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CORONARY RISK APPRAISAL
IN SINGAPOREAN SCHOOL CHILDREN

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Introduction

In adults, pathological conditions associated with heart disease comprise the coronary risk factor model. In children, there is less conclusive evidence to support that children’s health follows the same coronary risk pattern. However, the presence of coronary risk factors in youth has been successfully tracked from childhood into adulthood (Freedman et al., 1984; Lerner & Kanner, 1986). Therefore, monitoring the risk factors associated with heart disease is important in understanding how coronary atherosclerosis can be reduced, especially through early detection in children.

Visceral obesity, insulin resistance and dyslipidemia comprise the syndrome called metabolic disease (Després, 1997). Syndrome X manifests itself in adults with the presence of four heart disease risk factors: hypertension, hyperlipidemia, diabetes and glucose intolerance. One the other hand, in children, one of the first indicators of coronary heart disease is obesity as measured by body fatness. Obesity has been classified as a predictor of hyperinsulinemia, dyslipoproteinemia, hypertension and premature onset of atherosclerotic plaque (American College of Sports Medicine [ACSM], 1995).

One common understanding among physical education specialists is that improved fitness is a positive benefit for disease prevention, especially in terms of cardiorespiratory function, reduced coronary heart disease (CHD), decreased mortality as well as psychological considerations such as enhanced well-being, decreased anxiety and depression (ACSM, 1995).

A number of global landmark studies have documented that physical activity and CHD are inversely related. (Schmidt et al., 1997a; Kikuchi et al., 1992). Lifestyle behaviours affecting physical activity patterns and coronary risk factors are continually being studied by health and physical educators (Aaron & Laporte, 1997). The implications from these studies consistently point to decreasing youth physical activity, more sedentary living and increasing obesity along side sociological and behavioural factors related to stress in schools, scholastic pressures and more accessibility to modern conveniences such as television, computers and information technology.

There is a growing body of research that reports association between coronary risk factors and the control of metabolic disorders with increased physical activity. Research also indicates that physical activity has a preventive effect in the control of obesity. As stated by Kriska and Casperson (1997), “recognition of the importance of physical activity to the nation’s health has also influenced all public health research; most population studies that examine chronic disease incorporate the assessment of physical activity into their study design” (p. 55). It is with concern for identification of risk factors in Singaporean children and to provide greater understanding of Asian patterns that the present investigation was designed.

Singapore provides an ethnic population mix of three racial groups: Chinese, Malay and Indian with the balance of mixed or unknown heritage. In addition to the diversity of racial groups, the Singaporean populations tend to associate in their cultural heritage and live, eat and marry within their respective ethnic groups. This makes environmental factors easier to study because the Singapore population can then be studied as a common entity or separately as three racial assemblies.
THE STUDY

Purpose of study

The present study documents coronary risk factors including blood pressure, lipid and lipoprotein concentrations, body fat and physical activity patterns in a cross-sectional population of children in Singapore. Field-based research provides the opportunity to study children in their natural environment with less interference to the curriculum and allows a large pool of children to be readily assessed. In this study, 15 schools throughout Singapore were invited to participate to determine baseline measures of coronary risk factors that could be tracked over several years.

Subjects

This study included 1802 children (826 boys [45.8%] and 976 girls [54.2%]) who with their parents gave informed consent for all testing procedures. The racial mix of this group was 81.9 percent Chinese, 8.7 percent Malay and 5.3 percent Indian with the remaining 4.1 percent of unknown or mixed heritage. Ethical approval for the study was provided by the School of Physical Education committee on Ethics involving Human Subjects. Ministry of Health and Ministry of Education permission was obtained for working with the individual schools and physical education teachers provided additional support needed to conduct a project of this magnitude.

Methods

On a Saturday morning in each of the schools, children who had fasted for 12 hours assembled in a classroom where they completed a survey of self-reported physical activities. They had measures of heart rate, blood pressure, height and weight taken immediately after filling out the activity forms. In separate venues for boys and girls and with trained research assistants of the same sex, body composition measures were made on eight skinfold sites, 10 circumferential girths and two bone widths. Following the anthropometry, children had their blood drawn by a sterile needle ‘lancet technique to the finger. Because each child had fasted, a packet juice drink was provided after completion of the blood draw. Blood was immediately centrifuged, packed on ice and transported to the School of Physical Education exercise physiology laboratory for analysis of plasma lipids, lipoproteins, triglycerides and glucose. Inter-reliability testing was performed at the Singapore General Hospital. Individual results were given to the physical education teacher for distribution to the child and the school received a composite profile of all participating children.

