Prevalence of Type II Diabetes and Metabolic Syndrome among Overweight School Children in Khon Kaen, Thailand†

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Background: *Childhood obesity has been accompanied by an increase in the prevalence of type 2 diabetes mellitus (T2DM) and metabolic syndrome (MetS) among children and adolescents worldwide.*
Objective: *To determine the prevalence of T2DM and MetS among overweight children and adolescents in Khon Kaen province, Northeast Thailand.*
Material and Method: *A cross-sectional, prospective pilot study was performed in school children between 10 and 15 years of age. The weight and height measurements and body mass index (BMI) calculations for 2,156 school children were analyzed. The BMI for the age and sex value at $\geq 85^{th}$ percentile was considered overweight and the overweight children were evaluated for family history of diabetes, signs of insulin resistance, plasma fasting glucose and lipid level.*
Results: *Five hundred and ninety four (27.6%) overweight children were identified, of whom 186 (31.3%) participated in the present study. T2DM was documented in 4 (2.2%) while MetS was documented in 6 (3.2%) children. At least one type of dyslipidemia was found in 87 (46.8%) children.*
Conclusion: *T2DM and MetS are common among overweight school children in Khon Kaen, Thailand. Preventive interventions to reduce overweight and consequently prevent T2DM in Thai children should be provided at school and the community level.*

Keywords: *Overweight, Type 2 diabetes, Metabolic syndrome, Prevalence, School children*

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Type 2 diabetes mellitus (T2DM) and metabolic syndrome (MetS), long considered diseases of older adults, are now affecting a growing number of children[1-4]. Obesity, the primary risk factor for T2DM, has become epidemic, affecting the children in both developed and developing countries[5,6]. The highest prevalence of T2DM in youths was 3.8% in males and 5.3% in females of the Pima Indians[7]. Between 1990 and 1998, in the capital Bangkok, the prevalence of overweight among school children between 5 and 15 years of age varied from 5.8 to 32.3%, while the prevalence of T2DM among diabetic children in Siriraj Hospital, one of the tertiary hospitals increased from 5 to 17.9% between 1996 and 1999[8-10]. These trends coincide with a rising prevalence of overweight and physical inactivity. There is no data available on the incidence or prevalence of T2DM and overweight for children in northeast Thailand. The authors, therefore performed a cross-sectional, prospective, pilot survey among school children between 10 and 15 years of age to ascertain the prevalence of T2DM and MetS among overweight children and adolescents in Khon Kaen province, Northeast, Thailand.

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Material and Method

In 2006, the authors analysed the weight (Wt) and height (Ht) measurements and the body mass index (BMI) calculations of 2,156 school children

between 10 and 15 years of age at Khon Kaen University Demonstration School, Khon Kaen province, Northeast Thailand. The BMI for age and sex value greater than or equal to the 85th percentile is considered overweight while one greater than or equal to the 95th percentile is considered obese. Overweight children who met these criteria were evaluated for a family history of DM and hypertension, blood pressure measurement, physical examination for acanthosis nigricans (AN) and screened for T2DM and dyslipidemia using fasting plasma glucose (FPG) and lipid levels [total cholesterol, high density lipoprotein (HDL), low density lipoprotein (LDL) cholesterol and triglyceride (TG)]. The oral glucose tolerance test (OGTT) was performed in overweight children with abnormal FPG. Hemoglobin A1c (HbA1c) and serum insulin level were evaluated in children diagnosed with T2DM. The Khon Kaen University Human Investigation Committee approved the present study, and written, informed consent from parents and assent from children were obtained.

Definition of hypertension

Blood pressure was measured with a mercury sphygmomanometer, pre-hypertension and hypertension were classified using the blood pressure-for-height cutoff points: -pre-hypertension greater than or equal to the 90th percentile, and hypertension greater than or equal to the 95th percentile, using the average of two measurements[11].

Definition of type 2 diabetes and metabolic syndrome

T2DM was defined as a FPG of $\geq$ 126 mg/dL or a two-hour glucose tolerance plasma glucose level of $\geq$ 200 mg/dL[12,13]. MetS in the present study was defined as overweight or obesity according to the BMI criteria plus any two of the following: triglyceride $\geq$ 150 mg/dL, HDL cholesterol $\leq$ 40 mg/dL, hypertension and impaired FPG between 101-125 mg/dL[14].

