RESEARCH BRIEF

Waist to Height Ratio for Recording the Risks of Overweight in Schoolchildren in Kerala

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The prevalence of overweight/obesity among 6000 children at 7-12 years was monitored using the established methodologies. Prevalence rates obtained using percentiles were proximate to that using waist-to-height ratio (WHTR) 0.50 and were on par with the reported rates. The prevalence were worked out with WHTR values from 0.45 to 0.53 and compared with percentiles. The minimum per cent deviation of 5.4 was observed at WHTR of 0.48 (against 6.4% at WHTR 0.50) and further the deviation at this point was distributed near-uniformly (2.6% above and 2.8% below the WHTR), suggesting that this is the optimum cut-off point for children in this region. ROC analysis against percentiles has given a higher sensitivity of 0.630 at WHTR 0.48 in this region and area under ROC curve was 0.827 at WHTR 0.48.

Key words: *BMI, Childhood, India, Obesity, Overweight.*

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Waist-circumference and more precisely the waist-to-height ratio (WHTR) are superior to BMI in predicting the cardiovascular risks in European and Asian children [1] and Japanese adults [2]. WHTR is significantly associated with the risk factors for obesity, much better than BMI [3,4]. Since the height and waist circumference of children increases continually as they age, the value of 0.50 was suggested as an appropriate cut-off point for all age groups [5,6]. WHTR is more sensitive than waist circumference in different populations since it adjusts to different statures [3] and because of the negative correlation of height to certain metabolic risk factors [7]. The WHTR cut-off point is population specific and for Chinese population, WHTR 0.445 is optimum for overweight in both boys and girls. For obesity, the cut-off points proposed are 0.485 for boys and 0.475 for girls [8]. The relevance of 0.50 as cut-off point for Indian schoolchildren in Southern India is being revalidated here.

METHODS

The study was carried out during 2004-2011 among school-going children aged 7-12 years from Thrissur district of Kerala, India. Multistage random sampling design was adopted with the total schools in the district at the first stage. The total number of schools were 1013 comprising of 263 government, 711 government-aided private and 39 unaided private schools. At the second stage, six thousand samples were selected by proportionate random sampling to represent urban, semi-urban and rural backgrounds, from a population size of 112,386 children. Height was measured with a stadiometer, and waist circumference with a plastic tape, midway between the lower rib margin and the iliac crest. Averages of three measurements, appropriated to the nearest 0.1 cm, were recorded. Scatter plot for height *vs* waist circumference was plotted using the statistical software Minitab v16 and area of distribution was marked with a single smooth circle. To avoid erroneous conclusions, samples leading to outlying values were excluded from further analysis. The prevalence of overweight/obesity at every age were computed using percentiles given by Cole, *et al*. [9], CDC [10] and Khadilkar, *et al*. [11], waist circumference [1], WHTR of 0.50 given by McCarthy and Ashwell [5] and WHTR by Yan, *et al.* [8] and the results were compared.

To verify at what WHTR cut-off value the study population will show the minimum percentage deviation in the prevalence of overweight/obesity from that computed using the percentiles Cole, *et al*. [9], WHTR cut-off points from 0.45 to 0.53 were tested in the population. Per cent deviation was recorded as the sum of the per cent of children not overweight obesity by percentile method at the specific WHTR and per cent of children overweight obesity by percentile method below

the specific WHTR. Since there was no overweight or obese child in the sample who was recorded normal at 0.53 WHTR, and no non-obese/overweight child in the population who was recorded overweight obesity below 0.43, further extension of WHTR values was not necessary. The WHTR that is in proximity with the results obtained by percentiles was considered as optimum cut-off value for schoolchildren in this region. The specificity and sensitivity of the newly identified and the existing WHTR cut-off values against the BMI percentiles were compared through ROC (Receiver Operating Characteristic) analysis using the statistical software SPSS v17.

RESULTS

Analysis with BMI percentiles yielded prevalence rates of overweight/obesity of 3.17 and 6.67 for boys and girls (***Web Table* I**). Prevalence rates obtained through BMI percentiles and WHTR 0.50 have been proximate and on par with the existing reports and were hence chosen as the standard. Using 0.50 cut-off point, a countable percentage of samples varied in overweight/obesity of prevalence. The percentage of children not overweight/obesity of at or above 0.50 and the percentage overweight/obesity of even below the WHTR 0.5 were 1.2 and 5.2, respectively. Thus a total of 6.4% of the population was not obeying the WHTR 0.50 cut-off point. Per cent variation among both methods by employing the cut-off points from 0.45 to 0.53 are furnished in ***Web Fig*. 1**. It is evident that both the lines meet at 0.48 and at this point, minimum per cent of samples disobey the percentiles (5.4 per cent against 6.4 per cent at WHTR 0.50). The best equilibrium with respect to minimum deviations of 2.6 and 2.8 per cent above and below this point was achieved against 1.2 and 5.2 at WHTR 0.50. The remarkable difference both in terms of the rate of prevalence as well as the variation from the standard, it is proposed that a better WHTR cut-off for children from this region is 0.48.

