Prevention of Childhood Obesity: A Position Paper of the Global Federation of International Societies of Paediatric Gastroenterology, Hepatology and Nutrition (FISPGHAN)

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ABSTRACT

Global childhood obesity increased more than 8-fold over 40 years, inducing a very large personal, societal, and economic burden. Effects of available treatments are less than satisfactory; therefore, effective prevention is of high priority. In this narrative review, we explore preventive opportunities. The available evidence indicates large benefits of improving nutrition and lifestyle during early life, such as promoting breast-feeding and improving the quality of infant and early childhood feeding. Promoting healthy eating patterns and limiting sugar-containing beverage consumption from early childhood onwards are of great benefit. Regular physical activity and limited sedentary lifestyle and screen time alone have limited effects but are valuable elements in effective multicomponent strategies. The home environment is important, particularly for young children, and can be improved by educating and empowering families. School- and community-based interventions can be effective, such as installing water fountains, improving cafeteria menus, and facilitating regular physical activity. Reducing obesogenic risk factors through societal standards is essential for effective prevention and limiting socioeconomic disparity; these may comprise food, drink, and physical activity standards for day cares and schools, general food quality standards, front-of-pack food labeling, taxation of unhealthy foods, restriction of food advertisements to children, and others. Effective prevention of childhood obesity is not achieved by single interventions but by integrated multicomponent approaches involving multiple stakeholders that address children, families, and societal standards. Pediatricians and their organizations should be proactive in supporting and empowering families to support their children's health, and in promoting societal measures that protect children.

Key Words: children, nutrition, obesity prevention, physical activity, public health policy

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What is known?

- Childhood obesity prevalence markedly increased over the last four decades and induces a very high personal, societal and economic burden.
- Since effects of available obesity treatments are less than satisfactory, prevention is of high priority.

What is new?

- Effective prevention of childhood obesity requires an integrated multicomponent approach addressing individual behaviour and diet, family habits, educational institutions, and societal standards.
- Preventive effects are largest in early life, with marked risk reduction through improved infant and young child feeding.
- Promoting the health of disadvantaged children, both in low- and low-medium income countries and in disadvanted groups in affluent countries, requires particular attention.
- Paediatricians and their organisations should actively support and empower families and promoting societal measures to protect the health of children.

Childhood obesity induces very high personal, societal, and economic burden throughout the world. Childhood obesity coexists together with micronutrient deficiencies and with stunting in individuals, families, and populations, which is commonly referred to as double-burden of malnutrition (1,2). During the last 4 decades the worldwide prevalence of childhood obesity has increased more than 8-fold among 5- to 19-year olds, and it continues to rise on a global basis (1). Although the increase of mean body mass index (BMI) has flattened in a number of European and other high-income countries as well as the Asia-Pacific region, obesity prevalence has continued to increase since 2000 in most countries of the Organization for Economic Co-operation and Development) and has accelerated in east and south Asia for both sexes, and southeast Asia for boys (1,2). It is estimated that in 2016, 50 million girls aged 5 to 19 years and 74 million boys worldwide will be obese, with serve adverse consequences for the wellbeing of individuals, for associated costs and for society (1). Overweight and

obesity in childhood are serious threats for health and well-bring due to increased risks for metabolic disorders, insulin resistance and diabetes, cardiovascular diseases, nonalcoholic steatohepatitis, some forms of cancer, musculoskeletal, and psychological disorders and markedly increased mortality (3). The World Health Organization concluded that obesity currently is the fifth leading cause of global deaths and responsible for 44% of the burden of diabetes mellitus, 23% of ischemic heart disease, and 7% to 41% of certain cancers, with a large impact on health care costs, loss of productivity, and the global economy (4). There are indications for marked inter-individual variations of the adverse health impact of similar BMI elevations, which may be due to variation in genotype and/or other variables modifying risk. Better understanding of these influencing co-variables might lead to more targeted preventive approaches in the future. Changes in socioeconomic disparity occurred over time, as documented, for example, in the United Kingdom: children and adolescents from lower socioeconomic groups had lower body weight when born until 1970, whereas among those born later a much higher obesity risk emerged and widened over time (5). These substantial changes indicate the impact of societal changes on child and adolescent obesity and the insufficiency of established policies in protecting the health of socioeconomically disadvantaged children.

