The Indian Journal of Pediatrics (July 2021) 88(7):645–649
https://doi.org/10.1007/s12098-020-03563-x

ORIGINAL ARTICLE

A Study on New IAP 2015 Growth References in Rural South Indian Children

Vandana Kuniyedath Chalil[1] · Hemchand Krishna Prasad[2] · S. A. Mohamed Abdul Nassir[3] · K. V. Arulalan[4] · Thangavelu Sangaralingam[1] · Nedunchelian Krishnamoorthy[1]

Received: 2 June 2020 / Accepted: 28 October 2020 / Published online: 19 November 2020

Abstract

Objectives To ascertain the utility of the new pan Indian 2015 IAP references in rural South Indian children and the ability of new IAP charts to recognise children with abnormal cardiometabolic risk factors in 10 to 16 y age group.

Methods Among school health camps conducted at two centres of Tamil Nadu– rural Vellore and rural Erode- height, weight, waist circumference, blood pressure, triceps skin-fold thickness and body fat percentage were measured by trained pediatricians and Z-scores calculated. The anthropometric measures were studied as per IAP 2015 references and compared to other national and international references. Their utility in identification of malnutrition and cardiometabolic risk ascertained.

Results A total of 420 children (210 from Erode and 210 from Vellore) in the age group of 10 to 16 y were included in the study. New IAP references recognized more short stature (4.2 *vs.* 3%), wasting (11 *vs.* 1.5%) and overweight (14.2 *vs.* 13.2%) children compared to old IAP charts. The Z-scores of anthropometric measures as per New IAP 2015 references had significant correlation with old IAP and other international data ($p < 0.05$). It was noted that new IAP charts could detect 83.3%, old IAP chart 50% and WHO 83.3% of subjects with malnutrition. New IAP charts could detect 70.3% cardiometabolic risk associated with over nutrition compared to old IAP (57.4%) and WHO (51.8%).

Conclusions There is a significant prevalence of both under nutrition and overweight in rural setting. IAP 2015 reference is useful to diagnose children with under nutrition and overweight including abnormal cardiometabolic risk.

Keywords Pan Indian IAP 2015 growth reference · Cardio metabolic risk · Rural Tamil Nadu

Introduction

Growth is a barometer of well being in any given child. The Indian Academy of Pediatrics (IAP) came out with growth charts for Indian children constructed across India in 1993 by K N Agarwal. This was the first pan Indian references useful for Indian children [1]. Subsequently, the World Health Organisation came out with WHO 2007 standards based on the Multicentre Growth Reference Study, which recommended paediatricians all over the world to use this chart for children less than 5 y [2]. For children more than 5 y, WHO recommends to use country specific growth charts. Indian Academy of Pediatrics came with growth monitoring guidelines in 2007. WHO recommends updating of growth charts every 10 y to take into account the secular trends. Hence, the Indian Academy of Pediatrics came out with the Pan Indian 2015 references for pediatricians to follow [3]. These charts are unique as they take into account the secular trends. Also, they have redefined abnormal growth parameters linking to disease states, making the chart more prescriptive in nature. Since the IAP adapted the new charts for Indian children, numerous publications have emerged on its utility for Indian children. Researchers have ascertained the utility of these references in hospital based data [4], School going urban children [5–9], low socioeconomic children [10], semi urban

✉ Hemchand Krishna Prasad
pediatricendocrinology.mehta@gmail.com

[1] Department of Pediatrics, Mehta Multispeciality Hospitals India Pvt Ltd, Chennai, Tamil Nadu, India

[2] Department of Pediatric Endocrinology, Mehta Multispeciality Hospitals India Pvt Ltd, Chennai, Tamil Nadu 600031, India

[3] Department of Pediatrics, Be Well Hospital, Erode, Tamil Nadu, India

[4] Department of Pediatrics, AA Child Care Centre, Vellore, Tamil Nadu, India

children [11], and specific communities [12]. Researchers have also attempted to compare the rural and urban children using the new references [13, 14]. However, none have looked into impact of the new charts on exclusive rural population and relationship between children with abnormal anthropometric parameters and established risk factors, in, South India. Hence, the present study was performed, to ascertain the utility of the new pan Indian 2015 IAP references in rural south Indian children and the ability of new IAP charts to recognise children with abnormal health risk factors in 10 to 16 y age group.

