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Review Article

Metabolic Syndrome among Children and Adolescents in World Health Organisation South-East Asia Region (WHO-SEAR)

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ABSTRACT

The South-East Asia Region experiences the double burden, that of communicable diseases which remain as an important public health issue, as well as non communicable diseases (NCD) which are emerging as the leading cause of death. Evidence from the data from the members of SEAR region clearly exhibits that metabolic syndrome is no more an adult problem; children and adolescents are being increasingly affected by it. This trend is attributed to health transition occurring in these countries. Progression of metabolic syndrome to CVD and diabetes results in increasing economic and social burden of NCD. Thus there is a need to identify risk factors leading to condition of MS and prepare systematic and scientific approach for its prevention at this young age with the assistance of government and non government initiatives.

Key words: Metabolic Syndrome, children, adolescence, India, Indonesia,Thailand, Srilanka, Bangladesh

INTRODUCTION

Metabolic syndrome (MS) is a constellation of cardiovascular disease (CVD) risk factors including elevated blood pressure, obesity, elevated triglycerides, low HDL cholesterol (altered lipid Levels) and glucose intolerance. [(1)] Identifying individuals with MS is crucial as it increases the risk of developing type 2 diabetes by 5 fold and CVD by 2 fold. [(2,3)]

Progression of MS to these diseases results in burdening of the national economy. Estimated loss in national income from heart disease, stroke and diabetes were 18 billion dollars in China, 11 billion dollars in the Russian Federation, 9 billion dollars in India and 2.7 billion dollars in Brazil in 2005. As more people will suffer from these disorders each year, losses will tend to accumulate and estimates for 2015 for the same countries are between 3 and 7 times those of 2005. [(4)]

Historical aspect of Metabolic Syndrome and its definition

Expanding waist line of the world is exhibited by the presence of MS. [(5)] Similar to other research topics, MS has evolved over the years and has contributed, and continues to contribute to the understanding of various aspects of it. More than 80 years

ago, Banting and Best [6] described clustering of various components of the MS. Since the mid-1960s, several scientists worked independently in different countries and published their observations on this constellation and gave several names to it (Table 1).

Table 1 : Names given to the clustering of metabolic syndrome disorders over the years

S.No	Year	Terms for metabolic syndromes
1	1923	Hypertension–hyperglycaemia–hyperuricaemia syndrome (Hypertoni–Hyperglycemi–Hyperurikemi syndrom) [7]
2	1966	Metabolic trisyndrome (trisyndrome metabolique) [8]
3	1967	Plurimetabolic syndrome [9]
4	1968	Syndrome of affluence (wohlstands syndrom) [10]
5	1981	Metabolic syndrome (metabolische syndrom) [11]
6	1988	Syndrome X [12]
7	1989	Deadly quartet Kaplan [13]
8	1991	Insulin resistance syndrome [14]
9.	1992	Metabolic Cardiovascular syndrome [15]

Similar to the term MS, its definition has also been proposed several times. Defining MS at younger age is valuable, considering the increasing rates of obesity, insulin resistance and CVD in the younger population [16] but it is more complicated than defining in adults, as no uniformity exists regarding the choice of the individual components and their cut-off. As per the published literature, there are multiple definitions (Table 2) resulting in confusion and difficulties in making direct comparisons between the data from studies.

Table 2: Various proposed definitions for metabolic syndrome among children and adolescents