Unfortunately, our ability to effectively treat childhood obesity is less than satisfactory, and treatment tends to be costly (6–8). Therefore, the development, evaluation, and implementation of cost-effective prevention strategies are of high priority (9). The need for childhood obesity prevention was proposed already many decades ago even though little information on possible effects was available at that time (10). More recently, refined prevention strategies have been developed and evaluated. A current Cochrane review including 153 randomized controlled trials evaluating obesity prevention strategies in children, mostly from high-income countries, concluded that particularly interventions addressing both diet and physical activity can reduce the risk of obesity, but the mean effect sizes are small and not satisfactory (6). Of interest, the observed effect sizes were greater in young children aged 0 to 5 years than in older children, indicating a potentially larger preventive potential at early ages. Studies on long-term effects on body weight and later health benefits are, however, lacking.

The aim of this position paper of the global Federation of International Societies of International Societies of Pediatric Gastroenterology, Hepatology and Nutrition (FISPGHAN) is to highlight applicable opportunities and priorities for preventing childhood obesity, building on preceding comments of FISPGHAN expert teams on this topic (11–13) and the World Health Organization report on ending childhood obesity (4).

DEVELOPMENT OF THIS POSITION PAPER

The council of FISPGHAN identified the topic of childhood obesity prevention as a global priority issue to be addressed by an expert team, with the goal to describe feasible actions that may contribute to reducing obesity risk. The FISPGHAN member societies nominated experts in the field. The FISPGHAN council selected and appointed members of the expert team and a chair. The team worked together using phone conferences and digital communication. The subtopics included in this manuscript were chosen through a consensus of the experts involved. Each co-author drafted the first version of 1 section in the format of a narrative review, based on an electronic literature search performed by the respective author. These first drafts were then jointly revised by all authors, additional considerations and references were added, and these were combined to a final manuscript that was reviewed and approved by all authors. This manuscript was reviewed by the FISPGHAN council and approved with some modifications as a FISPGHAN position paper.

EARLY LIFE FACTORS MODULATE LIFELONG OBESITY RISK

During periods of developmental plasticity in early life, environmental and nutritional cues can metabolically program long-term body size and body composition, and the risk of obesity, adiposity, and associated noncommunicable diseases (NCDs) (14–16). The potential of early interventions for life-long promotion of health and prevention of NCDs is of considerable interest in view of very high and rising global burden of NCDs (17–21). Prenatal lifestyle and nutrition choices provide an opportunity for attenuating the obesity risk of the offspring (15). Maternal BMI at the time of conception is a particularly strong predictor of offspring obesity, whereas weight gain during pregnancy has little effect (22). Therefore, health care providers should encourage women who wish to and may get pregnant to approach normal body weight before conception (15).

Infant feeding and early weight gain trajectories can markedly modulate long-term obesity risk (23,24). In a first large study on the effects of breast-feeding, obesity prevalence at early school age among 9357 children was shown to be much higher in children who were never breast-fed than in those who had been breast-fed, with an inverse dose-response relation between the duration of breast-feeding and later obesity prevalence (25). After adjusting for potential confounding, breast-feeding remained a significant protective factor against later overweight (odds ratio [OR] 0.79, 0.68–0.93) and obesity (OR 0.75, 95% confidence interval [CI] 0.57–0.98). The protective effect of breast-feeding

on later obesity has been replicated in numerous other studies summarized in several meta-analyses showing that breast-feeding is associated with a modest but consistent risk reduction for later obesity by 22% (26), 15% (27), 12% (28), and 22% (29), respectively. The impact of breast-feeding on later obesity, however, continues to be debated, because the data are based on observational studies with a considerable risk of residual confounding, even after adjusting for measurable influencing factors. A secondary analysis of a cluster-randomized trial designed to test the effectiveness of the 10 steps for promoting breast-feeding in obstetrical hospital settings in Belarus, breast-feeding duration, and the duration of exclusive breast-feeding did not reduce obesity risk in school age and adolescence (30,31). Of importance, this study did not compare breast- and formula-fed infants but only explored modest differences in breast-feeding duration, with an inadequate statistical power to detect effects on later overweight (statistical power <10%) (32). Although randomization of infants to breast- and formula feeding cannot be performed, studies on underlying mechanisms for the obesity preventive effect of breast-feeding may underpin the arguments for a causal preventive effect of breast-feeding (33).

