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Risk factors and prevalence of malnutrition among children between 6 months to 5 years in an urban slum of Cuttack

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ABSTRACT

Introduction: Children under five years constitute the most vulnerable segment of a country. Their nutritional status and mortality rate is a sensitive indicator of community health and nutrition. Globally more than half of the under- five deaths are attributable to under nutrition.
Aim & Objective: To estimate the risk factors and prevalence of malnutrition (defined as per WHO) among the subjects & to study the socio-demographic profile of the children between 6 months to 5 years in the slum area of Jobra, an Urban Slum of Cuttack.
Materials and Methods: This community based cross-sectional study with descriptive elements has been carried out in the registered slums under Cuttack Municipal Corporation (CMC) area of the Cuttack city under UPHC Brajarambha and UHTC, Department of Community Medicine, SCBMCH from January 2021to December 22 .
Result: 61.6% of children had a deficient protein intake with 18.8% having more than 30% deficiency and 23.8% with 20-30% deficiency. 53.9% of children had a deficient calorie intake with 11.6% having more than 30% deficiency and 21% with 20-30% deficiency. Only 2.8 percent children had not received any vaccination. 12.4% of children used open well water for drinking. 18.5% of the study population practiced Open Air Defecation (OAD) whereas the rest had access to either community toilet or had their own toilet.
Conclusion: Dietary deficiency (both calorie and protein) are significantly associated with all parameters of malnutrition considered for the study. Apart from nutrition, factors are sanitary habits, drinking water source and socio-economic status are significantly associated with malnutrition.
Recommendation: People must be encouraged to use toilets at home and must train their children the same. Open Well water, if used, must be covered and water should be boiled before drinking. Left out children must be reached and explained regarding the risks of diseases if the child remains un-immunized.

1. Introduction

Nutritional status plays a vital role in deciding the health status in children. Nutritional deficiencies give rise to various morbidities, which in turn, may lead to increased mortality. Malnutrition apart from impairing growth and development of the child increases his or her susceptibility to infections like diarrhea and pneumonia.[1]

Children under five years constitute the most vulnerable segment of a country. Their nutritional status and mortality rate are a sensitive indicator of community health and nutrition. Globally more than half of the under- five deaths are attributable to under nutrition. At national level NFHS-4

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data revealed the national under five mortality rates (U5MR) is 50 per 1000 live births, with 34 in urban and 56 in rural area. Odisha's U5MR is estimated to be 49 per 1000 live births with 25 in urban area.[1] The latest NFHS-5 data reveals the national U5MR to be 41.9 and that of Odisha to be 41.1.

Assessing national prevalence of under nutrition among under five, NFHS -4 data shows underweight is 35.7%, wasting is 21% and stunting 38.4% in India. The same indicator for Odisha is 34.4%, 20.4 % and 34.1% respectively. Whereas the latest NFHS-5 data reveals that underweight is 32.1%, wasting is 19.3% and stunting 35.5% in India.[2] The same indicator for Odisha is 29.7%, 18.1% and 31.0% respectively.[3]

Assessment of community nutritional status among children assumes even more significance in the current COVID-19 pandemic. Recent estimates indicate that in addition to the 690 million undernourished people in 2019, at least another 83 million people, and possibly as many as 132 million, may go hungry in 2020.[4] As of July 2020, an estimated 370 million children are missing school meals.[5] With these added shocks, children's dietary quantity and quality are expected to deteriorate below the already poor situation that existed pre-COVID-19, when only 29 per cent of children aged 6 to 23 months were fed a minimally diverse diet and only 53 per cent received the minimum meal frequency.

In July 2020, UNICEF, with the Food and Agricultural Organization, the World Food Programme and the World Health Organization issued a call to action in The Lancet,[6] warning of the pandemic's potential to worsen the pre-existing crisis of malnutrition and tip an additional 6.7 million children over the edge to become wasted during its first year. This is in addition to the 47 million children affected by wasting and 144 million affected by stunting in 2019 before the pandemic, according to the 2020 Joint Malnutrition Estimates.

Malnourished children have weakened immune systems and may face a greater risk of dying from COVID-19. At the same time, it may be more difficult for these children to access the treatment and care they need to survive and thrive. UNICEF country offices reported a 30 per cent decline in overall coverage of services to improve nutrition outcomes for women and children in the early months of the pandemic, and alarming reductions of 75 to 100 per cent under lockdown contexts.[6]

Rationality of the study: Malnutrition has been a long standing health care problem in the Indian Community. The fact that the most vulnerable population affected by it is children makes it even more important. According to WHO, 45% child deaths are associated with malnutrition.[7] This makes timely and periodic assessment of nutritional status a vital healthcare activity.

The activity assumes even more significance in the wake of the global and deadly COVID-19 pandemic. It is apparent that the pandemic has hit the underprivileged section the most and malnourishment which decreases one's immune levels, risks the young kids to fall prey to COVID-19 infections and subsequent complications.

Further, no such activity has been undertaken during the COVID pandemic and it shall be a first of its kind in the state providing a direction for further studies and shall help us to realize the extent of the problem and formulate plans to mitigate them.

