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문 경 래

A Comprehensive Review of Obesity Prevention in Children and Adolescents

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With an uncontrollable amount of energy dense food engulfing children's life today, no child is completely protected against being overweight or obese. An inordinate intake of energy dense food and lack of physical activity have resulted in a higher rate of obesity in children. In order to combat the seemingly intractable problem, various preventive measures against childhood obesity have been suggested and are currently in effect. It is imperative to evaluate the methodology and potential impact of published obesity-prevention programs, that focus primarily on home, school, and health care environments. **(Korean J Pediatr Gastroenterol Nutr 2011; 14: 325～333)**

Key Words: Obesity, Children, Adolescents, Prevention

INTRODUCTION

Childhood obesity, a rapidly growing chronic disease caused by an imbalance between energy intake and energy expenditure, is recognized as a serious public health problem worldwide. According to Korean National Growth Chart for Children and Adolescents in 2007[1], the overall prevalence of obesity was 9.7%, 11.3% in boys and 8.0% in girls[2]. Compared to 2003, the obesity rate rose by 1.7 times and the overweight/obesity rate by 1.5 times. For 2 to 4 year olds, the age-specific prevalence did not increase by much, whereas it almost doubled for 7 to 12, 13 to 15, and 16 to 18-year-olds. Nadar et al.[3] reported that 60% of children who were overweight during the preschool period and 80% of children who were overweight during the early elementary school period were overweight at age 12. Additionally, Kim et al.[4] found that 4.5% of normal weight children at age 7 became obese at age 12, whereas 53.6% of obese 7-year-olds continued to be obese at age 12. Moreover, Cho et al.[5] reported that 12.7% of normal weight boys and 9.8% of normal weight

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girls at age 7 became obese at age 17. As well as earlier weight problems persisting into the later years of childhood, newer weight issues emerge from the development of obesity and overweight among children whose weight used to fall within the normal weight range. Consequently, there have been numerous childhood obesity prevention programs targeting children with high obesity risks. Given the magnitude and the complexity of the issue, however, there is no consensus as to the most effective method.

This review is a comprehensive evaluation of recent publications on prevention of childhood obesity. It also contains recommendations of preventive strategies based on the evaluation.

EARLY DETERMINANTS OF CHILDHOOD OBESITY

Contrary to a commonly held notion regarding the link between birth weight and obesity in later years that higher birth weight leads to obesity, there has been a recent argument that intrauterine growth restriction could be followed by obesity in children[6]. Metabolic programming, also known as the "Barker Hypothesis," states that a fetus deprived of adequate nutrient supply in the womb will permanently be programmed to be more prone to diseases after birth[7]. Jackson et al.[8] strongly suggested the role of different types of nutrients in the stimulation of hypothalamic-pituitary-adrenal axis (HPA) between the mother and the fetus. They suggested that the amount of nutrients, especially protein, taken during pregnancy may negatively affect future metabolism. Moreover, a study displayed that children whose mothers had bariatric surgery post-pregnancy had a higher probability of developing obesity than those with mothers who went through the same surgery pre-pregnancy[9]. The result has placed an obese in-utero environment as one of the earliest determinants of childhood obesity. There is also research suggesting that excessive protein intake at age 2 is related to body fat gain at age 8[10]. Another study reports that eating high protein foods at an early age can increase the risk of obesity in later childhood. Agostoni et al.[11] demonstrated that having a high-protein diet, in which protein comprises 15～16% of total caloric intake, was related to an earlier adiposity rebound. The adiposity rebound refers to the period between age 5 and 6 at which the body mass index (BMI) undergoes a rapid surge after it hit its lowest. Early adiposity rebound is known to raise the risk of adult obesity.

