Reduced Arterial Compliance Associated with Metabolic Syndrome in Chinese Children and Adolescents[1]

BO XI [#,+], LI ZHANG[#], AND JIE MI [#,2]

[#]*Department of Epidemiology, Capital Institute of Paediatrics, Beijing 100020, China;* [+]*Graduate School, Peking Union Medical College, Beijing 100730, China*

Objective To explore the metabolic syndrome and its association with arterial compliance in Chinese children and adolescents. **Methods** 337 participants aged 6 to 18 years with males accounted for 55.8% were grouped according to their traits of metablic syndrome. Anthropometry, blood pressure, fasting plasma glucose, insulin and serum lipid profile were measured. Homeostasis model was assessed and insulin resistance (HOMA-IR) index was measured and calculated for estimating individual insulin resistance. Arterial compliance was also measured using digital pulse wave analyzing method (Micro medical, London), and stiffness index was calculated. **Results** The stiffness index in participants with metablic syndrome was significant higher than that in participants with no riskof metablic syndrome [(7.69±1.63) *vs* (6.25±0.86) m/s, $P<0.01$] and stiffness index and HOMA-IR were progressively increased with the increase of traits of metablic syndrom (P for linear trend <0.001). After gender, age, and pubertal development were adjusted, both traits of metablic syndrome and HOMA-IR were correlated positively with stiffness index (both $P<0.05$). **Conclusion** The clustering of metablic syndrome was closely associated with risk at increased arterial stiffness in Chinese children and adolescents. It was suggested that arterial compliance assessment of children and adolescents might be an important measure for prevention of cardiovascular diseases.

Key words: Metabolic syndrome; Arterial compliance; Children and adolescents

INTRODUCTION

The metabolic syndrome (MS), i.e. the clustering of central obesity, dyslipidemia, hypertension, elevated fasting glucose levels, and insulin resistance, increases the risk of cardiovascular diseases (CVD) and type II diabetes mellitus[1-2]. Arterial compliance, which has relationship with the risk of cardiovascular disease, is an independent predictor for CVD and its mortality[3-4]. Recent studies look at pathological changes of blood vessels, especially the changes of blood vessel wall which is fundmental to the development of CVD. An adverse association between MS and arterial compliance was observed in adults[5-6]. However, the relevant researches in children and adolescents are lacking. At present, more and more young people are affected by CVD, which has become a trend worldwide. Therefore, it is particularly needed to conduct relevant studies to explore whether the presence of MS represents an increased risk at vascular disease in children and adolescents. Thus, as a sub-components of the Beijing Child, and Adolescent Metabolic Syndrome Study, a cross-sectional survey was carried out in Chinese children and adolescents in 2004 in order to examine the negative impact of MS on arterial compliance. In this study, digital volume pulse (DVP), a recently developed simple and reliable automatic technique, was used for the measure of arterial compliance.

MATERIALS AND METHODS

Participants

337 participants aged 6 to 18 years with males accounted for 55.8% were recruited for the survey representing a sample of more than 20 000 Chinese children and adolescents aged 6 to 18 years in Beijing. The survey was conducted from April to October 2004. Body weight, height, waist circumference (WC), and blood pressure were measured. Fasting finger-stick capillary samples were collected and used to determine the concentration of blood glucose

[1]Foundation:The study was supported by the National Nature Science Foundation in China (30872165), the Beijing Municipal Nature Science Foundation (7072011) and Beijing Municipal Science & Technology Commission (D08050700320801, H030930030031).

[2]Correspondence: Dr. Jie MI, Department of Epidemiology, Capital Institute of Paediatrics, No. 2 Yabao Road, Chaoyang District, Beijing 100020, P.R.China. Tel: 86-10-8569-5591; Fax: 86-10-8563-2799; E-mail: jiemi@vip.163.com

Biographical note of the first author: Bo XI, male, born in 1980, Ph. D. candidate in Public Health at Peking Union Medical College, majoring in epidemiology. E-mail: swei006@163.com

0895-3988/2010
CN 11-2816/Q

and lipid using ACCUTREND GCT (Roche y Diagnostics Shanghai Ltd., China). Then, the children at high risk were identified by the screening criteria (Table 1).