1.1. Burden of malnutrition in Odisha

Although some of the cities of Odisha are thriving, there are many more villages in certain districts which are still under the catch of malnutrition among children as well as women. One such example is Nagada village of Jajpur district where no ICDS authorities ever visited in the last two decades, none of the children were immunized there and Anganwadi centers were non-functional until the year 2016.[8] Cooked food and safe water are a distant dream for those tribal people residing there.[9]

Odisha has recorded good progress in reducing underweight in children under-five i.e. declining from 54% in the NFHS-2 1998-99 to 44% in the NFHS-3 2005-06. However, if absolute levels of child under-nutrition are considered, much remains to be done. As of 2015, there were more than 9 districts in the state with prevalence of underweight more than 50% with the state average being 44%. Prevalence in Cuttack district was 28%. 17 districts had more than 50% prevalence of stunting with the average being 46.9% and Cuttack district having prevalence of 30.9%.Among the children aged 6 to 23 months of age, only 45.4% received semi-solid or solid food while only 16.5% received food with minimum dietary diversity each day.

2. Aim of the Study

To study the risk factors and prevalence of malnutrition among children of 6 months to 5 years in an urban slum of Jobra, Cuttack.

3. Objectives of the Study

1. To assess the nutritional status of the above children by Anthropometry, Clinical assessment and Dietary assessment.
2. To study the socio-demographic profile of the children between 6 months to 5 years in the slum area of Jobra.
3. To estimate the risk factors and prevalence of malnutrition (defined as per WHO) among the subjects.
4. To make the parents aware about their child's nutritional status and suggests them ways to correct the problem, if any.

4. Materials and Methods

This study was carried out in the registered slums under Cuttack Municipal Corporation (CMC) area of the Cuttack city under UPHC Brajarambha and UHTC, Department of Community Medicine, SCBMCH from January 2021to December 22. The study was a community based cross-sectional study with descriptive and analytical elements.

Cuttack district is one of the 30 districts located in the eastern part of the country, within the state of Odisha. The Cuttack city is located at 20Ú31'25"N and 84Ú47'17"E covering an area of 192.5 square kilometers. It is bounded by Naraj in the west, Kandarpur in East, Choudwar in North and Phulnakhara in Southern side. The city's main river is the Mahanadi. Due to the recent expansion projects of the city, a new residential area was formed across Kathajodi River, known as Markat Nagar (CDA by local residents) and consists of 15 sectors. Being under the administration of Cuttack Municipal Corporation, it consists of 59 wards. According to the census of 2011, this city catered to a population of 6, 06,007. Being the2nd most populous city of the state and 72nd nationally, its population density is 3100 per square kilometers. Of this 1, 29, 720 people reside in slums (66, 194 males and 63, 526 females) and are distributed within 180 registered slums.1 The slum near Jobra is under PHC Brajarambha and the Department of Community Medicine has a UHTC associated with the PHC. The study was carried out there.

4.1. Sampling method

The slum under the UPHC is divided into 4 wards and there are 18 anganwadi centers in the 4 wards. From the under 5 register present in each anganwadi center, the names of children were randomly selected.

4.2. Sample size calculation

Considering the proportion of population having the features of interest of our study to be 50% i.e. p=0.5 so as to yield the maximum value of the sample size 'n' at confidence level as 95% (i.e. z= 1.96) and precision of the study as 5% (i.e. d=0.05), the sample size was calculated using $n = z^2pq/d^2$ Where, p= the proportion of population having the features of interest = 0.5, q (1-p) = 0.5,d= 5%. The sample was calculated to be 384.

4.3. Inclusion criteria

All children between 6 months and 5 years, with none of the below mentioned exclusion criteria, shall be included.

4.4. Exclusion criteria

1. All children less than 6 months old and more than 5 years old shall be excluded.
2. All children diagnosed with endocrine diseases like hypothyroidism, diabetes mellitus shall be excluded.
3. All children diagnosed with congenital abnormalities like Congenital Heart Diseases, which affects normal weight gain shall be excluded.
4. All children with Cerebral Palsy, Neurodegenerative disorders which affects feeding practices shall be excluded.

4.5. Study instrument

A pre-designed and pre-tested questionnaire was used to record relevant data. The questionnaire had following parts

1. Socio-demographic variables like age, gender, caste, parents education and occupation, type of family, socio economic status, type of house, sanitation practices, drinking water supply etc.
2. Nutritional history like calorie and protein deficits calculated on the basis of 24 hour recall method from the parents.
3. Past medical history, current illness, if any and the immunization history of the child.
4. Clinical findings from the head to toe examination and systemic examination of the child.

4.6. Data entry and analysis

Entry of data and analysis was done in the Department of Community Medicine, SCB Medical College under the supervision of the co-guide. Data was coded, entered and analyzed using IBM SPSS ver.22.0.Proportions were calculated for categorical variables and compared using chi square test. Mean and standard deviations were estimated for continuous variables as the measures of central tendency and dispersion respectively. Means were compared using unpaired t-test. Appropriate charts and diagrams were obtained where necessary. All analysis was done at a preset alpha error of 5% and results expressed at confidence levels of 95%.

5. Results

A total of 411 households were surveyed for the study. Of them 11 did not give consent for the study, 18 were excluded due to incomplete data and 20 children were excluded as they satisfied the exclusion criteria. Thus, a total of 362 children were analyzed among the children surveyed.

