

definition, International Diabetes Federation (IDF) consensus was developed in 2007 to define metabolic syndrome in children and adolescents [14]. The IDF definition is divided into age groups due to the age related differences in blood pressure, lipid levels, and body size in children and adolescents [14]. As there was insufficient data available in younger children, the definition of metabolic syndrome is only applicable in children of 10 years of age and older. Metabolic syndrome was defined as the presence of, abdominal obesity and 2 or more of these criterias (elevated triglycerides, low level of high density lipoprotein-cholesterol, high blood pressure and high fasting plasma glucose). With this new definition, few studies have reported the prevalence of metabolic syndrome in their population [7,15-17].

Previous studies had shown associations between certain behavioral characteristics and obesity as well as metabolic syndrome. For example, short sleep duration has been associated with overweight, obesity and metabolic risk factor [18-20]. A study by Chen et al. has shown that adequate sleep is associated with good health status and adoption of health-related behavior [21]. Prolonged screen time [22,23] and physical inactivity [24,25] however had been identified to be inversely related to metabolic syndrome and its risk factors. These two factors may impose a major problem to the country as it has been recently found that about 64% of Malaysian adolescents are physically inactive [26].

Data regarding the prevalence of metabolic syndrome amongst Malaysian adolescents and their behavioral characteristics is still lacking. Realizing the importance of such data and the health implications, a population based study was conducted to determine the prevalence of obesity, and metabolic syndrome and its risk factors among Malaysian adolescents.

Methodology

Ethics statement

The study received ethical approval from the Medical Ethics Committee, University Malaya Medical Centre (IRB Refence number 896.34)

Study design

This study was done in conjunction with the Malaysian Health and Adolescents Longitudinal Research Study (MyHeARTs), an on-going prospective longitudinal cohort study on risk factors for chronic non-communicable diseases among adolescents. The details of the study has been described previously [27].

This study was conducted in three states in the northern and central zone of Peninsular Malaysia - Perak, Selangor and Wilayah Persekutuan Kuala Lumpur. Participants comprised of both male and female students, aged 13 years old, who were in their first year of the public

secondary school (Form 1) and able to read and understand the national language of Malaysia, which is Bahasa Melayu. Participants from boarding, religious and vernacular schools were excluded from the study as they were not representative of the majority of students in Malaysian schools. The total sample size calculated for this study was 1500, using the formula $n=(z^2.p.q/r.e^2r$

(m²) and expressed as kg/m². Waist circumference was measured using ergonomic circumference measuring tape (Seca 201, Seca, UK), measured at the midpoint between the lowest rib margin and the iliac crest and recorded in the nearest 0.1 centimetre. Blood pressure was measured using mercurial sphygmomanometer (Spirit CK-101C, Spirit Medical Co., Taiwan) and stethoscope after a 5 minutes rest, in a seated position with the right upper arm positioned at the heart level and the feet flat on the ground [28]. Body fat percentage was measured using a portable Body Composition Analyzer (Tanita SC-240, Tanita, Japan) and expressed by percentage (%).

Biochemical analysis

Venous blood samples were taken after an overnight fast for at least ten hours prior to the study visit. Blood samples were collected by a trained phlebotomist and medical officers. Approximately 2 mls of blood was collected into sodium fluoride test tube for the measurement of fasting blood glucose. Another approximately 3 mls blood sample was collected in a plain test tube for the measurement of fasting lipids (triglyceride, total cholesterol, high density lipoprotein-cholesterol (HDL-C) and low density lipoprotein cholesterol (LDL-C). All blood samples were properly labelled and transported to a private certified central laboratory for analysis.

Definitions

Overweight and obesity was defined using the IOTF cri-

Table 5 shows that participants who slept between 7 and 9 hours a day had a lower risk of developing metabolic syndrome, OR 0.38 (0.15-0.94). This factor was found to be independently associated with metabolic syndrome after controlling for screen time and physical activity. Analysis was also carried out for the association between screen time and physical activity with metabolic syndrome but no significant associations were found (results not shown).

Discussion

This research studied the 13 years old adolescents attending the public schools in both rural and urban areas in Malaysia. The majority of the students were of

Malay ethnicity followed by Chinese and Indians reflecting the ethnic population of the country [30]. The majority of the participants in this study were females, by voluntary enrolment, although the gender of the students in each state were equally distributed [31].

This study revealed that the prevalence of overweight and obesity was high at 25.4% whereby 16.0% were overweight and 9.4% obese. A study by Ismail et al. had shown an increase in the prevalence of overweight and obesity in

[46,47]. Many studies have shown a U-shaped association between sleep duration and weight gain, whereby both short duration and long duration of sleep leads to weight gain [19-21,44,45]. However, the relationship between sleep duration and metabolic syndrome remains controversial. In adults, several studies have shown a relationship between both short and long sleep duration with metabolic syndrome [48,49]. Studies regarding sleep duration and metabolic syndrome in adolescents are few and have not shown any association

45. Bawazeer NM, Al-Daghri NM, Valsamakis G, Al-Rubeaan KA, Sabico SL, Huang TT, Mastorakos GP, Kumar S: **Sleep duration and quality associated with obesity among Arab children.** *Obesity* 2009,