Material and Methods

The present study was a cross-sectional study and was conducted over a period of 1 year. Two centres of Tamil Nadu to be representative of different parts of state were selected – rural Vellore and rural Erode. Two schools from these two regions were selected, to represent rural children of Tamil Nadu. School health camps were conducted in these selected schools and every consecutive child studying in the school between fifth and tenth grade was recruited. Prior approval from Institution review board and school authorities were obtained. Children with known systemic disease including cardiac, liver, renal disease and syndromic children were excluded. Anthropometric assessments –height, weight, waist circumference, blood pressure, triceps skin fold thickness and body fat percentage were measured [15–18] as per standard guidelines. Height was measured using a calibrated stadiometer with child standing without shoe or socks, with feet parallel on an even platform, stretching fullest, arms hanging on the sides, and buttocks, scapula and heels touching the rod. The head is held erect with lower border of the eye orbit in the same horizontal plane as the external canal of ear (Frankfurt plane). The head piece is lowered to touch the top of the head [15]. Weight was measured with minimal clothing using calibrated electronic weighing scale. Weighing scale is checked for zero and weighed standing to nearest 50 g [15]. Waist circumference was measured with a non-stretchable tape, exerting the same standard pressure on the tape at the midpoint of the lower rib cage and the iliac crest to the nearest 0.1 cm in standing position in end tidal expiration by a single pediatrician [16]. Blood pressure measured using adequate size cuff (covers two-third size of arm, bladder encircles 40% of arm circumference). After adequate exposure below shoulder and placing right arm on table with elbow flexed and palm facing ceiling, the cuff was wraped around arm 2 cm above cubital fossa crease with tube medial to biceps brachii tendon. Systolic Blood Pressure (SBP) was obtained by palpation. In auscultatory method, stethoscope was kept medial to biceps brachi tendon and inflated to 20 mmHg more than systolic BP noted by palpation. Reappearance of first sound on deflation was taken as systolic BP and point where sound was no longer heard was taken as Diastolic Blood Pressure (DBP). Triceps skin-fold thickness (TSFT) was measured using Harpenden's skin fold callipers between olecranon proess of ulna (elbow) and acromion process of scapula (shoulder), a point was marked on back of arm [17]. Body fat (BF) percentage was measured using hand-held body fat monitor based on bioelectrical impedance. Body Mass Index (BMI) was calculated from the formula, BMI = Weight (kg)/[Height (in m^2)]. The measured parameters were entered into excel sheet. Short stature was defined as height < 3rd percentile. From the BMI value calculated, wasting was defined as BMI <3rd percentile and overweight as BMI >23rd adult equivalent, based on IAP 2015 references. Definitions of abnormal health risk factors are summarised in Table 1. Z-score for height, BMI, waist circumference, systolic and diastolic blood pressure, triceps skin-fold thickness and body fat percentage were calculated. These were compared to new IAP [3], old IAP [1], CDC [21], British [22] and WHO growth references [2]. The study was approved by the institutional ethics committee.

From a previous study on prevalence of overweight and obesity among 5–16 y in semi-urban areas of Coimbatore [11], sample size was calculated within 20% variability in the estimated prevalence with 95% confidence as 420. Data was entered to Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of frequencies and proportions. Chi-square test was used as test of significance for qualitative data. Continuous data was represented as mean and SD. Paired t test was used as the test of significance for paired data. Pearson test was used for correlation. MS Excel and SPSS were used to obtain Scatter plots. p value of <0.05 was considered as statistically significant after assuming all the rules of statistical tests..