BIRTH WEIGHT AND OBESITY RELATED RISKS

According to a longitudinal study, the mortality rate of coronary artery disease was twice as high in the lower birth weight group as it was in the higher birth weight group[12]. There also was a negative correlation between birth weight and adult blood pressure. The prevalence of the metabolic syndrome was 18 times higher in the lowest birth weight group than the highest birth weight group[13]. In addition, the prevalence of diabetes in the low ponderal index group at birth was three times higher than the rest[14]. The mortality rate of coronary artery disease quintupled among people who had low ponderal indexes at birth but became overweight after experiencing the "catch-up growth"[15]. A 1 kg difference in birth weight seemed to be associated with a difference of 3.5 mmHg in Systolic blood pressure[16]. Prader et al.[17] reported that small for gestational age babies, in contrast to those with normal birth weight, showed rapid growth in height and weight for 2 years after birth. They therefore concluded that children who experience catch-up growth have a higher risk of developing obesity during the pre-school period. Nevertheless, even though genetic characteristics manage the limits of metabolic abilities, environmental aspects are the ultimate determinants for obesity and metabolic syndromes.

PREVENTION OF CHILDHOOD OBESITY

A majority of publications suggests that breast feeding

has a negative correlation with the development of obesity. von Kries et al.[18] reported that the longer the breastfeeding went on, the more the prevalence of later obesity dropped. According to Bergmann et al.[19], a group of 6-year-old children who had been breastfed for more than 3 months showed decreased occurrence of overweight and obesity. Moreover, Hediger et al.[20] reported that extended breastfeeding periods were related to the reduction in obesity and overweight prevalence among groups with equal socioeconomic status. Similarly, a recent study comparing sibling pairs who were breastfed for different durations successfully controlled potential cofounders and identified breastfeeding as an independent factor contributing to the prevention of obesity in later life; siblings who were breastfed longer had less body fat at ages 9～14[21]. Long-chain polyunsaturated fatty acids (LCPUFAs) in breast milk are known to play an essential role in preventing obesity. LCPUFAs enhance the function of insulin and the number of insulin receptors in bodily tissues. If LCPUFAs become scarce due to the reduction of breastfeeding, insulin levels rise[22]. Increased insulin concentration in blood cause an accumulation of fat and affect the early formation of fat cells, increasing the risk of becoming obesity[23]. Growth factors such as epidermal growth factor (ECF) and tumor necrosis factor (TCF) suppress the differentiation of adipocytes[24]. While breastfed babies self-regulate the amount of milk they consume, formula-fed babies' milk consumption is controlled by their parents, making them more prone to obesity due to the excessive intake of nutrition. In addition, researchers predict that breastfed babies tend to adapt to new types of food faster because of the flavor changes in milk they had experienced in regards to their mothers' diet. They also consume more fruits and vegetables, contributing to the lower prevalence of obesity among children who were breastfed as infants[25]. Therefore, mothers are strongly recommended to commit to breastfeeding their infants for a significant amount of period. An average of six months of exclusive breastfeeding followed by a year or more of combining breastfeeding and other foods is both ideal and realistic.

Recently, much research was devoted in discovering whether obesity is related to sleep. Nixon et al. reported that 7-year-old children who had less than 9 hours of sleep each night experienced an average of 3.34% body fat increase[26]. Wing et al.[27] noticed that children who slept for less than 8 hours per day, in contrast to those who regularly had an average of 10 hours of sleep per day, were exposed to the greatest risk of obesity. Most research is consistent in demonstrating longer sleep having a positive association with lower risk of obesity, decreased BMI, and lower body fat. Moreover, children and adolescents who had less sleep at night experienced higher cravings for food, more frequently reached for energy-dense food, and greater preference toward sedentary behaviors[28,29]. While research displays consistent findings of reduced obesity risk being associated with sleep duration, establishing a clear cause and effect relationship between the two is prohibited due to the nature of cross-sectional methods most studies used. Based on the aforementioned evidence, however, it seems plausible to recommend longer sleep duration to Korean children and adolescents since their sleep hours are noticeably short. When followed by close monitoring from health professionals for a significant amount of time, an innovative and simply applicable strategy for childhood obesity may surface.