TABLE 1

Screening Criteria for Children at High Risk of and The Definition of MS

Screening Criteria for Children at High Risk (Any One of the Followings)	Definition of MS (Three and above the Followings)
1. Obesity: BMI≥85th percentile (in accordance with age and gender-specific BMI reference norm in China[8]).	1. Central Obesity: Waist circumference≥90th percentile (in accordance with the results from Child Metabolic Syndrome Study in Beijing,China)
2. Hypertension: SBP and/or DBP≥90th percentile (in accordance with the results from a study conducted in 1987 in Beijing, China[9]).	2. Hypertension: SBP and/or DBP≥90th percentile (in accordance with the results from Child Metabolic Syndrome Study in Biejing, China)
3. Dyslipidemia: Fasting finger-stick capillary TC≥5.2 mmol/L (190 mg/dL) or TG≥1.7 mmol/L (150 mg/dL).	3. HDL-C≤1.03 mmol/L (40 mg/dL)
4. Fasting finger-stick capillary glucose≥5.6 mmol/L.	4. Hypertriglyceridemia: triglycerides≥1.24 mmol/L (110 mg/dL)
	5. Fasting plasma glucose≥5.6 mmol/L

Children at the high risk were divided into three groups (1 component, 2 components, 3 or more components of MS) and one control group in accordance with definition of MS[7] (Table 1). Participants and/or their parents or guardians were all informed and consent to the study, and the study was approved by the Ethics Committee of Capital Institute of Pediatrics.

Physical Examination

Body weight, height, and WC were measured twice and the average values were used. Blood pressure was measured on right arm in a relaxed, sitting position and, systolic blood pressure (SBP) and diastolic blood pressure (DBP) levels were defined with the first and fourth Korotkoff sounds, respectively. The pubertal development was assessed by the Tanner 5-phase method. The development of penis of male participants and the breast of female participants were measured for phase definition of the pubertal development.

Blood Biochemistry

Participants were informed to fast for 12 hrs before taking part in the examination. Fasting blood samples were collected to measure levels of fasting plasma glucose (FPG), fasting plasma insulin (FIN), triglycerides (TG), serum total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C). FPG levels were analyzed using a standard glucose oxidase method. FIN was measured using the enzyme linked immunosorbent assay[10]. Levels of serum TC, HDL-C, and TG were measured using standard enzymatic methods. LDL-C was calculated from the Friedewald formula. Glucose and lipid levels were determined by the Hitachi 7 170 Automatic Analyzer. FIN levels were measured at the Peking Union Medical College Hospital. Insulin resistance (HOMA-IR) index was determined to estimate individual insulin resistanceusing the formula: HOMA-IR = [FIN (mU/L) × FPG (mmol/L)] /22.5.

Arterial Compliance Measurement

Arterial compliance was measured by digital pulse wave analyzing method, using a new non-invasive automatic device (Pulsetrace 2 000, Micro Medical, UK). Photophethysmographic digital volume was determined by using an infrared light-emitting diode (940 nm) and phototransistor applied to either side of the index finger of the right hand. The signal from the phethysmograph was digitized using a 12-bit analogue-to-digital converter with a sampling frequency of 100 Hz. Software developed in-house was used to provide an objective measurement of stiffness index (SI). The waveforms were recorded over a 10 s period and ensemble averaged to obtain a single waveform, whose $\triangle T$ was determined as the time between the first systolic peak and the early diastolic peak/inflection point in the waveform. This point was defined as the point at which the first derivative of the waveform was closest to zero. SI was calculated from subject height and $\triangle T$: $SI = h/\triangle T$ (Fig. 1). SI was correlated negatively with arterial compliance[11-13]. Each subject was examined for three times to get the mean value of SI.

Reproducibility

In order to explore repeatability and stability of the digital pulse wave analyzing method in Chinese people, arterial compliance of the participants was measured three times in a day with a 3 minutes