

Assessment of Nutritional Status and Total Energy Requirement among under-five Anganwadi Children of Korba, Chhattisgarh, India

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ABSTRACT

On nutritional assessment scales, under-five children are one of the most vulnerable groups in India. Almost fifty percent of India's under-five children are underweight which is affecting overall health indicators of India. In this alarming situation, it is imperative to understand the nutritional status and total energy requirement of under-five children in time bound manner for better policy implications. A cross sectional study was conducted among 248 (124 boys and 124 girls) under-five children of seven anganwadi centre of Korba Block of Chhattisgarh using certain anthropometric measurements. The nutritional status and Total Energy Requirement (TER) was determined through the Body Mass Index (BMI)-for-age reference of WHO child growth standard (2006) and FAO/WHO/UNU (2004) equation. Variation in nutritional status and TER was calculated through Pearson chi-square and one-way ANOVA test respectively. Further, Pearson correlation (r) test was applied to check the relationship between them. The age-sex combined prevalence of undernutrition, normal and overweight was 37.5%, 54.8% and 7.7% respectively but found no age-sex variation ($\chi^2 = 9.27$; $df = 8$; $P > 0.05$). The mean total energy requirement of underweight, normal and overweight children was 871.68 Kcal, 930.31 Kcal and 896.13 Kcal per day respectively and again there was no significant ($F = 2.04$; $P > 0.05$) difference found between them. The significant correlation was found between total energy requirement with height ($r = 0.92$; $P < 0.01$), weight ($r = 0.96$; $P < 0.01$) and mid upper arm circumference ($r = 0.41$; $P < 0.01$). Major findings point out prevalence of undernutrition in 37.5 % of studied children population. The study suggests for conducting a screening that monitor total energy requirement of under-five tribal children in order to assess the impact of energy requirement on nutritional status.

Keywords: Body Mass Index, under-nutrition, overweight, total energy requirement, anthropometric measurements etc.

INTRODUCTION

Children are building blocks of any country's human resource and proper early nutrition makes a strong foundation for healthy individual in later phases of life. That's why we find good number of nutritional studies among children in early ages as it has spatial and temporal importance (Mitra et al., 2004; Mitra et al., 2007a) and still remain volumetric concern among researcher, academician and medical professional. Nutritional adequacy not only important for proper physical growth but also required for mental, emotional and intellectual building (Biswas et al., 2009; Mandal & Bose, 2014; Sinha et al., 2019; Vasudevan & Udayashankar, 2019; Mahapatra & Bose, 2020; Naik & Kumar, 2021).

In India, Integrated Child Development Services (ICDS) is a generous and intense nutritional programme which was launched on 2nd Oct 1975 to improve maternal and child health targeting under-six age children, adolescent girls, pregnant and lactating mothers (Jain et al., 2020; Naik & Kumar, 2021). But the outcome of this scheme is not satisfactory (Shahnawaz and Singh 2014; Das et al., 2020a) in many rural and tribal parts of India as undernutrition is still a major concern and one of the major causes of child mortality. Asia is home of roughly seventy percent malnourished children of the globe (Mahapatra & Bose, 2020) and only in India 49% children are underweight sharing 39% of global burden (Giri et al., 2017).

Nutritional indices like weight-for-age (underweight), height-for-age (stunting) and weight-for-height (wasting) were mostly used to evaluate the nutritional status of children. But now "*body mass index (BMI) for age reference of WHO child growth standards (2006) and internationally cut-off for overweight and obesity (Cole et al., 2000) and for thinness (Cole et al., 2007) also used to assess the nutritional status of 0-5 year children*" (Biswas et al., 2009).

A healthy child requires reasonable amount of energy along with protein to sustain reasonable growth and development (Das et al., 2017). The quantity of dietary energy demanded by the body to pair of energy output, to maintain the body size and body composition, proper growth and development and for required level of physical activity is known as total energy requirement (TER). Additional energy is also required during pregnancy and lactating mothers for milk secretion (FAO/WHO/UNO, 2001). Similarly, Total Energy Expenditure (TEE) is the quantum of energy utilised by the body per day (in a period of 24 hour) in its basal activities, physical activities and in its digestive process of meal (FAO/WHO/UNO, 2001).

