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Review Article

Type 2 Diabetes in Children and Youth: A High-Risk Epidemic

Michael Naafs, A. B.

Department of Medicine, Naafs International Health Consultancy, Netherlands

*Correspondence to: Dr. Michael Naafs, A. B., Department of Medicine, Naafs International Health Consultancy, Netherlands.

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Abstract

A high-risk type 2 diabetes epidemic in children and youth worsens further, fuelled by an obesity epidemic. Low-income groups and ethnic minorities are most at risk. Present prevention programs will not knock down both epidemics. Governments should take their responsibilities, as 30 of them already did, and follow the 2016 call of the WHO to curtail sugar consumption by fiscal policies. Sweetened sugar beverages (SSBs) and cheap poor quality ultra-processed foods should be taxed up to 20% of the retail price Closing non-committal sugar covenants with the soft drink and food industry and simultaneously raising taxes on fresh fruits and vegetables as the Dutch did recently, is a bad example of what to do not anyway.

Introduction

Recently, newspapers headed growing numbers of children and young adults are developing type 2 diabetes, a disease usually seen in those aged over 40 [1]. It was only in 2000 that the first recorded diagnosis of a child with type 2 diabetes took place. The number of people aged up to 25 with the condition in England and Wales increased from 507 in 2013 to 715 in 2016-2017- a 41% rise. These figures have been collected by paediatric diabetes units at hospitals across England and Wales and collated by the Royal College of Paediatrics and Child Health (RCPCH)- [1].

However, when some months later new figures were released by the charity Diabetes UK that included account data from GP surgeries, the true number was nearly 10 times higher approaching almost 7.000 [2]. Type 2 diabetes is much more aggressive in children and in young people than in adults, with a higher overall risk of complications that tend to appear much earlier.

Type 2 diabetes was closely associated with being very overweight in the NHS-RCPCH study. Almost 4 in 5 (79%) of the 715 children suffering from type 2 diabetes were also obese, the NHS data revealed. The figures showed that people from some ethnic minorities are much more likely than others to develop type 2 diabetes. Almost half of the 715 young people were black or Asian.

This trend of increasing prevalence and incidence of type 2 diabetes in young people seems to occur worldwide. Therefore, the epidemiology, pathophysiology, diagnosis complications, management of type 2 diabetes in children and youth are discussed in this mini-review, with a special emphasis on prevention programs. The different types of Maturity Onset Diabetes of the Young (MODYs) are beyond the scope of this mini-review.

Epidemiology

Type 2 diabetes in children has increased in frequency around the world over the past 2 decades [3]. Children from ethnic groups at high risk for type 2 diabetes in their adult population, namely those of African, Arab, Asian, Hispanic, Indigenous or South Asian descent, are disproportionally affected.

A Canadian national surveillance study demonstrated a minimum incidence of type 2 diabetes in children and adolescents < 18 years of age 1,54 per 100.000 children per year [4]. Significant regional variation was observed with the highest minimum incidence seen in Manitoba of 12,45 per 100.000 children per year. In this study, 44% of children with new-onset type 2 diabetes were of Aboriginal heritage, 25% Caucasian, 10,1% Asian,10,1% African-Caribbean and the remaining or other of mixed origin [4].

Recent data from the U.S. demonstrated an incidence of 8,1 per 100.000 person years in the 10-14 year age group and 11,8 per 100.000 person years in the 15-19 year age group. In this study, the highest rates were found in American Indian, African American, Asian, Pacific Islander and Hispanic youth and the lowest incidence occurred In non-Hispanic white youth [5]. Type 2 diabetes is a highly-heritable condition, with 90% of children and youth affected having a first-or second-degree relative who also has type 2 diabetes [6]. A significant proportion of youth with type 2 diabetes live below the poverty line of income from low-resourced homes [3,5,6]. Breastfeeding has been shown to reduce the risk of youth-onset type 2 diabetes in some populations [7].

A New Zealand study showed that the incidence of type 2 diabetes in children < 15 year of age has increased progressively at 5%/year over the last 21 years. The risk was disproportionally associated with girls and children from high-risk ethnic groups [8].

