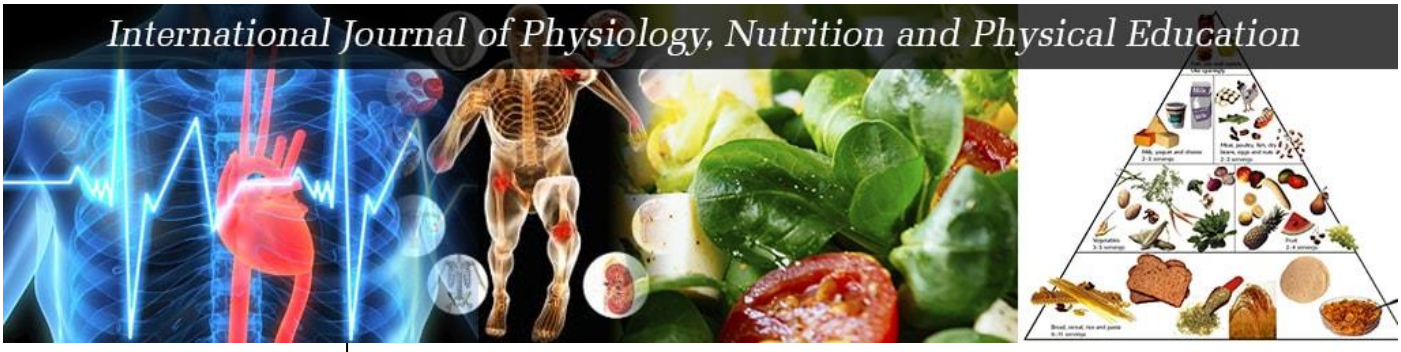

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Anthropometric parameters reveal a severe malnutrition among the children living in rural areas of Paschim Medinipur District

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Abstract
Chronic under nutrition is associated with serious health impairments in the rest of the life of those children who were able to survive even after chronic undernutrition. Thus a community based, cross-sectional survey was carried out among 836 children (393 boys and 443 girls) of age group belonging to 2-5 years living in rural areas of Paschim Medinipur District, West Bengal. The nutritional status of the children, Composite Index of Anthropometric Failure (CIAF), and the stunting index, underweight index and wasting index were evaluated. The said parameters were calculated as Z-score using the suitable reference values. The One-way ANOVA analysis (F value), Student's 't' tests and Chi square test were also done to evaluate the association amongst individuals, as well as group. The study revealed that the prevalence of underweight, stunting and wasting were 46.53%, 40.31% and 28.59% respectively. It was noted that the age has significant (χ^2=17.329; P<0.001) effect on the prevalence of stunting as well as wasting (χ^2=9.658; P<0.05) among the children. However, the age seems to have no significant association with underweight (χ^2=3.474; P>0.05) and CIAF (χ^2=5.501; P>0.05). The present study revealed a high prevalence of malnutrition among preschool children in the studied area.

Keywords: Rural area, undernutrition, preschool children, stunting, wasting, CIAF

Introduction
Undernutrition is one of the most serious public health problems throughout the globe [1, 2]. Mostly the children are affected and become victim of undernutrition living in the developing countries where resources are limited [3]. This condition is much more serious in the South Asia and sub-Saharan Africa [4-7]. In 2006, UNICEF reported the causes of childhood malnutrition were the insufficient diet, frequent infections, poor breastfeeding practices, delayed introduction of complementary foods and inadequate protein in the diet [8]. According to UNICEF (2006), the other factors associated with the food intake are health status, food taboos, growth and personal choice related to diet. Malnutrition can also develop owing to neglect, irregular mealtimes, inadequate food and lack of parental knowledge [8].

It is well known that the children are vulnerable group in any community because of their rapid growth rate [9]. For the proper physical and mental development of the child, more attention and care are needed, thus nutritional status of the children plays an important role in this matter. Childhood malnutrition is an important cause of childhood morbidity and mortality. Chronic under nutrition is associated with serious health impairments in the rest of the life of those children who were able to survive even after chronic undernutrition [10]. Under nutrition during childhood results delayed physical growth and development of motor system, impedes behavioral and cognitive development that ultimately leads to diminished academic performance and social skills [3]. Ansuya *et al*. (2018) commented that "moreover malnutrition during early childhood leads to serious long term consequences later in life which increases risk of developing diseases or disabilities and even death. Despite of these consequences, malnutrition is a treatable with prompt identification, anticipation and management" [3]. However little information regarding the prevalence of undernutrition among the rural children in a district (Paschim Medinipur District) of West Bengal State, India are available. Therefore, we attempted a thorough study to find out the prevalence of undernutrition among the preschool children living in the rural areas of Paschim Medinipur District.

