# Type 2 Diabetes in Children: Etiology, Epidemiology, Management and Prevention

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**Background:**Type 2 diabetes in children is a new epidemic which should be alarmed to its seriousness, so as to be taken care of by the medical care providers. **Aim:** Review of type 2 diabetes in children regarding the etiology, epidemiology, management and prevention. **Methods:** Thorough search was done through the electronic data-bases : Medline, Embase, Cinahl. Handsearch of diabetes related journal. Conclusion: Prevention of obesity and instituting physical activity protocols at school and home since early age is the cornerstone in facing this disease, children at risk should be recognised and followed up for long period of time

**Key words**: Type 2 diabetes, prevention, obesity, children diabetes.

The International Diabetes Federation Consensus Workshop (2004) declared that the global prevalence of type 2 diabetes in children is rising steadily worldwide, in parallel with the increase in childhood obesity (Williams and pickup 2004).It seems that reduced physical activity (weir et al1994)and prevalence of obesity(Raben 2004) are the main risk factors involved in the etiology of type 2 diabetes in children.But, still the notions of over nutrition and under activity alone are too simplistic (Wilkin 2004). Body fat mass and central body fat distribution, in particular, were more important than physical activity, physical inactivity, in predicting metabolic risk in obese children (Ball et al2003).Therefore, differentiating type 2 diabetes and type 1 disease and starting appropriate treatment is vitally important( Pinhas-Hamiel et al 2004). Because ,both the two types of diabetes may exist togetherin a combined defect (defrenzo et al 1997).As well as differentiation from MODY DM which is difficult to be made (Ihtisham et al 2004).Type 2 diabetes Cases in children may still be under diagnosed and hidden (lobestien and leach 2004),due to using fasting glucose levels as the main screening tool which appears to be insufficient in detecting those children(Wiegand et al 2004).The aim of this review is to discuss this new epidemic of type 2 diabetes in children age group.

**Etiology** Type 2 diabetes in children may be due to genetic disorder of Insulin resistance complicated by obesity or weight gain, aging and a sedentary lifestyle (Pinhas-Hamiel and Seitler 2004).Ultimately, Followed by progressive beta-cell failure (Gungor and Arslanian 2004) Leading to hyperglycemia (Groop 1999). Obesity is most significantly modifiable risk factor for type 2 diabetes (National Framework for diabetes2004). Unfortunately, childhood obesity is also increasing at an alarming pace worldwide (Freedman et al1997). Obesity epidemic has been followed by a simultaneous rise in type II diabetes (Raben 2004).High BMI seems to be associated with increased risk of diabetes in both sexes and all ethnic groups (Tuomilheto et al 1997). Therefore, screening in individuals with normal or slightly elevated BMI is important in the prevention of diabetes and cardiovascular disease (Onge et al 2004). Large hip and thigh circumferences are associated with a lower risk of type 2 diabetes independently of BMI, age, and waist circumference, whereas a larger waist circumference is associated with a higher risk.(Snijder 2004 and Grundy 1999). Each element of the syndrome becomes worse with increasing obesity (Weiss et al 2004), due to the fact that adipose tissues which is expanded in obese children tend to secrete and synthesize metabolites that alter insulin secretion, insulin sensitivity, and even cause insulin resistance (William and pickup 2004).In particular, skeletal muscles fat (good paster and wolf 2004), Which can be measured by magnetic resonance images (Goodpaster et al 2004). Obese children with a family history of type 2 diabetes, acanthosis nigricans and hyperandrogenism are seen regardless of the ethnic background of the patients and represent clinical indicators for the presence of type 2 diabetes( Freedman et al 2001). Like children who were born at term but who were small for gestational age, children who were born prematurely have an isolated reduction in insulin sensitivity, which may be a risk factor for type 2 diabetes (Hoffmanet al2004).

Both genetic and environmental factors play in the pathogenesis of type 2 diabetes in children (Kiess et al 2003). Ongg and dunger (2004) suggested that the size at birth and early rapid postnatal growth rates are important determinants of type 2 DM.

Acanthosis nigricans is an independent risk factor for insulin resistance in overweight Hispanic children at risk for type 2 diabetes.