Risk factors	Cook et al .,2003 (Modified NCEP) [17]	Ferranti et al.,2004[18]	Cruz et al., 2004 [19]	Weiss et al.,2004 [16]	Ford et al.,2008 [20]	IDF ,2007 [21]
Waist circumference (Percentile)	>90th	>75th	≥90th (age-, sex- and race-specific, NHANES III) *	BMI –Z score ≥2.0 (age- and sex-specific)	≥90 (sex-specific, NHANES III) *	≥ 90 th percentile
Blood Pressure (percentile)	>90th	>90th	>90th (age-, sex- and height-specific, NHBPEP)**	>95th (age-, sex- and height-specific, NHBPEP)**	≥90th percentile (age-, sex- and height-specific, NHBPEP)**	Systolic≥ 130 or Diastolic ≥ 85 mmHg or taking anti hypertensive drug
HDL-C(mg/dl)	≤ 40	<50 (girls) , <45 (boys)	HDL-C ≤10th percentile (age-and sex-specific, NHANES III)*	HDL-C <5th percentile (age-, sex- and race-specific, NGHS)***	HDL-C ≤40 mg/dL (all ages/ sexes, NCEP)	≤ 40
Triglycerides (mg/dl)	≥110	≥100	≥90th percentile (age- and sex-specific, NHANES III)*	Triglycerides >95th percentile (age-, sex- and race-specific, NGHS)***	≥110 (age-specific, NCEP)****	≥ 150
Fasting glucose or OGTT(mg/dl)	≥110	≥110	Impaired glucose tolerance	Impaired glucose tolerance	Fasting glucose ≥110 mg/dL (additional analysis with ≥100 mg/dL)	≥ 100
Diagnosis of MS	3 or more among 5 criteria	3 or more among 5 criteria	3 or more among 5 criteria	3 or more among 5 criteria	3 or more among 5 criteria	Central obesity + 2 or more criteria

(1)*NHANES, National Health and Nutrition Examination Survey, **NHBPEP, National High Blood Pressure Education Program, *** NGHS, National Growth and Health Study , ****NCEP, National Cholesterol Education Panel.

MS in South East Asia Region

According to WHO's South-East Asia Region classification there are 11 member countries Bangladesh, Bhutan, India, Maldives, Myanmar, Indonesia, Nepal, Sri Lanka, Timor Leste, Thailand and DPRK Korea. These members accommodate 25% of world's population with almost 30 % of the global disease burden. [22] Members in SEAR are undergoing epidemiological transition indicated by the evidence; communicable diseases, maternal and child ill health as well as malnutrition have been replaced by NCD. As per estimates, of the 14.5 million total deaths in 2008 in SEAR, 7.9 million (55%) were due to NCDs affecting at young age as compared to rest of the world. [23]

The current review will focus on 5 members of SEAR region (India, Thailand, Indonesia Bangladesh, and Sri Lanka) for data on metabolic syndrome in children and adolescents. These regions have been selected, keeping in view the availability of literature and CVD or/ and diabetes trends as MS progresses to these diseases and the impact on national development. For example in India, CVD is the chief cause of death and the number of new cases of CVDs is projected to increase to 64 million in 2015 (from 29 million in 2000. [24] In Bangladesh also, main cause of death in 2008 were CVD— 27% of all deaths and is projected to rise to 37% by 2030. [25] An increasing trend in diabetes prevalence has been reported from several countries. In Bangladesh, prevalence increased threefold, from 2.3% in 1999 to 6.8% in 2004 [26] and in India, diabetes prevalence in urban areas increased tenfold during 1971–2000. [27]

India and Metabolic Syndrome

India is a multi ethnic nation and accommodates one sixth of world's population. The major health problem the country is facing is the dual burden of communicable and non communicable diseases. [22] This implies the existence of rapid economic development. The other way of understanding the situation is, some people do not have enough resources to meet their basic energy requirement leading to under nutrition while in others energy intake exceeds contributing to over nutrition. [28] There is enough evidence to support this situation; under nutrition is primarily seen in the poor while over nutrition among economically better-off groups. [29] Over nutrition with sedentary lifestyle are responsible factors for obesity amongst adults, children and adolescents [30] and is responsible for the constellation of metabolic derangement during childhood and adolescence. [31]

There are a few studies in India (Table 3) pertaining to MS in children and adolescents but it is difficult to compare the results due to differences in the study subjects (normal, risk of overweight, overweight and obese) , sample size , age ranges and different cut offs used for waist circumference , BMI , blood pressure and lipids. Astonishing situation is that children aged 6 yrs have been identified with MS. This indicates the need of attention of professionals working in the health sector. [32,33] Various factors found to be associated with MS among Indian adolescents were socio economic status, family history of hypertension , higher BMI/ obesity, [34] low birth weight and insulin resistance [35,36] but the main factor responsible for maximum variance in clustering and causing MS is obesity [37] and obesity becomes worse with urbanisation and migration. [38] As per the evidence from another study, two groups believed to be descended from a common ancestral population and reside in the same ecological region, prevalence of MS was higher among the group living in the urban places. This group was involved in less physical exercise, consumption of large amount of red meat and dairy products thus

focussing the impact of urbanisation on MS occurrence. [39,40]