Pathophysiology

In children, the role of obesity in the development of insulin-resistance and ultimately type 2 diabetes is well established [9,10]. Excessive visceral fat has been independently associated with the development of diabetes due to an increase in insulin resistance [11]. Independent of obesity, certain ethnicities have higher risk of insulin resistance and beta cell dysfunction, as mentioned above. Both diabetic ketoacidosis (DKA) and hyperglycaemic hyperosmolar states (HHS) are more common in children and youth with type 2 diabetes compared to adults [12].

Diagnosis

Most children with type 2 diabetes are obese or extremely obese at diagnosis and present with glucosuria without ketonuria, absent or mild polyuria and polydipsia and little or no weight loss [13,14]. Currently, children with type 2 diabetes are usually diagnosed over the age of 10 years and are in middle or late puberty [13-15]. One third of patients are diagnosed by urine analysis during routine physical examination [13,14]. In its severest form, the child presents with polyuria, polydipsia and weight loss. Up to 33% in particular ethnic groups have ketonuria and 5%-25% have ketoacidosis at presentation [13,14]. Very rare type 2 diabetes in children and youth manifests with HHS coma. With these clinical pictures the distinction from type 1 diabetes is not possible until months later when insulin requirements decline and a non-insulin course develops without dependence on insulin for survival.

Acanthosis nigricans and polycystic ovarian syndrome (PCOS), disorders associated with insulin resistance and obesity are common in youth with type 2 diabetes [14]. Acanthosis nigricans is up to 50% to 90% of children with type 2 diabetes and it is more frequently diagnosed in dark skinned obese individuals. PCOS is characterized by hyper androgenism and chronic anovulation. Lipid disorders and hypertension also occur more frequently in children with type 2 diabetes.

Complications

Young people with type 2 diabetes appear to be at a much higher risk of developing early diabetes mellitus associated complications than those with type 1 diabetes. The higher level of risk does not appear to be related to overall levels of glycemic control or duration of disease but to the presence of hypertension and dyslipidemia [16]. These cardiovascular risk factors are more frequent in adolescents suffering from type 2 diabetes compared to type 1 diabetes [6].

In the today study, 14% of adolescents with type 2 diabetes suffered from hypertension, 80% demonstrated low HDL- cholesterol concentrations and 10% had hypertriglyceridemia [6]. In the SEARCH study, 92% of adolescents with type 2 diabetes fulfilled the definition of metabolic syndrome [5]. These prevalence's are similar to cardiovascular risk factors in European adolescents with type 2 diabetes [17,18].

As from time diagnosing type 2 diabetes in children and youth the development of macro vascular complications takes many years, little is known yet about this subject in youth type 2 diabetes. However, already adolescents with type 2 diabetes showed increased intima-media thickness, which is predictive for heart attack and stroke [19,20].

Microvascular diseases is the hallmark of hyperglycaemia diagnosed at young age. Data from Japanese, Pima Indian children show the presence of microvascular diabetic complications already at diagnosis and follow-up [21]. In Japanese children, incipient retinopathy was detected in 36% of the cases at the time of diagnosis, and in 39% of the cases at 2-years follow-up, while microalbuminuria was observed in 39% at 2-years follow-up [22]. Among Pima Indian children, 22% had microalbuminuria, and at follow-up between the age of 20-29 year 60% had microalbuminuria and 17% had already macro albuminuria [23].

In the Search study 4% of the adolescents with type 2 diabetes demonstrated retinopathy and 28% microalbuminuria [5] In contrast, in European adolescents with type 2 diabetes no retinopathy and only 5% microalbuminuria was reported suggesting genetic differences [17,18].

Management

Last ADA (American Diabetes Association) guidelines for the management of children and adolescents with type 2 diabetes were issued in 2016 [24]. Most of the recommended guidelines for treatment of children and youth with type 2 diabetes are extrapolated from experience gained in adults [14,24,25]. HbA1C goals and blood sugar (BS) goals are the same as in adults.

Treatment of every child with type 2 diabetes should begin with lifestyle modifications, including physical activity and nutrition. Only 10% of pediatric patients with type 2 diabetes achieve their BS goals with lifestyle modifications alone. This is likely secondary to loss of follow-up, a high rate of depression in teenagers which affects adherence and peer pressure steering toward unhealthy eating habits [26].