On the other hand, Kobaisi et al (2004) and Lindsay et al 2001) suggested that immune function or activation may play a role in the development of type 2 diabetes.

Comparison of type 1 and Type 2 diabetes (Adapted from Watkins P, 2003)

| Type 1 diabetes | Type 2 D diabetes |
|---|---|
| Inflammatory reaction in the islets | No insulitis |
| Islet B cell desroyed | B-cell function |
| Islet cell antibodies | No islet cell antibodies |
| HLA related | Not HLA related |
| Not directly inherited | Strong genetic basis (some cases) |

| Type 1 diabetes | Type 2 D diabetes |
|---|---|
| Not overweight | Obese or over weight |
| Severe const | Insidious |
| Polyuria | Polyuria |
| Polydispsia | Polydipsia |
| Insulinopenia | No insulinopenia |
| No insulin resistance | Insulin resistance |
| Autoantibodies | No auto antibodies |

Diagnostic Criteria of type 2 in children adapted from Watkins 2003.

| Family history of type 2 Diabetes |
|---|
| High –risk ethnic Groups: African –American ,Asian,Carribean,Hispanic |
| Obesity |
| Female sex |
| Pubertal period |
| Clinical signs of Insulin resistance :Acanthosis nigricans,Polycystic ovary signs |
| Biological signs of insulin resistance detectable ,High or normal insulin or C-peptide level |
| No insulin therapy necessary for survival. |
| Negative facts in favor of type 2 diabetes |
| No HLA haplotypes associated with type 1 diabetes |
| No signs of autoimmunity :no anti-islet cell antibodies |

**Epidemiology of the disease:** The Majority of children with type 2 diabetes are non-Caucasian and majority are from minority Groups(Defronzo et al 2004). Sex-linked genes may help to explain the female preponderance of type 2 diabetes in children (Murphy et al 2004). Most cases of Type 2 diabetes occur around the age of puberty due to increased growth hormone Production at this age (Arslanian and Suprasongsin 1997). And not due to the increase in sex hormones (Caprio et al 1989).The American Indian community has one of the highest rates of types 2 diabetes in adults and obesity in both adults and children(Defronzo et al 2004).The same is the case in Japan, which has seen an approximate fourfold rise in the incidence of type 2 diabetes in 6- to 15-year-olds, Which comprises 80%of childhood diabetes (Raz et al 2003).Following studies have proved prevalence of type 2 diabetes in children in the named countries: Canada(Harris et al 1996).Thailand (Likitmaskul et al2003). India (Ramachandran et al 2003).Taiwan (Wei et al 2003).Libya (Kadiki et al 1996).The British Society for Pediatric Endocrinology and Diabetes Clinical Trials/Audit Group 2000, found that UK children still have low prevalence of type 2 diabetes. The crude minimum UK prevalence of type 2 diabetes under 16 years is 0.21/100 000 (Ihtisham et al 2004).and incidence is related to rising in incidence of obesity in children of UK (Hibbert et al2004 ).It seems that the cases are still under diagnosed and hidden, due to the fact that around 20 000 children has impaired glucose tolerance (Lobestien and leach, R 2004). Further research is required to determine the role of the oral glucose tolerance test (OGTT) in screening asymptomatic young people(International Diabetes Federation Consensus Workshop (2004).

**Clinical management of type 2 DM:** Due to the fact that Obesity –related diabetes is increasing at an alarming rate in children as shown previously, pediatricians should be aware of this trend and its management (Pohl 2004).A multifactorial intervention (Diet, Physical activities, pharmaceutical agents) can reduce complications(miller and Dunstan 2004).

| Save life |
|---|
| Alleviate symptoms |
| Prevent longterm complications |
| Reduce risk factors |
| Smoking |
| Hypertension |
| Obesity |
| Hyperlipidemia |
| Educate patients and enhance self managemenT. |