Determination of Overweight

The calculation of overweight in Singapore is 120 percent of the relative weight score; that is, the weight of the individual 20 percent in excess of the standard for a given height within the individual’s age and sex. There are well-recognised difficulties involved in using an arbitrary weight-for-height score particularly in determination of the proportion of obese persons calculated from the reference population (Dwyer & Blizzard, 1996).

Another measure of stature is the Body Mass Index (BMI) or the Quetelet’s Index which is the weight divided by the square of the height (measured in kilograms and meters, respectively). This scale is often used as the basis of comparison to norm-referenced standards. Between cultures, further studies are needed in order to determine specific criterion for adult’s and children’s BMI for determination of the point where disease begins.

It was the intention of this research to provide a simple, yet accurate method of assessment of site specific body composition for determination of percent body fat. Two skinfold equations were used that did not require removal of subject’s clothing. Several equations have been derived in western populations for Caucasian children and have been validated in Chinese populations for children (Deurenberg & Wang, 1997). Equations (Janz et al., 1993) used for this study were:

for boys \( \% BF = 0.735 \times (\text{triceps + calf}) + 1.0 \ (SE = 3.8) \) and
for girls \( \% BF = 0.610 \times (\text{triceps + calf}) + 5.1 \ (SE = 3.8) \)
RESULTS AND INTERPRETATION

In the present study, 4.5 percent of the children were overweight (weight for height greater than 120 percent), however 9.3 percent had elevated predicted body fat percentage (greater than 25 percent for boys and greater than 30 percent for girls). The Ministry of Education announced in 1995 that the number of overweight children had dropped to 11.1 percent from a high of 15.1 percent in 1991. The mean (± S.D.) standard weight was 99.10 ± 16.86, indicating that this sample appears to adequately represent the standard weight-for-height distribution of the country. Perhaps, the lower number of overweight children represented school-selection sampling. The number of children with elevated percent body fat, may indicate a more accurate measure of assessing the body composition of this population.

Wang and Deurenberg (1996) asserts that prediction formulas from Western populations for body fat using skinfold measurements are acceptable and valid in the adult Chinese population. Employing skinfold callipers in assessment of body composition is not unique (Fu, Fung & Yang, 1995). In fact, most international fitness batteries such as the Asian Health Related Fitness Test, Eurofit, Physical Best, Fitnessgram and President’s Council on Physical Fitness and Sports include skinfold calliper assessment of percent body fat as a component (Schmidt & Kunalan, 1997). More general techniques, such as the waist circumference (Ko et al., 1996) and more extensive procedures, such as bioelectrical impedance, total body electrical conductivity and dual energy x-ray absorptiometry have been used to measure body fatness (Ellis, 1996). In the present investigation, the Pearson correlation coefficient between BMI and body fat was \( r = .65 \) (\( p < .001 \)). The Pearson correlation between weight-for-height and BMI was \( r = .81 \) (\( p < .001 \)) and between weight-for-height and body fat was \( r = .69 \) (\( p < .001 \)).

Blood Pressure

Few researchers have documented elevated blood pressure in children and therefore hypertension is not considered an epidemiological health problem for this age group. Alpert and Wilmore (1994) claimed that the relationship between physical activity and blood pressure is difficult to discern because blood pressure is related to both body size and hormone levels. In the present study, 17 children (less than one percent) had elevated systolic or diastolic blood pressure and only four had both. Elevated blood pressure is defined as less than the 90th percentile for age and sex. A population sample such as this provides normal blood pressure readings for adoption by agencies employing health standards. These data have been submitted to international journals (Schmidt et al., 1997a; 1997b) for world-wide distribution of normative standards for Singaporean children to sports scientists and pediatricians.

Blood Profile

CHD risk assessment for adults includes analysis of total cholesterol, high and low density lipoprotein, triglycerides and glucose as components of a blood profile due to the relationship of hyperlipidemia and hyperglycemia with heart disease (ACSM, 1995). No gender differences were found in this study and a total of 6.4 percent of children had elevated total cholesterol (greater than 180 mg·dl\(^{-1}\)), while 2.5 percent had elevated low density lipoprotein (greater than 130 mg·dl\(^{-1}\)), 1.4 percent had elevated triglycerides (greater than 180 mg·dl\(^{-1}\)), and 0.2 percent had high glucose (greater than 160 mg·dl\(^{-1}\)). The relatively low number of children with blood plasma problems seemed proportionate to the low number with elevated body fat or high blood pressure. As a population, it is reassuring to know that there is a low incidence of adult coronary risk factors. However, on an individual basis, for those children whose total cholesterol was elevated, prudence in diet is warranted to assess the long-term prognosis for development of CHD.