One mechanism appears to be the attenuating effect of breast-feeding on high rates of weight gain, when compared to feeding conventional bottle milk (34,35). Rapid weight gain in infancy and the second year of life is consistently associated with increased adjusted odds for later obesity (36,37). The analysis of combined data of 6708 children from 11 high-income countries showed that breast-feeding for at least 3 months is associated with a significantly lower likelihood of rapid weight gain and of an elevated BMI until school age, as well as of high BMI, skinfold thickness, and fat mass up to the age of 20 years (38). Given that a lack or short duration of full breast-feeding is associated with rapid early weight gain and increased long-term obesity risk in adulthood, protection, promotion, and support of breast-feeding remains a very important priority for pediatricians and other health care professionals.

Weight gain depends on dietary energy supply, and avoiding overfeeding and an excessive energy intake contributed to preventing high rates of weight gain. An additional modulating factor is the macronutrient composition of infant feeds. Compared to human milk, conventional infant formulae traditionally have provided a much higher protein supply (39,40). Randomized clinical trial evidence demonstrates that infant feeding with formula with a reduced protein supply, more similar to breast milk, normalizes weight gain in early childhood, and it also markedly reduces the adjusted odds for obesity at early school age by as much as 2.6-fold (95% CI 1.33, 5.10), compared to conventional formula with a high protein content (41,42). This strategy also significantly reduced body fatness at school age (43). In a small study, Putet et al (44) randomized 154 infants to formula feeding with a smaller difference in protein intake for only the first 4 months of life. At several time points during the first 60 months children receiving the lower protein intake during the first 4 months showed lower body weight, length, and head circumference but no differences were detected for body composition and obesity prevalence with the limited statistical power of this study. Another trial that randomized healthy 1-year-old children to standard cows' milk or a reduced protein milk for the second year of life showed that a lower protein intake reduced body fatness at the age of 2 years (45). In their systematic review on interventions to reduce childhood obesity risk during the first 1000 days of life, Blake-Lamb et al (46) concluded that protein-enriched formula increase childhood obesity risk.

We conclude that improved infant feeding strategies can have a greater impact than any other obesity prevention strategy evaluated in children. Therefore, avoiding excessive protein intakes in infancy through effective promotion of breast-feeding, use of infant formula with lower protein contents, and avoidance of providing unmodified cows' milk as a drink in the first year of life has been recommended but requires further evaluation (15,33,47). The effects of limiting protein intake in early life should be further explored and also include studies in populations in low- and low-medium–income countries.

The effects of complementary feeding on later obesity have been less well studied. Although timing of introducing solids between 4 and 6 months or after 6 months does not seem to affect growth and later obesity risk, introduction of solids before 4 months of age increased the risk, particularly in formula-fed children (48). Complementary feeding patterns with high intakes of sugar and of animal protein were associated with increased risk of obesity at school age, but the impact of the quality of complementary food on short-term growth and later obesity risk should be elucidated further.

A recent systematic review identified 6 randomized trials with multicomponent interventions in infancy targeting promotion of breast-feeding (4 trials), responsive infant feeding (2), and promotion of healthy diets that reported BMI reductions at the end of the intervention, although the 2 trials with follow-up to toddler age did not find a persistent significant effect (49).

Together, the available data demonstrate the large potential of improving nutrition and lifestyle in early life for risk reduction of later obesity, which should consider the whole period of preconception, pregnancy, infancy, and early childhood as a window of opportunity.

