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Original Article

Physiology Section

Impact of Nutritional Status on Cognition in Institutionalized Orphans: A Pilot Study

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ABSTRACT

Introduction: Proper nutrition is critical for maximizing brain function and enhancing learning. There is accumulating evidence that early malnutrition, marked by stunting, is associated with long-term deficits in cognitive and academic performance, even when social and psychological differences are controlled. All over the world, children living without permanent parental care are at a heightened risk for under-nutrition, putting their health and development in great jeopardy.

Aim: To assess the nutritional and cognitive status in institutionalized orphans which might help to formulate effective interventions for improving the nutritional status of vulnerable children in future.

Materials and Methods: This cross-sectional, case control study included 70 children (35 orphans and 35 non-orphans). Their anthropometric measurements (height, weight, and BMI) were measured and cognition was assessed using subsets of Wechsler Intelligence Scale for Children-Revised (WISC-R): Block design and Digit span. The data obtained was subjected to descriptive statistical analysis.

Results: 18.57% (13) of children had stunting, 15.71% (11) had wasting, 22.86% (16) were underweight, and 17.14% (12) showed thinness. Mean±SD of Block design in non-orphans was significantly higher compared to orphans (p-value 0·05). Mean±SD of Digit span in non-orphans was significantly higher compared to orphans (p-value 0·000). For Block design, there was moderate positive correlation with nutritional status based on Z-scores (p-value <0·05). Digit span also showed moderate positive correlation (p-value <0·05).

Conclusion: The results of our study indicate that children in orphanages have high rates of both malnutrition and cognitive delay compared to the non-orphans and there was a direct correlation between both the variables. If orphanages are here to stay as a last resort for children deprived of a family there is an urgent need to improve the institutional environment in order to foster the development of millions of children in orphanages around the world.

Keywords: Block design, Digit span, Nutrition, Z-scores

INTRODUCTION

Optimal nutrition is necessary for physical and mental growth and development in children. United Nations Educational Scientific and Cultural Organization (UNESCO) since 1972, for the purpose of statistics, considers 6-11 years as primary school age and 12-17 years as secondary school age [1]. It is recorded that in India, one fifth population comprises of children between 5-14 years, the age group covering primary and secondary school age [2].

School age is considered as a dynamic period of growth and development because children undergo physical, mental, emotional, and social changes. The foundation of good health and a sound mind is laid during this period. Good nutrition is important in supporting growth and maximizing learning potential [3]. Nutritional intake affects energy levels, physical stamina, mood, memory, mental clarity, and emotional and mental well-being. Children who fail to grow optimally during this crucial period may not make-up the loss in growth even on an excellent diet in later life.

The WHO has developed child growth standards which describe how a child should grow, and the growth standards are used to identify children who are over-nourished or under-nourished. A child is diagnosed as having under-nutrition when the child's height or length (stunted), weight (underweight), or weight-for-height (wasted) is well below the mean on the growth standards for his or her age [4].

Proper nutrition is critical for maximizing brain function and enhancing learning. Adequate brain function is a prerequisite for efficient cognition and performance of organized behaviour [5]. Therefore, the effect of malnutrition delays physical growth and motor development which have impact on cognitive development resulting in lower Intelligence Quotient (IQ), less attention span, and lower educational achievement [6].

Cognition represents a complex, multidimensional set of abilities. Cognition in children tracks the development of key areas such as learning, memory, reasoning, problem solving, and knowledge representation from infancy through childhood [7]. Working memory at the start of formal education is a more powerful predictor of subsequent academic success than IQ in the early years [8]. Memory itself is a very complex set of processes (e.g., short-term, long-term, visual, spatial, verbal etc.,) that can be investigated using different assessment tools. The Wechsler scales continues to be the most widely used intelligence batteries. The concepts, methods, and procedures inherent in the design of the Wechsler scales have been so influential that they have guided most of the test development and research in the field for more than a half century [9]. Block design and Digit span are two subsets of the Wechsler scales which test the perceptual reasoning and working memory, respectively.