For this, we determined the prevalence of underweight, stunting, wasting as well as composite index of anthropometric failure (CIAF) among the children belonging to the age group of 2 to 5 years living in the rural areas of this district. The study revealed that the prevalence of underweight, stunting, wasting were 46.53%, 40.31% and 28.59% respectively.

Methods

Study area of human participants

The study was undertaken in the villages under the blocks namely Midnapore Sadar Block, Keshpur Block and Salboni Block of Paschim Medinipur District, West Bengal, India.

Human participants

A total 836 children (393 boys and 443 girls) of age group belonging to 2-5 years were studied.

Ethical Issues

The current research topic had been approved by the concerned Institutional Board of Ethics within which the study was conducted. The necessary permission for carrying out this study was also obtained from the administrative authority of the district. A written consent was taken from the respective mothers of the children before the conduct the study.

Study design

The study was designed as a community based cross-sectional type which was conducted from January 2017 to December 2017. We visited the study area several times during the said period.

Anthropometric Assessment

The questionnaire was based on demographic information, anthropometric data and personal hygiene. The child was identified by name, age and sex. The date of birth was noted from the hospital record. The anthropometric data including the height and weight of the children were measured using standard techniques [11]. The height and weight measurements were recorded to the nearest 0.1 cm and 0.5 kg respectively. Body mass index (BMI) was computed using the following standard equations [12]:

BMI (kg/m^2) = Weight (kg) / height^2 (m^2).

The nutritional status of the children was evaluated using age and sex specific values of height and weight from the National Centre for Health Statistics (NCHS) reference data [13]. The indices of undernutrition such as stunting, underweight and wasting were calculated by Z-score using the reference values of height-for-age, weight-for-age and weight-for-height of NCHS standards, respectively. Z-scores were calculated following the standard formula:

Z-score = (X – Median of NCHS) / Standard deviation of NCHS, where X is an individual value.

Three Z-scores were calculated:
height-for-age Z-score (HAZ),
weight-for-age Z-score (WAZ) and
weight-for-height Z-score (WHZ).

The following scheme was utilized to define undernutrition

Stunting: HAZ < –2,
underweight: WAZ < –2 and
wasting: WHZ < –2.

Children with Z-score below –2 of any of the indices were considered to be undernourished and the children with Z score below –3 are considered to be severely undernourished.

Based on their nutritional status, children were grouped into six categories (A to F) to evaluate the CIAF value following the Peter Svedberg's (2000) model [14]. These groups included children with height and weight appropriate for their age (i.e., Z-scores > –2) and were designated under the category of no "anthropometric failure". And the rest children were designated as "anthropometric failure" of one or more forms. The CIAF evaluation are done excluding those children who are not in anthropometric failure group (A) and including those children who are wasted and/or stunted and/or underweight (groups B–F). It therefore provides a single measure with which overall prevalence of undernutrition may be estimated more precisely [15].

A	:	No failure
B	:	Wasting only
C	:	Wasting and underweight
D	:	Wasting, stunting and underweight
E	:	Stunting and underweight
F	:	Stunting only
Y	:	Underweight only
B-Y	:	CIAF

This measure extended the model of Svedberg (2000) by identifying an additional subgroup of only underweight designated as Y.

The rates of stunting, underweight and wasting relative to the overall prevalence of undernutrition (CIAF) was computed by the following method [16]:

Stunting Index (SI) = Stunting / CIAF
Underweight Index (UI) = Underweight / CIAF
Wasting Index (WI) = Wasting / CIAF

Statistical analysis

One-way ANOVA analysis (F value) was undertaken to test for age differences in mean height, weight, BMI, WAZ, HAZ, WHZ, BMIZ. Student's 't' tests were done in the present investigation to study the difference in the said parameters among the boys and girls. Chi square tests were done to verify age association, difference between CIAF and 'no failure'. Pearsons product moment correlation was done to study relationship between age and different anthropometric parameters among the children. Data processing and statistical analyses were done using the SPSS for Windows statistical software package (Version 16.0). Descriptive statistics were used for all the variables studied. The p value of <0.05 was considered statistically significant.

