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Validity of Newly Developed BMI and Waist Cutoff Values for Sri Lankan Children

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Background

Childhood obesity is increasing in epidemic proportions worldwide. Morbidity related to obesity is associated with the degree of body fat mass (FM) and direct measurement of it would be the best way making the diagnosis. However, due to practical difficulties surrogate markers have been used and most popular are the BMI and waist circumference (WC). Although none of them are specific, they could be used to obtain a reasonable assessment. However, the reliability of these measures depends to a greater extend on the cutoff values used. International cutoffs are mainly based on white Caucasian studies and its usefulness in other ethnic groups are doubtful. There is a clear ethnic differences in body composition, where Asian populations have more fat in the body to any given BMI compared to white Caucasian populations. Because of that even WHO has suggested to have lower BMI cutoff values for Asian populations while IDF has used a lower waist circumference cutoff to diagnose metabolic syndrome in Asian populations. Although there is no universal consensus in drawing up of ethnic/population specific anthropometric cutoff values, in the published literature there are cutoff values derived for such groups for both adults and children. It is interesting to assess the suitability of newly developed Sri Lankan anthropometric cutoff values in the diagnosis of obesity in Sri Lankan children.

A set of BMI and WC cutoffs for Sri Lankan children were published by Wickramasinghe et al. [1] and its usefulness in diagnosing obesity in a group of 5-15 year old Sri Lankan children was compared with other available cutoffs (IOTF, WHO, British and CDC BMI and British WC).

In the assessment of 920 children FM showed significant associations with BMI($r=0.92$, $p<0.001$), WC($r=0.90$, $p<0.001$). Based on %FM cut offs, 22.5% girls and 18.5% boys were obese. All international anthropometric cutoff values underestimated obesity. However, Sri Lankan WC and BMI cutoff values over-estimated the diagnosis. International BMI and WC based cutoff values had high specificity but a low sensitivity while Sri Lankan BMI and WC cutoff values had high sensitivity but low specificity. It is clear that internationally available BMI and WC cutoff values underestimate the problem of obesity in Sri Lankan children. Locally developed BMI and WC cutoff values are more sensitive in detecting cases of obesity. Consensus should be developed to improve the screening/diagnosis of obesity in children of Asian populations.

Introduction

The dawn of the twenty first century has seen a considerable change in the nutritional status and disease pattern all over the world. Obesity has taken the place of under-nutrition that dominated previous century. Non communicable disease (NCD) burden has increased which is directly related to the obesity epidemic. Obesity, by definition is accumulation of excess body fat in the body that is associated with morbidity [2]. Therefore diagnosis of obesity should be ideally based on absolute body FM measurements. However, due to practical difficulties different surrogate measures have been used and BMI had been the most prevalent while WC had been gaining importance due to its direct association with metabolic risks. Fat content of the body vary between populations/ethnic groups, where for any given BMI value south Asian populations have a very high body FM, thus using the conventionally accepted 25kgm^{-2} and 30kgm^{-2} for overweight and obesity respectively will lead to under detection of many obese individuals in the Asian region. This made WHO to consider that BMI cut offs should be low as 22-25 kgm^{-2} [3] for adults. Similarly the WC cutoff values are also low in Asian populations compared to white Caucasians [4]. In children BMI and WC changes with age and sex, therefore a single cutoff value cannot be used. BMI for age charts were developed by different bodies (WHO 2007; CDC/NCHS 2000; British Growth Foundation 1990). The International Obesity Task Force (IOTF) developed age and sex specific cut-off values to diagnose both overweight and obesity from 2 years to 18 years at half yearly intervals [5]. All these cut-off values are based on population distribution of an anthropometric parameter rather than on a biological end point and the prevalence of obesity will depend on the centile/Z score charts and their cutoff values used. Because of this the prevalence of obesity could vary depending on the cutoff value used [6]. Most of these studies showed that IOTF cutoffs had the lowest prevalence while CDC gave the highest prevalence [7,8].

Therefore in multiethnic communities, diagnosis of childhood obesity, using a universal definition had been unsuccessful [9]. This has resulted in a debate as to whether ethnicity-specific [10] or population-specific [11] BMI cut off values should be used.

WC is more closely related to insulin resistance and associated metabolic abnormalities. WC is used as an absolute criterion in the diagnosis of metabolic syndrome, by IDF. WC has shown to have a strong association with metabolic derangements in obese Sri Lankan children than BMI [12].

A limited number of studies have looked at the FM that is associated with adverse metabolic outcomes and most are in non-Asian populations. Few studies have identified the percentage FM associated with metabolic risk to range between 30-35% in girls and 20-25% in boys [13-15] International cutoff values have shown a very low sensitivity in detecting obesity among Australian children of white Caucasian and Sri Lankan origins [16]. Once again the IOTF cutoffs showed the lowest sensitivity. In view of this, in 2011, a new set of BMI and WC based cut off values were developed to diagnose obesity among Sri Lanka children [17]. Rather than using the population distribution of the two parameters, percentage FM s associated with metabolic risk and developed based on regression models. They were based on a %FM of 35% for girls and 25% for boys [18].Validated and compare these cutoff values with existing international cutoff values in an independent group of Sri Lankan children.