183(50.6%) children were females and 179(49.4%) were males. Of the children, a maximum of 24.3% belonged to 12-23 completed months while the least 14.6% were between 36-47 completed months. The mean age of the study population was 22.6 ± 14.77 months. Around 18.5% of the study population practiced Open Air Defecation (OAD) whereas the rest had access to either community toilet or had their own toilet. The study showed that 48.6%

Table 1: Demographic profile of study group (n=362)

Parameter		Number	Percentage
Sex	Female	183	50.6
	Male	179	49.4
Age in months	06-11	82	22.7
	12-23	88	24.3
	24-35	85	(23.5)
	36-47	53	14.6
	48-59	54	14.9
Sanitation	Open defecation	67	18.5
	Community toilet	119	32.9
	Own toilet	176	48.6
Drinking water supply	Tubewell	159	43.9
	Tapwater	158	43.6
	Open Well water	45	12.4
Immunization status	Non-Immunised	10	2.8
	Partially Immunised	118	32.6
	Completely Immunised	234	64.6
Socio Economic status	Lower(I)	2	0.6
	Upper Lower(II)	146	40.3
	Lower Middle(III)	161	44.5
	Upper Middle(IV)	53	14.6

of the population use their own toilet. Around 12.4% of children used well water for drinking whereas the rest used either tube well water or tap water for drinking purposes.64.6% children were completely immunised and 32.6% were partially immunised. Only 2.8 percent children had not received any vaccination. Socio-Economic Status classification was done using the Updated Modified Kuppuswamy Scale-2021. Most of the families i.e. 40.3% and 44.5% belonged to Upper Lower and Lower Middle class. Only 2 families belonged to the lower class. The Upper Middle class was taken was reference for subsequent comparisons. The mean income of the study population was 17136.74 and the mean SES Score was 11.10.(Table 1)

As per the 24-hour recall method, it was seen that 33.4% of the children had around normal protein intake and 5% had an intake of more than 10%. Thus it was seen that 61.6% of children had a deficient protein intake with 18.8% having more than 30% deficiency and 23.8% with 20-30% deficiency. As per the 24-hour recall method, it was seen that 39.5% of the children had around normal calorie intake and 6.6% had an intake of more than 10%. Thus it was seen that 53.9% of children had a deficient calorie intake with 11.6% having more than 30% deficiency and 21% with 20-30% deficiency.(Table 2)

Data showed that 68% children had weights in the normal range, whereas 27.3% children were in underweight and 4.7% in overweight range. 12.4% of all children were severely underweight and 14.9% were moderately underweight. It was also found that 4.7% children were overweight and 0.6% were found to be obese.

68.8% children had length/heights in the normalrange whereas 31.2% children were stunted. 14.9% were severely stunted and 16.3% children were moderately stunted. It was found that 79.6% of the children were normal weight/length and 20.4% children were found to have wasting. 7.7% children were having severe wasting (Severe Acute Malnutrition) and 12.7% children were having moderate wasting (Moderate Acute Malnutrition).

MUAC was found to be normal in 79.3% of the study population and decreased in 20.7% of children. Out of them, 9.1% were having SAM and 11.6% were having MAM. On combining the results of wasting and MUAC, an overall assessmen for the prevalence of SAM and MAM was done.(Table 3)

It was found that in our study population, 27.9% children were having MAM and 12.4% children were having SAM. After anthropometry, clinical assessment of the children was done to look for features of malnutrition.(Table 4)

The evidence of pallor was found in 40.9% children whereas 59.1% were found to have apparently normal examination. The grading of pallor was not a part of the study. 22.9% children had hair changes and 77.1% children had normal hair. 79.8% children had apparently normal examination of the oral cavity, 20.2% had one of the mentioned findings.The evidence of pedal edema was found in 9.4% of the population while the rest had no evidence of pedal edema.(Table 5)

We enquired for the sanitary habits of the children from the parents and divided them into those who practised open air defecation (OAD) and those who used toilets. Toilet usage included the use of either own or community toilet.

Effects of sanitary habits was analysed and open defecation was taken as a risk factor and compared with those who used toilets. A significant association of open

Table 2: Calorie and protein intake (n=362)

Parameter		Number	Percentage
Protein deficit	> 30% deficit	68	18.8
	20-30% deficit	86	23.8
	10-20% deficit	69	19.1
	-10 to +10%	121	33.4
	>+10%	18	5
Calorie deficit	>30% deficit	42	11.6
	20-30% deficit	77	21.3
	10-20% deficit	76	21
	-10 to +10%	143	39.5
	More than +10%	24	6.6

Table 3: Antropometry of the study group (n=362)

Parameter		Number	Percentage
Weight Classification	Underweight	99	27.3
	Normal	246	68.0
	Over weight	17	4.7
Weight for age	<-3 SD (Severely underweight)	45	12.4
	-2 to -3 SD (underweight)	54	14.9
	-2 to +2 SD	246	68
	+2 to +3 SD(overweight)	15	4.1
	>+3 SD(obese)	2	0.6
Stunting	Yes	113	31.2
	No	249	68.8
Length for age	< -3SD	54	14.9
	-2 to -3SD	59	16.9
	-2 to +2 SD	242	66.9
	+2 to +3 SD	4	1.1
	> +3SD	3	0.8
Wasting	Yes	74	20.4
	No	288	79.6
Weight for length	< -3SD	28	7.7
	-2 to -3SD	46	12.7
	-2 to +2SD	261	72.1
	+2 to +3SD	19	5.2
	> +3SD	8	2.2
Mid-upper Arm Circumference (MUAC)	< 11.5 cm (SAM)	33	9.1
	11.5-12.4cm(MAM)	42	11.6
	≥ 12.5cm (Normal)	287	79.3

Table 4: Prevalence of MAM & SAM in the Study Population (n=362)

Parameter		Number	Percentage
MAM	No	261 (72.1)	72.1
	Yes	101 (27.9)	27.9
SAM	No	317	87.6
	Yes	45	12.4

Table 5: Assessment of malnutrition (clinical) (n=362)