**Aim of Diabetes treatment** (Adapted from Watkins 2003)

**DIET**: Increasing intake of refined carbohydrates concomitant with decreasing intakes of fiber paralleled the the upward trend in the prevalence of type 2 diabetes observed in U.S.A (Gross et al 2004).Therefore, care should be taken to reduce refined sugars and increase fibers ketogenic diet (very low caloric diet:VLCD) is an effective short term and possibly long term therapy for pediatrics patients (willi et al 2004).Moreover,(Astrup 2003) recommends a diet rich in fibers and grains, high protein, low fat, more carbohydrates and low in sugar rich beverages as best choice for the prevention of weight gain ,obesity, type 2 diabetes and cardiovascular disease .And promote weight loss in patient with type 2 diabetes without causing unfavorable alterations in plasma lipids or glycemic control (Gerhard et al 2004). But (miyashita et al 2004) recommends a diet low caloric/low carbohydrates in obese subjects with type 2 diabetes ,which can lead to reduction in visceral fat , An increase in HDL-c,And improved insulin sensivities.in contrast, polyunsaturated fish oils can be positive (protective) component of diet against metabolic syndrome (graham et al 2004). Vitamin E improves insulin resistance transiently (manning et al 2004). And significantly increases HDL-c and apo A1,if used with other vitamins such as Mg,zn., and vitamin C.(fervid et al 2004).Fasting longer than 6 hours optimizes

fat oxidation (Achten and Jeukendrup 2004).Long term Coffee consumption was found to have a protective effect on lowering risk for type 2 diabetes (Salazar et al 2004, van dam et al 2004, Agardh et al 2004,Rosengren,et al 2004). In contrast, others have reported no relationship between ingestion of coffee and type 2 diabetes (Saremi et al 2003).(Jenkins et al 2003) recommends vegetarian food along with other therapeutic measures in prevention ,treatment of type 2 D.M.

**Physical activities**: Either supervised or partially supervised exercise training is an important initial adjunctive step in the treatment of individuals with the metabolic syndrome (carol and Dudfield 2004). Exercise found to decrease the arterial stiffness in carotids and femoral arteries and improve insulin resistance (Yokoyama et al 2004).Water aerobics effectively reduces A1c (gilcrest andMayo 2004). In the other hand, subjects who are predisposed to type 2 diabetes due to a small birth size are strongly protected from glucose intolerance by regular exercise (Eriksson et al 2004) .Research has shown that losing 5%-7% of body weight through diet and increased physical activities can prevent or delay pre-diabetic from progression to type 2 diabetes( Spiegel2003 and NIDDK). But unfortunately, these intervention programmes which are based on diet control and exercise seem to fail most of times (Kay et al 2001) .

**Pharmacotheraputic agents**: Metformin is the only drug approved for the treatment of type 2 diabetes in children (Gaylor and Condren 2004), it can effectively lower HbA1c values, positively affect lipid profiles, And improve vascular and hemodynamic indices (Setter et al 2003).And increases insulin action by unknown mechanism(williamsandpickup 2004).

The role of insulin in treatment should be further assessed as was stated by the international diabetes federation consensus workshop (2004). Because, It causes weight Gain (Williams and pickup 2004).

Combining an insulin secretagogue (i.e., sulfonylurea or meglitinide) and an insulin sensitizer (i.e., metformin or a glitazone) has unique mechanisms of action and results in significant A1C lowering ( Elasy et al 2004).Acarbose may be used to prevent type 2 diabetes( Scheen AJ 2003).GH treatment may improve some symptoms of the metabolic syndrome, such as abdominal obesity, high blood pressure, and lipid abnormalities, and thereby may decrease the risk of cardiovascular disease(Johannsson 2003).It is amazing to know that most cases of Type 2 diabetes occur due to increased growth hormone Production at prepubertal age (Arslanian and Suprasongsin 1997). Treatment with lipid-lowering agents reduces cardiovascular risk(Vijan andHayward 2004).A reduction in the frequency of diabetic nephropathy by angiotensin-converting enzyme (ACE) inhibitor treatment in normotensive lean microalbuminuric type 2 diabetic patients has been shown (Morgensen 2003).

Bariatric surgery is the only treatment recognized to have long lasting effects on weight control, but its use is limited at present to those who are morbidly obese, And treatment of type 2 diabetes in obese children with insulin makes weight go up (Heller 2004).