Parental influences are crucial in developing children's attitude toward food and their eating habits. The way certain foods are introduced to little children has an immense influence on developing their food preferences. It has been examined that kindergarteners favor foods that were given to them as a reward. Rewarding children when they eat nutritionally rich foods increase their consumption in the beginning, but their preferences for the particular foods start to decline as the reward disappears. Therefore, rewarding children for the purpose of increasing the consumption of certain foods may diminish their preference for foods that benefit their health. Also, a report concluded that encouraging children to eat foods that are good for the heart could prevent the

onset of obesity among 4- to 7-year-old children[30].

Enforcing the nutrition facts labels on food products and adjusting portions through single-serve packaging are practical strategies that reduce overall calorie intake, hence potentially promoting a reduction in the prevalence of childhood obesity[31]. Even though Korea has adopted the mandatory inclusion nutrition facts labels for most packaged products, their portions rarely meet the serving size guidelines. Moreover, snacks are often produced in forms of "variety pack" and "super-size", luring customers with cheap price. Lucrative for the snack companies only, bigger portion sizes that exceed the recommended dietary allowance are significantly responsible for the increased prevalence of obesity worldwide. Adults and children obtain 30% and 25% more calories respectively when eating foods with bigger portions[32]. Most packaged snacks exceed the recommended serving size by approximately 2.5 times, as well as cholesterol contents that are 2.4 times higher than normal[33]. Given the positive association portion control has on the reduction of obesity prevalence, companies should practice stricter adherence to the portion control guidelines and recommendations.

The majority of food that children consume must solely be prepared by parents, so children can decide what to eat based on what is offered to them. Families should not frequently eat out at restaurants or get take-outs as most restaurant foods are largely portioned and contain processed ingredients that are high in fat and sugar. Research shows that fats generate low satiety responses among people, causing them to feel they are not "full" and eventually leading to overeating[34]. Reducing the consumption of fat, fast food, and sweetened drinks is necessary as well as the increased intake of fruits and vegetables.

Longer time spent in front of TVs and computer screens is widely understood as one of the environmental determinants of childhood obesity. The risk of higher BMI or weight gain within 1～2 years is massive for children who spend 1～2 hours to watch TV or play video games every day[35]. An hour added to daily TV watching is associated with 1-2% rise in the prevalence of obesity, and the risk of weight gain increases by 40～50% when more than 35 hours per week are spent in front of TV[36]. Gortmaker et al.[37] reported that the prevalence increased by 4.6 times for children who watch TV for 5 hours or more per day in comparison to those who watch it for less than 2 hours per day. TV viewing can hence be one of the important factors that trigger obesity and cutting down on TV watching must be included in building effective prevention strategies for obesity. In Korea, however, there is a lot of research declaring that there is no correlation between television watching and the prevalence of childhood obesity[38]. This may have resulted from Korean parents' restrictive mediation of their children's TV watching in addition to less food being consumed during TV screening time.

Half of the television commercials advertise food products, and 91% of the foods contain inordinate amounts of fat, sugar, and sodium[39]. More than 60% of people buy food products that are newly advertised on TV and other forms of media[40]. This attitude is more common among those who are young because they are oblivious of the true intent of marketing schemes. Overexposure to food marketing is especially dangerous for preschool children as it can influence their food preferences as well as food consumption[41], factors that are associated with high obesity risk when formed improperly. In spite of countries such as Canada and Norway administering stricter regulations on advertisement broadcasting in order to combat the problem, younger children continue to be exposed to mass marketing of unhealthy products because companies refuse to abide by the new regulations[42]. Given the complexity of the issue, it appears that parental control over children's TV screening may be the only working solution for now. As for Korean children, the degree of influence that mass marketing has on food related behaviors seem trivial, since stringent parental restriction over TV has long been existed.