Parameter		Number	Percentage
Pallor	Present	148	40.9
	Not present	214	59.1
Hair changes	Present	83	22.9
	Not present	279	77.1
Oral cavity changes	Present	73	20.2
	Not present	289	79.8
Edema	Present	34	9.4
	Not present	328	90.6

Table 6: Association with risk factors (n=362)

	Open defecation		
Parameters	**Yes**	**No**	**p Value***
	N (%)	**N (%)**	
Underweight	35 (52.24)	64 (21.69)	<0.001
Severely underweight	22 (32.84)	23 (7.8)	<0.001
Stunting	37 (55.22)	76 (25.76)	<0.001
Severe Stunting	14 (20.90)	40 (13.56)	0.128
Wasting	28 (41.79)	46 (15.59)	<0.001
Severe Wasting	16 (23.88)	12 (4.07)	<0.001
MAM	28 (41.79)	73 (24.75)	<0.001
SAM	22 (32.84)	23 (7.80)	<0.001
Hair Changes	25 (37.31)	58 (19.66)	0.002
Oral Cavity Changes	21 (31.34	52 (17.63)	0.012
Pallor	41 (61.19)	107 (36.27)	<0.001
Edema	6 (8.96)	28 (9.49)	0.892

defecation was found for all anthropometric parameters like underweight, severely underweight, stunting, wasting, severe wasting, MAM and SAM and clinical parameters like hair changes, oral cavity changes and pallor except for severe stunting and edema for which the association was non-significant.(Table 6)

The mean values of weight, height and MUAC was compared in both groups. A lower value in all parameters was recorded in the group practising open defecation but the decrease was statistically significant in weight and MUAC.(Table 7)

Effects of drinking water supply was analysed and use of well water for drinking was taken as a risk factor and compared with those who used tap water or tube well water. A significant association of well water use was found for all anthropometric and clinical parameters except for severe stunting and MAM for which the association was non-significant.(Table 8)

On comparing the mean values, however it was seen that only the decrease in MUAC was statistically significant.(Table 9)

Comparison was done in between children who were non-immunized and the children who were partially or completely immunized with the parameters of malnutrition taken in the study and no significant association was found in between these two groups in any of the parameters except for in children with severe stunting where non-immunized children where significantly more prone for stunting than those who were immunized or partially immunized.(Table 10)

On comparing the mean values of weight, length and MUAC between non-immunized children and others, it was found that although the non-immunized children had a lower mean weight and length, the difference was not statistically significant.(Table 11)

A significant association of lower SES was seen in case of underweight, severely underweight and wasting and was non- significant with other parameters of our study.(Table 12)

On comparisons of the mean values of weight, length and MUAC with the two groups, a significant difference was seen only with MUAC.(Table 13)

A significant association was seen with deficient protein intake and all the parameters considered for assessment in the study i.e. underweight, severely underweight, stunting, severe stunting, wasting, severe wasting, MAM and SAM and clinical parameters like hair changes, oral cavity changes, pallor and edema.(Table 14)

The significant association was also reflected when the mean values of length, weight and MUAC of the deficient group was compared with the reference group in which the group with deficient protein intake was seen to have

Table 7: Comparison of mean anthropometric parameters between OAD and toilet using population

Parameters	Open defecation		p Value*
	Yes	No	
Mean Weight	9.78 ± 2.40	10.84 ± 3.13	<0.025
Mean Length	81.37 ± 9.37	82.30 ± 12.68	0.644
MEAN MUAC	13.42 ± 1.96	14.42 ± 1.99	<0.001

Table 8: Co-relation of use of open well water with various study parameter(n=362)

Parameter	Use of open well water		p-value
	Yes	No	
	N (%)	N (%)	
Underweight	24(53.33)	75(23.66)	<0.001
Severely underweight	13(28.89)	32(10.09)	<0.001
Stunting	24(53.33)	89(28.08)	0.001
Severe Stunting	10(22.22)	44(13.88)	0.142
Wasting	15(33.33)	59(18.61)	0.022
Severe Wasting	11(24.44)	17(5.36)	<0.001
MAM	17(37.78)	84(26.50)	0.114
SAM	12(26.67)	33(10.41)	0.002
Hair Changes	18(40.00)	65(20.50)	0.004
Oral Cavity Changes	19(42.22)	54(17.03)	<0.001
Pallor	17(60.00)	121(38.17)	0.005
Edema	8(17.78)	26(8.20)	0.039

Table 9: Comparision of mean anthropometric parameters to compare various sources of drinking water supply

	Use of open well water		p-value
	Yes	No	
Mean Weight	10.45 ± 2.38	10.68 ± 3.12	0.926
Mean Length	84.52 ± 11.15	81.79 ± 12.25	0.092
Mean MUAC	13.38 ± 1.74	14.36 ± 2.03	<0.002

Table 10: Co-relation of immunization status with various study parameters (n=362)

Parameter	Non- immunized		p-value
	Yes	No	
	N (%)	N (%)	
Underweight	4 (40)	95 (26.99)	0.363
Severely underweight	2 (20)	43 (12.22)	0.462
Stunting	5 (50)	108 (30.68)	0.194
Severe Stunting	5 (50)	49 (13.92)	0.002
Wasting	1 (10)	73 (20.74)	0.406
Severe Wasting	0 (0)	28 (7.95)	0.353
MAM	2 (20)	99 (28.13)	0.572
SAM	0 (0)	45 (12.78)	0.227
Hair Changes	4 (40)	79 (22.44)	0.193
Oral Cavity Changes	3 (30)	70 (19.89)	0.432
Pallor	4 (40)	144 (40.91)	0.954
Edema	0 (0)	34 (9.66)	0.302