Results

The age and anthropometrics parameter of the preschool children belonging to the age group of 2 to 5 years are presented in Table 1. The average age of the children under study was 3.73±1.04 years, the body weight and height being 12.41±2.44 kg and 93.70±9.07 cm respectively. The BMI was calculated as 14.14±2.05kg/m^2. The weight-for-age Z-score, height-for-age Z-score and weight-for-height Z-score were -1.92±1.21, -1.42±1.64 and -1.34±1.30 respectively. BMI-for-age Z-score calculated from this data and was recorded as -1.17±1.70. The 95% CI for each parameter are presented in Table 1.

The distribution of Z-score for weight-for-age Z-score, height-for-age Z-score and weight-for-height Z-score of the preschool children was compared with the international reference values which is being presented in Fig. 1. It is revealed from the Fig. 1 that 95% CI of WAZ, HAZ and WHZ for both boys and girls are towards left hand side from the NCHS reference indicating the negative tendency from the standard health statistics. Thus, the undernutrition is highly prevalent in this group of children as evident from this figure.

Table 2 presents the distribution of weight, BMI, WAZ, HAZ, WHZ and BMIZ according to different age and sex group. The data were analyzed with ANOVA (to study the age difference) and student's t test (to study the sex difference). It may be mentioned that the BMI and BMIZ of boys of 2 years of age are significantly higher than those of girls of same age. However, the HAZ of the girls of these age group is significantly higher than the boys. The body weight, height, WAZ and HAZ of boys of 4 years of age were found to be significantly higher when compared with those of the girls of the same age. However, the WAZ and WHZ of boys of 5 years were found to be significantly lower than those of girls of same age group. When the said data of both boys and girls were analyzed, the BMI and the BMIZ of both sexes were found to be highest in 2 years of age and lowest in 5 years of age.

Fig. 2 represents the subgroups of anthropometric failure among the preschool children. It is revealed from the Fig. 2 that different categories of CIAF were significantly different ($P<0.001$) with respect of age in boys and girls separately and also in combined together.

The impact of age of the children in the prevalence of underweight, stunting, wasting and CIAF is shown in Fig. 3. It may be commented that the age has significant ($\chi^2=17.329$; $P<0.001$) effect on the prevalence of stunting as well as wasting ($\chi^2=9.658$; $P<0.05$) among the children of the rural areas of Paschim Medinipur District. However, the age seems to have no significant association with underweight ($\chi^2=3.474$; $P>0.05$) and CIAF ($\chi^2=5.501$; $P>0.05$).

The Pearsons product moment correlation between age and different anthropometric parameters were presented in Table 3. It may be mentioned that as the age progresses the BMI does not proportionately increase and has been found to be negatively correlated which was highly significant ($P<0.001$) as observed in Pearsons product moment correlation between age and different anthropometric parameters.

Fig. 4 represents the values of stunting index, underweight index and wasting index among the studied children in different age of both sexes. The UI and SI of the boys are higher in compared to that of girls in all age group except age 3 years, similarly the WI is also higher in all age group except age 2 years.

Table 1: Age and anthropometric parameters of the preschool children belonging to age group 2–5 years

Parameters	Mean± SD	95% CI
Age (years)	3.73±1.04	3.66 – 3.80
Weight (kg)	12.41±2.44	12.25 – 12.58
Height (cm)	93.77±9.07	93.16 – 94.39
BMI (kg/m^2)	14.14±2.05	14.00 – 14.28
WAZ	-1.92±1.21	(-)2.00 – (-)1.84
HAZ	-1.42±1.64	(-)1.53 – (-)1.31
WHZ	-1.34±1.30	(-)1.43 – (-)1.25
BMIZ	-1.17±1.70	(-)1.29 – (-)1.06

Table 2: Distribution of weight, height, body mass index (BMI), weight for age z-score (WAZ), height for age z-score (HAZ), weight for height z-score (WHZ) and body mass index for age z-score (BMIZ) according to different age and sex group