An excessive intake of sugar-sweetened drinks may be accountable for causing childhood obesity[43]. Commercials that air on TV the most during children's peak viewing time periods are soft drink commercials[44]. In addition, an

increased diversity of beverages and their easy accessibility have resulted in an enormous surge of drink consumption. Much researchers have dedicated to demonstrate a correlation between obesity and the consumption amount of soft drink and other sugary drinks[45,46]. For instance, Dubois et al. reported that the risk for being overweight at 4.5 years more than doubled among 2 to 4 year old children who drank sugar-sweetened beverages regularly[47]. These days, unfortunately, the negative effect of sugar-sweetened drinks on children's weight is not limited to soft drinks or other conventional sugary drinks. Emphasizing their "nutritious" ingredients such as antioxidant and vitamins, some newer drinks are disguised as healthy alternatives to soft drinks when in fact they are packed with calories from sugar. While these drinks do have lower calories than most soft drinks, they still contain enough calories solely from sugar- not from the dismal amount of vitamins- to cause weight gain in children when consumed regularly. Given that 0.5 kg of monthly fat weight gain is caused by a daily intake of 120 kcal of extra energy[48] corresponding to an average number of calories contained in a typical 500 mL bottle of these drinks, the adverse effect of the low calorie drinks on childhood obesity prevention should not be overlooked.

By the time children enter kindergarten, their food preferences are established[49]. Providing nutrition education to the entire family is very effective in reducing the risk of childhood obesity. Children whose dietary habits are shaped by parents that emphasize careful consumption of fat carry less risk of becoming obese at age 3 than the children whose parents do not stress the importance of restrictive fat intake[50]. Also, as children eat fruits and vegetables regularly on a daily basis, they can experience various types of food and get accustomed to having well-balanced meals. Such practice can correct children's dietary habits heavily consisted of high calorie fast foods and consequently help preventing obesity. Nevertheless, severe caloric restriction for children who are still growing is dangerous and should not be permitted. Childhood obesity prevention programs must share the long-term goal of children achieving regular growth and development through the sufficient and balanced nutritional intake.

Increasing the amount of physical activity can be effective for the prevention of childhood obesity. Building safe outdoor facilities is crucial for promoting physical activity among obese children and children who are at high risk for obesity. Forcing children to participate in a systematic exercise program, however, can have an adverse influence on their activity patterns. Children who are under 9 get easily distracted and have a hard time concentrating on a single activity for a long period of time. Fun and enjoyable exercise for younger children should therefore be encouraged. Since the primary goal of increased physical activities is a lifelong maintenance of energy balance, reducing the time spent in doing sedentary activities is more important than designating a short period of time for intense exercise. On the other hand, long-term exercise training is metabolically beneficial to overweight children ages 9～12[51]. It has a positive association with increased fat oxidation, stimulated glycometabolism, and increased number of mitochondria, as well as active sympathetic nervous system and lipoprotein lipase[52,53].

Improving the environment of local communities is also essential for the prevention of childhood obesity. One example of successful community-centered approach is a 12-week obesity prevention program administered in the United State[54]. The program consisted of regularly holding local community meetings, promoting joint physical activity for children and parents, encouraging low fat diet, opening after-school dance classes, and reducing TV time for all participating families.

The role of schools in preventing childhood obesity is beyond crucial. However, school-based obesity prevention programs are reported to be only moderately effective. They have not been producing as many visible results as other school-based interventions, most notably anti-smoking programs and sex education courses. Nevertheless, school is where children and adolescents spend most of their day and school-based prevention programs should therefore continue to be encouraged.