Table 11: Comparison of mean anthropometric parameters to compare effects of non-immunization

Parameter	Non- immunized		p-value
	Yes	No	
Mean weight	9.97 ± 2.65	10.67 ± 3.05	0.526
Mean length	78.90 ± 12.71	82.22 ± 12.12	0.460
Mean MUAC	14.69 ± 1.85	14.23 ± 2.03	0.300

Table 12: Co-relation of low SES with various study parameters (n=362)

parameters	Lower SES		p-value
	Yes	No	
	N (%)	N (%)	
Underweight	6 (11.32)	93 (30.10)	0.005
Severely underweight	2 (3.77)	43 (13.92)	0.039
Stunting	12 (22.64)	101 (32.69)	0.145
Severe Stunting	7 (13.21)	47 (15.21)	0.705
Wasting	5 (9.43)	69 (22.33)	0.031
Severe Wasting	1 (1.89)	27 (8.74)	0.085
MAM	11 (20.75)	90 (29.13)	0.209
SAM	3 (5.66)	42 (13.59)	0.106
Hair Changes	12 (22.64)	71 (22.98)	0.957
Oral Cavity Changes	11 (20.75)	62 (20.06)	0.908
Pallor	19 (35.85)	129 (41.75)	0.420
Edema	5 (9.43)	29 (9.39)	0.991

Table 13: Comparision of mean anthropometric parameters to compare effects of low SES

Parameters	Lower SES		p-value
	Yes	No	
Mean Weight	10.57 ± 2.87	11.12 ± 3.85	0.685
Mean Length	82.41 ± 11.90	80.49 ± 13.43	0.268
Mean MUAC	14.15 ± 2.00	14.75 ± 2.10	0.034

Table 14: Co-relation of protein deficit with various study parameters (n=362)

Parameter	Protein deficit		p-value
	Yes	No	
	N (%)	N (%)	
Underweight	8 (6.61)	89 (39.91)	<0.001
Severely underweight	1 (0.83)	44 (19.73)	<0.001
Stunting	5 (4.13)	108 (48.43)	<0.001
Severe Stunting	1 (0.83)	53 (23.77)	<0.001
Wasting	13 (10.74)	59 (26.46)	0.001
Severe Wasting	2 (1.65)	25 (11.21)	0.002
Hair Changes	3 (2.48)	80 (35.87)	<0.001
Oral Cavity Changes	2 (1.65)	71 (31.84)	<0.001
Pallor	27 (22.31)	119 (53.36)	<0.001
Edema	1 (0.83)	33 (14.80)	<0.001

Table 15: Comparision of mean anthropometric parameters to compare effects of protein deficit vs protein adequacy

Parameters	Protein deficit		p-value
	Yes	No	
Mean Weight	9.82 ± 2.81	11.98 ± 2.92	<0.001
Mean Length	79.37 ± 11.91	86.54 ± 11.18	<0.001
Mean MUAC	13.51 ± 1.85	15.40 ± 1.72	<0.001

statistically significant lower values of weight, length and MUAC.(Table 15)

A significant association was seen with deficient calorie intake and all the parameters considered for assessment in the study i.e. underweight, severely underweight, stunting, severe stunting, wasting, severe wasting, MAM and SAM and clinical parameters like hair changes, oral cavity changes, pallor and edema. (Table 16)

The significant association was also reflected when the mean values of length, weight and MUAC of the deficient group was compared with the reference group in which the group with deficient protein intake was seen to have statistically significant lower values of weight, length and MUAC.(Table 17)

Table 16: Co-relation of calorie deficit with various study parameters (n=362)

Parameter	Calorie deficit		p-value
	Yes	No	
	N (%)	N (%)	
Underweight	3 (2.10	94 (48.21)	<0.001
Severely underweight	1 (0.70)	44 (22.56)	<0.001
Stunting	21 (14.69)	92 (47.18)	<0.001
Severe Stunting	9 (6.29)	45 (23.08)	<0.001
Wasting	10 (6.99)	62 (31.79)	<0.001
Severe Wasting	2 (1.40)	25 (12.82)	<0.001
Hair Changes	3 (2.10)	80 (41.03)	<0.001
Oral Cavity Changes	2 (1.40)	70 (35.90)	<0.001
Pallor	25 (17.48)	120 (61.54)	<0.001
Edema	7 (4.90)	27 (13.85)	0.007

Table 17: Comparison of mean anthropometric parameters to compare effects of calorie deficit vs calorie adequacy

Parameter	Calorie deficit		p-value
	Yes	No	
Mean Weight	9.75 ± 2.59	11.69 ± 3.18	<0.001
Mean Length	80.35 ± 11.35	84.20 ± 12.71	0.010
Mean MUAC	13.24 ± 1.72	15.40 ± 1.70	<0.001

6. Discussion

6.1. Study population

A total of 362 children were analyzed among the children surveyed after excluding those who did not give consent or for whom there was incomplete data or who those fell in the exclusion criteria. 183(50.6%) children were females and 179(49.4%) were males. Of the children, a maximum of 24.3% belonged to 12-23 completed months while the least 14.6 % were between 36-47 completed months. The mean age of the study population was 22.6 ± 14.77 months.