Table 3: Prevalence of Metabolic syndrome among children and adolescents in India

S. No	Author year Location	Sample Size and age of subjects	Definition of MS used	Prevalence according to criteria used
1	Singh et al., 2007 [34] Chandigarh	1083 Healthy Subjects 12-17 years	Modified NCEP ATP by Cook et al., 2003	Overall: 4.2%
2	Gupta et al., 2009 [41] Delhi	1292, 15-18 yrs adolescents	Modified NCEP (2003) with triglyceride≥150 mg/dl	0.0% in male and 0.2% in females
3	Kapil and Kaur, 2010 [32] NCT of Delhi	1331 Healthy Subjects 6-18 yrs children & Adolescents	IDF with blood pressure ≥95th percentile for age and sex , 2007	6.5% (males 6.9% and females 5.9%)
4	Yatheesha et al., 2010 [42] Kochi	81 children &adolescents risk of overweight &overweight	Modified NCEP , 2003	25.9%
5	Saha et al ., 2011 [43] Kolkata	49 obese , 6-11 yrs children	Ferranti et al, 2004	14.3%
6	Singh et al., 2013 [40] Jammu & Kashmir	1160 , 10-18 yrs adolescents	Modified NCEP , 2003	2.67% (Males 3.8% and females 1.62%)
7	Andrabi et al.,2013 [44] Jammu & Kashmir	758, 8-18 yrs children & Adolescents	Modified NCEP , 2003	3.8% (Male 3.9% and females 3.8%)

Thailand and Metabolic Syndrome

Thailand is among the well-off countries in the Region with only 10% of the people below the national poverty line and the Human Development Index is at 0.784. Major health problem in country is NCD's such as diabetes and hypertension and since 1996 to 2003, these problems have doubled. Also there is an increasing trend of over-weight among children which indicates that obesity could become an over-riding public health problem in Thailand. [22]

There are a few studies which reported the prevalence of MS among children and adolescents. All the studies have included overweight or obese subjects; it has been seen obesity is responsible for 55% of variance in insulin sensitivity in children, after adjusting for other confounders, such as age, gender, ethnicity and pubertal stage. [45] As per the data presented in poster presentation, medical records of 125 obese children and adolescents were reviewed and 32.8% children were found to have MS, which means nearly one third of children and adolescent had MS. [46] Another study reported the prevalence of MS among 89 obese subjects aged between 4-18 years based on the IDF criteria. Due to relation of obesity and MS, study subjects were divided into two groups; group 1 (mild and moderate) and group 2 (severe and morbid) based on percentage of ideal weight for height, into mild > 120 to 140%, moderate > 140 to 160% , severe > 160 to 200% and morbid obesity >200% .Weight for height index was used than BMI because the criteria for severity classification based on BMI is not available. Prevalence of MS was 22.9% and 9.8% in group 2 and group 1 respectively. Prevalence increased with increasing age, higher number of subjects in age group of 10-16 yrs and > 16yrs had metabolic syndrome in comparison to younger group. [47] Similar study was reported by Panamonta et al., (2010) [48] on overweight and obese subjects but a different approach was used to reach these high risk subjects. Based on BMI, subjects over 85th percentile were screened out. Underlying concept associated with screening was association of higher BMI with elevated blood pressure and lipid profile and children fitting into these criteria should be evaluated. [49] By using modified IDF criteria (inclusion of BMI than waist circumference) 3.2% of these overweight (BMI ≥ 85 percentile) and obese subject (BMI≥ 85 percentile) had MS. This

indicates the need of MS recognition at early ages to maintain the safety and efficacy of intervention at early life. [50]