Results

In the present study, 420 children who were studying in the schools were recruited consecutively through a school camp

Table 1 Definition of abnormal risk factors

Health risk factor	Definition
Undernourished	Triceps skin fold thickness < −1.6SD [19]
	Body fat percentage < 2nd percentile [20]
Abnormal cardiometabolic risk	Waist circumference > 70th percentile [16]
	Triceps skin fold thickness > 70th percentile [17]
	Body fat percentage > 75th percentile [18]

(210 children were from rural Erode and 210 from rural Vellore). Table 2 illustrates the demographic, anthropometric and cardiometabolic parameters of children in the two centres. The children from both the centres were comparable in the study parameters. Subsequent data presented represents children from both the rural centres. The anthropometric parameters were classified as abnormal (short stature, wasting and overweight) as per the new IAP, old IAP, WHO standards, CDC standards and British references. New IAP chart could detect 4.2% short stature, 11% wasting and 14.2% overweight. New IAP charts detected more short stature (4.2% *vs.* 3%), wasting (11 *vs.* 1.5%) and overweight (14.2% *vs.* 13.2%) than old IAP charts. Comparison of abnormal growth detected by new IAP charts *vs.* other international standards (Fig. 1) showed, short stature was detected by 4.2%, 11.3%, 32.5%, 11.2% as per New IAP, WHO, CDC, British charts respectively. Wasting was detected by new IAP, WHO, CDC, British charts as 11%, 30.9%, 44.5%, and 29% respectively. Overweight was detected by new IAP, WHO, CDC, British charts as 14.2%, 11.8%, 16.8%, and 13.5% respectively.

The anthropometric parameters were converted into Z-scores and correlation analysis between the Z-scores calculated by the different standards and IAP 2015 references was performed. A significant linear correlation of height Z-scores as per new IAP 2015 charts *vs.* all other growth references (data not presented) was observed.

Among 420 children, 6 (1.4%) had at least one health risk factor associated with malnutrition which included 5 (1.2%) children with low triceps skin fold thickness and 2 (0.47%) with low body fat percentage; of which new IAP chart could detect 83.3%. Among 420 children, 54 (12.8%) children had at least one cardiometabolic risk factor, which included 40 (9.5%) with high waist circumference, 49 (11.7%) with high triceps skin-fold thickness and 40 (9.5%) with high body fat percentage; of which new IAP charts could detect 70.3%. On comparison of new IAP charts with old IAP and WHO charts to detect malnutrition showed, new IAP could detect 83.3%, old IAP chart 50% and WHO 83.3% malnutrition. New IAP charts could detect 70.3% cardiometabolic risk associated with overnutrition compared to old IAP (57.4%) and WHO (51.8%).

Table 2 Comparison of study parameters in the two selected schools

Characteristics	Erode ($n = 210$)	Vellore (n = 210)
Demographic data		
Males (number)	123	138
Age (in years)	14.0 ± 1.4	13.2 ± 1.6
Females (number)	87	72
Age (in years)	14.2 ± 1.6	13.5 ± 1.6
Height (cm)	155.7 ± 11.5	152.0 ± 11.7
Weight (kg)	41.4 ± 11.01	41.0 ± 11.83
Body mass index (kg/m^2)	17.4 ± 4.0	17.3 ± 3.9
Waist circumference (cm)	63.6 ± 11.2	61.7 ± 9.5
Systolic blood pressure (mmHg)	99.3 ± 12.6	99.5 ± 11.0
Diastolic blood pressure (mmHg)	67.2 ± 8.3	64.9 ± 6.4
Body fat percentage (%)	17.7 ± 5.7	18.5 ± 9.6
Triceps skin-fold thickness (mm)	9.3 ± 5.0	9.6 ± 5.1
Waist circumference Z-scores	−2.2 ± 1.6	−2.3 ± 1.5

Z-scores of abnormal cardiometabolic risk factors [waist circumference, blood pressure, triceps skin-fold (TSF) thickness and body fat (BF) percentage] were compared across different BMI cut-offs of wasting, normal and overweight as per the new IAP references; was found to have linear relation. The mean values of waist circumference Z-scores, Blood pressure Z-scores, TSF Z-scores and BF Z-scores increased from wasting to overweight children classified as per the new IAP references (Fig. 2).

General health advice was given to all children who participated in the health camp. Children who had overnutrition and abnormal cardiometabolic risk factors were given advice on healthy living. Children with undernutrition were advised and dietary advice was provided. Children suspected to have underlying disorders, were referred to appropriate centres for further management.

