ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

"Learning disabilities among school going children with Protein Energy Malnutrition in relation to psychosomatic constitution"

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Manuscript Info

Manuscript History:

Received: 15 February 2015
Final Accepted: 22 March 2015
Published Online: April 2015

Key words:

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Abstract

As reported Ayurvedic approach of cognitive deficits mainly depends upon the type of diet as well as type of Prakriti. Utilizing the Ayurvedic wisdom of cognitive development particularly among those genetically susceptible children for inadequate cognitive development, present study was conducted the study recruited -1520 children belonging to different localities of Eastern Uttar Pradesh were screened, out of which 124 children showed evidence of malnutrition along with poor cognitive functions belonging to three distinct prakriti group. These selected malnourished children were evaluated on various neuropsychophysiological assessments including certain biochemical parameters. Results indicated that mal-nourished children had a poor memory and learning abilities and more susceptibility towards development of infectious diseases. Thus a proper training and improved dietary regimen as per their body type may prevent/minimize the prevalence of malnutrition and thus improved mal-nourishment will definitely improved the school performance of the children. For the study institutions ethical approval was taken to conduct present study.

INTRODUCTION

Large masses of children population in the developing world suffer from varying degrees of malnutrition. Malnutrition is considered as a pathological state where the patient may suffer from under-nutrition resulting in nutrient deficits along with deficiency diseases or over-nutrition resulting in obesity, toxicities etc. Present Indian scenario depicts that nearly two-third of the pre-school children are malnourished with highest percentage of underweight children residing here which is nearly double than that of Sub-Saharan Africa. As per NFHS III, 48% of the children under the age of five years are stunted which indicates that half of the country's children are chronically malnourished. According to the presently done studies, 19.8% of the children up to 5years of age are wasted and 43% are found underweight (IIPS AND MINFHS –2005-2006).

Malnutrition being a major health burden in developing countries is manifested by lack of essential nutrients, poor health status etc that may get aggravated by many other circumstances. The aetiology of malnutrition among children is complex that involves interaction of multiple determinants constituting biological, cultural and socio-economic aspects. Early or late weaning, inadequate access to food, micronutrients deficiencies leading to increased losses from intestinal malabsorption are also some of the crucial factors increasing the severity of malnutrition.The associated drawbacks include low socio-economic status of the family, maternal malnutrition, maternal literacy, poor living and sanitary conditions. National poverty, poor educational status, inadequate medical facilities, cultural practices and beliefs, natural and manmade disasters, poor agricultural harvest are some of the crucial community based factors influencing the prevalence of malnutrition (IIPS AND MINFHS –2005-2006)..

To curb and cure the problem of malnutrition, it is very important to correctly diagnose the degree and type of under-nutrition a child is suffering from. It can be measured by checking the prevalence of stunting and underweight. The internationally recommended way to assess malnutrition at population level is to take body or anthropometric measurements (e.g. weight and height). In children the three most commonly used anthropometric indices are weight-for-height, height-for-age, and weight-for-age. These indices can be expressed in terms of z-scores, percentile, or percentage of median, which enable comparison of a child or a group of children with a reference population (Onis and Bloessner,2003). Thus, by using such parameters, the prevalence of stunting and underweight can be measured. The marginal line for child stunting is considered as height for age below 2 SD from the medium height of the normal range. The age-specific estimates of stunting and underweight are derived on the basis of the WHO/NCHS norms (Georgieff and Rao,2001). Stunting constituted by retarded skeletal growth is conventionally regarded as the most sensitive marker of long-term deprivation of micronutrients and prolonged illness. Underweight condition reflects calorie deficiency and more acute illness (Dobbing,1990; Rao and Georgieff 2001;ECM-Vitamins). Undernourished state retards the growth and development of the body and alters the brain function as the early years of life is the pivotal phase for structural as well as functional growth of the brain.