Our study had more female participants (M: F = 1: 1.02) as against the under-5 sex ratio of 950 in Odisha.[2] Various studies show either sex being more predisposed to malnutrition. In a study, done by Choudhury et.al[10] in Western Rajasthan found males were more than females (74.6% v/s 25.4%) with a ratio of 2.9:1 and in a study, Ashraf et al[11] reported that malnutrition is relatively more common in males as compared to that of females(53.7% v/s 46.3%). Likewise, Aneja et al[12] in their study on malnutrition observed that 55.5% of children were males as compared to females (44.5%). But Joshi et al[13] observed that incidence of malnutrition was higher in females (78%) as compared to that in males (22%). Singh et al[14] and Rao et al[15] reported that extent of malnutrition was significantly higher in girls than boys i.e. ($p<0.05$) and ($p<0.01$) respectively.

6.2. Socio- demographic factors

6.2.1. Sanitary habits

Around 18.5 % of the study population practiced Open Air Defecation (OAD) whereas the rest had access to either community toilet or had their own toilet. The study showed that 48.6% of the population use their own toilet and this when compared with the NFHS-5[2] data for Odisha, it was seen that 72.7% of the urban population in the state had access to improve sanitation facilities (unshared toilet) and is a huge improvement than 61% reported in the NFHS-4 data.[16] Similar data for Cuttack district as per NFHS-5[3] showed that 60.2% of the population had access to improved sanitation facilities which is again higher than 40.2% as per NFHS-4.[16] The data indicates that the slum population does lag behind the general population in access to sanitation facilities.

6.2.2. Drinking water supply

Around 12.4% of children used well water for drinking whereas the rest used either tube well water or tap water for drinking purposes. The NFHS-5[2]for Odisha shows that 97.1% of the population had access to improved drinking water source(includes tap water, tube well and protected dug well) as against 91.1% in NFHS-4[16].The data for Cuttack district[3] shows that 92% of the population have access to improved drinking water source and the figure is same as NFHS-4.

6.2.3. Immunisation

64.6% children were completely immunized and 32.6% were partially immunized. Only 2.8 percent children had

not received any vaccination. The findings are comparable to NFHS-5[3] reports of Cuttack district163 which says that 97% of the children are vaccinated based on data obtained from the vaccination card while the overall state figure for the urban population stands at 93.4%.[2]

6.2.4. Socio-economic status

Most of the families i.e. 40.3% and 44.5% belonged to Upper Lower and Lower Middle class. The mean income of the study population was[1] 17136.74 and the mean SES Score was 11.10. Low SES is known to be associated with illiteracy, poor sanitary and drinking water habits, overcrowding, large family size and the bearing of these factors on malnutrition should be studied.

6.3. Deficit in calorie and protein intake

As per the 24-hour recall method, it was seen that 33.4% of the children had around normal protein intake and 39.5% of the children had around normal calorie. Around 61.6% of children had a deficient protein intake and 53.9% of children had a deficient calorie intake. A significant proportion of the proportion consumed less than 70% of the recommended daily calorie and protein and it was seen that protein deficit was more prevalent than calorie deficit.

The effects of a proper nutrition on growth and development is a well known fact and when coupled with other factors like socioeconomic status, sanitary habits, immunization practices and drinking water supply could have multiplying effects on causing malnutrition. Any study on malnutrition is incomplete if dietary intake is not considered as a parameter in the study. Moreover, the current scenario of lockdowns, job losses, economic adversities coupled with infections makes the nutritional assessment of every section of the society extremely important.

This shortage of nutrition was seen mostly in the lower socio-economic strata but few cases were also seen in the upper middle class. So not only does the financial limitations but also ignorance and unawareness of the ill- effects of a deficient diet in the early years of life is responsible for these figures. In addition to these, the suspension of the regular anganwadi activities, ICDS activities during the COVID-19 lockdowns could also play a significant role in causing these deficits.

In a study conducted by MR Prasanth et al[17] on 103 SAM cases, it was seen that statistically significant dietary risk factors included protein deficit (66%) and calorie deficit (79.6%) as well as other factors like pre- lacteal feeds, bottle feeds etc and hence a detailed nutritional history is of utmost children in infants and young children because almost complete brain growth occurs by 5 years of age.

6.4. Assessment of malnutrition (Anthropometry)

6.4.1. Weight for age

Data showed that 68% children had weights in the normal range whereas 27.3 children were in underweight and 4.7% in overweight range. Among them, it was seen that 12.4 of all children were severely underweight and 14.9 were moderately underweight. It was also found that 4.7% children were overweight and 0.6% were found to be obese. The values are similar to the Evidence paper on coverage of nutrition specific and nutrition sensitive interventions for under two children in 15 high burden districts in Odisha which showed that Prevalence of underweight in Cuttack district was 28%. The data is comparable to the NFHS-5[2] data which shows that the prevalence of underweight children in Odisha is around 29.7%. In a study conducted by SwaminathanS et al[18] showing the trends of malnutrition in India till 2017, the prevalence of underweight was found to be 32.7%.Study was undertaken by Anshuman P et al[19] among slum children residing in Bhubaneswar city, India showed that 45.4% of children were found to be underweight. 4.7% of the children in the study were found to be overweight and it was similar to the findings to NFHS-5 data of Cuttack district[3] and Odisha.[2]

6.4.2. Length for age

Data showed that 68.8% children had length/heights in the normal range whereas 31.2% children were stunted. The results are similar to the NFHS-5 data for Odisha[2] which says that 31% of under 5 children in Odisha are stunted whereas the data for Cuttack[3] district shows the stunting prevalence to be 20.4% which again shows that the slum population does lag behind the general population in terms of growth in length. However, study was undertaken by Anshuman P et al[19] among slum children residing in Bhubaneswar city showed that a very high percentage i.e. 57.4%, of children were found to have stunting.