Great care should be exerted when prescription of antiobesity medication (Orlistat and sibutramine) is considered for children (Gowers 1999 and kay2001), most of these drugs have not yet been sufficiently studied with respect to long-term efficacy, safety and overall long-term effects in children and adolescents (Strauss and Pollack 2001, Palmert and Gordon2002).

**Smoking**: Faccini et al (1992) suggested that smoking to be associated with the development of insulin resistance, which has been reversed by cessation of smoking,by unknown mechanism(bloomgarden1998). The relation between dual effect of both smoking and alcohol was not assessed in this study. Therefore, It is not generalizable to the population.

**Prevention of type 2 diabetes in children:** Primary Prevention means, dealing with the whole population to prevent the early stages of metabolic syndrome (Defronzo et al2004). It is critical that health care professionals and the public are educated about this disease and studies are conducted that focus on children with type 2 diabetes(Gaylor and Condren 2004). Prevention of obesity and type 2 diabetes in early age group is primary health care goal(Kapllen2004).as well as Identification of inappropriate rapid weight gain in infants through frequent weighing should trigger immediate adjustment of energy intake, a simple intervention in bottle-fed infants, the ones at greatest risk for becoming obese (Kral 2004).Therefore, a fundamental policy shift is required to widen responsibility for the prevention of diet, activity and weight-related ill health across the whole of Europe's population (James et al 2004).Moreover , Good control has been shown to reduce the complications of diabetes (UK Prospective Diabetes Study Group, 1998 and Elasy et al2004).Lifestyle interventions, including exercise and dietary-induced weight loss may improve insulin resistance and glucose tolerance in obesity states and are highly effective in preventing or delaying the onset of type 2 diabetes in individuals with impaired glucose regulation(Carroll and Dudfield 2004).Recent research showed that the development of diabetes can be approximately halved if these lifestyle changes are maintained over 4 years (Watkins 2003). Local long-term therapeutic programs for obese young patients are an important tool to establish a more active and health-oriented life style in children and their families and to reduce the individual and public burden of obesity in childhood (Knerr 2004).

**Secondary Prevention:** American academy of pediatrics recommends to avoid cow milk introduction in infants who are at risk of developing diabetes (Cheta 1999).Because, it might trigger an autoimmune process (Karges and Dosch 1996). In the contrary, other studies have found cow milk to have a protective effect on developing diabetes (Norris et al 1996).But again early weaning of infants has been associated with obesity which is a risk factor in type 2 diabetes in children and adults (COMA report 1995). Prevention programmes aimed at stimulating breast feeding and daily physical activity and the restriction of sweetened drinks and watching TV are very promising under supervision of both school and the parents is important (Renders 2004).

It is crucial to identify Persons who are Pre-diabetic and follow them up by Impaired glucose tolerance (IGT) and impaired Fasting Glucose (IGF) as was stated by the WHO study group (1985). Through screening programmes which are recommended for type 2 diabetes mellitus in children and especially in adolescents with substantial risk for the development of this disease (Molnar 2004).

**Conclusion:** The diagnosis of type 2 diabetes in children and adolescents is rising in the societies due to awareness of the health professionals, and prevalance of obesity. It looks as a cost which we have to pay for civilization and prosperity . It is true that obesity is the number one risk factor . Fortunately , Not every obese children will be a diabetic. But only those group which have genetic as well as environmental factors on play.

Therefore, detection of , the pre-diabetics with impaired glucose tolerance tests and follow them up over a long period of time both at home and school must be taken in order to prevent and delay the progression of the disease. Preventive measures should be taken since early infancy to fight obesity by instituting extended breastfeeding for at least for six months of age, and stopping the early weaning practices which may lead to obesity, diabetes and many other health hazards. As well as making daily life routine includes physical activity.

Media role should be played to make society aware of this clinical entity . Treatment and complications of diabetes 2 in children is much more a burden on the budget than preventive measures, due to the fact that those patients shall suffer from diabetes and its complications longer than others,therefore, a pound of prevention is better than an ounce of cure.

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