The low intake of energy in comparison of energy expenditure for extended period of time makes person underweight (Jain et al., 2020; ICMR-NIN, 2020). Vice versa more energy intake compare to energy expenditure leads to overweight body or obesity and it is a major cause of many dilapidated diseases (ICMR-NIN, 2020). In this pretext, it is very importance to assess the energy requirement of children along with their nutritional status. Thus, the present study aims to assess the nutritional status and total energy requirement of under-five children of seven *anganwadi* centres of Korba block of Chhattisgarh.

RESEARCH METHOD

Study Population and Sampling

A cross-sectional study was conducted among under-five children of seven *anganwadi* centres of Korba block in the state of Chhattisgarh. The villages are surrounded by the forest and have very limited resources. The selected children were from different caste categories like Kavar, Manjhar, Birhor, Painaka, Yadav etc. Each and every under-five children of selected *anganwadi* were taken into the sample who were present at *anganwadi* centre on that particular day of investigation and their detail anthropometric measurement were taken. The study includes total 248 (124 boys and 124 girls) children (as table 1 shows the distribution of selected children age and sex specifically).

Table 1: Distribution of Studied Children (Age and Sex Specific)

<i>Age Group (M)</i>	<i>Boys</i>		<i>Girls</i>	
	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>
<i>0-12</i>	18	14.5	25	20.2
<i>13-24</i>	31	25.0	23	18.5
<i>25-36</i>	29	23.4	32	25.8
<i>37-48</i>	26	21.0	13	10.5
<i>49-60</i>	20	16.1	31	25.0
<i>Total</i>	124	100.0	124	100.0

Data Collection

The required ethical and standard procedure was maintained while conducting the research. The oral consent was taken from parents or care taker of all the children before taking anthropometric measurements. The recumbent/standing height of children was recorded to the nearest 0.1 cm barefoot and weight was taken with minimal clothing with the precision of 0.1 kg or 100g; some time it was taken from *anganwadi* worker. Unfortunately, the most anthropometric measurements of children were taken on the day when their parents brought

them to the *anganwadi* for measurements locally known as '*vajantyohar*'. Age estimation is very important in any nutritional study (Mitra et al., 2007b), so the age of the selected children was recorded from either birth certificate or obtained from *anganwadi* centres.

Analysis

All the statistical analysis was carried out in the Statistical Package for Social Science (SPSS) version 16.0. The Body Mass Index (BMI) was computed by using standard formula $BMI = \text{weight (kg)} / \text{height (m}^2\text{)}$. The nutritional status was determined by the BMI-for-age reference of World Health Organization (WHO) child growth standard (2006). The total energy expenditure of selected children was estimated by FAO/WHO/UNU, 2004 equation adopted by ICMR-NIN expert group (2020). The energy deposition (cost) for normal growth was added with estimated total energy expenditure in order to obtain the energy requirement. Independent sample t-test and one-way ANOVA (*F*) test was used to see the sexual difference in anthropometric characteristics and daily energy requirement among children according to their nutritional status. Age and sex variation was assessed by the Pearson chi-square (χ^2) test. Further Pearson correlation (*r*) test was applied to check the relationship between anthropometric measurement and nutritional requirement of children with their daily energy requirement.

FAO/WHO/UNU, 2004 equation for estimation of TEE and TER for Infant (0-1Year):

$$TEE \text{ (Kcal/d)} = -152.0 + 92.8 * \text{body weight (kg)}$$

$$TER \text{ (Kcal/d)} = [TEE] + [\text{weight gain (g/d)} * \text{energy deposition (Kcal/g)}]$$

FAO/WHO/UNU, 2004 equation for estimation of TEE and TER for children (1-5Years):

$$TEE \text{ (Kcal/d)} = 310.2 + 63.3 * \text{body weight (kg)} - 0.263 * \text{body weight (kg}^2\text{)} \text{ [Boys]}$$

$$TEE \text{ (Kcal/d)} = 263.4 + 65.3 * \text{body weight (kg)} - 0.454 * \text{body weight (kg}^2\text{)} \text{ [Girls]}$$

$$TER \text{ (Kcal/d)} = [TEE] + [\text{energy cost of growth}]$$

RESULTS

The age and sex specific anthropometric characteristic of children was presented in the table 2. The table shows that age combined height ($\bar{x} \pm \sigma$) of children was 83.41 ± 12.94 cm for boys

and 82.63 ± 14.04 cm for girls. Similarly, the mean weight, BMI and MUAC was 10.57 ± 2.81 kg, 15.01 ± 1.64 kg/m² and 15.29 ± 1.56 cm among boys; while it was 10.24 ± 3.08 kg, 14.75 ± 1.55 kg/m² and 15.27 ± 1.56 cm among girls respectively. There was no significant difference ($P > 0.05$) observed between boys and girls for any of the anthropometric characteristics in any age groups except for weight among 13-24 month and 25-36 month old children ($P \leq 0.05$).