Patients should be encouraged to vigorous physical activity or exercise. A registered dietician should provide initial comprehensive detailed nutritional counselling to maximize adherence and outcomes. These recommendations should be culturally sensitive and financial feasible [26]. Common dietary recommendations should include eating regular meals and healthy snacks, reducing portion sizes, choosing calorie-free beverages, increasing dietary intake of fruits and vegetables, and consuming 3-4 servings of low-fat dairy products per day. Sugar sweetened beverages (SSBs) and ultra-processed foods should be avoided [27,28].

Unless there are contraindications, all children with type 2 diabetes should be started on metformin. Patients should be educated in self-monitoring [29]. AAP and ADA guidelines recommend metformin or insulin as first line therapy in children with type 2 diabetes, depending on clinical presentation.

With limited pediatric data, the choice of an additional agent is a challenge to the health care practitioner [30].

Prevention

Recently, the ADA issued a position statement on comprehensive care for pediatric patients with type 2 diabetes as the incidence of type 2 diabetes in youth continues to rise in the U.S. [31].

New in this position statement are the screening for obstructive sleep apnea, cardiac function testing, non-alcoholic fatty liver disease (NAFLD) and a careful consideration of bariatric surgery [31,32].

Lifestyle modification programs that incorporate evidence-informed behavioural strategies to promote changes in diet and physical activity stay the cornerstone. Family-based behavioural weight management programs in school-aged children without diabetes have a modest, but positive impact on weight and cardio metabolic risk factors but are less effective in adolescents and children with severe obesity [33-37]. These studies show weight loss gains of just 5-10 kg. As mentioned above these programs are only successful in 10% of obese children and youth with type 2 diabetes [26]. Until now the strongest evidence regarding the impact of lifestyle interventions for youth with type 2 diabetes comes from the today study where the goal was to achieve a 7%-10% decrease of overweight [37].

It is therefore disappointing the recent ADA position paper takes no position regarding sugar taxes, like the WHO did in 2016 [31,38]. As highlighted by the WHO, taxing sugary drinks to at least a 20% increase in the retail price would result in proportional reductions in consumptions of such products, according to the "Fiscal Policies for Diet and Prevention of Non-Communicable Diseases" and can lower sugar consumption, reduce obesity, type 2 diabetes and tooth decay [27,38] So, it Is also disappointing the ADA position paper pays no attention to tooth decay, as treating gum disease may help manage type 2 diabetes, probably particularly in the youth with type 2 diabetes [39].

Already thirty countries introduced a sugar tax [27] What governments should not do is closing a non-committal sugar covenant, while raising at the same time taxes on fresh fruits and vegetables, as did the Dutch, recently [27].

A next inevitable step could be taxing ultra-processed foods as poor low-income groups are condemned to buy junk food, SSBs and cheap free sugars containing, energy dense, poor quality ultra-processed foods. Governments and politicians must show strong leadership in battling this high-risk type 2 diabetes epidemic in youth, fuelled by an obesity epidemic, and facing and forcing the food industry to reduce sugar contents of food according to settled goals. Subsequent tax revenues should return to education, lifestyle modifications and dentistry programs to those people whom it concerns and need most, as the WHO already stated in 2016 [38].

Conclusion

It is obvious education, lifestyle modifications, behavioural- and exercise programs will not knock down the high-risk type 2 diabetes epidemic in children and youth, fuelled by an obesity epidemic. It is time more than the present 30 countries take their responsibility and follow the 2016 call of the WHO to curtail sugar consumption by fiscal policies [38]. Both sugar sweetened beverages (SSBs) and ultra-processed foods

should be taxed up to 20% of the retail price. Tax revenues should be spend at prevention and dentistry programs, integrating oral health in general health for those at risk.

Populations at risk for obesity and type 2 diabetes in children and youth are often condemned to buy cheap SSBs and cheap poor quality ultra-processed foods because these low income groups and ethnic minorities can't afford more.

What governments should not do is closing a non-committal sugar covenant with the soft drink and food industry and simultaneously raising taxes on fresh fruits and vegetables, as the Dutch did, recently [27].

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