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Original Research Article

Impact of malnutrition on head size and development quotient

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ABSTRACT

Background: Malnutrition is one of the most common global health problem. It produces notable morphological changes in the brains which damage the intellectual potential and leads to reduced brain size, inferred from measurements of head circumference(HC). Aim is to study the impact of malnutrition on head size and development quotient(DQ) in children suffering with malnutrition.
Methods: It is a hospital based study on 120 children including 100 moderates to severely malnourished children and 20 healthy controls aged 6-60 months admitted in malnutrition treatment center. Statistical analysis of head circumference and development quotient was done with severity of malnutrition and with each other.
Results: Out of 120 children, 80 were severely malnourished (SAM) and 20 were moderately malnourished (MAM) and 20 age and sex matched controls were taken. Mean age was 19.00±8.54 months. 36.25% of severely malnourished, 5% of moderately malnourished children and none in control had microcephaly (HC<-3SD). Mean DQ was 57.46±14.98, 78.35±6.60 and 94.45±3.96 in SAM, MAM and control children respectively. Statistically significant association was found for head circumference and development quotient with severity of malnutrition and with each other.
Conclusions: SAM adversely affects the developing brain of children as evidenced in our study by reduced head size and low DQ scores in children suffering from malnutrition. As seen in this study, prevalence of microcephaly and lower DQ scores increases with severity of malnutrition. Therefore, the study emphasizes the importance of early and timely intervention in such children before the severity of malnutrition increases to an extent of irreversible effects on brain and development.

Keywords: Development quotient, Head size, Malnutrition

INTRODUCTION

Malnutrition refers to undernutrition resulting from inadequate consumption, poor absorption or excessive loss of nutrients.[1,2,3] It is one of the most common global health problem, involving hundreds of millions of children in the world, contributing to childhood morbidity, mortality, impaired intellectual development, suboptimal adult work capacity, and increased risk of diseases in adulthood.[1] According to NFHS-4, carried out in 2015-16, 35.7% of children under the age of 5 years in India are underweight, 21% are wasted, 7.5% are severely wasted and 38.4% stunted.[4] These data are even more unacceptably high in Udaipur district of Rajasthan where the toll of Severe Acute Malnutrition has reached to 11.4% as per NFHS 4.[5] India shares the burden of almost 50 percent of children with severe acute malnutrition (SAM) worldwide.[6] Protein-energy malnutrition produces notable morphological changes in the brains which damage the intellectual potential and limit their capacity to become part of the competitive world.[2] Brain size is reduced as the result of changes in structural proteins, growth factor concentrations, and neurotransmitter production.[1]

Head growth, primarily owing to brain development, is most rapid within the first three years of life.[6] Routine measurement of HC (the frontal occipital circumference) is a component of the nutritional assessment in children up to age three and longer in children who are at high nutritional risk and has been defined as the most sensitive anthropometric index of prolonged under nutrition during infancy, associated with intellectual impairment.[1,7] But in many studies these measurements are often neglected. In the above light, the present study has been planned to assess effect of nutritional status on head circumference and DQ of children suffering with malnutrition.

METHODS

This case control study was carried out among the children admitted in malnutrition treatment center of Maharana Bhupal Government Hospital situated at Udaipur, Rajasthan, India during the period of July 2015 to June 2016. Children between 6 months to 60 months who were admitted in the hospital MTC along with 20 healthy controls were included. Children having history of perinatal insult (birth asphyxia/trauma/IVH/kernicterus etc.) or NICU admissions in the neonatal period, evolving central nervous system disease or secondary malnutrition were excluded. Nutritional status of the children was evaluated according to the deviation from the WHO median in the age and sex-specific WHO child growth standards charts (Multicenter Growth Reference Study, MGRS) as Z score of: <-2 standard deviation (SD) Z-score value labelled as Moderate undernutrition and <-3 SD Z-score value labelled as Severe undernutrition where SD refers to the standard deviation from the median3. The head circumference was measured by placing a non-stretchable tape around the cranial vault taking the maximum circumference of the head from the occipital protuberance to the supraorbital ridges on the forehead. If abnormal, a second measurement was performed to confirm the result.

The measurement was recorded to the nearest 0.1 cm. HC assessment of the children was evaluated using the World Health Organization (WHO) recommended HC-for-age specific z-scores cut-off value.[8] Screening of developmental delay was done by Denver developmental screening (Denver II) and development quotient was calculated as (average age at attainment/ observed age at attainment x 100).[9] DQ below 70% was taken as a delay, DQ of 70-90 as borderline and DQ 90-110 as normal.[10] Both head circumference and DQ were correlated with severity of malnutrition. All the data was evaluated using SPSS 20 software.