Table 2: Anthropometric Characteristics of studied Children

Age Group (M)	Sex	Height (cm) ($\bar{x} \pm \sigma$)	Weight (kg) ($\bar{x} \pm \sigma$)	BMI (kg/m²) ($\bar{x} \pm \sigma$)	MUAC (cm) ($\bar{x} \pm \sigma$)
0-12	Boys	61.07±8.89	5.90±1.96	15.47±2.44	14.52±1.18
	Girls	62.54±8.01	6.07±1.73	15.26±2.08	15.20±0.45
<i>t-value (Sig)</i>		-0.56 (0.57)	-0.30 (0.76)	0.30 (0.75)	-1.51 (0.15)
13-24	Boys	77.73±6.71	9.14±0.99	15.24±1.70	15.00±1.11
	Girls	74.74±5.59	8.50±1.09	15.27±1.45	14.08±0.88
<i>t-value (Sig)</i>		1.75 (0.08)	2.22 (0.03)*	-0.06 (0.94)	1.87 (0.07)
25-36	Boys	85.62±5.37	11.03±1.25	15.08±1.51	14.97±1.49
	Girls	84.84±4.23	10.45±1.02	14.53±1.27	14.92±1.70
<i>t-value (Sig)</i>		0.63 (0.52)	1.99 (0.05)*	1.52 (0.13)	0.73 (0.94)
37-48	Boys	91.95±4.71	12.70±1.27	15.03±1.21	16.20±1.77
	Girls	91.08±4.57	12.25±1.32	14.78±1.41	15.92±0.65
<i>t-value (Sig)</i>		0.55 (0.58)	1.02 (0.31)	0.57 (0.56)	0.29 (0.77)
49-60	Boys	98.00±3.84	13.56±1.37	14.10±1.03	15.77±1.96
	Girls	98.91±3.55	13.84±1.37	14.16±1.26	16.28±1.79
<i>t-value (Sig)</i>		-0.86 (0.39)	-0.72 (0.47)	-0.18 (0.85)	-0.60 (0.55)
Total	Boys	83.41±12.94	10.57±2.81	15.01±1.64	15.29±1.56
	Girls	82.63±14.04	10.24±3.08	14.75±1.55	15.27±1.56
<i>t-value (Sig)</i>		0.45 (0.65)	0.87 (0.38)	1.27 (0.20)	0.07 (0.94)

(*Significance at $P \leq 0.05$; \bar{x} -mean, σ - standard deviation)

Table 3 show the nutritional status of studied children (age and sex specific). Overall, maximum 54.8% (55.6% boys and 54.0% girls) children were found normal; whereas age-sex combined prevalence of undernutrition was 37.5 % (37.1% among boys and 37.9% among girls). At the same time 7.7% (7.3 boys and 8.1% girls) children was found overweight in this study. The prevalence of underweight was highest among 49-60 month old boys (45.0%) and girls (41.9%); whereas the prevalence of overweight was highest among 0-12 month old boys (16.7%) and 37-48 month old girls (15.4%). However, there was no significant ($\chi^2 = 9.27$; $df = 8$; $P > 0.05$) age and sex variation was estimated for nutritional status among studied children.