Discussion

The authors have described the results of their study on the new IAP charts and rural south Indian children. Previous research has tested the utility of the new IAP references across India [4–13]. The present study dogmatically points to the presence of a double burden of malnutrition and overnutrition in the rural south Indian children and the superiority of the new IAP references in early recognition of these children. The authors observed that 1.4% of subjects had risks associated with undernutrition in the present study. Percentage of cardiometabolic risk (CMR) in present study of 420 children in age group of 10–16 y was 12.8%. Similar study at Wardha including 405 children in 10–19 y showed CMR of 9.9% [23]. Study from Ecuador [24] in 770 children between 10 and 16 y showed adolescents from rural area had 2.8 times metabolic risk than urban area ($p < 0.05$). Although these studies have used lipid profile as a marker of cardiometabolic risk, authors used non-invasive markers like triceps skin-fold thickness (TSFT) and waist circumference as markers of CMR. This highlights that rural India is also passing through a secular trend and needs an updated growth reference to tackle the double whammy of over and under nutrition.

The present study showed more overweight children were picked up by new IAP *vs.* Old IAP (14.2% *vs.* 13.2%) references. Also, the percentage of overweight and obese children was higher than the WHO 2007 (11.8%) references as well.

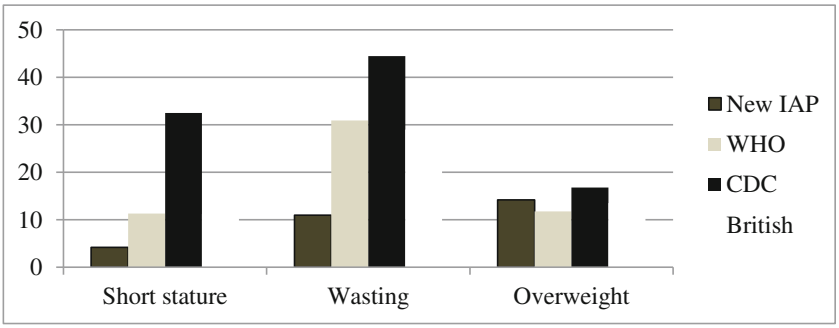

Fig. 1 Comparison of abnormal anthropometric parameters as per different references *vs.* IAP 2015 references in the study population

This in in line with the previous reports from Rajkot [6], Coimbatore [11], Pune [14] and Jammu & Kashmir [4]. The probable explanation is that IAP 2015 references were constructed based on the WHO recommendations of excluding subjects with weight for height > +3SD. Thus, normalisation of obesity was meticulously avoided and resulted in a robust reference.

New IAP charts could detect 70.3% cardiometabolic risk associated with overnutrition compared to old IAP (57.4%) and WHO (51.8%). The IAP 2015 references are prescriptive in nature for the BMI cut-offs. The cut-offs are linked to cardiometabolic risks in adults as recommended by the International Obesity Task Force (IOTF). Because of the prescriptive nature of these cut-offs, a significantly higher percentage of subjects with cardiometabolic risks were detected by the BMI cut-offs.

In the present study, more thin children were picked up by new IAP *vs.* old IAP but similar to WHO. The authors have demonstrated that the new IAP charts are capable of recognising these children who have a low TSFT and low body fat. A similar observation was made in a study from Pune [14] wherein WHO overestimated and old IAP charts underestimated wasting. A study from New Delhi have shown that the mean BMI SD scores calculated as per the WHO 2007 references was lower and Agarwal 1992 references was higher than the BMI SD scores calculated as per the IAP 2015 references [5]. In contrast, authors from Rajkot observed that lesser thin children were recognised by IAP 2015 references [6]. This may be attributable to the fact that they have used the 5th percentile to define thinness; the present study has adopted the −2 SD cut-off to recognise under nutrition.