PROMOTING HEALTHY EATING AND DRINKING IN CHILDHOOD

After infancy, no single dietary nutrient alone has been consistently associated with the development of overweight and obesity; rather dietary habits and the choice of portion sizes and dietary patterns appear to be predictive (50,51). For example, preventive effects have been associated with a Mediterranean diet pattern (52). The Mediterranean diet is rich in plant-based foods with low energy density and dietary fiber, such as cereals, fruits, vegetables, legumes, tree nuts, seeds, and olives, along with high to moderate intakes of fish; a moderate consumption of eggs, poultry, and dairy products; a low consumption of red meat; and the use of vegetable oils high in unsaturated fats such as olive oil. The observed decline in adherence to the Mediterranean diet has been associated with an increase in NCDs, also in children (53), whereas increasing adherence to a Mediterranean dietary pattern was associated with a favorable body composition in school-aged children (54) and a favorable BMI change among adolescents (55). The Nordic diet, a similar dietary pattern rich in foods traditionally consumed in Scandinavian countries, including fiber-rich plant-based foods such as rye, apples, berries, cabbage, and root vegetables as well as fish (56), was proposed to also facilitate achieving a normal body weight and health, but further studies are needed in childhood.

Risk increasing dietary habits associated with excessive childhood weight gain that predicts an increased risk of subsequent overweight and obesity (33,38,57) are characterized by poor diet quality; high intakes of processed and fast foods, unhealthy snacks, and sugar-sweetened beverages; high total energy density; high intakes of saturated fats, salt, and sugar, and a low fiber intake (51,54). A current Cochrane review of randomized intervention trials on obesity prevention in children concluded that combined interventions addressing both diet and physical activity have a preventive benefit in children aged 0 to 5 years; that dietary interventions may be beneficial in young children aged 0 to 5 years, whether there is only weaker evidence for benefit of dietary intervention (6).

High intakes of sugar-containing beverages in children and adolescents have been consistently linked to an increased

overweight and obesity risk, and randomized intervention trials documented marked benefits of strategies that reduce their consumption (58). Preschool- and school-based programs aiming at changing eating and drinking behavior may be beneficial (59). Governments and health care service providers should provide consistent information on the benefits of replacing sugar-containing beverages by water and other nonsweetened beverages, to ban advertising of such products to children and their distribution in preschools and schools, and to consider taxation, because this may contribute to reducing their consumption among children (58). In addition, interventions targeting the food environment around schools are promising (60). Supporting health promoting dietary patterns and habits should begin very early in life because unhealthy dietary patterns established in infancy and early childhood tend to persist to older age and may thus adversely affect long-term health (61).

PROMOTING REGULAR PHYSICAL ACTIVITY IN CHILDREN AND ADOLESCENTS, WHILE REDUCING SCREEN TIME AND SEDENTARY LIFESTYLE

Physical activity is the main modifiable component of human total energy expenditure. Moderate and vigorous physical activities appear to be the most relevant components. In cross-sectional and prospective analyses in children and adolescents, moderate to vigorous physical activity (MVPA) was associated with lower adiposity (62,63). Causality may, however, be bidirectional because intervention studies do not show good efficacy regarding indicators of increased physical activity. In children aged 0 to 5 years, a meta-analysis including 21 studies showed only a very small mean difference for MVPA between intervention and control groups of 2.88 (95% CI = 1.54, 4.23) minutes/day (64). In children aged 5 to 12 years, a meta-analysis of 19 family-based interventions also showed only a small effect in favor of the intervention group (standardized mean difference: 0.41; 95% CI 0.15−0.67) (65). In adolescents older than 10 years, randomized controlled trials conducted in the school setting showed pooled effect sizes that were small and nonsignificant for both total physical activity and moderate-to-vigorous physical activity (66). Recently, active video games have been proposed as a strategy to increase physical activity; however, there is currently insufficient evidence to recommend their use within schools (67). The promotion of school environments that facilitate and encourage regular physical activity appears as a promising strategy for lowering the risk of obesity (68).

With regard to sedentary behaviors, a recent long-term study showed that television viewing of at least 4 hours/day versus no television at the age of 3 to 5 years was associated with an increased later risk of overweight and obesity (69). The ORs were 1.61 (95% CI: 1.20, 2.17) at age 5 years, 1.46 (95% CI: 1.14, 1.86) at age 10 years, 1.31 (95% CI: 1.00, 1.70) at age 18 years, and 1.32 (95% CI: 1.10, 1.59) in adulthood (69). Interventions aiming at reducing sedentary behaviors appear to be effective, with a meta-analysis of 34 randomized intervention trials showing a pooled reduction from baseline of −20.44 min/day (95% CI: −30.69; −10.20) (70). A systematic review of interventions targeting sedentary behaviors in children showed a significant but small reduction of BMI and BMI z score; however, there was an encouraging greater effect in children with overweight or obesity and with multicomponent interventions (targeting both sedentary and other behaviors) (69).