Human brain development depends upon the interaction between genetic and environmental factors that are regulated by nutrition, stimulation, metabolism, child's upbringing etc. The brain cells are more sensitive towards nutrients and dietary chemicals as compared to other body cells. It is metabolically most active organ that consumes a maximum amount of energy and is the holistic body of entire existence that builds intelligence, personality, emotional well being, spirituality and soul. The brain is essentially dependent on the nutrients for its optimal functioning and gets affected adversely followed by nutritional deficits. Brain development depends upon availability of the nutrients and on the degree as well as nature of afferent stimulation. Proteins, Iron, Zinc, Selenium, Iodine, folate, vitamin A, Chlorine, PUFA appear to have greater effects on neural growth and development during foetal and neonatal phase of life (WHO-1999; Mendez et al.,1999;De onis,2001). Both macro- and micronutrients deficiencies have insidious effects on neurological development. Iodine deficiency adversely affects development of the central nervous system leading to loss of IQ and mental retardation. Iron is needed to make brain chemicals (neurotransmitters) that aid in concentration; iron deficiency constrains cognitive development in children. Chronic undernutrition has neurological consequences that lead to cognitive impairments. The prefrontal cortex is especially vulnerable to undernutrition with the result that undernourished children can suffer from attention deficits and reduced working memory. Other neurological insults resulting from chronic undernutrition include damage to the parts of the brain responsible for spatial navigation and motor skills, The parts of the brain (axons) responsible for transmitting signals from one neuron (brain cell) to another are damaged by chronic undernutrition with the result that these signals are passed more slowly and inefficiently (Sushruta, Sushruta Samhita,2011).

Previously done research work reveals that poor nutrition during intrauterine and early years of life leads to profound and varied effects and may affect negatively leading to delayed motor development, general effects on cognitive development resulting in lower IQ, decreased attention, lower educational achievement and behavioural problems with minimum social skills at school age (Charak Samhita,1998). A number of studies have demonstrated the association of impaired growth with delayed mental development, poor school performance, and reduced intellectual capacity (V., A. H,1194;13A, C. S.,1998-8/96,8/97). Many studies have demonstrated that inadequate nutrition during early life leads to permanent effect on brain size thus affecting the attention span, perceptual abilities, activity level, orienting responses, learning speed and language skill are deficient in malnourished children.

The field of Ayurveda that deals with physical and mental strength depends upon the type of Prakrit (psychosomatic constitution) of the individual which is genetically determined. The term 'Prakrit' refers to physical (deha) and mental (manas) constitution that determines biological variations, response to stimuli, drugs and susceptibility towards diseases. It is a genetic-epigenetic conceptualization of Ayurveda that personifies three major body types- Vataj, Pittaj and Kaphaj which are consider as the metabolic variants signifying different manifestations at anatomical, physiological and psychological dimensions. The unique concept of Prakrit helps in understanding the individual variations, special abilities and idiosyncrasies. According to Ayurveda, prakriti of an individual is determined at the time of conception and remains unaltered throughout lifetime which can be understood in terms of virtue with respect to the expression of certain genes associated with specific metabolic functions.

The Prakrit analysis reinforces the concept of preventive and personalised medicine. Deha Prakrit is the term used to denote the psychophysiological typology based on the principle of Tridosa, the backbone of Ayurveda. The tridoshas represent biological process that takes place inside the body. The Vata, Pitta and Kapha are the essential factors of human organisms (S.S.Su 21/23). Based on tridosha, Ayurvadic scholars like Caraka Susruta and

others have divided Prakrit on seven types in accordance the relative preponderance of three basic humours viz. prakriti Vataj, Pittaj, Kaphaj, Vata- Pittaj, Pitta- Kaphaj, Vataj- Kaphaj and sama-dosika (15). In classics the characteristics of different types of Prakrit have been mentioned(16-18) .

(C.S.Vi 8/94). Vata Prakrit (constitution) includes Akasha and Vāyu are the Heena (inferior) Panchbhautic structure of Vata. Its function is rajasika which is concerned with the production of those somatic and psychic phenomenons that are predominantly dynamic in nature. Hence, the presence of vata is to be inferred in such mental phenomena as the exhibition of enthusiasm, concentration etc. During conception, the aggravated vata dosha leads to the development of foetus of Vata Prakrit which marks depleted physical and psychological qualities principally due to apatarpana (emaciation regimen). This further leads to depletion in dhatu (basic tissues) as a consequence of various inferior qualities that are present in body and mind (19). Tejasa is the Madhyama (moderate) Panchabhautic structure of Pitta. It is attributed by mental phenomenon as intelligence and clear conception; and such physical phenomenon as digestion and heat-production, healthy appearance, courage etc. (20-21). Agni in the body is provided by Pitta (22-23) which is produced in the body by digestion and metabolism. In the process of digestion of food, complex substances are broken down to simpler one and later produced on excretory parts thus executing the process of catabolism. In balanced state Pitta dosha, the catabolic process remains in equilibrium state and if Pitta increases, then the catabolism of dhatu is more than their formation. Its presence is to be inferred in such mental phenomena as the production of courage, knowledge, understanding vitality etc and the physical phenomenon as the production of bodily strength, build integrates of structural elements of the body etc (24-26) .