Indonesia and Metabolic Syndrome

Indonesia is a densely populated country with nearly 17000 islands with human development index more than 0.7 and is better than many other countries of SEAR. Tuberculosis and malaria are the major health problems. However NCDs are emerging as a major threat. [22] It is one of the developing countries that have increasing number of chronic diseases. According to latest WHO data published in 2011, coronary heart disease deaths have reached 17.05% of total deaths. [51] This may be because Indonesians have Asian genetics and often follow the Western style in eating food, like consumption of food with high energy, sugar and saturated fat and with low physical activity. [52]

MS prevalence has been closely associated with the increase in degree of weight (overweight and obesity) and distribution of fat tissue. [53] The mechanism behind the relationship is, the metabolic activity of visceral fat increases free fatty acid circulation, decreases insulin uptake by the liver , increases circulating insulin levels and ultimately leads to glucose intolerance. [54]

This insulin resistance impairs the breakdown of triglycerides which in turn stimulates the production of other atherogenic lipoproteins and decreases HDL-C cholesterol levels. [55] Screening based on weight and height was therefore used as an approach and 250 obese subjects were identified from junior high and senior high school and of these based on IDF criteria, 73 subjects were identified as having MS. To further evaluate the difference in the diets of subjects with MS and non MS, the constituents of diet were evaluated. The major constituent of diet which was significantly higher in MS subjects was the dietary fat. [52]

In another study, difference in MS prevalence as per BMI was studied. For this, subjects (10-14 yrs) were divided into two groups i.e. obesity (BMI >3 SD) and overweight (BMI 2-3 SD). Definition for the identification of MS used was the NCEP modified criteria and it was seen that prevalence was higher in the obese category than the overweight and the most common risk factor was waist circumference and blood pressure in obese subjects. [53] Similar results of high prevalence among obese subjects of age 12-18 were seen in another study. [56]

Sri Lanka and Metabolic syndrome

As per data, population of Srilanka is 20 million [57] and 30 % of population lives in urban areas. [58] It has an inspiring track record of achieving MDGs (Millennium Development Goals) than other countries in the South East Asian Region; the island has achieved middle-income status in a short time. [22] In Sri Lanka, injuries, ischemic heart disease, asthma, disease of the pulmonary circulation and burns contribute to 55% of burden of disease (BOD) which is measured by , disability adjusted life years or DALY [59] resulting in weakening the economy and health budget. As per the evidence from the study reported in 2012, modifiable factors (physical inactivity, family history of type 2 diabetes mellitus, high waist circumference and BMI) were more prevalent in age group of 10-14 yrs in comparison to group 15-19 yrs and 20-40 yrs . The reason speculated for high prevalence at this young age could be less sports or exercise in schools and exposure to unhealthy diet. [57]

Another study was done in obese children (BMI >95 percentile as per National Standard for Health Statistics (NCHS) for assessing the incidence of MS and to identify the best predictor of the

metabolic derangements. Total of 62 subjects participated in the study of age > 2 years and MS was diagnosed in 11 subjects, indicating 18 % had MS based on the following criteria; WC above 98th percentile with 2 or more of the following: serum triglyceride >150 mg/dL, HDL cholesterol <40 mg/dL, hypertension (systolic or diastolic blood pressure > 95th centile), and impaired glucose tolerance. The best predictor was waist circumference, in comparison to BMI; WC showed a stronger relationship to systolic and diastolic blood pressure, insulin resistance and triglyceride. [(60)] As per the results from a recent study where 920 subjects of age 5-15 years were enrolled to determine the MS prevalence based on IDF criteria, 1.6% of the subjects had MS and metabolic derangements were seen in non obese subjects too. [(60)]