School-based prevention of childhood and adolescent obesity should aim for students' behavioral changes that may lower the risk of obesity. Schools must consistently conduct courses dedicated to health and fitness education so the students can frequently be reminded of the seriousness of the problem. Rosenbaum et al. reported a significant decrease in BMI and body fat among children ages 13～14 who had been enrolled in a school-based prevention project for 4 months[55]. In addition, schools should modify their lunch menus in order to provide more nutritionally balanced meals for every student. Moreover, healthier snack options should replace energy dense foods that are available for sale during breaks. Students who purchase pre-packaged products at school cafeterias and bending machines consume more than twice the number of calories from fat and sugar compared to those who do not. These interventions regarding children's nutritional intake at school are strongly recommended as they are associated with changes in obesity-related behaviors, such as a significant drop in daily caloric intake and dietary fat consumption[56]. Furthermore, while it is difficult to prevent obesity through conventional physical education courses, incorporating activities that interest and motivate students- competitive sports or dance routines to name a few- into the lesson plan is proven to be very effective. Still, PE teachers should always keep their students not to be overly competitive to avoid unnecessary injuries. In addition, placing longer breaks in between class periods and building more outdoor recreational equipment encourage students to play outside during recess, contributing to the reduction sedentary behaviors. Overall, school-based obesity prevention programs should be designed for students to adopt and maintain lifelong habits of balanced diets and physical activity.

As well as home and school environments, the role of medical professionals is critical for preventing childhood obesity. Pediatricians, gynecologists, psychologists, nutritionists, and other health care professionals should make a collaborative effort to educate the public, trace high-risk groups, and maintain obesity prevention clinics. Obesity education from health care facilities should be obligatory to all parents- especially when they are obese- whose children are up to 6 year olds, regardless of their current weight. Education must begin at the first hospital visit during pregnancy[54], as prenatal environment is associated with the development of obesity in later life. After childbirth, parents who have infants with high risk factors for obesity should strictly adhere to the prevention programs. Since November 2007, the Ministry of Health and Welfare, the National Health Insurance Corporation, and the Korean Pediatric Society have been jointly providing routine medical check-ups for infants. For children who are 30-months to 5-years olds, nutrition education aimed for overweight prevention is included in the check-ups. Preventing and treating childhood and adolescent obesity in clinical settings is proven to be very effective when the process is family-oriented and parent-driven. Goran et al.[57] documented that education targeted toward parents instead of children had yielded in higher weight loss and less cases of giving up in the middle.

Increased awareness of the importance of obesity prevention among health care professionals is associated with the effectiveness of medical interventions. Because children age 7 or more with higher risk of obesity become increasingly more susceptible as they grow[58], appropriate dietary and physical interventions from their pediatricians are necessary. Nevertheless, many physicians tend to overlook the significance of preventive strategies and fail to diagnosis children who are at risk for obesity. Even though regular documentation of BMI for all patients is strongly recommended, BMI tracking is often limited to children who are already overweight or obese[59]. Moreover, many pediatricians disregard the degree of influence they have on their patients. Most children and parents are more than willing to follow healthy lifestyle recommendations from their physicians, especially concerning childhood obesity prevention. However, a recent study demonstrated that less than 50% of children had been informed of and warned against risk factors like sugar-sweetened beverages and sedentary behaviors during their

visits to the doctor's office[60]. It is a common mistake in clinical settings to assume that patients are aware of widely known risk factors and preventive measures- less consumption of energy dense food and more physical activity for instance- of childhood obesity. Although they might be knowledgeable of such information, they are neither going to constantly remind themselves of the potential obesity risks nor practice prevention procedures unless they are directed by their physicians. By recognizing their comprehensive role of advising and supervising, health professionals will bring more in-depth and effective medical interventions for the prevention of childhood and adolescent obesity.

CONCLUSION

The multi-dimensional causes of obesity include genetic factors, an energy imbalance, lack of exercise, and hormonal/metabolic disorders. Family environment also plays a crucial role in the development of obesity. As children with higher obesity risk are likely to develop subclinical metabolic disorders either genetically or behaviorally, prevention process should start from verifying obesity determinants from children early and continue with consistently monitoring them for the development of obesity risks. The active involvement of doctors who frequently encounter overweight children is necessary in obesity prevention as well as home and school environments. Therefore, comprehensive interventions to promote nutritionally balanced diet and increase physical activity are vital in reducing the risks factors predisposing to childhood and adolescent obesity.

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