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"A Cross-Sectional Study for Measuring Undernutrition through Composite Index of Anthropometric Failure (CIAF) among Indian Children"

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Abstract

Children's undernourishment remains a severe public health concern and is one of the main causes of illness and early mortality among children of under-five. The analysis in focus was intent to measure the prevalence of and factors associated with nutritional status of under-five children by using the Composite Index of Anthropometric Failure (CIAF). Current cross-sectional study was conducted with a total of 749 children which were selected through cluster sampling methodology. Field staff has been trained in all aspects of data collection including taking consent and measurements. Assessment of the nutritional status of the children was computed through CIAF. Multivariable logistic regression analysis was applied to analyze the leading factors associated with undernutrition. The overall prevalence of undernutrition was 54.5% among under five children according to CIAF while 9.6% experienced wasting only, 8.8% were classified as both wasting and underweight, 7.2% as wasting underweight and stunting, 11.9% stunting and underweight, 8.0% stunting only and 8.9% underweight only. Most of the mothers were educated to secondary and above level, 55% working mothers, around 40% mothers have age at the time of delivery was 26 years and above. It was observed that female children were more likely to suffer from undernutrition than male children. Children age (13 – 24 Months): [aOR:1.48, CI: 1.10-1.86]; female child: [aOR:2.88, CI: 1.65-4.97]; family monthly income

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of up to INR 15,000 [aOR: 2.46, CI: 1.77-4.82], underweight mother: [aOR: 2.01, CI: 1.18-3.21]; mother's education above secondary level: [aOR: 2.68, CI: 1.29-3.01], working mother: [aOR: 1.95, CI: 1.57-2.89], and age of introducing complementary food: [aOR: 1.88, CI: 1.62-2.36] were significantly associated with anthropometric failure among children. Most of the children under five experience anthropometric failure. CIAF is a helpful resource that offers a comprehensive image of the prevalence of undernutrition. However, more evidence is required in similar settings to confirm its usefulness.

Abbreviations

aOR = Adjusted Odds Ratio
CI = Confidence Interval
CIAF = Composite Index of Anthropometric Failure
cOR = Crude Odds Ration
HAZ = Length/height-for-age
INR = Indian Rupees
NFHS = National Family Health Survey
WAZ = Weight-for-age
WHO = World Health Organization
WHZ = Weight-for-length/height

Introduction

Hunger is still an issue in the developing world, as it causes a rise in undernutrition, diseases, and disability that has an impact on the nations' economies. According to the 2023 Global Hunger Index study, one in three people globally are undernourished due to a lack of calories. A third of children worldwide die from malnutrition, which is responsible for 2.6 million fatalities.[1] Malnutrition, which is frequently linked to nutritional inadequacies, results in stunted growth in children as well as psychological development and academic performance, which can have disastrous effects on one's career path, financial income and increase poverty.[2] Undernutrition in children remains a major public health issue. According to World Health Organization (WHO) globally, 17 million children of under five are severely wasted, 52 million are wasted and 115 million children are stunted. Every 2nd under five child in Asia suffer from growth failure, which manifests as stunting, wasting or overweight. In India, almost half of the under five children are malnourished and about one million children die before completing their 1st month of age.[3-7] In India, 32.1% of under five children were underweight, 19.3% were found to be wasted and 35.5% of children were stunted.[8]

High levels of poverty, inadequate dietary intake, inadequate feeding practices, inequitable distribution of food within the household, low socio-economic status, bad lifestyle choices, and parenting styles are all linked to undernutrition issue[9-12] which is characterized by stunting, underweight and wasting.[13] Additionally, it is linked to infectious disorders such tuberculosis, diarrheal diseases, and acute respiratory infections.[10,14-16] Poor environmental sanitation and a lack of hygiene habits are also contributing factors to the high frequency of infectious diseases. Furthermore, maternal age, mother's education, non-exclusive breast feeding and initiation time of complementary feeding are other factors responsible for increased prevalence of child undernutrition.[17, 18] However, children who eat healthily, grow and develop to their full potential and also lowers the risk of developing non-communicable diseases.[19]

The population's anthropometric measures can be used to identify signs of undernutrition in children. The human body's size, proportions, and composition are evaluated using this technique. Even children's growth and development patterns, nutritional sufficiency, and overall health can be assessed using anthropometry.[20,21] There have been numerous attempts to grade the severity of malnutrition.[22, 23] The first set of WHO Child Growth Standards is presented in the WHO report utilizing the traditional indices of weight-for-age (WAZ), length/height-for-age (HAZ), weight-for-length/height (WHZ), and BMI-for-age.[24,25] Four standard indices are weight-for-age, height/length-for-age, weight-for-height/length (for children ages 0–60 months), and BMI-for-age (for children ages 0–60 months and 5–18 years) in day to day practice. A child's current nutritional status is represented by the weight-for-age index, which also identifies general nutritional issues.

