Type 2 Diabetes: An Emerging Pediatric Disease

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Abstract: Since the early 1990s, clinicians have recognized a rising incidence of Type 2 diabetes in youth and adolescents. The rising incidence of diabetes has been directly correlated with the increasing incidence of obesity in children with BMI ranging from 26-38 kg/m2. This phenomenon has been observed worldwide including parts of Europe and Asia. Lifestyle changes related to behavioral, environmental and social factors have been suggested as contributing to increasing childhood obesity and Type 2 diabetes. Genetics is also thought to be influencing this trend, as parental obesity and a family history of diabetes appears to put children at higher risk for these diseases. The American Diabetes Association has provided strong recommendations regarding treatment of Type 2 diabetes in youth. Initial management should focus on diet modification and increasing physical activity. Pharmacological therapy for controlling glucose levels, hypertension and hyperlipidemia is recommended if necessary. The strongest recommendation in the literature focuses on disease prevention as youth diagnosed with Type 2 diabetes will be at higher risk for cardiovascular disease and diabetic complications at a young age. Prevention strategies are designed to address both family-based and school-based programs. These programs emphasize physical activity, appropriate dietary choices, behavior modification and parental involvement.

Type 2 diabetes has traditionally been a disease of adulthood; however, over the past decade the incidence of Type 2 diabetes has been increasing at an alarming rate in the younger population.[1-4] Previously, 1-2% of children diagnosed with diabetes were found to have Type 2; however, recent data from the American Diabetes Association (ADA) published in 2000 suggests that 8-45% of those newly diagnosed will have Type 2.[3] The variation in the percentages reported appears to depend on the race/ethnicity and sampling strategies.[3] Cases of Type 2 diabetes have been documented in children as young as age 8.[1,2]

The frequency of Type 2 diabetes in youth is increasing proportionally within racial/ethnic groups that have experienced an increased prevalence of the disease in the adult population.[6,7] This trend highlights a growing concern that youth diagnosed with Type 2 diabetes will be vulnerable to diabetic macrovascular and microvascular complications, such as cardiovascular and renal disease, in young adulthood. This paper will examine the current state of knowledge regarding the epidemiology of Type 2 diabetes in youth with a focus on the changing lifestyle factors that contribute to the increasing incidence of the disease as well as treatment strategies.

Epidemiology

Type 2 diabetes in children has become a growing concern over the past decade. A landmark study by Pinhas-Hamiel, conducted in Cincinatti, Ohio, analyzed rates of Type 2 diabetes in Caucasian and African-American children from birth to 19 years of age.[1,2] The incidence of Type 2 diabetes in this age group increased from 4% prior to 1992 to 16% in 1994. Type 2 diabetes accounted for 33% of diagnoses in patients 10-19 years of age. An important finding by Pinhas-Hamiel concerned the strong correlation of obesity and Type 2 diabetes. Of all youth documented to have Type 2 diabetes, the mean body mass index (BMI) at the time of diagnosis was 37.7 kg/m2. The increasing incidence of Type 2 diabetes in children, which parallels the increasing prevalence of obesity in children, has been noted by other authors with BMI values reported between 26-38kg/m2.[5, 8]

Fagot-Campagna et al. recently reviewed 11 studies from 1992-1998 that examined the incidence and characteristics of Type 2 diabetes in North American youth.[8] The authors noted clear evidence of increasing rates in Native American, Hispanic, African-American, South Asian and Caucasian youth. This study indicates that, in North America, the increasing incidence crosses cultures.