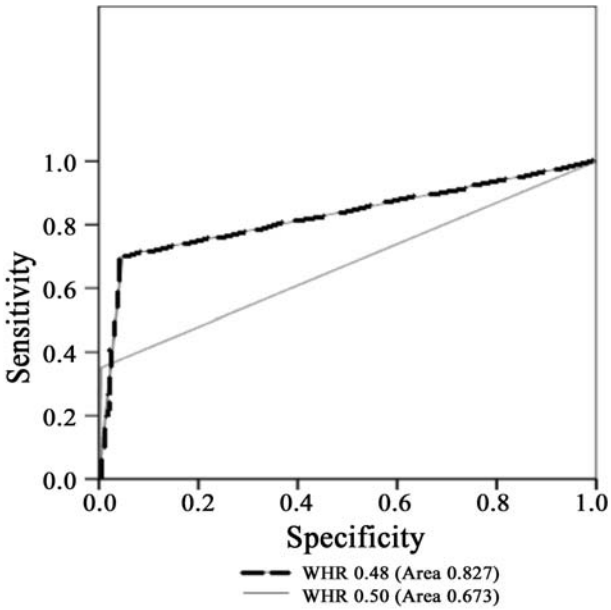

Fig. 1 *Specificity and sensitivity curves for Waist-to-height ratio cut-off values 0.50 and 0.48 against the BMI percentiles for estimating the prevalence of overweight/obesity in a population of children aged 7-12 years.*

ROC curve area is a direct measure on the sensitivity of the cut-off points assessed for a particular population. Using 0.48 cut-off, the area under the ROC curve was 0.827 against 0.673 at 0.50 (***Fig.* 1**). WHTR 0.48 has given 407 true positive samples against 233 at WHTR 0.50 and similarly, the sensitivity was 0.630 against 0.376 (***Table* I**). The false positives were remarkably less at WHTR 0.48 (115) compared to WHTR 0.50 (289). The distinctly higher graph area and the higher specificities against the BMI percentiles clearly show that 0.48 is more accurate.

DISCUSSION

The overweight/obesity of rates worked out using Cole, *et al*. [6] and CDC [10] percentiles and WHTR 0.50 were comparable with the existing report from Kerala state [12].

TABLE I SPECIFICITY AND SENSITIVITY OF WAIST-TO-HEIGHT RATIO CUT-OFF VALUES 0.48 AND 0.50 AGAINST BMI PERCENTILES

Condition		*Waist-to-Height Ratio cut-off value*					
		0.48			0.50		
		True	False	Total	True	False	Total
Overweight/ obese as per BMI percentiles	Positive	407	115	522	233	289	522
	Negative	5239	239	5478	5092	386	5478
Total		5646	354	6000	5325	675	6000
Sensitivity		0.630				0.376	
Specificity		0.978				0.946	

WHAT THIS STUDY ADDS?

- The Waist to Height Ratio (WHTR) cut-off point is population-specific and for children from South India, optimum WHTR cut-off point is 0.48

Further, for this population, 0.48 was a more accurate WHTR cut-off point than 0.5.

The very high prevalence rates from waist circumference centiles was confirmatory to our previous report that this methodology is not acceptable for population of Southern India and alternative centiles as product of BMI and WHTR should be used [13]. The available report on the prevalence of overweight/obesity in this state suggests only 6.57% for boys and girls together [12]. From this study that employed WHTR 0.50, it was clear that, from 6.57% in 2007, the prevalence rose to 9.84% by 2011. But a growth from 6.57% in 2007 to 27.15% in 2011 may not be a true situation. This assumption is further supported by another study in Indian children [14]. However, no effort has so far been made to precisely define the WHTR cut-off for Indian population. The lower cut-offs proposed from the study by Yan, *et al*. [8] are specific for Chinese since comparatively short stature of this population restricts the flexibility towards higher WHTR levels. The health risks for Asians begin to increase for smaller amounts of central fat and smaller waist circumferences than their European counterparts [15]. This explains the reason behind the decrease in the WHTR cut-off for this population. The population under study is shorter than the British population in which WHTR 0.50 cut-off point was initially proposed [7].

Further confirmation of the results may be obtained by analyzing the correlation of WHTR cut-off with biochemical and clinical parameters associated with pediatric obesity. Practicing paediatricians may prefer WHTR 0.48 over 0.5 in deciding the obesity status of children from southern India.

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