Bangladesh and Metabolic Syndrome

It is a densely populated country and accommodates more than 2% of the world's population. It lies in category of least developed countries but has shown marked improvement in the recent past. The country is facing the dual burden of under nutrition and over nutrition like India. Data from the National Child Measurement Programme (NCMP) showed obesity to be increasing for Bangladeshi boys, [(61)] which may be attributed to decreased physical activity among Bangladeshi community. [(62)] As per NCMP data, Bangladeshi children have higher prevalence of obesity than that for the Black African and other ethnic groups despite a perception that the latter groups have highest obesity prevalence. [(61)] In Bangladesh, there is paucity of data on the reporting of MS among adolescents. Mohsin et al (2011) [(63)] reported 36.6% prevalence of MS among 161 obese adolescents aged 6-18 years living in Dhaka and the criteria used by them was adapted from Weiss et al (2004). [(16)] As per this definition, obesity is defined by BMI instead of waist circumference, considering waist circumference and waist to hip ratio are difficult to interpret in children as body composition changes occur during this age group. However, reflect abdominal adiposity and have been suggested as being superior to BMI in predicting CVD risk. This concept is largely based on the rationale that increased visceral adipose tissue is associated with a range of metabolic abnormalities, including decreased glucose tolerance, reduced insulin sensitivity and adverse lipid profiles, which are risk factors for type 2 diabetes and CVD. [(64)]

Prevention of Metabolic Syndrome

It has been clearly evident from the existing review of literature that MS exists in children and adolescents; however it is relatively uncommon among non obese and non overweight subject but highly prevalent among overweight and obese subject. Comparison of studies from different members of SEAR indicated that metabolic syndrome prevalence is higher in India as compared to other members of the region. Although the situation in the SEAR region does not look serious if seen only at percentage of prevalence calculated from small sample but when population weighted estimates are made, the real situation becomes clear. None of the members of SEAR region have calculated these weighted estimates but Cook et al. in 2003 [(17)] estimated 4.2% prevalence in United States adolescents aged 12-19 and further calculated population weighted estimates which was approximately 910 000 US adolescents with MS. Similarly if estimates are made for SEAR region, the situation will be similar to that of United States if not higher .This indicates that spending money on primary and primordial prevention of MS is more beneficial and productive than curing MS and bearing the cost of expensive complications associated with its progression to CVD and diabetes. The root

cause responsible for occurrence of complex pathological problem called MS in children is obesity. Obesity mainly occurs due to combination of factors like genetic, metabolic, behavioural, environmental and socio economic factors but for majority of individuals it results due to excessive energy consumption (unhealthy diet) and less physical activity.[65] Disease burden contributed by obesity could be significantly reduced and prevented, with thousands of lives saved and untold suffering avoided, through identification of high risk subjects(overweight and obese) and developing education programs. Aim of such programs should be primordial and primary prevention of obesity for both normal and high risk subjects. For this, governmental and non-governmental organizations should institute school-based education program for children, parents and teachers.

School is considered to be an appropriate place for disseminating such information to children and adolescents, as they spend maximum of their time in school during the first two decades of life. Such health education programs should involve combination of diet and physical activity components to prevent children becoming overweight in the long term. If only physical activity component is included in the education program then the results persist for short duration. [66]

Under dietary component, education program should focus on different aspects like foods which need to be consumed in fewer amounts such as saturated fat, refined carbohydrates and sweetened beverages. [67,68] On the other hand, food which need to be consumed in large amounts are, fruits and vegetables as they are rich in water and fibre, and low in energy density [69] and play an important constituent for displacement of energy-dense foods. [70,71] Other important aspects are reducing the consumption of fast food intake and regular intake of meals because evidence from research has shown that fast food consumption and skipping meals are associated with increased body mass index in children. [72]

In nutrition education programs for physical activity component, children should be made aware that they should include 60 minutes of moderate to vigorous physical activity. [73] It is indispensable for normal growth, development and obesity prevention.[74] Their indulgence in sedentary habit may continue in adulthood thus their involvement in physical activity right from young age is crucial. But in today's world they are more attracted and involved in technology related activities like television, internet and video games. [75] There are various reasons which are known to be responsible for this shift such as are lack of green spaces, steady pressure on children to perform in academics, reduced emphasis on physical activity and lack of playgrounds in school. [76]

By doing such education program at this age, two objectives will be met. First, there will be enhancement of knowledge, attitude and skills about nutrition information as well as the selection of healthy food choices. Second, there will be reduction of the risk of chronic diseases through changes in specific behaviours such as eating adequate servings of fruits and vegetables and engaging in physical activity. [77] By change in knowledge, attitude and behaviour of children and adolescents regarding diet and physical activity, there will be reduction in alarming figures of obesity and subsequently MS and its features will show a decline.

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