. In individuals with kappa predominance (anabolic function) are firm, compact, plump, muscles and well-developed joints . When the Kaphaj is increased, the people become more resistant and not get easily affected by apatarpana vitiating vata dosha. Kaphaja purusha has increased tamasa and satva guna. Tamas guna produces low grade qualities e.g. excessive sleep and satva guna which produces many sattvika qualities e.g. calm and cool behaviour, excellent memory, dignitu etc. Hence, Kapha prakriti is considered best (uttam) among doshaja prakriti.

Materials and method

A cross-sectional design was used for carrying out a survey to explore protein energy malnutrition related learning disabilities in school going children in relation to the Prakrit. Total of 489 subjects were screened and 240 subjects were identified and their Prakrit were determined. Subsequently, from these 167 subjects, a total of 122 unrelated ethnically matched malnourished subjects of both sexes (58 males and 66 females) with predominance of V , P and K were recruited for the study from various schools of Varanasi city and nearby. The study protocol was approved by the ethics committee of Institute of Medical Sciences, Banaras Hindu University India (ref No.) and written informed consent was obtained from all subjects.

Subjects: The data according to different variables available on 122 school children (5-12 year of age) from a total of 1520 individuals of different ages of both the sexes from 3 districts of Uttar Pradesh for analysis from .. to.

Variables : The trial screened all the children for degree of malnourishment, type of constitution and its effect on cognitive deficits particularly learning abilities. Data were gathered by a combination of a structured questionnaire and the collection of anthropometric data through measurements of height and weight was measured. A well-structured questionnaire was used to assess the type of Prakrit (psychosomatic constitution) on the basis of characteristics mentioned in Ayurvedic classics. Height was measured using portable stadiometer(Harpenden) and weight by electronic scale (model no.) skinfold thickness was assessed using Harpenden and skinfold calliper. Psychomotor performance was determined in terms of Auditory and visual reaction time using reaction time apparatus. Memory span of the children long term memory using Dr. O.P. Chaudhury 1978 and short term memory using Peterson LKS et.al 1969. Leraning abilities based on trial and error methods by Human Maze learning postulated by Theruak. EEG, Muscle action potential, galvanic skin resistance and attention span were applied among all selected children for electrophysiological assessment. Brain activity by EEG analyser. Occipitofrontal muscle action potential with EMG biofeed back apparatus MBF- 4000 Mediciad system.

Prakriti assessment

Prakriti was assessed using a multiple-choice questionnaire (Additional file 1: TNMC Prakrit 2004) which was designed in the basis of literature in Ayurvedic texts comprising 37 objective questions related to the person's physical characteristics, psychological make-up and physiological habits (Table 1). Each of the questions had three options to choose from referring to a property attributed to Vata (V), Pitta (P) or Kapha(K). The score obtained by a person for answers in the V, P and K domain were summed up and the person was identified as having a specific Prakrit depending on the scores obtained.

Statistical analysis

The subjects screened for malnutrition were categorized in three different constitutions on the basis of pre-formed perform. The anthropometric observations, brain function assessment, psychomotor performance and electrophysiological assessment with EEG, EMG, GSR are presented as mean±SD and as percentage (%). Both

bivariate and multivariate analyses are employed to identify the relation of malnourment woth Prakrit of undernourished school children. In the bivariate analysis, the Chi-square test was employed to see the association between each of the independent variables under study and the nutritional status of school children as measured by underweight, p-values less than 0.05 are considered as significant.

Result

In the present epidemiological study the children population under consideration shown a varying degree of PEM. BMI has been considered as an index for malnutrition 124 children whose BMI corresponding to mid-degree of malnutrition were selected and their deha prakriti was appraised. The lowest BMI valve 13.2 and 11.6 in females was observed in vatic group whereas, in male and 12.25 in female in kaphaj group which is statistically significant.

Tables

Table 1: Pattern of Body Mass Index determined among mild degree of PEM children in relation to three distinct prakriti groups.

Type of prakriti	Sex	No. of Cases	BMI	Height(cm)	Weight
Vattic	Male	23	13.20	P>0.05	P>0.05
	Female	26	11.60	P>0.05	P>0.05
Paittic	Male	19	13.80	P<0.05	P>0.05
	Female	22	12.60	P<0.001	P>0.05
Kaphaj	Male	16	14.02	P>0.05	P>0.05
	Female	18	12.25	P>0.05	P>0.05

Table 2: Auditory and visual reaction time measurement among mild degree of PEM children in relation to deha-prakriti.