Physical Activity Patterns

When asked to give their own assessment of their physical activity, there appeared to be a clear demarcation between those who identified themselves as sedentary or low active and those who were moderate to high active. Boys indicated that they exercised harder than girls, whereas, girls stated that they participated in more “easy” exercises than boys. Consistently, children documented between three and four hours of daily television or video watching or computer usage. One noticeable trend was the rapid decline in girls’ annual participation in sports after 13 years and a less drastic decrease in sports
play for boys after 15 years. These trends appear to represent a lifestyle that is commonly anecdotally
documented: that is, as children become older, with greater access to computers and information
technology, a greater demand for academic excellence and more socio-economic benefits, these young
adults tend to decrease physical activity and increase sedentary lifestyle behaviours (Shepherd, 1997).

Research relating to children with particular attention to overweight

This study set out to document physical activity and coronary risk factor patterns in a school-based
population of Singaporean children. As a field-based study, there are many limitations that affect
cross-sectional sampling. Children from these schools were selected by the schools and may not
represent the entire pediatric population. In general, however, using a few key indicators of
comparison, it is possible to give a credible explanation of Singaporean school children’s health risk,
based on adult risk factor analysis.

The increasing incidence of obesity is documented by Ministry of Health (1995) officials, but the
measuring tools of their assessment have not incorporated the two compartment model, that is, fat and
fat-free mass. The Singapore weight-for-height index has been incorporated into the scholastic milieu
and appears to justify the criterion for entry into the Trim and Fit (TAF) scheme supported by the
Ministry of Education and the Ministry of Defence. Special programmes of weight management and
supplemental exercise are planned for those whose weight-for-height exceeds 120 percent of the
relative weight for that gender. Concerns related to the composition of the fat and fat-free mass have
not been raised and undue alarm has not spread due to lack of further testing. In the present study,
body mass index showed a strong to moderately strong relationship with the weight-for-height index
indicating that these three techniques are good measures of body composition.

In further presentations of this symposium, information will be disseminated regarding physiological
and biochemical differences between obese and non-obese adolescents. This paper explains on-going
research at the School of Physical Education involving intervention exercise programmes associated
with the TAF scheme in a government-aided Singapore school. The third paper explains the critical
element of self-perceptions of overweight children and weight management strategies designed for
these children. A common element between these two presentations will be that those children who are
overweight have physiological and psychological differences that have implications for school
intervention programmes.

The final presentation demonstrates a variety of simple to complex methodologies that are used in
measurement of body composition. From the simple scales readily available in schools, clinics and
pharmacies, to the sophistication of x-ray scanners and electrical circuitry, there are limitations and
differences between each technique. A common concern is that Asian, or specifically, Singaporean
norms and formulas are not currently available. The suggestion to adopt western norms has met with
some success and the formulas listed previously (Janz et al., 1993) provide the basis for a two site
skinfold assessment that can be performed on either gender in a school or clinical situation.

Implications

Based on school-based assessment of a large population of children, the practical application of blood
lipid and lipoprotein values, body fat percentages and blood pressure readings present an interesting
epidemiological study. The greater question that arises is: Are Singaporean children at risk for heart
disease? From the findings of this investigation, the number of children with health risks is relatively
low (6.5 percent elevated total cholesterol, 9.3 percent overweight, less than one percent with high
blood pressure). Clearly, the health risks of this group of society, using an adult factor model, are not
as great as in adults where 27 percent have hypercholesterolemia, 15 percent have hypertension and
5.1 percent are obese (MOH, 1993). The worrying trend however, is the number of overweight
children.

Total cholesterol and triglycerides in the cross-population study showed a clear distinction between
those children with different activity patterns. The Ministry of Health (MOH, 1991) recommendations
for exercise, in concert with world-wide bodies such as the American College of Sports Medicine
(1995), emphasize the need for 30 minutes of daily, moderate exercise for health benefits and more
intense exercise for development of fitness.
Further studies at the School of Physical Education are examining the relationship between the role of physical education and the health of children. Fitness, as measured by the Singapore National Physical Fitness Award (NAPFA) scheme and by comparison against field and lab-based measures of aerobic and anaerobic capacity provide detailed understanding of the status of children’s health and fitness. Moreover, these tests lead to intervention programmes specifically aimed at children’s health and fitness. From what was once considered to be the domain of sports medicine physicians, to bringing sports science to the classroom or the “padang”, the School of Physical Education is on the forefront of health appraisal, physical activity assessment and physical education curriculum design in Singapore.

References


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