In India, population below 18 years of age stands at 42,06,78,000, among which 2,57,00,000 are orphans [10]. An orphanage is an institution dedicated to the care and upbringing of children who have lost their parents [11]. It has been observed that institutionalized children lack basic social and inter-personal skills, have lower levels of educational achievements, have problems adjusting to life outside the orphanage and lack parental skills. Hence, the grave matter of children's health and education in orphanages requires attention by all.

The present study, therefore, was undertaken to assess the nutritional and cognitive status in institutionalized orphans which might help to formulate effective interventions for improving the nutritional status of vulnerable children in future.

Variables	CONTROL (Non-orphan children)		STUDY GROUP (Orphan children)	
	No.	%	No.	%
Age (in years)				
6-11	17	48·6	17	48·6
12-16	18	51·4	18	51·4
Gender				
Female	21	60	21	60
Male	14	40	14	40
Education				
Primary	20	57·14	20	57·14
Secondary	15	42·86	15	42·86
Total (70)	35	100·0	35	100·0

[Table/Fig-1]: Distribution of demographic variables in non-orphans and orphans.

MATERIALS AND METHODS

This cross-sectional, case control study which was conducted at AJ Institute of Medical Sciences, Mangalore, Karnataka, India in the months of July-August 2013 included 70 children (aged between 6-16 years) of which 35 were selected from orphanages and the other 35 served as control (age-matched non-orphans). Informed consent was obtained from the parents/guardians/caregivers of subjects after explaining the purpose and the procedures involved in the study. We excluded children aged <6 years and >16 years, orphans/non-orphans having any long standing systemic disease or physically and mentally disabled, and children who were sick at the time of data collection. Institutional Ethical Committee approval was obtained.

Self-structured questionnaire was divided into following categories:

A. General information: Included the name, age, gender, education, and history of past/present medical or surgical illness of child;

B. Anthropometric measurements: Included height (recorded in centimetresusing a stadiometer (range 60 cm-200 cm) with an accuracy of 0.1 cm), weight (recorded in kilograms to the nearest 0.1 Kg using mechanical weighing scale), and body mass index (kilograms/metre^2);

Anthropometric indicators such as height for age, weight for age, weight for height, and BMI for age was derived as Z score of a child's measurement to the median of the international standard or reference, i.e., the growth references of WHO (2007)/ NCHS (National Centre for Health Statistics). The Z score of <-2 is generally considered as the cut-off point for screening the children who are likely to be malnourished [12];

C. Assessment of Cognition: Using subsets of Wechsler Intelligence Scale for Children-Revised (WISC-R): Block design and Digit span [9].

As per the data obtained, nutritional status based on Z-scores and cognition was compared between orphans and non-orphans. Later relationship between cognition and nutrition was assessed in institutionalized orphans and was statistically analyzed. The data obtained was subjected to descriptive statistical analysis. Student t-test (two-tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups (Inter-group analysis). Relationship between nutritional status and cognition in orphans was analyzed using Pearson Correlation.

RESULTS

As shown in [Table/Fig-1], the average age (SD) was 10·32±1·89 years and 10·31±1·89 years in the study and control group respectively, and there was no statistical difference between the two groups with p-value of 0·898. With regard to gender, 60% were girls and 40% were boys. There were 40 children in primary school and 30 in secondary school.