Underweight or severely underweight children are evaluated using this measure. The height/length for-age index is a measure of chronic malnutrition. Children who have experienced chronic illness or malnutrition can be identified using this indicator, which is divided into two categories: short (stunted) and extremely short (severely stunted). However, it has been argued that these conventional indicators cannot truly reflect the prevalence of undernutrition.[22] More so, scientists are forced to select one category of anthropometric failure to represent the nutritional status of the target population while foregoing information on the other nutritional indices. Hence, to overcome this limitation, Svedberg developed the Composite Index of Anthropometric Failure (CIAF) to report the prevalence of accurate data. With this approach, children with one or more anthropometric deficiencies can be identified.[26,27] To assess children under five years old's nutritional condition, the CIAF is an anthropometric index that integrates the three indices of weight-for-age, height/length-for-age, and weight-for-height/length. This research was focused at measuring the prevalence of and leading factors associated with nutritional status of under-five children by using CIAF index.

Materials and Methods

Study Design

This cross-sectional study was conducted from April 2023 to March 2024.

Sample Size

We considered the prevalence of undernutrition (60.5%) through CIAF from a previous Indian study.[28] The calculation was based on the following assumptions: prevalence of undernutrition: 0.605, and a margin of error: 0.035 by using the Cochran formula (1997)[29] as:

$$n_0 = \frac{z^2 pq}{e^2}$$

Where;

n_0 = desired sample size

e = the intended degree of accuracy, or error margin (0.035)

p = the (estimated) percentage of the population that possesses the relevant characteristic (0.605)

q = 1 – p (0.395)

z= confidence interval (at 95%)

Calculated sample size: 749

A total of 749 samples were obtained.

Participants Inclusion and Exclusion Criteria and Sampling

All under five children of the urban area were the target population. Children between the age group of 0-59 months and those children whose parents/guardians have consented to participate in the study were included while children suffering from any ailment at the time of the data collection, and pre-term children (28 weeks' gestational age) were excluded from the study. Cluster sampling methodology used to enrol the study participants. Ten urban administrative wards with slum population (one ward = one cluster) selected and from each ward 75 children under five selected.

Data Collection Procedures

A tool based on sociodemographic and other objective-related characteristics has been developed in order to collect the necessary data from the participants. Data collection team has undergone training on the study procedure. During the training session, the investigators provided the briefing including getting the participant's consent, asking questions in a consistent manner, showing consideration and politeness, and recording the participant's answers. Every question was clarified to the team during the training sessions, and concerns were addressed appropriately. The Institutional Review Board reviewed and approved the study protocol and data collection tool. Before conducting the interview, a participant information sheet was provided and explained to each parent or guardian of the participant, and consent was taken from them.

Assessment of Nutritional Status

The measurement of length for the age of children between 0-23 months, Infantometers (Harpenden, range 300-1100 mm) were used by field staff with support of local person in the particular area by holding the infant in position securely. Head held vertical against the head plate by mother/or any other person; back straight on the infantometer. Field staff also trained on the standardization of

weight scale and measuring tape (Standard weight and tape for testing accuracy). For children 24-59 months, a digital scale with a 0.1 kg precision was used to weigh the children. Similarly, a flexible, non-extensible tape was used to measure height with a precision of 0.1 cm, and it was calibrated using the industry standard anthropometric scale. WHO guidelines were followed for all anthropometric measures. The birth date was used to determine the exact age of the children. When data on the actual date of birth was not available, the mother's age was utilized to the nearest month. Weight-for-age, length/height-for-age, and weight-for-length/height are the three anthropometric indices that are combined to create the CIAF. Nutritional status of the children was assessed using CIAF[30] through formula as mentioned below.