Subjects

A cross-sectional descriptive study had been carried out among 920, 5-15-year-old apparently healthy Sri Lankan children selected randomly from schools in the district of Colombo, Sri Lanka. Validity and accuracy of the indicators were evaluated by calculating sensitivity, specificity, positive predictive value and efficiency, relative to true obesity diagnosed by absolute %FM based on Bioelectrical Impedance Assay (BIA) technique. Results

Boys to girls ration of the group was 547/373. Correlation of BMI and WC with FM was stronger compared to the relationship of BMI and WC with %FM. Anthropometric measures had a significant stronger association with FM than with %FM.

Based on percentage FM 22.8% girls and 18.5% of boys were obese. The IOTF BMI based cutoff detected only 4.8% girls and 2.5% boys as obese. The proportions of obese children detected by WHO and British growth standards were little higher than the proportion detected by IOTF cutoff values. International WC measures were able to diagnose more cases of obesity than BMI based cutoff values. The newly developed Sri Lankan BMI standards detected 26.3% girls and 19.0% boys as obese. Both Sri Lankan BMI and WC cutoff values over-estimated the obese cases.

BMI based international cutoff, in both girls and boys had a very low sensitivity ranging from 11.9 to 32.9%, but high specificity (>98.6%). The positive predictive value was more than 84% and efficiency was also high ranging between 79.9-86.7% in both groups. Diagnosis of obesity based on international WC cutoff demonstrated better sensitivity (84.7-93.1 %) with slightly low specificity (88.1-97.3%) compared to BMI.

The Sri Lankan based BMI cutoff values had higher sensitivity in detecting obese patients compared to the available IOTF cutoff values in both gender groups. Although the specificity was lower than the other BMI based cutoff values, it was more than 90% in both gender groups. The positive predictive value was low but the efficiency was better than other BMI based cutoff values. Although the specificity was low the Sri Lanka based WC (79.7-82.3%) cutoff values had higher sensitivity (93.1-95.3%) and was better than all tested obesity diagnostic tools when screening for obesity in Sri Lankan children. Furthermore the efficiency was equal to other methods.

Discussion

Childhood body composition is directly responsible for the onset of non-communicable diseases. Fatness in childhood and adolescence persists into adulthood and the adverse metabolic profiles show a cumulative effect. Therefore when fat accumulation begins from a younger age, adverse outcomes would show early onset. Although, there is still no consensus developed on the exact percentage body fat that could be linked to adverse metabolic profiles, a %FM of about 25% in male and 35% in girls could be considered as reasonable cutoff.

Ideally, obesity should be diagnosed and followed up based on the absolute fat measurement of body. However, as this is not practical in field settings, BMI is used as a surrogate measure. BMI, which is a ratio between weight and height, does not always reflect the percentage body fat accurately. Furthermore BMI does not distinguish between different components of the body, as well as it cannot quantify the FM of the body.

Similarly there are many other studies that have shown that internationally agreed cutoff does not provide satisfactory results. In New Zealand detection of obesity in children of Indian and Pacific Island origin was low [16]. Similarly the IOTF showed poor sensitivity in diagnosing obesity in Swedish adolescence, improved by the use of country specific charts [17]. Therefore lowering cutoff value is one option, such as using overweight cutoff values to detect obesity, but still they are not specific to a population/ethic group thus not provides the correct solution.

As much as it has shown by many other studies, obesity prevalence is low in this group of Sri Lankan children when available international BMI cutoff values were used. This underestimation of the problem could delay detection of cases as well as the danger of policy makers overlooking the problem would have many long term adverse health and economic outcome for individuals as well as for a country. Although the Sri Lankan cutoffs had high sensitivity, as authors have argued, it could lower the threshold of detecting obese children. Furthermore such detections would lead only to be aware of the increased risk and impart a positive health. Specific managements of obesity depends on specific complications rather than the simple state of excess fat. Therefore over diagnosis of obesity with no metabolic complications will not cost the health system additional resources but will provide some benefits through preventions of developing complications.

There had been a long cry for population specific cutoff values. As WHO (2000) also has acknowledge the need for lower BMI cutoff values for Asians, a feasible option would be either to revise BMI cutoff values to suit a population/ethnic groups or use methods to assess the absolute body content of body.

Waist circumference is an easy measure and reflects abdominal obesity which is directly related to the adverse metabolic consequences better than BMI. WC in this study showed a higher sensitivity but low specificity compared to BMI. Its high sensitivity could lead to over diagnosis of the issue leading to panic as well as strain on the health system. However as authors point out such over detection would increase awareness of the condition and would have a buffer zone for people to take preventive action much early.

The %FM associated with morbidity defined in this study is what has been set for western populations. The body fat content that would be associated with morbidity in Sri Lankan children have been evaluated recently where the percentage FM associated with adverse metabolic profile in males is 28% and in girls it is 32% [15]. Therefore it clearly shows that the fat percentage associated with adverse health outcomes is more or less similar in all populations but due to changes in the body composition distribution, the BMI and WC reflecting the FM differs.

The weak association shown between BMI and %FM cast doubt over used of BMI/WC as surrogate a markers of body FM. However, its simplicity to use in the community and reproducibility makes it the most prudent screening tool for obesity. However, as far as children are concerned, there is no universal agreement on the use of cutoff value, whether centile based or Z score based or absolute values. Furthermore, cutoff values whether internationally available or country specific or ethnic specific in multiethnic populations needs more research. This study highlights that best would be to use BMI and WC as screening tools and have more objective measures such as BIA to evaluate the absolute fat content of body for the diagnosis and management of obesity in Sri Lankan children

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