Eating while watching TV was also positively associated with overweight (OR = 1.28; 95% CI: 1.17, 1.39) (71). Reallocating 30 minutes of sedentary time into 30 minutes of MVPA was associated with less waist circumference, trunk fat mass, and total body fat mass after 20 months (72). The direction of the causality of the association is, however, not entirely clear, given that a high fat mass index in children at baseline was associated with lower physical activity and higher sedentary time after 200 days, but not vice versa, even in normal-weight children (73).

Although promotion of physical activity by itself is not sufficiently effective for preventing obesity, promoting physical activity and reduced sedentary behaviors may be one valuable element in effective multicomponent strategies for childhood obesity prevention (74). Environments at home, at school, and at the community level that facilitate and encourage physical activity, outdoor activity and play, and social interactions should be promoted, whereas using screen devices at meal times and in bedrooms should be avoided (75).

STRATEGIES FOR EDUCATION, MOTIVATION, AND EMPOWERMENT OF FAMILIES

The home environment greatly influences young children. Parents may serve as positive role models to their children regarding healthy nutrition, physical activity, and emotional and social health. Interventions targeting parenting style and parental child feeding practices during early childhood may positively affect children's eating practices. Parenting style is defined as a ''*constellation of attitudes toward the child that are communicated to the child and create an emotional climate in which the parent's behaviors are expressed*'' (76). Authoritative parenting is characterized by a parent's control over their child's behaviors while also displaying warmth and responsiveness; authoritarian parenting is characterized by high control and low levels of warmth and responsiveness. The authoritative style is favored to provide healthier trajectories including lower risk of obesity, higher physical activity, and lower sedentary behaviors (77,78). Adverse parental child feeding practices include restriction, pressure to eat, and monitoring. Increased awareness and avoidance of these practices is crucial, particularly with regard to food restriction: it appears to have the unintended consequence of increasing rather than decreasing the child's preference for and intake of restricted items (79). Restrictive behaviors decreased the child's self-control over their eating behaviors and increased eating in the absence of hunger. Children who are more restricted tend to have a higher BMI (80). An example of a successful program is the Feeding Dynamic Intervention targeting caregivers of 2 to 5 year old children, which may curb parental restrictiveness and pressuring in their feeding practices (81).

Children of all age groups appear to have less obesogenic behaviors when living in households that enforce family rules, particularly those that limit duration of screen time (television, computer and mobile device use, and video games). The benefits appear to be related to promoting self-regulation and are manifested by reducing consumption of fast foods and soft drinks, while increasing consumption of fruits and vegetables and vigorous activity (82).

CHILDCARE, SCHOOL, AND PRIMARY CARE−BASED OBESITY PREVENTION PROGRAMS IN CHILDREN

Because obesity in adults is difficult to treat through changes in the lifestyle, prevention of obesity in early childhood is a key strategy for obesity prevention. Two crucial aspects of obesity prevention in children are early childhood and school-based interventions (83). Targets of childcare-based programs should include improving the nutritional quality of food provided such as fruits and vegetable, increasing intake of water and reducing intake of sugar-sweetened beverages, promoting physical activity, and reducing screen time. Great care must be taken to avoid potential harm, and

particularly stigmatization and blame and shame of overweight and obese children needs to be avoided. There is emerging evidence from high-income countries showing benefits of obesity prevention programs targeting children attending early childcare settings, such as preschool or kindergartens (59,84,85). For example, an Australian obesity prevention project promoting healthy eating and active play among children younger than 5 years showed that children in the intervention group had a significantly lower intake of packaged snacks, fruit juice, and cordial and a higher vegetable consumption as compared to the control group (86). A behavioral intervention program in kindergarten settings in Germany achieved a lasting increase of the consumption of vegetables, fruits, and water instead of sugary drinks in the family home, as compared to a control group (59).