CIAF = 1-A / A + B + C + D + E + F + G + Y = 1-A/1 = 1-A

According to the CIAF, undernutrition is classified as either anthropometric failure or no failure (normal). Anthropometric failure is further divided into six sub-groups (labelled A-F) as follows: A - (no anthropometric failure), B - (wasting only), C - (wasting and underweight), D - (wasting, stunting and underweight), E - (stunting and underweight), F - (stunting only) and Y - (underweight only).

Statistical Analysis

The estimates were presented as mean and standard deviation for continuous variables, percentage and frequency distribution for discrete and categorical variables using descriptive statistics and crude odds ratios (cOR) using univariate logistic regression.

Multivariable logistic regression analysis was also employed to identify the leading factors to undernutrition. The adjusted odds ratio (aOR) and 95% confidence interval (CI) were used to present the results. The model was adjusted for all background and other independent parameters in order to display the aOR. The dependent variable was dichotomous: either any CIAF failure or no CIAF failure. P values were recorded to evaluate the model fit.

Table 1. Sociodemographic characteristics of children and mothers (n=749)

Variable	Male Children		Female Children		Total	Percentage
	n (328)	%	n (421)	%	n (749)	%
Age (In months)						
0-12	106	32.3	138	32.8	244	32.6
13-24	65	19.8	106	25.2	171	22.8
25-36	67	20.4	82	19.5	149	19.9
37-48	42	12.8	45	10.7	87	11.6
49-59	48	14.6	50	11.9	98	13.1
Religion						
Hinduism	277	84.5	322	76.3	599	80.0
Islam	51	15.5	99	23.5	150	20.0
Mother's education						
Illiterate	57	17.4	87	20.7	144	19.2
Primary	80	24.4	119	28.3	199	26.6
Secondary	110	33.5	115	27.3	225	30.0
Above Secondary	81	24.7	100	23.8	181	24.2
Monthly income (Indian Rupees - INR)						
Up to 15000	224	66.3	335	79.6	559	74.6
15001-25000	60	18.3	66	15.7	126	16.8
>25000	41	12.5	23	5.5	64	8.6

Mother's occupation						
Housewife/Not working	100	30.5	59	14.0	159	21.2
Working	130	39.6	281	66.7	411	54.9
Self employed	98	29.9	81	19.2	179	23.9
Mother's age at delivery						
≤25	201	61.3	242	57.5	443	59.1
26-30	77	23.5	136	32.3	213	28.4
>30	50	15.2	43	10.2	93	12.4
Mother's BMI						
Underweight	109	33.2	133	31.6	242	23.3
Normal weight	163	49.7	214	50.8	377	50.3
Overweight	39	11.9	56	13.3	95	12.7
Obese	17	5.2	18	4.3	35	4.7
Age at which supplementary feedings begin						
≤6 months	98	29.9	139	27.6	237	31.6
>6 months	230	70.1	282	72.4	512	68.4

Results

Table-1 depicts that data were collected for 749 children-mother pairs. Among the total participants, it was found that 56.2% were female children and 43.8% were male children. A higher proportion of children participants belongs to the age group of 0 to 12 months (32.6%) followed by 13-24 (22.8%), 25-36 months (19.9%) respectively. Around 19% of mothers had no formal education whereas 24.2% of mothers had 10 plus years of education. Majority of the participants belong to a family with income of up to 15,000 Indian rupees/month (74.6%) and only 8.6% of participants belong to family with more than 25000 Indian rupees' monthly income. Almost 79% mothers were working. It was observed that around 50% mothers belonged either underweight or overweight and obese category of body mass index (BMI).

The prevalence of undernutrition by CIAF is depicted in table-2. The overall anthropometric failure was 54.5%. Compared to children who were male (47.9%), a greater percentage of female youngsters (59.6%) experienced anthropometric failure. According to CIAF classification, 341 children (45.5%) were well nourished (Group A). The prevalence of Group E (stunting and underweight) was 11.9%, and Group D (wasting, stunting and underweight) was 7.2% respectively. The CIAF reports that a single anthropometric failure (wasting only, stunting only and underweight only) affected 26.5% of the children.