The increasing incidence of Type 2 diabetes in youth, however, is not purely a North American phenomenon. Owada et al. reported a 1.5 fold increase in the incidence of Type 2 diabetes in Japanese children from 1974 to 1988 that correlated with an increasing prevalence of obesity in Japan during the same time period. The authors also noted that 80% of Japanese children diagnosed with Type 2 diabetes were obese during this time period.[10] Ronnemaa et al. also noted an increased incidence among Finnish youth.[11]

Because Type 2 diabetes is a relatively recent problem in children, limited data exists on long-term follow-up. The most comprehensive longitudinal study by Fagot-Campagna et al. was done on Pima Indian youth in Arizona, a population at a particularly high risk for developing Type 2 diabetes.[9] The authors monitored 36 individuals for an average of 10 years until they reached an average age of 26. Follow-up at 10 years revealed an increased number of subjects with urinary albumin excretion as well as an increased magnitude of the albuminuria. It was also noted that these patients had higher baseline levels of cholesterol and triglycerides. These results are consistent with evidence of lipid and nephrogenic complications associated with diabetes. As supported by the data, the issue of Type 2 diabetes in youth is a significant public health concern which must be approached aggressively.

Risk Factors Related to Type 2 Diabetes in Youth

Overweight & Obesity

In 1998 the World Health Organization designated

obesity as a global epidemic. Obesity has been clearly identified as a risk factor for the development of Type 2 diabetes in adolescents. [1-5,12] Longitudinal studies have demonstrated that obesity and other risk factors for Type 2 diabetes can develop early in life and persist into adolescence and adulthood, leading to increased morbidity and mortality.[13,14] Varying estimates of obesity prevalence exist in the literature due to the use of different anthropometric indicators. BMI has been recommended as the best indicator to measure overweight and obesity in children and adolescents.[15-17] Overweight has been defined as a BMI > 85th percentile and obesity as a BMI > 95th percentile.[18]

Numerous studies have been conducted on Canadian and American youth to examine the prevalence of overweight and obesity. Ball et al. have summarized the most recent regional studies examining prevalence in Canada over the past decade.[19] Ranges from 13%-36% for boys and 14%-34% for girls have been reported. A large national study by Tremblay et al. examined secular trends in weight status, comparing data from the Canadian Fitness Survey (1981), the Campbell's Survey on Well-being in Canada (1988), and the National Longitudinal Survey of Children and Youth (1996).[20] The authors concluded that the proportion of children who were overweight (BMI > 85th percentile) increased from 15% in 1981 to 35.4% in 1996 (a 136% increase) in boys and from 15%-29.2% (a 94.7% increase) in girls. Obesity (BMI > 95th percentile) increased from 5%-16.6% in boys and from 5%-14.6% in girls. These values may be an underestimation of the true incidence, as data collected from the National Longitudinal Survey of Children and Youth (NLSCY) was collected using parental reports.

The National Health and Nutrition Examination Survey (NHANES), which looks at health indicators in the United States, also shows a rising prevalence of obesity in children and adolescents throughout the 1990s.[21] Obesity prevalence for children aged 2-19 increased from 10% in 1988-1994 to 14.4% in 1999-2000. Specifically, prevalence for obesity was 15.5% for 12-19 years, 15.3% for 6-11 years and 10.4% among 2-5 years compared with 10.5%, 11.3% and 7.2% from data examined from 1998-1994.[21] Jolliffe examined data from the NHANES I-III for persons between 2 and 19 years from 1971-2000 in order to determine the amount by which children are exceeding the obesity threshold. Conclusions drawn from the data indicate that children with obesity have been getting steadily more obese and that the extent of obesity has been increasing faster than the increasing prevalence of childhood and adolescent obesity.[22]

Lifestyle Changes Related to Increasing Overweight and Obesity

The emerging epidemic of obesity in children and adolescents has been attributed to changing behavioral, environmental, and social factors that are promoting weight gain. Factors associated with childhood obesity include time spent in front of a television or computer, availability of facilities for participation in physical activities, and opportunities to safely engage in sports and exercise. Unlike lifestyle behaviors that contribute to and sustain obesity and overweight in adults, these behaviors have not been as extensively studied in youth.