Table 3: Nutritional Status of Children

<i>Age Group (M)</i>	<i>Sex</i>	<i>Undernutrition</i>		<i>Normal</i>		<i>Overweight</i>	
		<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>
0-12	Boys	8	44.4	7	38.9	3	16.7
	Girls	9	36.0	13	52.0	3	12.0
13-24	Boys	12	38.7	19	61.3	-	-
	Girls	7	30.4	14	60.9	2	8.7
25-36	Boys	12	41.4	14	48.3	3	10.3
	Girls	13	40.6	18	56.2	1	3.1
37-48	Boys	5	19.2	18	69.2	3	11.5
	Girls	5	38.5	6	46.2	2	15.4
49-60	Boys	9	45.0	11	55	-	-
	Girls	13	41.9	16	51.6	2	6.5
Total	Boys	46	37.1	69	55.6	9	7.3
	Girls	47	37.9	67	54.0	10	8.1
Age-sex combined		93	37.5	136	54.8	19	7.7
Chi-Square	$\chi^2 = 9.27; df = 8; Sig. = 0.32$						

The mean total energy expenditure (shown in the table 4) among underweight children was 838.08 Kcal/d (864.70 Kcal/d among boys and 812.02 Kcal/d among girls); while it was observed 897.23 Kcal/d [942.81 Kcal/d (boys) and 850.28 Kcal/d (girls)] and 844.82 Kcal/d [860.48 Kcal/d (boys) and 830.71 Kcal/d (girls)] among normal and overweight children respectively.

Table 4: Total Energy Expenditure of Studied Children (Kcal)

<i>Age Group (M)</i>	<i>Sex</i>	<i>Underweight (Kcal/d)</i>	<i>Normal (Kcal/d)</i>	<i>Overweight (Kcal/d)</i>
0-12	Boys	385.08	362.38	503.79
	Girls	380.16	423.57	457.39
13-24	Boys	865.62	867.58	-
	Girls	748.16	806.02	774.10
25-36	Boys	951.19	989.91	1012.00
	Girls	860.73	917.78	954.31
37-48	Boys	1006.60	1090.03	1065.60
	Girls	950.62	1033.10	990.95
49-60	Boys	1095.73	1139.80	-
	Girls	1043.40	1091.23	1225.30
Total	Boys	864.70	942.81	860.48
	Girls	812.02	850.28	830.71
Age-sex combined		838.08	897.23	844.82

The estimated total energy requirement of studied children was presented in the table 5; estimated based on total energy expenditure also recommended by ICMR-NIN (2020) expert group. The mean (age combined) total energy requirement of underweight, normal and

overweight boys was 896.70 Kcal/d, 973.41 Kcal/d and 924.64 Kcal/d respectively. Similarly, the mean total energy requirement was 847.20 Kcal/d, 885.93 Kcal/d and 870.47 Kcal/d among underweight, normal and overweight girls, respectively. There was no significant difference observed in total energy expenditure among underweight, normal and overweight boys or girls ($P > 0.05$) children except for 25-36 month and 49-60 month old girls ($F = 0.27$ and $F = 0.21$; $P < 0.05$ respectively).

Table 5: Total Energy Requirement of Studied Children (Kcal)

Age Group (M)	Sex	Underweight (Kcal/d)	Normal (Kcal/d)	Overweight (Kcal/d)	ANOVA	
					F	Significance
0-12	Boys	475.41	491.18	642.77	2.68	0.10
	Girls	482.82	527.80	550.39	0.87	0.43
13-24	Boys	881.45	883.42	-	0.00	0.92
	Girls	762.19	820.04	788.12	2.26	0.13
25-36	Boys	982.75	1021.00	1044.00	1.37	0.27
	Girls	892.23	949.28	985.80	5.59	0.00*
37-48	Boys	1029.00	1112.00	1088.03	3.12	0.06
	Girls	970.79	1053.00	1011.00	2.13	0.16
49-60	Boys	1104.00	1148.00	-	1.63	0.21
	Girls	1053.00	1101.00	1235.00	9.52	0.00*
Total	Boys	896.70	973.41	924.64	1.82	0.16
	Girls	847.20	885.93	870.47	0.43	0.64
Age-sex combined		871.68	930.31	896.13	2.04	0.13

(*Significance at $P < 0.05$)

Table 6 shows the relationship between total energy requirement of children with their anthropometric characteristics and nutritional status. The total energy requirement of studied children was found significantly correlated with their height ($r = 0.92$; $P < 0.01$), weight ($r = 0.96$; $P < 0.01$) and mid upper arm circumference ($r = 0.41$; $P < 0.01$). But there was no correlation observed between total energy requirement of children with their BMI ($r = -0.03$; $P > 0.01$) and nutritional status ($r = 0.09$; $P > 0.01$).

