exercise physiologists is responsible for the training. All therapists build up a therapeutic alliance with the children and their families. They have to involve family members, adopt a non-blaming position, assume motivation, focus on small changes, identify the resources of the family and create a positive approach by reframing questions (for details see[37] and Table 1).

The 1-year training programme is divided into three phases (see Fig. 3): in the intensive phase (3 months), the children take part in a nutrition course and in the eating-behaviour course in six group-sessions each lasting for 1·5 h. At the same time, the parents are invited to attend six parents' evenings. In the second phase (6 months), individual psychological family therapy is provided (30 min/month). In the last phase of the programme

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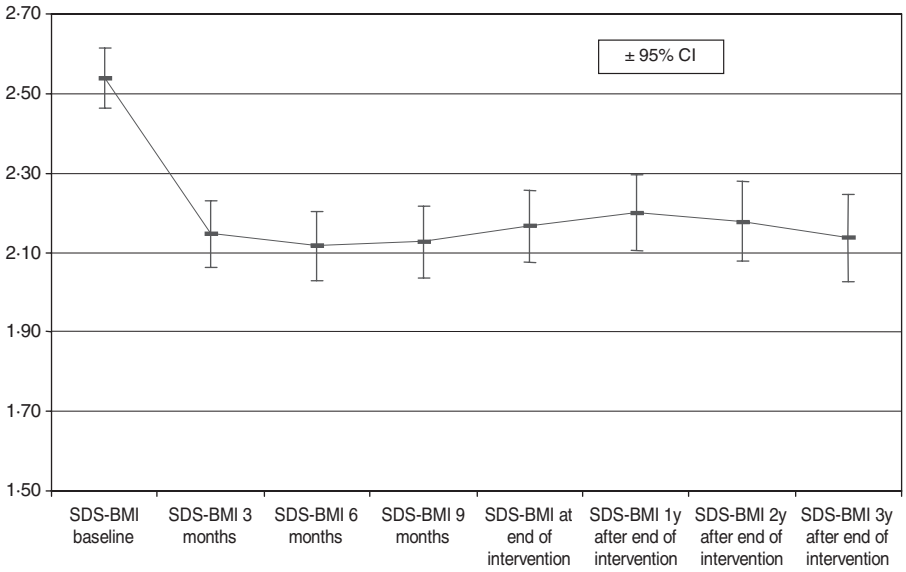

Fig. 4. Degree of overweight as the SD score of BMI (SDS-BMI) in a 4-year follow-up of 227 participants of the lifestyle intervention 'Obeldicks' (intention-to-treat analysis, data as mean and 95% CI) adapted from[73].

(accompanying the families back to their everyday lives) (3 months), further individual care is possible, if and when necessary. Children older than 10 years are separated in gender-specific intervention groups, while younger boys and girls receive the intervention together.

The exercise therapy takes place once a week for the whole year, and consists of ball games, dancing for girls, wrestling for boys, trampoline jumping and guidance in physical activity as part of everyday life. Furthermore, a reduction of the amount of time spent watching television or playing computer games is aimed for. We have demonstrated an increase of physical activity and a decrease in sedentary behaviour during intervention[71].

The nutrition course is based on the prevention concept, described as the 'optimized mixed diet'. Current scientific recommendations are translated into food-based dietary guidelines adapted to the dietary habits of families in Germany. In contrast to the current diet of children in Germany with a fat content of 38% of energy intake, 13% proteins and 49% carbohydrates including 14% sugar[71], the 'optimized mixed diet' has reduced amounts of both fat and sugar, and contains 30% energy from fat, 15% proteins and 55% carbohydrates including 5% sugar. The children follow a 'traffic-light system' when selecting their food. In this system, the foods and drinks available in Germany are separated according to their fat and sugar contents into 'red = stop', 'orange = consider the amount' and 'green = o.k. when hungry or thirsty'. Three-d weighed dietary records demonstrated a reduction of the mean energy content of 6100 (SD 1587) kJ/d before intervention, to a mean of 5234 (SD 1252) kJ/d at the end of intervention and a reduction of percentage fat from 36·3 (SD 5·0) % to 30·4 (SD 7·1)%[70].

The eating behaviour course is predominately behavioural-cognitive and also uses systemic treatment approaches[37]: The training is based on behaviour contracts, booster systems, self-reflection curves, impulse control techniques, self-instructions, cognitive restructuring, the development of problem-solving strategies, training of social competences, model learning via parents and strategies to support the prevention of relapses. The individual counselling sessions based on systemic and solution-focused theories are aimed at developing solutions to change the family health behaviour consistently, tailored to the individual family situation.

The complete material and the exact description of the 1-year lifestyle intervention 'Obeldicks' is available as a training book[71].

Effectiveness of the lifestyle intervention 'Obeldicks'

This lifestyle intervention 'Obeldicks' for obese children and adolescents led to a reduction of overweight in the majority of the more than 1000 participants. In contrast to a control group, the intervention group were able to achieve long-term success[49,72]: The success rate based on the 'intention-to-treat' approach is 79% with a drop-out rate of 17%. The mean reduction of SDS-BMI was 0·40. Even 4 years after the end of intervention, this weight reduction was sustained[73,74] (Fig. 4).

Furthermore, the reduction of overweight was associated with an improvement of cardiovascular risk factors such as hypertension, dyslipidemia, disturbed glucose metabolism and metabolic syndrome, not only at the end of intervention but also 1 year after the end of intervention[23]. Additionally, this lifestyle intervention led to a reduction of carotid intima-media thickness[75]. Finally, the weight loss was also associated with an improvement of quality of life in the participants, suggesting a clinical relevance not only from the medical point of view but also from the participants' point of view[70].

