

## Inactivity Physiology—The Anthropometric and Blood Parameters of Singaporean Youths

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**THE ANTHROPOMETRIC** and blood parameters of 229 Singaporean adolescent youths, aged 13–15 recruited from seven secondary schools, were examined. Out of these youths, 71.5% were of healthy weight, 14.7% were underweight, 8.9% were overweight and 4.9% were obese, based on the BMI-for-age for adolescents set by the Ministry of Education. Health measurements like waist circumference, resting blood pressure and blood parameters—triglycerides, high-density lipoprotein, blood glucose derived from a fasted state, and insulin resistance—were obtained in accordance to standard international protocols. Clustered metabolic risk was used to quantify participants who were at significant risk of metabolic syndrome. Twenty-seven or 11.8% were identified as at-risk of metabolic syndrome. CMR was significantly associated with body mass, waist circumference, resting systolic and diastolic blood pressure, fasted blood triglyceride, and fasted blood glucose. CMR was also moderately associated with IR. Waist circumference, percentage of body fat, and blood triglycerides and resting blood pressure were significantly correlated with IR. From the study, it was found that poor metabolic health is a concern among adolescent youths in Singapore, not only in those who were overweight or obese, but also in those who are of normal weight and underweight.

### INTRODUCTION

Singapore has one of the highest rates of Type II or adult-onset diabetes in the world. Poor metabolic health is a primary course

### KEY IMPLICATIONS

- Results suggest that improving metabolic health among youths should involve youths of all weight status since youths of underweight and normal weight can also be insulin resistant.
- Adolescent youths need to be less sedentary and take every opportunity to be physically active throughout the day. This must be over and beyond the formal periods of physical education.
- Findings should be disseminated so that these data could be utilized as the evidence-based studies in health and physical education and exercise physiology.

of premature death, decreased quality of life, more diseased years of life in the adult lifespan, and increased healthcare costs to the country. Emergent evidence among adult Singaporeans suggests that overweight and obese youths are at higher risk of having poor metabolic health where indicative conditions such as hypertension and hyperlipidaemia are predictive of future heart disease and some cancer forms in adulthood.

Metabolic syndrome is a proxy indicator for poor metabolic health, which is also known as Syndrome X, the insulin resistance (IR) syndrome and the deadly quartet. It is a disorder defined by a set of metabolic abnormalities and is caused by the increased prevalence of obesity.

Research on 201 severely obese children in Singapore showed that 26.4% had elevated liver transaminases and hence were at risk for non-alcoholic fatty liver disease. Increased waist-hip ratio, reduced physical activity, IR and elevated triglyceride levels were found to be significant predictors for the elevated liver transaminase.

In the extant literature, there is some agreement that clustered risk factors could be used as a surrogate indicator for metabolic syndrome. Clustered risk factors (CRF) for metabolic syndrome as defined by Alberti et al. (2009) include summing the z-scores for the five metabolic abnormalities—elevated resting blood pressure, low levels of high-density lipoprotein, elevated waist circumference, elevated triglycerides, elevated fasting blood glucose—and identifying individuals with more than 1 standard deviation (SD) in this score.

Other researchers have advocated that IR is a more sensitive predictor for metabolic syndrome. IR is

estimated according to the homoeostasis model assessment (HOMA) as the product of fasting glucose (mmol/L) and insulin ( $\mu\text{U/ml}$ ) divided by the constant 22.5 (Matthews et al., 1985).

Studies conducted in China and Italy showed that obese children were more insulin resistant when compared to controls and that the severity of fatty liver was positively associated with BMI, waist and hip circumference, and insulin resistance. The consensual view is that Syndrome X has its genesis in childhood and adolescence and if left untreated and intervened, becomes entrenched in adulthood.

Yong et al. (2006) reported that people in Asia tend to develop diabetes with a lesser degree of obesity at younger ages, suffer longer with complications of diabetes, and die sooner than people in other regions. They recommend urgent action and advocacy for lifestyle changes as the cost of inaction is clear and unacceptable.