Table 2: Prevalence of anthropometric failure according to CIAF (n=749)

Group Name	Anthropometric Measures	Male Children n = 328 (%)	Female Children n = 421 (%)	Total n = 749 (%)
Group-A	No failure	171 (52.1)	170 (40.4)	341 (45.5)
Group-B	Wasting only	22 (6.7)	50 (11.9)	72 (9.6)
Group-C	Wasting and underweight	26 (7.9)	40 (9.5)	66 (8.8)
Group-D	Wasting, stunting and underweight	20 (6.1)	34 (8.1)	54 (7.2)
Group-E	Stunting and underweight	39 (11.9)	50 (11.9)	89 (11.9)
Group=F	Stunting only	19 (5.8)	41 (9.7)	60 (8.1)
Group Y	Underweight only	31 (9.5)	36 (8.5)	67 (8.9)

Note: CIAF: Composite index of anthropometric failure

Table 3: Univariate logistic regression analysis of factors for undernutrition by using CIAF indices (n = 749)

Variables	CIAF Anthropometric Failure			
	No Failure n=341 (%)	Any Failure n=408 (%)	p value	cOR (95% CI)
Children Age (Months)				
0 -12	97 (28.4)	147 (36.0)	0.049	1.07 [0.98 - 1.18]
13 – 24	61 (17.9)	110 (27.0)		1.13 [1.0 -1.36]*
25 – 36	66 (19.4)	83 (20.3)		0.98 [0.79 - 1.65]
37 – 48	63 (18.5)	24 (5.9)		0.86 [0.76 - 1.96]
49 – 59	54 (15.8)	44 (10.8)		Ref.
Sex				
Male	159 (46.7)	169 (41.4)	0.043	Ref.
Female	182 (53.3)	239 (58.8)		1.23 [1.04 - 2.07]*
Religion				
Hinduism	313 (91.8)	286 (71.1)	0.001	Ref.
Islam	28 (8.2)	122 (29.9)		4.08 [1.94 - 5.28]**
Mother's education				
Illiterate	79 (23.1)	65 (15.9)	0.063	Ref.
Primary	95 (27.9)	104 (25.5)		0.98 [0.91 - 1.05]
Secondary	104 (30.5)	121 (29.7)		1.25 (0.94 - 1.32)
Above secondary	63 (18.5)	118 (28.9)		1.12 [0.83 - 1.45]
Monthly income (Indian Rupees - INR)				
Up to 15000	220 (64.5)	339 (83.1)	0.078	1.40 [0.87 - 3.32]
15001-25000	70 (20.5)	56 (13.7)		0.97 [0.84 - 1.13]
>25000	51 (15.0)	13 (3.2)		Ref.
Mother's occupation				
Housewife/Not working	72 (21.1)	87 (21.3)	0.016	Ref.
Working	176 (51.6)	235 (57.6)		1.93 [1.78 - 2.09]*
Self employed	93 (27.3)	86 (21.1)		1.13 [1.07 - 1.20]
Mother's age at delivery				
≤25	191 (56.0)	252 (61.8)	0.004	1.70 [1.23 - 1.29]**
26-30	90 (26.4)	123 (30.1)		1.06 [0.91 - 1.23]
>30	60 (17.6)	33 (8.1)		Ref.
Mother's BMI				
Underweight	69 (20.2)	173 (42.4)	0.008	1.89 [1.36 - 4.76]**
Normal weight	207 (60.7)	170 (41.7)		Ref.
Overweight	48 (14.1)	47 (11.5)		0.82 [0.36 - 1.98]
Obese	17 (5.0)	18 (4.4)		0.71 [0.42 - 1.72]
Age at which supplementary feedings begin				
≤ 6 months	79 (23.2)	158 (38.7)	0.001	1.62 [1.42 - 2.95]**
> 6 months	262 (76.8)	250 (61.3)		Ref.

Note: Ref. - Reference category; cOR - Crude odds ratio; CI - Confidence interval; **p<0.01, *p<0.05

Table-3 depicts the univariate analysis of the factors for undernutrition. Children at 13-24 months of age were 1.13 [95% CI; 1.10-1.36] times more likely to have anthropometric failure as compared to rest of all study children. Female children were 1.23 [95% CI; 1.04-2.07] times more likely to have anthropometric failure than male children. Children whose mothers were working had 1.93 [95% CI; 1.78-2.09] times higher odds of having anthropometric failure than housewives and self-employed mothers. Children whose mothers were underweight had 1.89 [95% CI; 1.36-4.76] times higher odds of having

anthropometric failure as compared to other BMI categories. Mothers delivered baby before or at 25 years of age had 1.70 [95% CI; 1.23-2.29] times higher odds of having anthropometric failure as compared to mothers delivering above 25 years of age. Less than 6 months of age of initiation of complementary feeding had 1.62 [95% CI; 1.42-2.95] times higher odds of having anthropometric failure as compared to more than 6 months of age of initiation of complementary.