Education settings (preschool, primary, and secondary schools) are popular settings for intervention as most children attend school and many schools have existing infrastructure to support the implementation of interventions (87). Similar to child care–based program, school-based intervention program should also focus on cultivating healthy eating habits and promoting physical activity at school. In addition, it is important to engage the involvement of both parents and teachers. Parental involvement is important in achieving sustained behavioral change in preschool-aged children. Evidence shows that successful interventions have multiple components and are adapted to the local context. A recent narrative review of 14 randomized trials that were school (n = 11) or community (3) based concluded that benefits on BMI or body composition can be achieved, even though the effect sizes tend to be modest, and there is a lack of information on long-term effects. Of importance, a recent health economic analysis suggested cost-effectiveness even of relatively small population level reductions in BMI if intervention effects can be maintained. An mean reduction in BMI *z* score by −0.13 in children aged 2 to 5 years, observed in a scoping review of systematic reviews, would result in 36,496 health-adjusted life years saved and health care cost savings of approximately 301 million Australian dollar if modeled over the lifetime (88). Similarly, for the German population an infancy intervention reducing BMI *z* score by −0.20 at the age of 2 years was calculated to save 750 € of health-related costs per person over a lifetime, discounted at 3% (89). If this intervention reaches only about 20% of the German infant population, the resulting cost savings are calculated as 3.5 billion € (89).

Benefits of approaches changing the child's environment, such as installation of water fountains to reduce the consumption of sugar-containing drinks and changes of cafeteria menus have been reported, potentially in combination with health education lessons, although these were rated less sustainable (90). Culturally and environmentally appropriate programs are more likely to be implemented and sustained (91). More attention should be devoted to developing and evaluating setting-based interventions addressing obesity prevention in low- and low-medium–income countries. It is also important to realize that sustained efforts are necessary to make community-based interventions successful. Often, programs lasting only for 1 to 2 years may result in a change in eating behavior but not in effects on BMI or BMI *z* score (83).

COMMUNITY-BASED STRATEGIES

Community organizations have arisen to provide resources for obesity prevention. Given that no one organization is likely to have sufficient expertise in health education, environmental change, institutional decision making, and policy change, community coalitions—comprising representatives of diverse communities of geography, identity, and practice—may play a key role in applying a social-ecological approach to obesity prevention. These

organizations pursue 4 major categories of action: increase healthy options, reduce deterrents to healthy behaviors, build community capacity, and improve social and economic resources for individuals and families. A few selected examples among the numerous initiatives include the Be Active Eat Well program in Australia, the Consortium to Lower Obesity in Chicago Children (CLOCC), and Fighting Obesity Reaching Healthy Weight Among Residents of DuPage (FORWARD DuPage) in the USA.

The Australian Be Active Eat Well program was a multi-faceted community capacity-building program promoting healthy eating and physical activity for children aged 4 to 12 years in the town of Colac. Anthropometric and demographic data were collected in 1001 children in 4 preschools and 6 primary schools at baseline and 3 years later, with a follow-up rate of 84% (92). The comparison sample was a stratified random selection of preschools and primary schools from other parts of the same Australian state (n = 1183). Children in Colac children had significantly lower increases in body weight (mean: −0.92 kg) and BMI *z* score (−0.11) than comparison children, adjusted for baseline variables. Of importance, in Colac the anthropometric changes were not related to 4 indicators of socioeconomic status (SES), whereas in the comparison group 19 of 20 such analyses showed significantly greater gains in anthropometry in children from lower SES families. These observations point to the potential of community-based approaches to reduce obesity risk increasing health inequalities.

The American CLOCC program of Ann and Robert H Lurie Children's Hospital of Chicago comprises more than 3000 individuals representing over 1200 organizations working on childhood obesity prevention across Illinois and throughout the country. Working together, CLOCC staff and partners have implemented numerous programs, projects, and policy initiatives to increase individual and family knowledge about healthy lifestyles; strengthen organizational and institutional practices to support healthy eating and physical activity; and improve environments so that healthy food and physical activity are widely available where people, and especially children, live, work, learn, and play (93).