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Obeldicks light

As a consequence of these promising results of 'Obeldicks' in obese children, we adopted this effective lifestyle intervention to overweight but not obese (BMI>90th<97th percentile) children and called this new type of intervention 'Obeldicks light'. The intervention was shortened from 1 year ('Obeldicks') to 6 months ('Obeldicks light'). Compared to 'Obeldicks', the amount of physical activity training and the time- and cost-intensive individual counselling was reduced by about 50 %. The same training materials as in 'Obeldicks'[48] are used. An RCT proved the effectiveness of the lifestyle intervention 'Obeldicks light' for overweight children and adolescents (mean reduction of SDS-BMI 0·2; 94 % success rate[48]): The reduction of overweight achieved was clinically relevant as demonstrated by a reduction of fat mass both in bioimpedance analyses and skinfold thickness measurements[48]. Additionally, waist circumference was reduced substantially only in the intervention group. Furthermore, blood pressure decreased substantially in the intervention group.

A challenge to our study in overweight children was the recruitment process. We used multiple advertising strategies such as newspaper, television, broadcasting, school events, distribution of leaflets and information of family doctors[76]. Even though more than 200 families presented in the first 6 months of the recruitment period of the evaluation study, this process resulted primarily in the enrolment of obese but not overweight children, indicating that in the search for overweight children, predominantly obese children felt addressed. Overweight children perceived themselves to be normal weight and their parents also perceived their children were of normal weight[76]. Therefore, the perceived need for lifestyle interventions for overweight children seems to be low.

Obeldicks Mini

For obese children younger than 8 years, we developed the lifestyle intervention called 'Obeldicks Mini'. This intervention is based on the same materials and methods as compared to 'Obeldicks', but all interventions apart from exercise sessions are applied only to parents (22·5 h of lessons for parents *v.* 4·5 h of lessons for children)[77]. Furthermore, every fourth exercise lesson is performed together with the child and his/her parents. The exact training programme and all materials are published in a manual[77]. Interestingly, the degree of overweight reduction was more pronounced in our study (− 0·46 SDS-BMI) as compared to lifestyle intervention in obese school children and adolescents[78]. This weight loss was sustained in the course of 3 years after the end of intervention[78]. Our promising results may be explained in part by the new innovative concept focusing on the parents of obese children, and most importantly the early intervention in young children aged 4–8 years. Intervention of obesity in this early age range also seems meaningful from a developmental physiological point of view since healthy behaviour is determined in this age range.

Intervention in preschool children who are already obese also seems meaningful due to the fact that nearly half of the obese preschool children already demonstrated moderately increased blood pressure values or dyslipidemia (36 % hypertension, 35 % hypertriglyceridaemia, 52 % increased LDL-cholesterol and 19 % decreased HDL-cholesterol). The amount of weight loss in the lifestyle intervention 'Obeldicks Mini' was sufficient to improve the cardiovascular risk factor profile[78]: blood pressure values, insulin resistance and TAG levels decreased significantly, while HDL-cholesterol concentrations increased significantly. The prevalence of hypertension and dyslipidemia also decreased. Furthermore, the intima-media-thickness, decreased significantly after the lifestyle intervention 'Obeldicks Mini'[78].

Implementation of 'Obeldicks' at different treatment centres

Even though all materials and the exact guidance of procedures are published as training books[71,77], other treatment centres have demonstrated a significant lower success rate (one-third lower) and degree of overweight reduction[79]. Therefore, we established 1-week training seminars at our institutions. In this seminar, there is a focus on the moderation of groups, behavioural, systemic and solution focus theories (see Table 1), and visits to interventions groups are offered. After the participation of therapists in these seminars, the success rate and the degree of overweight reduction did not subsequently differ from the findings at our institution[79].

Remaining questions

Even if our knowledge concerning lifestyle interventions in overweight and obese children and adolescents is increasing there are many problems to be solved:

What is the transferability of findings in RCT to real-life scenarios?
How can a therapist be educated in treating obese children and their families?
How should the motivation of children and families to change their life habits be measured?
What is the minimum of amount of time and intensity needed to result in effective nutrition and physical exercise sessions?
How should the children be monitored after a lifestyle intervention?
Do we need tailored interventions for high-risk groups such as minorities?
How to treat unmotivated obese children?
How to treat disabled obese children?
How to treat extreme obese adolescents?

Summary

Lifestyle interventions based on nutrition courses and physical activity training are effective to reduce overweight in children and adolescents if they are motivated,

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and most importantly if parents are involved. A reduction of >0·5 SDS-BMI (which means a stable weight over 1 year in growing children) is associated with an improvement of cardiovascular risk factors, while improvement of quality of life seems independent of the degree of weight loss. Younger children and less overweight children particularly profit from this intervention in contrast to extremely obese adolescents. Most lifestyle interventions are based on behaviour therapy. However, in recent years, interventions for overweight children have moved on to systemic and solution-focused theories. Failures in weight reduction are not only attributed to lack of motivation but also to genetic background. The degree of weight loss in lifestyle intervention is only moderate questioning its benefit in severely obese children. RCT are likely to overestimate the effectiveness of interventions.

Conclusions

Future longitudinal research should focus on the identification of which children and adolescents profit from which kind of intervention, in order to be able to tailor specific treatment approaches. Studies under normal day-to-day circumstances are necessary to prove the benefit of this kind of intervention. Even if our knowledge concerning lifestyle interventions in overweight and obese children and adolescents is increasing there are so far no efficient lifestyle interventions for unmotivated obese children, disabled obese children and extreme obese adolescents. A certification process for treatment centres and a structured education of therapists may be helpful to improve the outcome after lifestyle intervention for obese children and adolescents.

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