Statistical analysis

Data are presented as numbers, percentages for overweight and obesity. Statistical analyses of BMI, plasma glucose and lipid levels were performed using the mean $\pm$ SD (M $\pm$ SD).

Results

Five hundred and ninety four (27.6%) overweight children were identified, of whom 186 (31.3%) participated in the present study. T2DM was documented in 4 (2.2%) while MetS without abnormal plasma glucose was documented in 6 (3.2%) children, all of them had dyslipidemia. At least one type of dyslipidemia was found in 87 (46.8%) children (Table 1, 2). All had normal insulin level. Table 3 shows clinical characteristics of the 4 children with T2DM.

Discussion

In 2000, the ADA developed specific guidelines to identify children at risk of T2DM. Children who are overweight (BMI > 85th percentile) and having any two of the following risk factors: ethnic minority (including Asians), positive family history, and signs of insulin resistance or associated conditions (AN, hypertension, polycystic ovarian syndrome) are at risk and should be referred for DM testing[15]. The prevalence of overweight and obesity in the present study is consistent with the increasing prevalence reported among children in Thailand[10]. About one fourth of school children the authors surveyed were overweight and about one half of the overweight children are at risk of developing T2DM according to the ADA guidelines. Unlike T1DM, manifestations of T2DM in most children are usually mild or asymptomatic with micro- and macrovascular complications already present at diagnosis; thus, the occurrence of this disease is believed to be underestimated with a small number of ketosis and almost all having clinical feature of MetS[16,17]. It has been shown that T2DM diagnosed before 20 years of age is associated with substantially increased risk of end stage renal disease and mortality in middle age[18]. Only one in four T2DM children in the present study had the mild symptoms of diabetes, while two out of four had a family history of T2DM and acanthosis nigricans and all had at least one form of dyslipidemia, which indicated the risk of vascular complications. Moreover, about 87 (46.8%) of the overweight children had at least one form of dyslipidemia, a criterion for MetS and a risk factor of cardiovascular disease. For MetS, multiple definitions of MetS were proposed for children, adolescents and adults. The prevalence of the MetS varied significantly between 6% and 39% depending on the different definitions , only 2% of the children fulfilled the criteria of MetS in all definitions[19]. The authors modified the new worldwide definition of dyslipidemia in MetS from the International Diabetes Federation (IDF)[14] and 3.2% of MetS were documented. Many studies suggested considering the waist circumference, a marker of abdominal obesity as an important component of the pediatric MetS definition. Unfortunately, data on obesity by waist circumference (WC) are not available for Thai children during the present study. In 2008, WC

Table 1. History of diabetes in the family and signs of insulin resistance in 186 overweight children

	Overweight (%)	Obesity (%)	Total (%)
Number of children	153 (82.3)	33 (17.7)	186 (100.0)
History of T2DM in family	95 (51.0)	20 (10.8)	115 (61.8)
Acanthosis nigricans	79 (42.4)	20 (10.8)	99 (53.2)
Hypertension			
Pre-hypertension	38 (20.4)	7 (3.8)	45 (24.2)
Hypertension	11 (5.9)	5 (2.7)	16 (8.6)

Table 2. Mean ± SD of plasma lipid and glucose, dyslipidemia and abnormal plasma glucose in 186 overweight children

	Mean ± SD (mg/dL)	Dyslipidemia*, n (%)	Abnormal plasma glucose, n (%)
Total cholesterol	140.1 ± 37.9	45 (24.2)	
HDL cholesterol	53.2 ± 11.9	19 (10.2)	
LDL cholesterol	101.4 ± 31.3	31 (16.7)	
Triglyceride	92.4 ± 45.8	52 (28.0)	
Plasma glucose	87.9 ± 28.9		
Impaired FPG			2 (1.1)
T2DM			4 (2.2)

* Dyslipidemia: total cholesterol ≥ 200 mg/dL, HDL cholesterol ≤ 40 mg/dL, LDL cholesterol ≥ 130 mg/dL, triglyceride ≥ 150 mg/dL
Dyslipidemia in MetS includes hypertriglyceridemia and low HDL level