A large population based study by McDowell et al. reported that although the total energy and fat intake has not increased substantially in the United States in the last decade, the number of overweight persons has increased.[23] This paradox has also been observed by other authors.[24] Declining physical activity and sedentary behavior has been hypothesized as contributing to the positive energy balance that leads to overweight and obesity in youth.[25-28] Crespo et al. have found that the prevalence of overweight and obesity is lowest among children watching one or fewer hours of television a day, and highest among those watching four or more hours per day.[27] These data are consistent with reports from other authors.[29-31] Additionally, energy intake was increased for those that had higher (>5) hours of television watching. The authors also noted an inverse relationship between television watching and physical activity for both sexes, a relationship that has been noted by other authors.[25,26,32] Experiments where televisions were introduced into small communities in Canada and Scotland also noted the inverse relationship with physical activity demonstrated by Crespo et al.[26,27] Gortmaker et al. examined data collected from a cohort of 746 adolescents in order to assess the prevalence of obesity in association with television watching. The authors reported in 10-15 year old adolescents that the prevalence of obesity increased by 2% for each additional hour of television viewed.[28]

A Canadian study by Tremblay et al. in 2003 concluded that sedentary behavior (video game use, television watching) is a risk factor for being overweight (17-44% increased risk) or obese (10-61% increased risk).[33] Physical activity was negatively associated with being overweight (10-24% decreased risk) or obese (23-43% reduced risk).[33] This was the first large scale study that examined the relationship among physical activity, sedentary behavior, and BMI on a nationally representative sample of Canadian children. Authors in non-North American countries have also demonstrated a positive relationship between television viewing and obesity prevalence.[34-36]

Other reports in the literature have focused on examining specific types of food and liquid consumption associated with television viewing. Boynton-Jarrett et al. noted an inverse relationship between television viewing and the intake of fruit and vegetables in a large group of children (N=548, average age 11.7).[37] The authors reported for each additional hour of television viewing per day, fruit and vegetables servings decreased by 0.14 of a serving.[37] Other authors have noted positive correlations between time spent watching television, BMI and soft drink consumption in 11-13 year old children.[38]

Family History of Obesity and Type 2 Diabetes

The association of childhood obesity and parental obesity was examined by Dowda et al.[40] These authors reported a positive correlation in overweight youth who have an overweight parent. Familial patterns of obesity have been attributed to both genetics and family environment.[41,42] Youth in families with one or two overweight parents consume a higher percentage of their energy intake as fat.[43] Additionally, overweight or obese children are more likely to become overweight adults.[44, 45]

The relatively new emergence of Type 2 diabetes in youth has raised the question of the role of a positive family history for diabetes. In high risk groups (e.g. African American and Latino), parental diabetes was more commonly found in adolescents with Type 2 versus Type 1 diabetes.[46] Molyneaux et al. conducted a large prospective study (n=5193) examining patients with Type 2 diabetes to determine the role of family history in age of disease development.[47] The results demonstrated that the greater the number of family members with diabetes, the younger the age of onset of the disease.

Treatment of Type 2 Diabetes in Children and Adolescents

Once Type 2 diabetes is established in youth, treatment is targeted at decreasing the complications that may arise. The initial management focuses on diet modification and increasing physical activity.[3] If patients remain symptomatic or the disease continues to progress, pharmacologic treatment may be necessary. As of the year 2000 Insulin and Metformin are the only therapies approved by the FDA for use in youth with Type 2 diabetes.[3] Hypertension and hyperlipidemia must be monitored closely and pharmacological therapy instituted as necessary.[3] While treatment is available for Type 2 diabetes in the pediatric population, the focus must be placed on prevention as this population will be at higher risk for cardiovascular disease and diabetic complications at a young age.