Therefore, the purpose of the study was to examine the anthropometric and metabolic characteristics of Singaporean adolescent youths using internationally accepted criteria for Syndrome X.

## RESEARCH DESIGN

Institutional ethics clearance (DOER 20/09) for the study was granted and participants consist of 120 male and 109 female adolescents, aged 13–15 from seven secondary schools. Blood samples were obtained after an overnight fast and analysed at the National University Hospital of Singapore. (For the distribution of anthropometrical and biochemical measures, see Table 1.)

Table 1. Anthropometrical and biochemical measures by sex.

Participants	All	Male	Female
	229	119	109
Height (cm)	158.6 (8.2)	161.5 (8.5)	155.4 (6.4)*
Body mass (kg)	50.4 (11.6)	52.1 (12)	48.5 (10.9)
Body Mass Index (kg/m <sup>2</sup> )	19.9 (4.1)	19.9 (4.1)	20.0 (4.0)
Waist-to-hip ratio	0.8 (0.1)	0.8 (0.1)	0.7 (0.1)*
Cholesterol (mmol/L)	4.3 (0.9)	4.1 (0.7)	4.6 (1.1)*
Triglycerides (mmol/L)	0.8 (0.4)	0.8 (0.4)	0.9 (0.3)
Low density lipoprotein (mmol/L)	2.5 (0.8)	2.4 (0.6)	2.7 (1.0)
High density lipoprotein (mmol/L)	1.4 (0.3)	1.4 (0.3)	1.5 (0.3)
Fasting glucose (mmol/L)	5.0 (0.6)	5.0 (0.5)	5.0 (0.7)
Insulin (mU/L)	14.1 (9.0)	13.1 (10.3)	15.1 (7.1)
Insulin resistance (HOMA score)	3.2 (2.5)	3.0 (2.5)	3.4 (2.4)

\* $P < 0.05$  for sex differences

Z-scores were computed for the five metabolic abnormalities as described by Alberti et al. (2009) and summed up to construct a clustered metabolic risk score (CMR). Individuals with more than 1SD in this score were defined as being at-risk.

All statistical analyses were performed using Statistical Package for Social Science (SPSS). The independent student's *t*-test was used to evaluate between-sex comparisons. Homogeneity of variance between group data was established using Levene's test. The a priori significant alpha level chosen for all statistical tests was 0.05.

## KEY FINDINGS

Out of the 229 participants, 71.5% were of healthy weight, 14.7% were underweight, 8.9% were overweight and 4.9% were obese (see Figure 1) based on the BMI-for-age for children and adolescents set by the Ministry of Education.

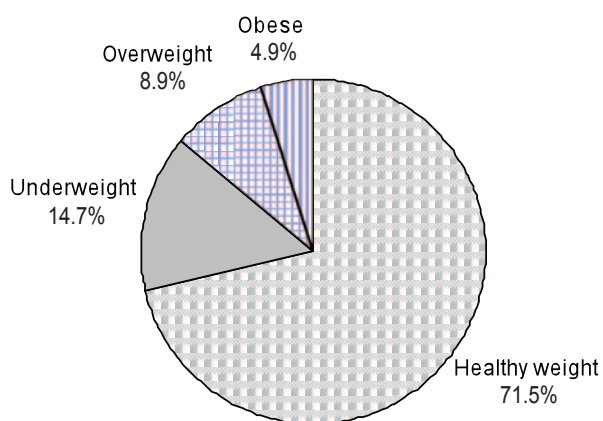


Figure 1. Distribution of underweight, healthy weight, overweight and obese Singaporean youths.

Health measurements like waist circumference, resting blood pressure and blood parameters—triglycerides, high-density lipoprotein, blood glucose derived from a fasted state, and IR—were obtained in accordance to standard international protocols. CMR defined by Albert et al. (2009) was used to quantify participants who were at significant risk of metabolic syndrome.