6.4.3. Weight for length

It was found that 79.6% of the children were normal for weight/length and 20.4% children were found to have wasting. The results are slightly higher than the NFHS-5 data for Odisha[2] which says that 18.1% of under 5 children in Odisha are wasted whereas the data for Cuttack[3] district shows even lower stunting prevalence at 14.9% which again shows that the data for slum population remains poor than the general population in terms of weight for length. The findings were similar to a study was undertaken by Anshuman P et al[19] among slum children residing in Bhubaneswar city, India which showed that 23.3% of children were found to have wasting. On further analysis of the data, it was found that 7.7% children were having severe wasting (Severe Acute Malnutrition) and 12.7% children were having moderate wasting (Moderate Acute Malnutrition). The NFHS-5 data for the state[2] pegs the

prevalence of severe stunting in the state at 6%.

6.5. Mid-upper arm circumference (MUAC)

MUAC is a very important anthropometric measurement in children between 6 months to 5 years. The reference values of MUAC is a constant for this age group, the scientific basis being that the growth in muscle mass corresponds to the loss of subcutaneous fat and hence, the total circumference. In cases of undernutrition, the gain in muscle mass will be inadequate and hence, the MUAC decreases. Owing to the simplicity in measurement as well as its interpretation, MUAC is an important tool for both community, OPD and IPD assessment of growth adequacy. In our study, MUAC was found to be normal in 79.3% of the study population and decreased in 20.7% of children. Out of them, 9.1% were having SAM and 11.6% were having MAM. On combining the results of wasting and MUAC, an overall assessment for the prevalence of SAM and MAM was done. It was found that in our study population, 27.9% children were having MAM and 12.4% children were having SAM. In a study conducted by Sethy et al[1] in urban slums of Berhampur, it was seen that only 56.7% of children had MUAC more than 13.5 and 11.7% children were having MUAC below 11.5cm (SAM).[4]

6.5.1. Assessment of malnutrition (clinical)

A head to toe examination of children in the study sample was done to look for evidence of malnutrition.

It was found that the evidence of pallor was found in 40.9% children whereas 59.1% were found to have apparently normal examination. The data was comparable to the state NFHS-5 data[2] which reports that 56.2% of children between 6 months to 5 years were having pallor. It was found that 22.9% children had hair changes and 77.1% children had normal hair.79.8% children had apparently normal examination of the oral cavity while 20.2% had one of the mentioned findings. Evidence of pedal edema was found in 9.4% of the population while the rest had no evidence of pedal edema. Our incidence of edema was slightly higher when compared with a study conducted by Hegde S et al[20] in which a total of 200 subjects were enrolled, out of which 100 were cases and 100 were taken as controls. Out of the 100 cases, 5 presented with oedematous malnutrition. In a study conducted by Barus et al[21] in hospitalized children, easily pluckable hair was found in nearly 50% of the children.

The clinical features suggest that micro nutrient deficiencies co-exist in the background of malnutrition and the absence of a wholesome diet partly explains the co-existence. On the other hand, factors like poor sanitary habits and improper drinking water can also be responsible for micro-nutrient deficiencies. This study does not deal with micro-nutrient deficiencies in detail.

6.6. Association with risk factors

6.6.1. Sanitary practices

A significant association of open defecation was found for all anthropometric parameters like underweight, severely underweight, stunting, wasting, severe wasting, MAM and SAM and clinical parameters like hair changes, oral cavity changes and pallor except for severe stunting and edema for which the association was non-significant. Further, the mean values of weight, height and MUAC was compared in both groups. A lower value in all parameters was recorded in the group practicing open defecation but the decrease was statistically significant in weight and MUAC. In a study conducted by Hegde S et al,[20] it was seen that open air defecation was significantly associated with SAM and thus sanitary habits must be enquired for in nutritional analysis of children. Sanitary practices evolves with improvement in living standards. The government of India has also stressed upon each households having their own toilet. This signifies the importance of cleanliness and sanitation. The practice of OAD is mostly associated with bare footedness and this in cumulative predisposes children to multiple infections, most commonly via feco-oral route. It is an established fact that illness have a direct impact on child's nutrition and thus unhealthy sanitation practices like OAD causing intermittent illnesses is an important factor in causing nutritional deficits.

6.6.2. Drinking water supply

In the above table, effects of drinking water supply was analysed and use of well water for drinking was taken as a risk factor and compared with those who used tap water or tube well water. A significant association of well water use was found for all anthropometric and clinical parameters except for severe stunting and MAM for which the association was non- significant. On comparing the mean values, however it was seen that only the decrease in MUAC was statistically significant. Improper sterilization of water before using it for drinking purposes predisposed chidren to many infections, commonest being diarrhoea and on the other hand, malnourished children exposed to improper drinking water predisposed them to regular infection as shown in study conducted by Hegde et al[20] that children with SAM had >3 to 5 episodes of illness in a year which were mainly acute watery diarrhea, and 99% of the cases had inadequate feeding during illness ($p<0.001$). Study conducted by Meshram I et al[22] by using logistic regression analysis showed that Morbidities such as fever and diarrhea during preceding fortnight were significantly ($p <0.01$) associated with wasting and 2-fold increases in risk (OR for fever 1.90, CI 1.29–2 79 and OR for diarrhoea 1 95, CI 1 04–3 67

6.6.3. Immunisation status

No significant association was found in between the two groups in any of the parameters except for in children with severe stunting where non-immunized children where significantly more prone for stunting than those who were immunized or partially immunized. Further on comparing the mean values of weight, length and MUAC between non-immunized children and others, it was found that although the non-immunized children had a lower mean weight and length, the difference was not statistically significant. But various studies have shown a significant association of malnutrition with non-immunization and association of non-immunization with lower SES. Study done on SAM in Srinagar was either unimmunized (42.7%) or partially immunized (44%). Sharma et al,[23] Shah et al[24] and Devdas et al[25] observed that better the socioeconomic and educational status of mothers, better was the immunization status of children. Also, Mishra K et al[26] in his study conducted in 2014 suggested that incomplete immunization was a significant risk factor for SAM.