Table 3. Clinical characteristics of the 4 children with T2DM

Age (years)	Sex	Family history of DM	BMI (kg/m^2)	AN	DM symptoms	HT	Dyslipidemia at least one lipid
12	M	Yes	23.2	No	No	No	Yes
10	F	No	24.3	No	No	No	Yes
11	F	No	21.2	Yes	No	No	Yes
12	F	Yes	21.8	Yes	Yes	No	Yes

M = male, F = female, BMI = body mass index, AN = acanthosis nigricans, HT = hypertension

measurements in 509 Thai adolescents, aged 10-18 years were performed. WC risk threshold for predicting the overweight adolescents was 73.5 cm for boys and 72.3 cm for girls. WC was increased to 75.8 cm for boys and 74.6 cm for girls in order to detect the obese children but the relationship between the increased WC and metabolic risk factors for obesity has not been studied yet[20]. In high-risk adults T2DM and MetS can be prevented by changes in lifestyle and the risk reduction remains after discontinuation of active counseling[21]. The present study indicates it is imperative to identify children at risk of T2DM and MetS as early as possible, and offer them counseling. To prevent these metabolic disorders with their complications, a school-based universal health screening program is necessary to provide an optimal environment for early detection and surveillance of obesity and related risk factors.

Conclusion

The prevalence of T2DM and MetS among overweight school children are 2.2 and 3.2% respectively. To prevent these metabolic disorders, all interventions to decrease the prevalence of

overweight among the youth should be conducted for all school children in Thailand.

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ความชุกของเบาหวานชนิดที่ 2 และกลุ่มอาการเมตาบอลิกในเด็กนักเรียนที่มีน้ำหนักเกินในจังหวัดขอนแก่น

อวยพร ปะนะมณฑา, นพรัตน์ ธรรมศิริ, มนัส ปะนะมณฑา

***ภูมิหลัง**: ภาวะอ้วนในวัยเด็กสัมพันธ์กับการเพิ่มความชุกของเบาหวานชนิดที่ 2 และกลุ่มอาการเมตาบอลิกในวัยเด็กและวัยรุ่นทั่วโลก*

***วัตถุประสงค์**: เพื่อศึกษาความชุกของเบาหวานชนิดที่ 2 และกลุ่มอาการเมตาบอลิกในเด็กและวัยรุ่นที่มีน้ำหนักเกินในจังหวัดขอนแก่น ซึ่งอยู่ภาคตะวันออกเฉียงเหนือของประเทศไทย*

***วัสดุและวิธีการ**: การศึกษาแบบตัดขวางไปข้างหน้าในเด็กนักเรียนที่มีอายุระหว่าง 10 ถึง 15 ปี จำนวน 2,156 คน โดยการชั่งน้ำหนักและวัดส่วนสูง คำนวณหาค่าดัชนีมวลกายเทียบกับอายุและเพศ ค่าดัชนีมวลกายที่มากกว่าเปอร์เซ็นต์ไทล์ที่ 85 ถือว่ามีน้ำหนักเกิน เด็กที่มีน้ำหนักเกินจะได้รับการซักประวัติโรคเบาหวานชนิดที่ 2 ในครอบครัว ตรวจหาภาวะดื้อต่ออินซูลินและตรวจวัดระดับน้ำตาลและไขมันในเลือดขณะอดอาหาร*

***ผลการศึกษา**: พบเด็กที่มีน้ำหนักเกินจำนวนทั้งสิ้น 594 คน (ร้อยละ 27.6) เด็กจำนวน 186 คน (ร้อยละ 31.3) เข้าร่วมการศึกษา เด็ก 4 คน (ร้อยละ 2.2) ได้รับการวินิจฉัยเป็นเบาหวานชนิดที่ 2 เด็ก 6 คนหรือร้อยละ 3.2 พบกลุ่มอาการเมตาบอลิก ส่วนระดับไขมันผิดปกติอย่างน้อย 1 ชนิดพบในเด็ก 87 คน (ร้อยละ 46.2)*

***สรุป**: เบาหวานชนิดที่ 2 และกลุ่มอาการเมตาบอลิกพบได้บ่อยในเด็กนักเรียนที่มีน้ำหนักเกินในจังหวัดขอนแก่น จึงควรหามาตรการป้องกันและลดภาวะน้ำหนักเกินในระดับโรงเรียนและชุมชน เพื่อป้องกันเบาหวานชนิดที่ 2 ที่เกิดตามมาได้*