RESULTS

A total of 120 children (69 boys and 51 girls) in the age group of 6-60 months were included. 80 were severely malnourished (SAM) and 20 were moderately malnourished (MAM) and 20 heathy children were taken as control. Mean age was 19.00±8.54 months. Head circumference among SAM children was median±2SD in 24(30%), <-2SD but >-3SD in 27(33.75%) and <-3SD in 29(36.25%), among MAM children HC was median ± 2SD in 14(70%), <-2SD but >-3SD in 5(25%) and <-3SD in 1(5%) and among the controls, 18(90%) had HC median ±2SD, 2(10%) had <-2SD but >-3SD while none had HC <-3SD (Table 1).

Table 1: Distribution of children according to head circumference for age Z scores (based on WHO MGRS standards).

Head circumference for age Z score	SAM		MAM		Control	
	No.	%	No.	%	No.	%
<-3SD	29	36.25	1	5	0	0
>-3SD-<-2SD	27	33.75	5	25	2	10
Median±2SD	24	30	14	70	18	90

Mean head circumference among the different age groups of 6-11 months, 12-36 months and 37-60 months was 41.10±1.72 cm, 43.28±2.00 cm and 46.50±1.79 cm respectively in severely malnourished children, 42.50±3.12 cm, 45.22±2.04 cm and 48.75±1.77 cm respectively in moderately malnourished children and 43.28±2.11 cm, 46.18±1.96 cm and 49.10±0.57 cm respectively in controls. (Table 2). Thus 36.25% (29) of severely malnourished, only 5%(1) of moderately malnourished children and none in controls had microcephaly. Mean DQ was 57.46±14.98, 78.35±6.60 and 94.45 ± 3.96 in SAM, MAM and control children respectively (Table 3).

Table 2: Mean head circumference in study children.

Age group	Nutritional status	HC (cm)	
		Mean	SD
6m - <1year	SAM	41.10	1.72
	MAM	42.50	3.12
	Control	43.28	2.11
1-3 years	SAM	43.28	2.00
	MAM	45.22	2.04
	Control	46.18	1.96
>3-5 years	SAM	46.50	1.79
	MAM	48.75	1.77
	Control	49.10	0.57

Decreasing head size with increasing severity of malnutrition in all the age groups.

Table 3: Development quotient (DQ) with nutritional status.

Nutritional status	DQ (mean ± SD)	
	Mean	SD
SAM	57.46	14.98
MAM	78.35	6.60
Control	94.45	3.96

ANOVA p <0.001(HS), DQ decreases significantly with fall in nutritional status.

Head circumference and development quotient was found to be statistically significantly associated with severity of malnutrition and with each other (Table 2,3,4).

Table 4: Correlation of development quotient (DQ) with head circumference(HC).

HC (no. of cases)	DQ (Mean± SD)	
Median ± 2SD (56)	74.62	19.63
<-2SD (34)	66.79	14.99
<-3SD (30)	53.91	15.24

ANOVA p <0.001 (HS), decreasing head circumference for age, DQ decreases significantly.

DISCUSSION

Malnutrition in children is one of the most common health problem affecting almost 40% of children in developing country like India.[4] Effects of malnutrition on the body are protean involving almost all the organ systems in the body.

Protein-energy malnutrition produces notable morphological changes in the brains of children suffering from malnutrition.[2] These changes have been associated with retarded brain growth and functional development which damage the intellectual potential of those who survive and limit their capacity to become part of the competitive world.[2] Maximum insult occurs during the period of maximum brain growth.

The critical period of brain growth extends from mid gestation to the early preschool years. Thus, the fetal phase and the first two years are crucial period for brain development. During the critical period, the brain has biosynthetic abilities that do not persist into later life.[6]

The present study shows higher prevalence of microcephaly in children with increasing severity of malnutrition. A study by Kumar N et al in 2016 found SAM as the commonest cause of microcephaly followed by cerebral palsy.[11]

Another study by Oyedeji et al in 1997 found that mean HC values of malnourished children of both sexes fell mostly below the values for their well-nourished agemates.[12]

Current study also reveals lower DQ scores with increasing severity of malnutrition. Similar to the findings of present study, a study by Agarwal D.K et al in 1982 found that malnourished children scored poorly in all the areas of development, i.e., motor, adaptive, language and personal social and DQ decreased with the severity of malnutrition.[13]

Thus, the present study revealed malnutrition is one of the major cause of microcephaly in our country and is directly related to the development quotient of such children.

CONCLUSION

SAM adversely affects developing brain of children as evidenced in our study by reduced head size and low DQ scores in children suffering from malnutrition. As seen in this study, prevalence of microcephaly and lower DQ scores increases with severity of malnutrition, therefore this emphasizes the importance of early and timely intervention in such children before the severity of malnutrition increases to an extent of causing irreversible and permanent effects on brain and development hampering their cognitive and intellectual potential in future life. Inspite of many programmes running, malnutrition still continues to be prevalent as a serious medical and social disorder in India. Thus, to diminish the burden of malnutrition in the community, a collective attempt by the government, non-governmental organizations and the community is crucial. Effective and efficient program should be designed to reduce child malnutrition.

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