Age (years)	N	Weight (kg)	Height (cm)	BMI (kg/m2)	WAZ	HAZ	WHZ	BMIZ
Boys								
2	65	10.36±1.72	80.78±6.36	15.87±1.93***	-1.80±1.46	-1.51±2.00**	-0.82±1.09	-0.27±1.61*
3	94	11.64±1.48	91.39±6.58	14.07±2.20	-1.87±0.92	-0.93±1.73	-1.61±1.32	-1.48±1.98
4	116	13.25±2.41***	96.87±6.59***	14.11±1.90	-1.82±1.24*	-1.43±1.55*	-1.35±1.32	-1.15±1.67
5	118	13.89±2.42	101.45±6.24	13.49±1.91	-2.26±1.13**	-1.85±1.36	-1.66±1.34*	-1.58±1.75
Age combined	393	12.58±2.48	94.27±9.54	14.21±2.13	-1.96±1.19	-1.45±1.65	-1.42±1.32	-1.21±1.81
ANOVA		F=49.071; $P<0.001$	F=156.146; $P<0.001$	F=20.663; $P<0.001$	F=3.703; $P<0.05$	F=5.611; $P<0.001$	F=6.783; $P<0.001$	F=8.678; $P<0.001$
Girls								
2	66	10.17±1.50	82.75±5.09	14.83±1.45	-1.41±1.21	-0.55±1.58	-1.15±0.90	-0.76±1.17
3	111	11.50±2.00	90.16±6.28	14.12±1.77	-1.79±1.29	-1.01±1.69	-1.35±1.15	-1.18±1.45
4	146	12.29±1.99	94.07±5.33	13.94±2.22	-2.16±1.17	-1.87±1.32	-1.32±1.50	-1.20±1.91
5	120	14.09±2.28	101.19±7.54	13.80±2.01	-1.87±1.14	-1.63±1.71	-1.22±1.31	-1.22±1.52
Age combined	443	12.27±2.40	93.33±8.63	14.08±1.98	-1.88±1.22	-1.39±1.63	-1.28±1.29	-1.13±1.60
ANOVA		F= 62.077; $P<0.001$	F= 138.570; $P<0.001$	F= 4.343; $P<0.01$	F= 6.239; $P<0.001$	F= 14.016; $P<0.001$	F=0 .459; P>0.05	F=1.404; P>0.05
Sex combined								
2	131	10.26±1.61	81.77±5.82	15.35±1.78	-1.60±1.35	-1.03±1.86	-0.99±1.00	-0.52±1.42
3	205	11.56±1.78	90.72±6.43	14.10±1.97	-1.83±1.13	-0.97±1.70	-1.47±1.23	-1.31±1.72
4	262	12.72±2.23	95.31±6.07	14.02±2.08	-2.01±1.21	-1.67±1.44	-1.33±1.42	-1.18±1.80
5	238	13.99±2.35	101.32±6.91	13.64±1.97	-2.06±1.15	-1.74±1.54	-1.44±1.34	-1.40±1.64
Age combined	836	12.41±2.44	93.77±9.07	14.14±2.05	-1.92±1.21	-1.42±1.64	-1.34±1.30	-1.17±1.70
ANOVA		F=106.004; $P<0.001$	F=286.860; $P<0.001$	F=21.661; $P<0.001$	F=5.024; $P<0.01$	F=13.169; $P<0.001$	F=4.395; $P<0.01$	F=8.554; $P<0.001$
Significant sexual dimorphism at *$P<0.05$; **$P<0.01$; *$P<0.001$ level								

Table 3: Pearsons product moment correlation between age and different anthropometric parameters

Anthropometric indices	Boys N=393	Girls N=443	Sex combined N=836
Weight (kg)	0.516***	0.537***	0.526***
Height (cm)	0.722***	0.691***	0.706***

BMI (kg/m^2)	-0.325***	-0.154***	-0.239***
WAZ	-0.130***	-0.126**	-0.128***
HAZ	-0.127*	-0.247***	-0.189***
WHZ	-0.159**	-0.003**	-0.079*
BMIZ	-0.187***	-0.075	-0.132***
Significant at *P<0.05; **P<0.01; ***P<0.001 level			

Table 4: Classification assessment for severity of malnutrition by percentage prevalence ranges (WHO, 1995)