Table 4: Multivariable logistic regression analysis for undernutrition factors by using CIAF indices (n = 749)

Variables	CIAF Anthropometric Failure			
	No Failure n=341 (%)	Any Failure n=408 (%)	p value	Multivariate model aOR (95% CI)
Children Age (Months)				
0-12	97 (28.4)	147 (36.0)	0.039	1.06 [0.92 - 1.38]
13-24	61 (17.9)	110 (27.0)		1.48 [1.10 - 1.86]*
25-36	66 (19.4)	83 (20.3)		0.91 [0.72 - 1.45]
37-48	63 (18.5)	24 (5.9)		0.81 [0.76 - 1.76]
49-59	54 (15.8)	44 (10.8)		Ref.
Sex				
Male	159 (46.7)	169 (41.4)	0.001	Ref.
Female	182 (53.3)	239 (58.8)		2.88 [1.65 - 4.97]**
Mother's education				
Illiterate	79 (23.1)	65 (15.9)	0.002	Ref.
Primary	95 (27.9)	104 (25.5)		0.88 [0.91 - 1.35]
Secondary	104 (30.5)	121 (29.7)		2.26 [1.15 - 2.82]*
Above secondary	63 (18.5)	118 (28.9)		2.68 [1.29 - 3.01]*
Monthly income (INR)				
Up to 15000	220 (64.5)	339 (83.1)	0.041	2.46 [1.77 - 4.82]*
15001-25000	70 (20.5)	56 (13.7)		0.78 [0.73 - 1.43]
>25000	51 (15.0)	13 (3.2)		Ref.
Mother's occupation				
Housewife/Not working	72 (21.1)	87 (21.3)	0.004	Ref.
Working	176 (51.6)	235 (57.6)		1.95 [1.57 - 2.89]**
Self employed	93 (27.3)	86 (21.1)		1.28 [0.95 - 1.72]**
Mother's BMI				
Underweight	69 (20.2)	173 (42.4)	0.001	2.01 [1.18 - 3.21]**
Normal weight	207 (60.7)	170 (41.7)		Ref.
Overweight	48 (14.1)	47 (11.5)		0.64 [0.32 - 1.81]
Obese	17 (5.0)	18 (4.4)		0.81 [0.50 - 1.43]
Age at which supplementary feedings begin				
≤6 months	79 (23.2)	158 (38.7)	0.001	1.88 [1.62 - 2.36]**
>6 months	262 (76.8)	250 (61.3)		Ref.

Note: Ref. - Reference Category; aOR - Adjusted Odds Ratio; CI - Confidence Interval; **p<0.01, *p<0.05.

Table-4 depicts the association of independent variables with dependent variable through adjusted odds ratio (aOR). Children at 13-24 months of age were 1.48 [95% CI; 1.10-1.86] times more likely to have anthropometric failure as compared to children belonging to rest of all study age groups when adjusted for other variables. Female children were 2.88 [95% CI; 1.65-4.97] times more likely to have anthropometric failure than male children when adjusted for other variables. Remarkably, it was observed that those children whose mothers had 10 years (secondary level) and 10 plus years (above secondary level) of education have 2.26 (95% CI; 1.15-2.82) and 2.68 [95% CI; 1.29-3.01] times higher chances of having

anthropometric failure when adjusted for other variables. Furthermore, children whose mothers were working had 1.95 [95% CI; 1.57-2.89] times higher odds of having anthropometric failure than housewives and self-employed when adjusted for other variables. Children whose mothers were underweight had 2.01 [95% CI; 1.18-3.21] times higher odds of having anthropometric failure as compared to other BMI categories when adjusted for other variables. Less than 6 months of age for supplementary feeding had 1.88 [95% CI; 1.62-2.36] times higher odds of having anthropometric failure as compared to more than 6 months of supplementary feeding age when adjusted for other variables.