According to [Table/Fig-2], orphans with Z-scores <-2 are more in number than non-orphans indicating under-nutrition. Overall, 18.57% of children had stunting (inadequate HAZ), 15.71% had

Nutritional status (Z-scores)	Z<-2				Z-2 to+2				Z>+2			
	Non- Orphans		Orphans		Non- Orphans		Orphans		Non- Orphans		Orphans	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)
HAZ	2	5·7	11	31·4	33	94·2	24	68·6	-		-	-
WAZ	1	2·8	10	28·6	32	91·4	25	71·4	2	5·7	-	-
WHZ	4	11·4	12	34·3	30	85·7	23	65·7	1	2·8	-	-
BAZ	3	8·6	09	25·7	28	80	26	74·3	4	11·4	-	-

[Table/Fig-2]: Nutritional status based on Z-scores in children. < -2 (stunting/wasting/underweight), -2 to +2 (Normal), >+2 (overweight).
HAZ: Height for age, WAZ: Weight for age, WHZ: weight for height, BAZ: BMI for age

Nutritional status indices	Non-Orphans (n=35)		Orphans (n=35)		p-value
	Mean (Z-score)	±SD	Mean (Z-score)	±SD	
HAZ	-0·41	0·98	-1·69	0·78	<0·001**
WAZ	-1·14	1·43	-1·28	0·69	0·001**
WHZ	-0·52	0·92	-1·73	0·68	<0·001**
BAZ	-0·12	1·56	-0·45	1·20	0·32

[Table/Fig-3]: Comparison of nutritional status based on Z-scores in children.
Data analyzed using Student t-test.
HAZ: Height for age, WAZ: Weight for age, WHZ: weight for height, BAZ: BMI for age
SD: Standard deviation
**: highly significant

Cognition	Non-Orphans (n=35)		Orphans (n=35)		p-value
	Mean	±SD	Mean	±SD	
Block Design	43·65	12·18	38·57	9·37	0·05
Digit span	10·68	3·66	7·28	2·77	<0·001**

[Table/Fig-4]: Comparison of cognition in children.
SD: Standard deviation
**: Highly significant (p-value)

Cognition		HAZ	WAZ	WHZ	BAZ
Block design	'r' value	0·37	0·38	0·32	0·21
	'p' value	0·03*	0·03*	0·03*	0·05*
Digit Span	'r' value	0·66	0·42	0·34	0·34
	'p' value	<0·001**	0·01*	0·03*	0·03*

[Table/Fig-5]: Pearson correlation of nutritional status based on Z-scores and cognition in orphans.
HAZ: Height for age, WAZ: Weight for age, WHZ: weight for height, BAZ: BMI for age.
*: Significant difference (p-value)
**: Highly significant (p-value)

wasting (inadequate WAZ), 22.86% were underweight (inadequate WHZ), and 17.14% showed thinness (low BAZ) i.e., below the WHO/NCHS growth standards (Z-score below -2), though this variation in height can also be due to genetic factors.

As shown in [Table/Fig-3], Z-score was significantly higher in non-orphans compared to orphans with p-value 0.001. There was no significant difference in BAZ, i.e., -0·12 (1·56) in non-orphans and-0·45 (1·20) in orphans with p-value 0·32.

As shown in [Table/Fig-4], mean±SD of Block design in non-orphans (43·65+12·18) was significantly higher compared to orphans (38·57+9·37) with p-value of 0·05. Mean±SD of Digit span in non-orphans (10·68+3·66) was significantly higher compared to orphans (7·28+2·77) with p-value of <0·001.

For Block design, there was moderate positive correlation (r=0·32 to 0·38) with nutritional status based on Z-scores (p-value of <0·05). Digit span also showed moderate positive correlation with a p-value of <0·05. High positive significant correlation existed between Digit span and HAZ (r=0·66, p<0·001), as shown in [Table/Fig-5].

DISCUSSION

The results of the present study are discussed and interpreted under following headings:

- Significance of assessment of nutritional status of children;
- Inter-relation between cognition and nutritional status.

Significance of assessment of nutritional status of children:

Optimum growth and development of children lays a sound foundation in the areas of health, nutrition, language development, personality building, socio-emotional adjustment and cognitive development. Nutrition is an important factor in mental development and, consequently, in cognitive performance. Good nutrition is important for supporting growth and maximizing learning potential.