6.6.4. Socio-economic status

It was seen that a significant association of lower SES was seen in case of underweight, severely underweight and wasting and stunting, mean MUAC values. Similarly, in a study by Awasthi S et al,[27] they mentioned that lack of basic amenities make the slum dwellers particularly children vulnerable to infections which further compromises their nutrition and in the study conducted by Chaudhary S et al[28] in urban slums of Ahmedabad found out that initiation of breastfeeding within 1 h of birth occurred only in one third of the children and only one fifth of the children were breastfed for 2 years and beyond. Similarly, Soni et al[29] and Ashraf et al[11] in their studies reported that majority of malnourished children belonged to lower socioeconomic status. Likewise, Rao et al[15] Singh et al[14] and Swaminathan et al[18] also reported that malnutrition is related to per capita income and socioeconomic condition. It was seen that in a study conducted by Hegde S et al,[20] socio economic status (according to modified Kuppuswamy classification) falling below class IV had a significant association with edematous and non-edematous malnutrition. Low SES is associated with illiteracy, poor sanitary and drinking water habits, over-crowding, large family size and all of these have been proved to be risk factors for malnutrition in children.[20,22,30,31]

6.6.5. Protein and calorie deficit

It was found that a significant association was seen with both deficient protein and deficient calorie intake and all the parameters considered for assessment in the study i.e. underweight, severely underweight, stunting, severe stunting, wasting, severe wasting, and clinical parameters like hair changes, oral cavity changes, pallor and edema. The significant association was also reflected when the mean values of length, weight and MUAC of the deficient group was compared with the reference group in which the group with deficient protein and calorie intake was seen to have statistically significant lower values of weight, length and MUAC. In a study conducted by MR Prasanth et a[17] on 103 SAM cases, it was seen that statistically significant dietary risk factors included protein deficit (66%) and calorie deficit (79.6%) as well as other factors like pre- lacteal feeds, bottle feeds etc., and hence a detailed nutritional history is of utmost children in infants and young children because almost complete brain growth occurs by 5 years of age.

In our study, nutritional deficit was seen mostly in the lower socio- economic strata but few cases were also seen in the upper middle class. So not only does the financial limitations but also ignorance and unawareness of the ill- effects of a deficient diet in the early years of life is responsible for these figures. In addition to these, the suspension of the regular anganwadi activities, ICDS activities during the COVID-19 lockdowns could also play a significant role in causing these deficiencies.

7. Strengths of the Study

The study was conducted in a community on a house to house basis involving the community health workers like ASHA, ANM and AWWs with pediatricians being involved in history taking, clinical and anthropometric examination. The timing of the study in the aftermath of COVID-19 lockdowns also helps us to know the nutritional impact of the economic shutdown during the pandemic. Out of nearly 1100 children in the under 5 age group out of which 400 were approached which makes it a good representation of the community. Adequate number of girl children have been a part of the study. The study analyses the effect of both nutrition and socio- demographics together on the nutritional status. Standard definitions, clinical methods, cut-offs, instruments and charts have been used in the study..Appropriate statistical methods have been applied to decide the sample size and do the analysis.

8. Limitations of the Study

A better sampling method to collect the study population could have been used. Maternal literacy was not taken as a parameter for evaluation in this study. A more exhaustive nutrition history could have been taken to include fruits, frequency of snacks etc. Well water could have been further classified into covered and uncovered wells to include covered wells in the improved drinking water category as per NFHS criteria. As the socio demographic risk factors are inter-linked with each other and do co-exist, a multiple regression analysis could have been done to a get a more clear data.

9. Recommendations

Open Air Defecation is an avoidable unhealthy practice. People must be encouraged to use toilets at home and must train their children the same. The IEC materials explaining the risks associated with OAD and how they can be averted by using a sanitary latrine must be used to impart knowledge among the slum residents. Open well water, if used, must be covered and water should be boiled before drinking. The technique to boil water and the benefits of it and risks associated if not done must be explained to the residents. The community health care workers are already doing a good job in making a good coverage of immunization. Those left out must be reached and explained regarding the risks of diseases if the child remains un-immunized. They must be explained that the vaccines are being provided by the government free of cost and must be given to all children to achieve maximum benefit. The residents must be assured that nutritious food is not a luxury and can be obtained from a common household menu if we plan our meals and cook them properly. A sample individualized diet chart can be provided to them. The parents must be counseled to utilize the health care facility services in their nearby area in case of any illness so that correct and optimal treatment may be given to them and their children. The residents must be motivated to take their children for regular health check-ups which shall also be an opportunity to assess for the growth and development. Lastly, to make them realize that the first 5 years of their children's life is vital in shaping his entire life ahead and they must take utmost care of their children.

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None.

11. Conflict of interest

None.

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