Classification	Low (%)	Medium (%)	High (%)	Very High (%)
Stunting	<20	20 – 29	30 – 39	≥40
Underweight	<10	10 – 19	20 – 29	≥30
Wasting	<5	5 – 9	10 – 14	≥15

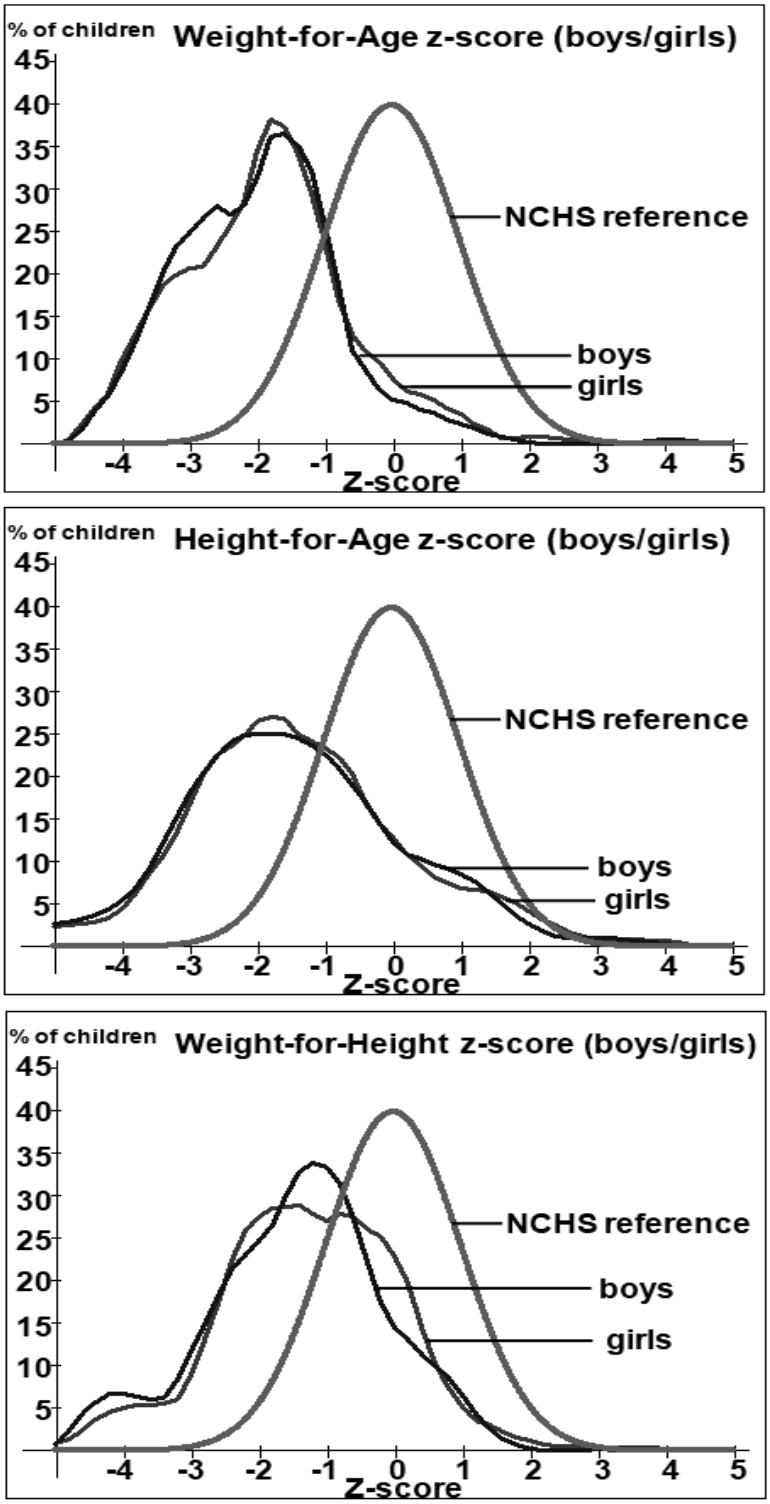

Fig 1: Distribution of z-scores for weight-for-height, height-for-age, and weight-for-age for the preschool children compared with the international reference values