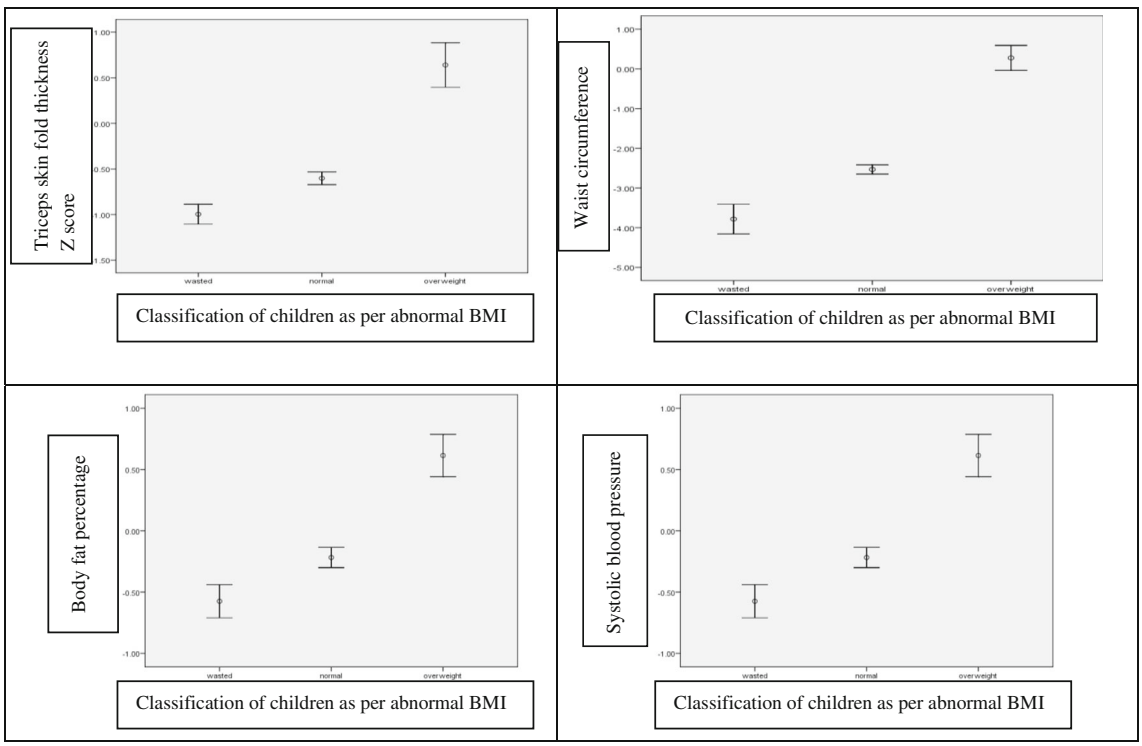

Fig. 2 Z-scores of risk factors across different BMI cut-offs as per new IAP references

Additional estimation of serum albumin and lipid profile in the undernourished and overnourished subjects could not be performed due to logistic reasons. However, the current consideration of using low TSFT and low BF for malnutrition has been defined previously [19, 20]. Researchers have used a TSFT cut-off of < −1.6 SD (considered synonymous to albumin depletion) to identify malnutrition in cancer patients [19]. In the present study, authors have used high waist circumference, BF and TSFT for cardiometabolic risk assessment [16–18]. The authors could not perform DEXA scan to assess body fat and Tanners stage of present subjects due to practical difficulties in a camp setting.

To conclude, there is significant prevalence of both under nutrition and overweight in rural setting. IAP 2015 reference is useful to diagnose children with under nutrition and overweight including abnormal health risk.

Authors' Contributions The study was conceived by HKP. The study was performed by VKC, SAMAN, KVA, HKP. TS was involved in conceptualisation of the study, performance of the study, and preparation of the manuscript. NK was involved in the performance of the study, statistical analysis and preparation of the manuscript. All authors contributed to the manuscript and HKP shall act as a guarantor of the study.

Compliance with Ethical Standards

Conflict of Interest None.