The FORWARD DuPage mission is ''to lead DuPage County, through a broad-based community coalition, in promoting effective and sustainable policy, systems, and environmental strategies for children and families to achieve a healthy weight.'' The coalition has more than 1400 members and consists of volunteers and professional practitioners. Among FORWARD DuPage's achievements are improved pedestrian and bicyclist transportation networks; healthy, sustainable food systems, expansion of school and community gardens, farmers' markets, and changes promoting health in early childcare facilities, schools, and businesses. FORWARD is currently establishing specific strategies for county-wide schools, worksites, and early childhood settings through education, tools, resources, and expertise (94).

Little information is available on community-based prevention strategies in low- and low-medium–income countries (95), which should be developed further.

SETTING SOCIETAL STANDARDS FOR EFFECTIVE OBESITY PREVENTION

Research has shown that adherence of patients and families to obesity prevention guidelines is extremely limited and highly dependent upon socioeconomic factors (96,97). In addition, early interventions aimed at promoting a healthy lifestyle have only limited long-term impact on obesity risk factors, such as dietary intake, physical activity, and screen time (98). Sustainability of successful obesity prevention strategies requires funding, community engagement, and leadership, among other factors (99).

Therefore, societal standards need to be set to support families in their efforts to prevent obesity and to reduce socioeconomic disparity of childhood obesity risk.

Societal aspects of obesity prevention include promotion of a healthy lifestyle through implementation of food quality standards (eg, elimination of sugar-sweetened beverages and unhealthy foods, and mandatory involvement in physical activities at day cares and schools) and development of an infrastructure that encourages healthy dietary intake and physical activity (100). The latter refers to the availability of and access to healthy but noncostly foods (eg, water, fruits, vegetables), as well as safe spaces where children can be active (eg, parks, community gyms/pools, etc.). Provision of education around healthy lifestyle choices at school and in the community, as well as elimination of barriers to expressing healthy preferences such as advertisements promoting unhealthy habits, are additional examples of measures that can be taken at the societal level. The literature on the efficacy of programs aimed at addressing some of the aforementioned risk factors has generated conflicting results. A meta-analysis of 115 predominantly North American studies showed that school-based interventions focusing on physical activity (alone or in combination with dietary changes) were effective in preventing obesity in children 2 to 18 years of age (95). In contrast, a large study from multiple Europe countries showed that combined interventions aimed at facilitating a healthy lifestyle at school, home, and the community had little impact on preventing childhood obesity (101). Socioeconomic and cultural differences may have contributed to the discrepant results of these studies.

Television (TV) advertising can influence food preferences and consumption, particularly in children from lower socioeconomic groups that tend to spend more spent watching TV. Brown et al (102) evaluated the effects of legislation to restrict TV advertising for foods and beverages high in fat, sugar and salt until 9:30 pm for the Australian population. The authors concluded that restricting TV advertising is likely to be cost saving. The most disadvantaged socioeconomic group reached 1.4 times higher total cost savings and 1.5 times higher health benefits, with savings of 17,512 health adjusted life years and 126.3 million Australian dollars, compared to 11,321 HALYs and 90.9 million Australian dollars saved in the least disadvantaged socioeconomic group.

Societies can also motivate consumers to make healthier dietary choices by leveraging on the impact of cost on purchasing behaviors. Generally, healthy foods tend to be more expensive, may require more time to prepare, and have a shorter shelf life as processed obesogenic foods. In today's society and particularly in the context of socioeconomic deprivation, these factors often determine consumers' choices, even if their original intent was to be healthy (103). This knowledge, however, can and has been leveraged to benefit consumers. Some countries implemented food taxes to motivate the public to limit the consumption of foods that exert negative health outcomes, such as sugar sweetened beverages or foods high in saturated fats or salt (104,105). This approach is effective in changing purchasing behaviors, particularly of subjects who are young and of a lower SES (103). In Mexico, a country in transition, the introduction of a 1-peso-per-liter tax to sugar sweetened beverages achieved sizable and sustained reductions in obesity and diabetes with a calculated average BMI reduction of $0.15 \, kg/m^2$ or 2.54% reduction in obesity prevalence. The largest effects occurred among people in the lowest level of SES and in young adults (106). Interestingly, informing consumers about price increases further enhances the effectiveness of this intervention (107). Taxation of not only unhealthy food items, but also unhealthy portion sizes, has the potential to rapidly alter consumer behaviors in a beneficial manner.