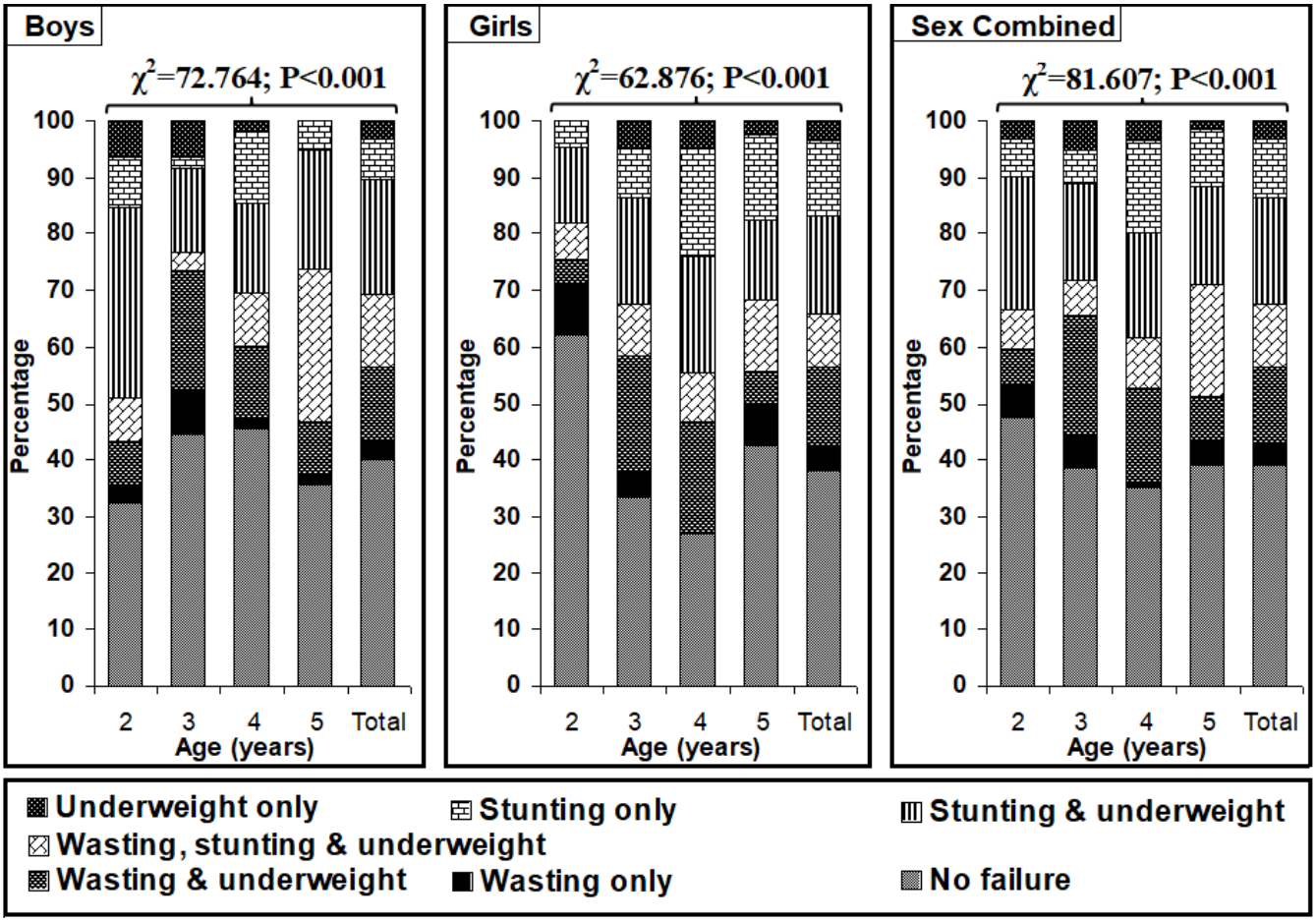

Fig 2: Subgroups of anthropometric failure among the preschool children

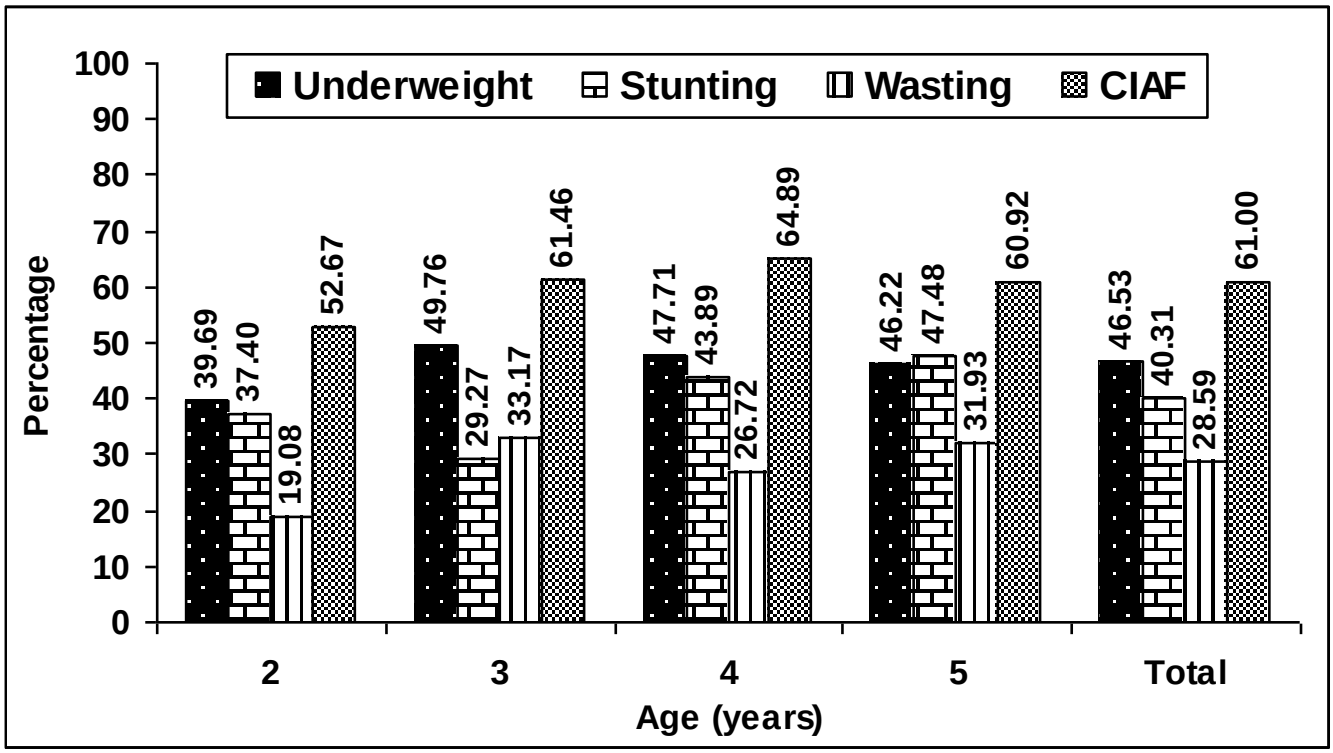

Fig 3: Impact of age of the children in the prevalence of underweight, stunting, wasting and CIAF. The age has significant effect on the prevalence of stunting (χ^2=17.329; *P*<0.001) and wasting (χ^2=9.658; *P*<0.05) among the children of rural areas and not showed any significant association with underweight (χ^2=3.474; P>0.05) and CIAF (χ^2=5.501; P>0.05).