Discussion

The study was conducted with an aim to find out the leading factors of nutritional status of under-five children by using CIAF index. It was found that CIAF detected 54.5% of undernutrition among children, which was less than of previous study conducted among slum children (73.4%) in Ahmedabad City, Gujarat, India.[31] It could be because this study was based on socio-economic deprived children and their chances of undernutrition is higher as compared to another socio-economic group. However, evidence suggested a higher or similar prevalence of undernutrition measured through CIAF among children across India, including Tamil Nadu (68.6%),[24] West Bengal (59.40%),[32] and Rural Haryana (53.1%).[33] It was observed that female children were more likely to suffer of undernutrition than male children. According to the National Family Health Survey (NFHS-4) report, in Gujarat state, the percentage of undernutrition for under five children were 39.3% for underweight, 38.5% for stunting, and 26.4% for wasting, respectively.[8] The result of the composite index of anthropometric failure found that 26.5% of children had single anthropometric failures (Groups B, F, and Y).

This study demonstrated a high correlation between the CIAF and characteristics linked to under five children, and mothers. A statistically significant difference in gender was observed overall. The result showed that female children were more likely to develop CIAF than male children. Male under five children were more likely than female under five children to be undernourished in the early stages of childhood. This could be because of the biological growth and vulnerability of male morbidity in early infancy.[34-36]

The age of the child had a significant association with undernutrition, which was in agreement with other study.[37] Children in the young age group (0-12 months) had a significantly increased risk of being undernourished. Similar findings were observed in study conducted in Karnataka that the younger group of children was significantly associated with wasting.[37] However, few studies' results contradict the present results.[28, 32, 38]

Many socio-demographic characteristics of the children and their mothers are associated with the presence of undernutrition. This study finding revealed that mother's educational level and child's nutrition have an inverse relationship. Children born to educated mothers are at higher risk of being underweight and stunting, in contrast with various other studies.[39, 40] It may be possible that as education level increases, employment opportunities also increase, leading to a decrease in children's nurturing time by mother, ultimately leading to malnutrition. In this study, several maternal factors were found to be associated with under five child undernutrition (such as mother's education, occupation, monthly family income, mother's weight, and age of initiation of complementary food). The study found that mothers who had delivered in the early age (≤25 years) had three times higher chances of undernutrition than women who delivered at a later age. These results are similar to previous study carried out in India.[41] Overall, the result of the study reveals that CIAF is a good tool to assess undernutrition. More so, evidence suggests that the CIAF evaluated a greater number of undernourished children than other methods, such as traditional indices.[42, 43]

This analysis merits few limitations. The findings only indicate the present scenario; however, it may be varied in other areas hence limited generalizability. The study did not address any biochemical markers; it only addressed anthropometric ones to assess the nutritional status of children under five. Current analysis did not include other conventional indices.

Conclusion

The CIAF measurement provides a thorough identification of undernutrition by describing the sum of all forms of undernutrition. The findings reveal that CIAF is a useful tool and provides a good estimate of undernutrition as it identifies children with multiple

anthropometric failures. The mother's education, underweight status, employment status, monthly family income, and the presence of a female child are the main factors that contribute to anthropometric failure in this study. The study's findings support the scientific consensus that the CIAF, is a reliable tool for accurately estimating overall undernutrition in children under five. The findings of this research can also be used to determine the best ways to avoid early undernutrition, which will lower the prevalence of undernutrition in children under five.

Improving the socioeconomic status, mother's weight and age of initiation of complementary feeding also require attention to prevent undernutrition. More so, increase in age at marriage will subsequently increase the mother's age at the time of delivery, and further it will improve the child's nutritional status. To enhance the nutrition of expectant underweight mothers, sensitive multi-sectoral and targeted nutritional interventions are required. These interventions should begin during the prepregnancy era, particularly during the second stage of rapid growth throughout adolescence. In a similar direction, determining the ideal nutritional status as a measure of growth requires improving children's nutrition during the early days of life.

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The author do not have any conflict of interest.

Data Availability Statement
The manuscript incorporates all datasets produced or examined throughout this research study.

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The Institutional Review Board approved the study protocol (No. IRB /2023/09).

Informed Consent Statement
Informed consent was obtained from all participants involved in the study.

Author Contributions
- **Suresh Kumar Rathi:** was responsible for the conceptualization, methodology, data curation, analysis, writing, and final approval of the manuscript.
- **Jayant Mayavanshi:** was responsible for the methodology, analysis, writing, and final approval of the manuscript.

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