Prevention Strategies in the Literature

It has been established that Type 2 diabetes is a significant public health problem in North America and is paralleling the increasing rates of obesity among youth.[8]

A focus on prevention of obesity is integral to the management of Type 2 diabetes in youth. Edmunds et al. suggests a two-pronged approach including both family-based and school-based programs which focus on physical activity, diet, behaviour modification and parental involvement.[48] Gahagan et al. recommend instituting large-scale community-based approaches to general health promotion and healthy living in youth.[49] In reviewing childhood obesity in Canada, Ball & McCargar support a long-term commitment to teaching healthy eating and involvement in physical activity throughout life.[19] These concepts are important with respect to not only Type 2 diabetes, but also the maintenance of a healthy lifestyle in general.

A reasonable starting point in prevention of overweight and obesity is diet modification. The American Diabetic Association (ADA) recommends that a diet low in caloric intake should be accompanied by increased energy expenditure through exercise.[3] The ADA has also made recommendations concerning percent caloric intake attributed to fat, carbohydrate and protein in children aged 2-11 years. Specifically, it is recommended that added sugars, saturated and trans fats, and cholesterol be consumed in as little amount possible while maintaining healthy nutrition.[50] In contrast, Ebbeling et al. have demonstrated that a decreased glycemic load diet (45%-50% carbohydrate and 30%-35% fat) is beneficial over a conventional diet (55%-60% carbohydrates and 25%-30% fat) in BMI and fat mass reduction in a small group (n=14) of adolescents 13-21 years of age.[51]

School-based approaches to healthy eating are another area of intervention. The Centre for Disease Control in the United States (1996) has generated guidelines for instituting school programs to promote lifelong healthy eating. Areas of focus include: school policy on nutrition, integration of school food service and nutrition education, staff training, family and community involvement. Grey et al. assessed the effectiveness of a school-based program to prevent Type 2 diabetes in high risk youth (age 12.6 +/- 1.1). The two groups all received nutrition education and exercise training, whereas the interventional group also received coping skills training. The latter group showed trends toward improved food choices, increased dietary knowledge and lower glucose and insulin levels.[52] Additionally, the parents of the intervention group were found to have better health responsibility, make healthier nutrition choices and a trend toward an increase in activity.[52] Other school-based programs implemented in preschools using diet modification (fat reduction in preschool meals and snacks) and a comprehensive preschool health education curriculum have demonstrated improvement in dietary choices as children enter grade school.[53]

The influence of lifestyle behavior is another area of focus in the prevention of Type 2 diabetes in children.[4] Behavior modification appears to be a key component in the management of childhood obesity.[48,54] Golan et al. found that a program of eating behavior modification with parents as the key agents of change resulted in a significantly greater reduction in weight when compared to a child-only program.[54] This highlights the importance of the parents' role in instituting healthy eating behaviors in overweight and obese children.

A number of studies have evaluated the effect of increasing physical activity in order to prevent overweight and obesity in childhood and adolescence. Owens et al. (1999) found a significant decrease in body fat of children age 7-11 who participated in 4 months of a physical exercise program.[55] In obese children between the ages of 8 and 12, programs designed to decrease sedentary behaviours (dietary changes, reducing TV viewing) and programs designed to increase physical activity were found to be equally effective in treating pediatric obesity.[55] Other authors have noted reductions in BMI as high as 9 kg/m2 in overweight boys and 10kg/m2 in overweight girls after a 6-12 month interdisciplinary weight reduction program primarily composed of progressive submaximal physical activity with recommended national dietary allowances. [56]

Conclusion

Type 2 diabetes in youth has been examined in the literature since the identification of its increasing incidence in youth in the early 1990s. The epidemiology, risk factors, pathophysiology, treatment strategies and prevention have been recently studied. The current literature suggests that prevention and treatment of childhood overweight/obesity is a key area of focus. The three main targets identified are promotion of healthy eating, increasing participation in physical activity, and decreasing sedentary behaviors. These issues must be addressed with family and in school. A focus on an overall healthy lifestyle throughout the population and starting at a young age is essential in preventing further increases in Type 2 diabetes in children.

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