Beyond cost, food labeling can also affect purchasing behaviors (103). Research on the topic has revealed that simple, clear, color-coded, and easy to interpret front-of-pack food labeling is effective in improving selection of healthier choices (108). Of importance, simple color-coded front-of-pack food labels are also effective in population groups with increased risk characterized by low levels of income or education, or high BMI (109). Mandatory labeling of foods can have an additional beneficial impact on those at risk by motivating manufacturers and restaurant chains to produce and sell healthier products (110). Examples from across the globe have underscored the impact that food labeling has on improving the quality of the food that is available to consumers (103).

CONCLUSIONS

- Effective prevention of childhood and adolescent obesity cannot be achieved by single interventions but requires an integrated multicomponent approach involving multiple stakeholders that empowers individual children and their families and reduces obesogenic risk factors in their environment through societal standards (Fig. 1).
- Increased understanding of developmental early origins of long-term obesity risks provides opportunities for marked risk reduction through improved infant and young child feeding. Promotion and support of breast-feeding are a very important priority for pediatricians and other health care professionals.
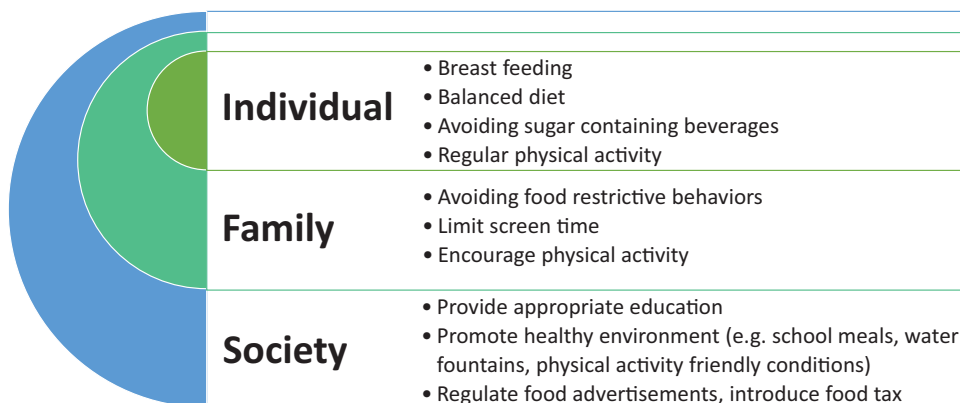
FIGURE 1. Effective prevention of childhood obesity cannot be achieved by single interventions but requires an integrated multicomponent approach involving multiple stakeholders that empowers individual children and their families and reduces obesogenic risk factors in their environment through societal standards.

In addition, infant feeding without excessive protein supply should be promoted.

- Healthy eating habits and food choices and the promotion of drinking water instead of sugar-containing beverages reduce risk and should be promoted from early childhood onwards, given that dietary patterns established in early childhood tend to persist to older ages.
- Regular physical activity and limitation of screen times and sedentary behavior should be promoted.
- Families should be educated and empowered to act as positive role models for their children on healthy eating, physical activity, and health.
- Educational institutions for children from early day care to secondary schools and other settings regularly attended by children (eg, sports facilities) should set and implement standards that proactively promote healthy eating and drinking by education and by creating healthy food environments, including standards for healthy school meals and the elimination of unhealthy snacks and sugar-containing beverages from educational institutions, and that promote regular physical activity and limit sedentary behavior.
- Societal standards that protect the health of children and adolescents should be established, which may include easy to understand color-coded front-of-pack labeling of food products, price incentives for healthy food choices, for example, through taxation of unhealthy foods, banning of advertising unhealthy foods to children, promotion of barrier free opportunities for regular physical activities, and multi-stakeholder collaboration for childhood obesity prevention in communities and other settings.
- Particular attention should be devoted to promoting the health of disadvantaged children, both in low- and low-medium–income countries and in disadvantaged groups in affluent countries
- Pediatricians and their organizations should take an active role in supporting and empowering families to implement steps that support the health of their children, and in promoting societal measures that protect the health of children.

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