Table 6: Correlation of TER with Anthropometric Characteristics and Nutritional Status

		Anthropometric Characteristics				Nutritional Status
		Height (cm)	Weight (kg)	BMI (kg/m^2)	MUAC (cm)	
TER	r	0.92	0.96	-0.03	0.41	0.09
	Sig	0.00**	0.00**	0.55	0.00**	0.14

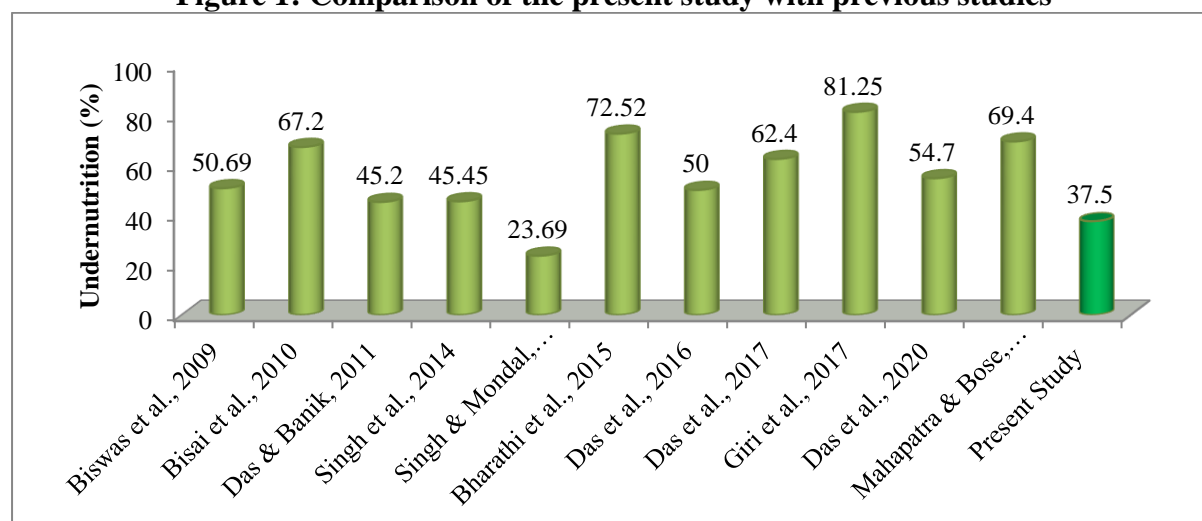
(** Significant at $P < 0.01$)

DISCUSSION

The under-five children are one of nutritional vulnerable segment in Indian society especially in tribal (Das et al., 2020b), rural and urban slum. Nutritional inadequacy among under-five children is one of the multifactorial (Adhikari et al., 2017) public concern causes certain morbidities and high mortality among them (Bisai et al., 2010; Mahapatra & Bose, 2020). It was mentioned that the prevalence of undernutrition is determined more accurately by low BMI-for-age (thinness) than the low weight-for-height (wasting) (Cole et al., 2007). Thus the present study aims to assess the nutritional status of studied children based on BMI-for-age reference.