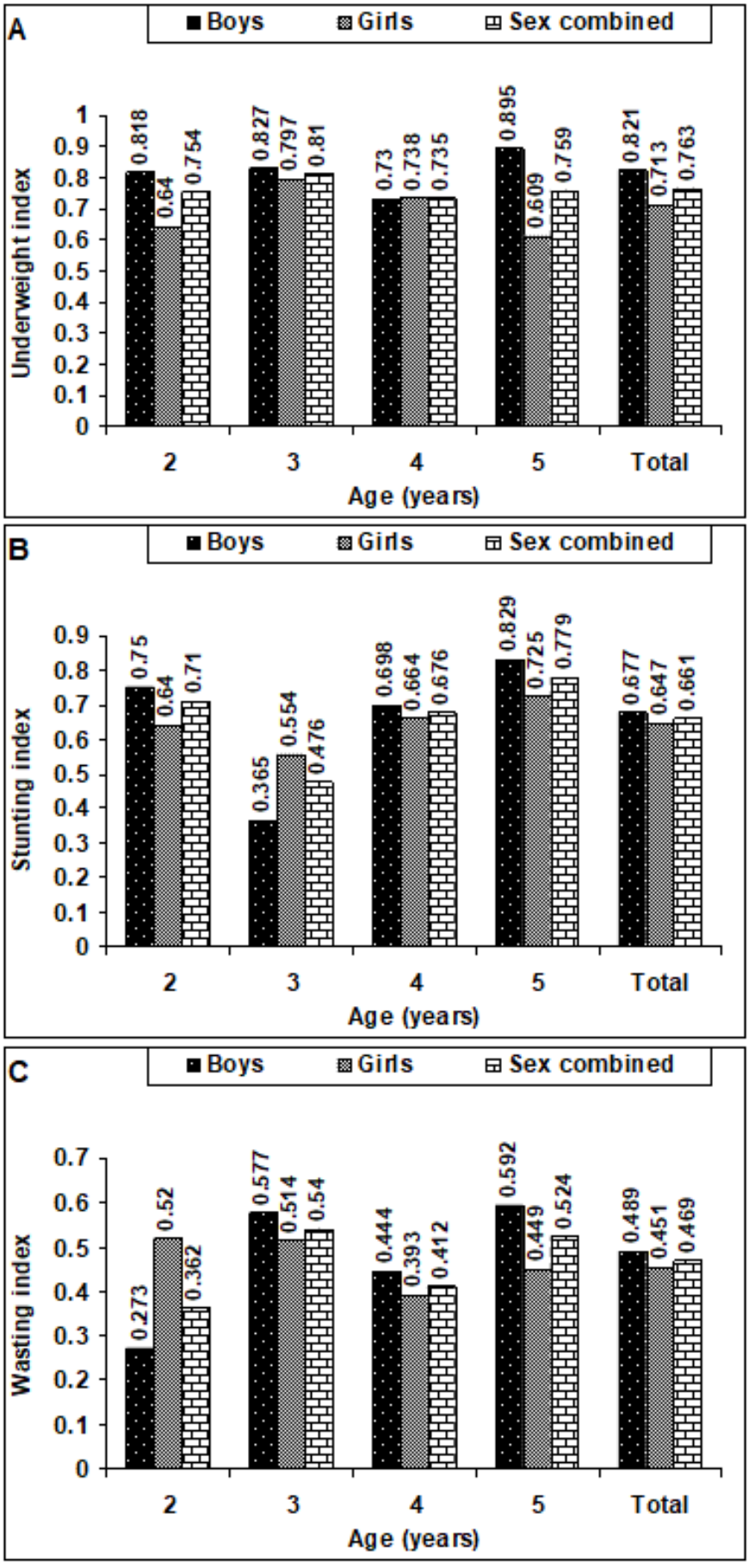

Fig 4: Values of UI, SI and WI among the studied children in different age of both sexes

Discussion

In an earlier study with children of urban area [2], we have noted that the parameters like stunting and underweight were found to be comparable. However, the percentage of wasting (28.59% vs 23.40%) and CIAF (61.00% vs 58.21%) in this study are noted to be higher as compared to the previous

study, which indicates the more severe undernutrition among the rural children. According to IIPS & ICF (2017), about 30% of Indian children are born with low birth weight leading to 29% of the global children be stunted [17]. We also noted that the percentage of underweight was more in case of male children when compare with that of female children. However, the other parameters of male and female children belonging to this age group were found to be comparable, which is corroborated with the previous study with the children of some villages [1]. It may be mentioned that our data regarding stunting, underweight and wasting revealed a very high severity of malnutrition as per the WHO standard [18]. The WHO classification for severity of malnutrition is presented in table 4 for ready reference.

Interestingly our study indicated a negative correlation between age and BMI. The prevalence of undernutrition in India as a whole is 36.7%, stunting 38.4% and wasting 21.0% which is quite low when compared to those in our study group [17]. However, our data on these parameters are very much comparable with those of children living in the states of Jharkhand, Bihar and Madya Pradesh indicating the similar pattern of malnutrition in those states of India [17].

Conclusion

The present study clearly indicates that the children living in the rural areas in Paschim Medinipur District are severely malnourished, as compared with WHO standard.

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