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Editorial

The Epidemic of Type 2 Diabetes Mellitus in Adolescents

The worldwide prevalence of type 2 diabetes is expected to increase in the next two decades and the adult diabetic population in China is projected to reach 46 million by 2025.[1] Type 2 diabetes mellitus has conventionally been described as a chronic disease of overweight middle-aged adults and the elderly but there is now evidence that this disease in also becoming more prevalent in children and adolescents of developed and developing countries.[1-5] The article by Huen et al[6] in this issue is a timely reminder that Hong Kong has not been spared from this epidemic. This emerging epidemic of type 2 diabetes mellitus can have significant financial and societal consequences and a prompt public health response is warranted.

One of the recommendations of the International Diabetes Federation Consensus Workshop on type 2 diabetes in the young is that population-based incidence/prevalence of type 2 diabetes mellitus in different countries should be collected followed by studies on the natural history and outcome of the disease. Certain ethnic groups including Hispanics, African-Americans, Canadian First Nations People, Native Americans and Asians have been reported to be at high risk of developing type 2 diabetes in adolescence and adulthood.[1]

Since 1974, urine has been collected from primary and junior high school children in Japan to be tested for glucose to detect diabetes. About 0.05-0.1% of primary school children and 0.12-0.2% of junior high school children have tested positive for urine glucose and 0.05% of the children have glycosuria on retesting. The incidence of type 2 diabetes has been estimated to be 3.0/100,000 children during 1975-2000.[3] The rising incidence of childhood type 2 diabetes has been attributed to a concomitant increase in childhood obesity associated with a Westernized and sedentary life style in Japan.[3] Over 80% of identified cases were overweight or obese and obesity was more common in boys than in girls (91.5% versus 77%). However, a recent trend towards a decrease in the incidence of childhood type 2 diabetes in the Tokyo area had been reported.[7]

A nationwide urine screening programme for diabetes among 2,862,083 school children was carried out in Taiwan between 1992-1999 and the estimated rate for type 2 diabetes was 6.5 per 100,000.[8] Only 54% of boys and 44% of girls with type 2 diabetes type 2 diabetes were obese in this cohort.[8] Since these landmark studies, many population-based incidence of childhood type 2 diabetes mellitus from different countries have been published (Table 1) with the incidence remaining fairly low in European countries as compared to America and the Pacific Islands. Among clinic based reports, the percentage of type 2 diabetes mellitus among newly diagnosed diabetic children and adolescents is also on the increase (Table 2). Between 1984 and 1996, only 7.3% of newly diagnosed diabetes cases in Hong Kong were type 2 diabetes but between 1997 to 2007, 47% of newly diagnosed diabetic patients had type 2 diabetes. This dramatic increase in type 2 diabetes in Hong Kong is paralleled by an increase in the prevalence of obesity in Hong Kong in the past two decades (Table 3).[33]

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The clinical presentation of childhood and adolescent type 2 diabetes can vary from minimal symptomatology to severe hyperglycaemia and ketoacidosis (5-25%). The differentiation of type 2 diabetes from type 1 diabetes in adolescence can be difficult. Based on the Taiwan experience, nearly 40% of Chinese type 2 diabetic patients are not obese. Acanthosis nigricans, polycystic ovary syndrome, non-alcoholic liver disease, hypertension and hyperlipidaemia are commonly associated features of type 2 diabetes and 74-100% of the patient have first or second-degree relatives with type 2 diabetes.[1,34,35] Between 10% to 75% of Caucasian youths diagnosed clinically with type 2 diabetes have islet cell antibodies (ICAs), insulin autoantibodies (IAA), glutamic acid decarboxylase (GAD) and tyrosine phosphatase antibodies (IA2)[34] but such information is not available in Chinese patients. The majority of type 2 diabetic patients diagnosed in our centre are islet-cell antibody negative, but we have to bear in mind that more than half of the type 1 diabetes in Chinese youths are idiopathic in nature. It has been reported that antibody-negative type 2 diabetic Caucasian youths are more insulin resistant whereas antibody-positive patients have insulin deficiency and β-cell failure. Phenotypically, there is no difference between antibody-positive versus antibody-negative type 2 diabetic patients with regard to HbA1c and glucose values, symptomatic presentation, family history of diabetes, body mass index and age of presentation.[34]

As mentioned in the article by Huen et al,[6] screening for diabetes by testing urine glucose in obese Hong Kong adolescents over 10 years of age was initiated by the School Health Service of the Department of Health in 2004. In the 2004 / 2005 school year, 4.99% of over 300,000 adolescents attending the School Health Service were obese and glycosuria was detected in 0.018% of this cohort with a confirmed prevalence of type 2 diabetes mellitus of 5.8 per 100,000 children and