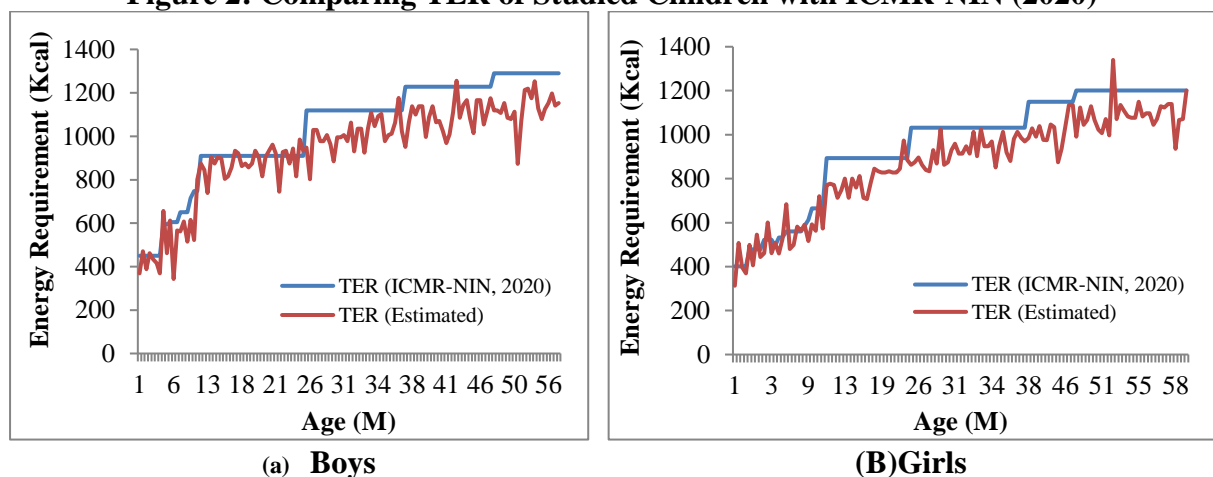
The maximum 54.8% (55.6% boys and 54.0% girls) children were found normal, whereas 37.5 % (37.1% boys and 37.9% girls) were undernourished and only 7.7% (7.3 boys and 8.1% girls) children were observed as overweight when age-sex combined analysis was done. The prevalence of undernutrition was found less than all other previous studies (Biswas et al., 2009; Bisai et al., 2010; Das & Banik, 2011; Singh et al., 2014; Bharathi et al., 2015; Das et al., 2016; Das et al., 2017; Giri et al., 2017; Das et al., 2020b; Mahapatra & Bose, 2020) but observed higher than Singh & Mondal, 2014 (as presented in figure 1). Hence, it was admitted that the nutritional status of studied population is improved than other reported studies. Probably it was due to well-functioning of *anganwadi* and ICDS centre nearby and supplements provided by the same also established in many studies (Radhamani & Rajeev, 2017; Jain et al., 2020; Naik & Kumar, 2021) or due to improved socio-economic condition, better hygiene practices, medical facilities, awareness and knowledge among parents about child nutrition etc.

Figure 1: Comparison of the present study with previous studies



Energy imbalance is also stated as malnutrition (Das et al., 2016). The estimated mean of total energy requirement among underweight, normal and overweight children was 871.68 Kcal/d, 930.31 Kcal/d and 896.13 Kcal/d respectively and there was no significant ($F= 2.04$; $P>0.05$) difference found among them. Still the estimated total energy requirement is found less than ICMR-NIN (2020) as shown in figure 2. There is lack of reported study that estimate total energy requirement among under-five children in Indian context so it become hard to compare with other studies. The total energy requirement of 3, 6, 9, 12, 18, and 24 month old children was estimated 532.62 Kcal/day, 618.61 Kcal/d, 709.37 Kcal/d, 807.29 Kcal/d, 888.50 Kcal/d, and 991.21 Kcal/d respectively (Butte et al., 2000a). It was estimated energy requirement of children was increased from 955.38 Kcal/d in 2 year to 2627.30 Kcal/d in 18 year old girls and from 1194.22 Kcal/d to 3582.68 Kcal/d in boys (Butte, 2000b). Walker et al. (2012) reported that the energy requirement of children with cerebral palsy had less than typically developing children.

Figure 2: Comparing TER of Studied Children with ICMR-NIN (2020)



Conclusion

The study concluded that the maximum (54.8%) children were found normal. Possibly the improved nutritional status of studied children was due to better coverage of ICDS program and supplements provided through scheme run under the umbrella ICDS or due to improved socio-economic condition, better hygiene practices, medical facilities, awareness and knowledge among parents about child nutrition etc. Still the prevalence of undernutrition is serious (37.5%) among the studied population. The estimated energy requirement was found highest among normal children followed by overweight and undernourished children; however, there was no significant difference was observed. The anthropometric

characteristics (height, weight and MUAC) of children were found as determinant of their total energy requirement; as significant correlation was found between them. No significant correlation between nutritional status and total energy requirement was underlie in this study however it is point of further research because distribution of undernourished, normal and overweight children was not equal in the present study. Thus, the study recommends a screening of all under-five tribal children to monitor total energy requirement in order to appraise the impact of energy requirement on nutritional status.

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Contribution of Authors: Author ANS and SY helped in designing and execution of the present study. Data collection, analysis and drafting of manuscript was done by author D and author SY also helped in significant improvement of the language. Authors confirm that the work has not been sent for the publication elsewhere, nor published.

Declaration of Conflict: The authors declared that there is no conflict of interest.

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