In the present study, overall, 37·1% of children had stunting (inadequate HAZ), 31·4% had wasting (inadequate WAZ), 45·7% were underweight (inadequate WHZ), and 34·3% showed thinness (low BAZ) i.e., below the WHO/NCHS growth standards (Z-score below -2). Nutritional status was also compared in orphans and non-orphans wherein the prevalence of under-nutrition was more in orphans and Z-scores were significantly less in orphans than non-orphans [Table/Fig-2].

The results are in support with other studies. Study done in Malawi showed 64% of young orphanage children were stunted compared with 50% of village orphans and 46·4% of non-orphans. The mean (SD) Z-score of height/age was significantly lower in the orphanage group, -2·75 (1·29) compared with -2·20 (1·51), and -1·61 (1·57) in the village orphan and non-orphan groups (p<0·05) [13]. Population-based study in rural Western Kenya to compare basic health and nutritional indicators showed W/H Z-scores in orphans were almost 0·3 SD lower than those of non-orphans. Orphans who stay in their communities may be at increased risk for poor health due to reduced circumstances and loss of parental care [14].

Interrelation between cognition and nutritional status:

Cognition can be defined as the process of thinking and knowing including attending, perceiving, interpretation, classifying and remembering information, evaluating ideas, imagining possibilities and generating strategies [2]. Hence, the cognitive development is the growth and refinement of the individual's intellectual capacity.

In the present study, cognitive performance was assessed by subsets of WISC-R such as Digit span and Block design. Cognition, when compared [Table/Fig-4], revealed that the cognitive scores were significantly less in orphans compared to non-orphans (p<0·05) and there was a moderate positive correlation between cognitive scores with that of nutritional anthropometric indices based on Z-scores in the orphans [Table/Fig-5].

Fernstrom JD et al., have also found that malnourished children with poor physical growth perform poorly in intelligence test and emphasized that malnutrition during childhood can lead to irreversible impairment of mental function in later life [14]. A study conducted in 2001 on children growing up in orphanages showed a substantial delay in IQ (Intelligence Quotient) assessed using WISC when compared with children reared in (foster or biological) families [16]. Similar results were obtained by Alaimo K et al., Suboticanec BK et al., and Kar BR et al., who indicated severity of malnutrition has greater impact on cognitive performance of the children [17-19].

The results of our study indicate that children in orphanages have high rates of both malnutrition and cognitive delay compared to the non-orphans and there was a direct correlation between both the variables. While orphanages may provide some of the nurture, they do not provide the holistic care that children are entitled to for all round development [20]. Because of care in large groups and poor environments, brain development may become delayed during the formative period after birth [21] and the lack of challenging stimuli and stable attachments may impair the intellectual development of institutionalized children [16].

Orphan children living in developing countries struggle to survive without the support and protection of parents or the love of a family environment. In developing countries, orphanages may provide care and cognitive stimulation equal to what (extended) families without resources are able to offer. If orphanages continue to serve as a last resort for children (temporarily) deprived of a family, there is an urgent need to improve the institutional environment in order to foster the (intellectual) development of millions of children in orphanages around the world.

LIMITATION

The limitations of the present study are as follows:

- Small sample size (as this was a pilot study).
- Gender differences, clinical examination of children and socio-economic status were not considered.
- Body mass index is not explained in depth.
- 24 hour dietary recall history, and invasive techniques such as estimation of haemoglobin levels etc. were not taken into account.
- Only two subsets of WISC-R were considered.

CONCLUSION

This study concludes that the nutritional status of the institutionalized orphans of Mangalore aged between 6-16 years had high rates of both malnutrition and cognitive delay compared to the non-orphans and there was a direct correlation between both the variables. Our study offers a new insight and enhances the existing literature in the field of nutrition and cognition in children so that parents/care-givers/institutions understand the meaning and importance of good nutrition so they will be able to develop healthy eating habits that will support a lifetime of maximizing learning potential.

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