Table 1 Population-based incidence of childhood type 2 diabetes mellitus

Country	Years	Age	Incidence (10^{-5})
United Kingdom[9]	2004-2005		
Asians		0-17	3.9
Whites		0-17	0.35
Sweden[10]	1998-2001	0-14	2.4
Finland[11]	1992-1996	15-19	0.5
Austria[12]	1999-2007	0-15	0.25
Australia[13]	2001-2006	0-19	2.5
New Zealand[14]	1999-2002	0-14	0.84
Japan[3,7]	1974-2004	6-15	2.55-3.0
Isreal[15]	1997	<18	0.05
	2000	<18	0.17
United States			
Non-Hispanic White[16]	2002-2003	10-14	3.0
		15-19	5.6
Asian-Pacific Islanders[17]	2002-2003	10-19	12.1
African Americans[18]	2002-2003	10-14	22.3
		15-19	19.4
American Indians[19]	2002-2003	10-14	25.3
		15-19	49.4
Hispanic	2002-2003		
Males[20]		0-14	4.8
Females		0-14	6.9
Hong Kong[6,21]	1984-1996	0-14	0.1
	1997-2007	10-14	2.3
		15-18	2.0

Table 2 Percentage of type 2 diabetes among newly diagnosed diabetic children

Country	Age	Years		
France	1-16	1993-1998	2.16%	Czernichow & Tubiana-Rufi, 2004[22]
		2001	5.5%	
Shanghai	<18	2001	2.4%	Zhi et al, 2003[23]
New Zealand	0-14	1996-2002	12.5%	Hotu et al, 2004[24]
		2000-2001	37.5%	
Sweden	0-18	2001	0.5%	Zachrisson, 2003[25]
	0-19	1998-2001	8%	Thunander et al, 2008[10]
Isreal	<18	1997	0.6%	Pinhas-Hamiel & Zeitler, 2005[15]
		2000	1.9%	
Thailand	0-14	1987-1996	5%	Likitmaskul et al, 2003[26]
		1997-1999	17.9%	
India	0-19	2005-2007	6%	Unnikrishnan et al, 2008[5]
Canada	<18	2002	4%	Zdravkovic et al, 2004[27]
Hong Kong	0-14	1984-1996	7.3%	Huen et al, 2000[21]; Huen et al, 2009[6]
	0-19	1997-2007	47%	
Taiwan	6-18	1992-1999	54.2%	Wei et al, 2003[8]
Japan	6-15	1974-2004	80%	Urakami, 2007[3]
Austria	<15	1999-2001	1.6%	Rami et al, 2003[28]
United Arab Emirates	<18	1990-1998	12.5%	Punnose, 2002[29]
USA, Montana + Wyoming	<20	1999-2001	70%	Moore et al, 2003[30]
New York	<18	1999	12%	Grinstein et al, 2003[31]
		2000	50%	
Cincinnati	10-19	1982-1992	2-4%	Pinhas-Hamiel et al, 1996[32]
		1994	33%	

Table 3 Prevalende of overweight and obesity in Hong Kong

	1993	2005/2006
Boys		
Overweight*	10.4%	15.8%
Obesity*	3.4%	5.1%
Girls		
Overweight*	7.7%	10.1%
Obesity*	1.8%	2.4%
Total		
Overweight*	9.3%	13%
Obesity*	2.6%	3.7%

*IOTF cutoffs

Adapted from So et al, BMC Public Health, 2008;8:320[33]

impaired glucose tolerance in 1.6 per 100,000 children over 10 years of age (Dr KH Mak, School Health Service, personal communication). However, children and adolescents with type 2 diabetes who are not obese will not be detected by this programme. The sensitivity of glycosuria in the screening for diabetes is low. Although the cost of urine test is low, it was estimated that the cost for identifying a youth with glycosuria was US$4028 to US$10,000.[1,8]

The American Diabetes Association recommends screening for diabetes in obese adolescents (BMI >85th percentile) and presence of family history of type 2 diabetes and signs of insulin resistance (acanthosis nigricans, dyslipidaemia, hypertension and polycystic ovary syndrome) by performing a fasting blood glucose every two years.[35] Impaired fasting glucose is defined as a fasting glucose 5.7-6.9% mmol/L. Fasting blood sugar is highly correlated with repeated measurements but the reproducibility of oral glucose tolerance test is poor[36] and HbA1c determination is not significantly sensitive. The blood sugar two hours after glucose challenge has been suggested to be more sensitive for the diagnosis of diabetes and impaired glucose tolerance.[37] In a cohort of 180 obese Chinese adolescents (mean age 10.5±3.4 years and BMI of 28.6±4.7 kg/m^2), asymptomatic diabetes was found in 2.7% and impaired glucose tolerance was found in 15.5% of patients (by oral glucose tolerance test).[38] As the prevalence of type 2 diabetes in youth remains relatively low, it may not be cost-effective to perform universal screening. Even for targeted screening adopted in Hong Kong, it remains to be proven that screening and early detection of type 2 diabetes in adolescents will improve outcome. Follow-up studies and some form of cost analysis is required to assess the urine glucose screening programme in Hong Kong school children.

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