Additionally, IR was estimated according to the homoeostasis model assessment (HOMA) as the product of fasting glucose (mmol/L) and insulin ( $\mu$ U/ml) divided by the constant 22.5.

Results show that even underweight and normal weight Singaporean youths were found to be at

risk of metabolic syndrome (see Figure 2). Twenty-seven or 11.8% were identified as at risk of metabolic syndrome (CMR>1SD). Among these 27, 48% were of healthy body weight (12) or underweight (1), and the remaining 52% were either overweight (7) or obese (7).

CMR significantly associated with body mass, waist circumference, resting systolic and diastolic blood pressure, fasted blood triglyceride, and fasted blood glucose ( $r=0.54$ ;  $0.41$ ;  $0.67$ ;  $0.67$ ;  $0.45$  &  $0.48$ ; all  $p<0.05$ ). CMR was also moderately correlated with IR ( $r=0.53$ ;  $p<0.05$ ).

Waist circumference, percentage of body fat, and blood triglycerides and resting blood pressure were significantly correlated with IR ( $r=0.21-0.34$ ; all  $p<0.05$ ). Waist circumference could potentially be used as a surrogate indicator of IR among Singaporean adolescent youths.

## IMPLICATIONS

### For Practice

As Singaporeans appear to be more susceptible to metabolic diseases because of our genetic disposition, adolescent youths need to be less sedentary and take every opportunity to be physically active throughout the day. This must be over and beyond the formal periods of physical education.

This is especially so since a sedentary lifestyle is entrenched in adolescent youths in Singapore. Poor metabolic health is not just limited to those who are overweight or obese but also affects those who are of normal healthy weight and also those who are underweight.

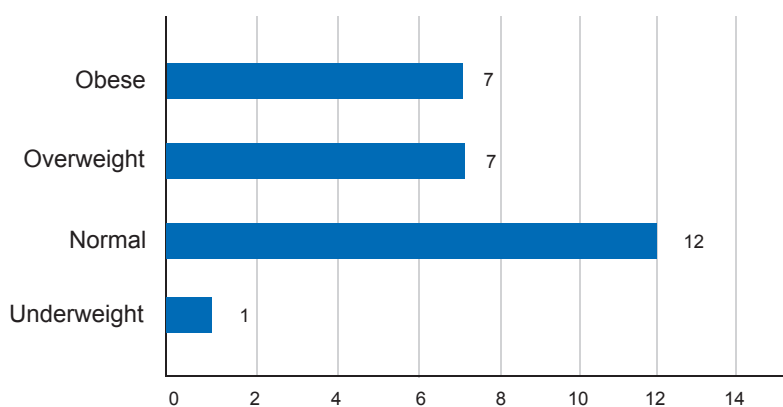


Figure 2. Distribution of Singaporean adolescent youths at risk of metabolic syndrome.

Results suggest that improving metabolic health among youths should involve youths of all weight status since youths of underweight and normal weight are also affected by IR.

### *For Teacher Training*

These findings should be disseminated so that these data could be utilized as the evidence-based studies in health and physical education and exercise physiology.

## REFERENCES

- Alberti, K. G. M. M., Heckel, R. H., Grundy, S. M., Zimmet, P. Z., Cleeman, J. I., Donato, K. A., ... Smith, S. C. Jr. (2009). Harmonizing the metabolic syndrome. *Circulation*, *120*, 1640–1645.
- Matthews, D. R., Hosker, J. P., Rudenski, A. S., Naylor, B. A., Treacher, D. F., & Turner, R. C. (1985). Homeostasis model assessment: insulin resistance and b cell function from fasting plasma glucose and insulin concentration in man. *Diabetologia*, *28*(7), 412–419.
- Yoon, K. H., Lee, J. H., Kim, J. W., Cho, J. H., Choi, Y. H., Ko, S. H., ... Son, H. Y. (2006). Epidemic obesity and type 2 diabetes in Asia. *Lancet*, *368*(9548), 1681–1688.

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