References

1. Agarwal DK, Agarwal KN, Upadhyay SK, Mittal R, Prakash R, Rai S. Physical and sexual growth pattern of affluent Indian children from 5-18 years of age. Indian Pediatr. 1992;29:1203–82.
2. de Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. Bull World Health Organ. 2007;85:660–7.
3. Khadilkar V, Yadav S, Agrawal KK, et al. Revised IAP growth charts for height, weight and body mass index for 5- to 18-year-old Indian children. Indian Pediatr. 2015;52:47–55.
4. Haq I, Raja MW, Ahmad MM. A comparison of the 2015 Indian academy of pediatrics, international obesity task force and World Health Organization growth references among 5–18-year-old children. Ann Trop Med Public Health. 2017;10:1814–9.
5. Singh P, Gandhi S, Malhotra RK, Seth A. Impact of using different growth references on interpretation of anthropometric parameters of children aged 8-15 years. Indian Pediatr. 2020;57:124–8.
6. Chudasama RK, Eshwar TKM, Thakrar D, Eshwar ST. Prevalence and comparison of obesity, overweight, and thinness by different growth standards among affluent schoolchildren (8–18 years) in Rajkot. J Mahatma Gandhi Inst Med Sci. 2017;22:99–104.
7. Jaiswal M, Bansal R, Agarwal A. Role of mid-upper arm circumference for determining overweight and obesity in children and adolescents. J Clin Diagn Res. 2017;11:SC05–8.
8. Patil AD, Shejul S, Bhandarkar P, Kattimani A, Mudassir A, Bantwal K. A study of adolescent obesity and hypertension in urban school in Mumbai. Int J Community Med Public Health. 2018;5:790–4.
9. Dasappa H, Fathima FN, Ganesh K, Prasad S. Prevalence, risk factors and attitude of parents towards childhood obesity among school children in Bangalore city. Int J Community Med Public Health. 2018;5:749–73.
10. Premkumar S, Ramanan PV, Dhivyalakshmi J. Rural childhood obesity – an emerging health concern. Indian J Endocr Metab. 2019;23:289–92.
11. Krishnan R, Ramachandran G, Sivasankaran B. Prevalence of overweight and obesity among 5-16 years in semi-urban areas of Coimbatore. India J Evol Med Dent Sci. 2017;6:1524–8.
12. Ashtekar S, Padhyegurjar MS, Powar J, Padhyegurjar SB. Ethnotribal growth differences among schoolchildren in a northwestern Maharashtra district: an analytical cross sectional study. Indian J Community Med. 2019;44:357–61.
13. Premkumar S, Venkatramanan P, Dhivyalakshmi J, Gayathri T. Comparison of nutrition status as assessed by revised IAP 2015 growth charts and CDC 2000 growth charts in lower socioeconomic class school children. Indian J Pediatr. 2019;86:1136–8.
14. Lohiya N, Khadilkar V, Pawar S, Khadilkar A, Chiplonkar S, Jahagirdar R. Field testing IAP 2015 charts. Indian J Pediatr. 2018;85:723–8.
15. World Health Organisation. Physical status: the use and interpretation of anthropometry. A report of a WHO expert committee. Geneva: WHO; 1995.
16. Khadilkar A, Ekbote V, Chiplonkar S, et al. Waist circumference percentiles in 2-18 year old Indian children. J Pediatr. 2014;164:1358–62.
17. Khadilkar A, Mandlik R, Chiplonkar S, Khadilkar V, Ekbote V, Patwardhan V. Reference centile curves for triceps skinfold thickness for Indian children aged 5–17 years and cut-offs for predicting risk of childhood hypertension: a multi-centric study. Indian Pediatr. 2015;52:675–80.
18. Chiplonkar S, Kajale N, Ekbote V, et al. Reference centile curves for body fat percentage, fat-free mass, muscle mass and bone mass measured by bioelectrical impedance in Asian Indian children and adolescents. Indian Pediatr. 2017;54:1005–11.
19. Sala A, Rossi E, Antillon F, et al. Nutritional status at diagnosis is related to clinical outcomes in children and adolescents with cancer: a perspective from Central America. Eur J Cancer. 2012;48:243–52.
20. McCarthy HD, Cole TJ, Fry T, Jebb SA, Prentice AM. Body fat reference curves for children. Int J Obes. 2006;30:598–602.
21. Kuczmarski RJ, Ogden CL, Grummer-Strawn LM, et al. CDC growth charts: United States. Adv Data. 2000;314:1–27.
22. Cameron N. British growth charts for height and weight with recommendations concerning their use in auxological assessment. Ann Hum Biol. 2002;29:1–10.
23. Bhalavi V, Deshmukh PR, Goswami K, Garg N. Prevalence and correlates of metabolic syndrome in the adolescents of rural Wardha. Indian J Community Med. 2015;40:43–8.
24. Ochoa-Aviles A, Andrade S, Huynh T, et al. Prevalence and socioeconomic differences of risk factors of cardiovascular disease in Ecuadorian adolescents. Pediatr Obes. 2012;7:274–83.