Type of prakriti	Sex	No. of Cases	Reaction time(in minutes)			
			Auditory	95% confidence interval of the limit of the mean	Visual	95% confidence interval of the limit of the mean
Vattic	Male	23	0.42 ±0.48	0.21-0.62	0.30 ±0.11	0.25-0.34
	Female	26	0.35 ±0.25	0.25-0.44	0.32 ±0.14	0.26-0.37
Paittic	Male	19	0.34 ±0.28	0.21-0.46	0.25 ±0.15	0.18-0.31
	Female	22	0.37 ±0.30	0.24-0.49	0.26 ±0.28	0.14-0.38
Kaphaj	Male	16	0.29 ±0.18	0.20-0.38	0.19 ±0.11	0.13-0.24
	Female	18	0.31 ±0.16	0.23-0.38	0.20 ±0.08	0.16-0.23

		Triceps	Subscapula r	Mid Upper arm	Head circumfrence
*Vs**	Male	P>0.05	P>0.05	P<0.05	P>0.05
	Female	P>0.05	P>0.05	P>0.05	P>0.05
*Vs***	Male	P>0.05	P>0.05	P>0.05	P>0.05

	Female	P<0.01	P<0.05	P>0.05	P>0.05
Vs*	Male	P>0.05	P<0.05	P<0.05	P>0.05
	Female	P>0.05	P>0.05	P>0.05	P>0.05

Table 3: Patterns of brain wave frequency, muscle action potential and in mild degree of PEM children in relation to deha-prakriti.

Type of prakriti	Sex	No. of Cases	Alpha frequency (Hz)	95% confidence interval of the limit of the mean	Beta frequency (Hz)	95% confidence interval of the limit of the mean	Muscle action potentials	95% confidence interval of the limit of the mean
Vattic	Male	23	8.23 ±2.05	6.78-9.67	31.59 ±4.25	28.58-34.59	32.24 ±6.25	27.82-36.65
	Female	26	8.89 ±2.84	6.57-11.20	29.28 ±5.82	24.52-34.03	31.35 ±5.75	26.65-36.04
Paittic	Male	19	10.96 ±2.44	9.55-12.36	26.32 ±3.70	24.18-28.45	29.94 ±4.48	27.25-32.53
	Female	22	9.86 ±2.06	8.48-11.23	27.84 ±4.15	25.07-30.60	27.40 ±4.85	24.16-30.63
Kaphaj	Male	16	10.72 ±3.22	8.44-12.99	25.34 ±2.08	23.86-26.81	22.86 ±4.05	19.99-25.72
	Female	18	10.55 ±2.80	8.43-12.66	24.38 ±3.15	21.99-26.76	23.96 ±3.63	21.21-26.70

		Alpha	Beta	Muscle aaction Potential
*Vs**	Male	P<0.001	P<0.001	P<0.05
	Female	P>0.05	P<0.001	P<0.05
*Vs***	Male	P<0.001	P<0.01	P<0.001
	Female	P<0.001	P<0.05	P<0.001
Vs*	Male	P<0.05	P>0.05	P<0.05
	Female	P>0.05	P>0.05	P<0.05

Table 4: Patterns of galvanic skin resistance and Attention span and in mild degree of PEM children in relation to deha-prakriti.

Type of prakriti	Sex		GSR (kohms)	95% confidence interval of the limit of the mean	Attention span	95% confidence interval of the limit of the mean
Vattic	Male	23	229.40 ±30.75	207.65-251.14	9.28 ±2.01	7.86-10.70
	Female	26	225.10 ±28.30	201.99-248.20	10.25 ±1.70	8.86-11.63
Paittic	Male	19	246.50 ±32.85	227.53-265.46	11.30 ±2.35	9.94-12.66
	Female	22	238.35 ±30.82	217.80-258.89	12.82 ±2.95	10.85-14.78
Kaphaj	Male	16	260.32 ±33.85	236.38-284.25	13.35 ±2.80	11.37-15.33
	Female	18	256.86 ±35.25	230.21-283.51	14.32 ±1.82	12.94-15.96

		GSR	Attension span
*Vs**	Male	P<0.001	P<0.05
	Female	P>0.001	P<0.05
*Vs***	Male	P>0.05	P<0.001
	Female	P>0.05	P<0.001
Vs*	Male	P<0.001	P<0.05
	Female	P<0.001	P<0.05
	Female	P>0.05	

Table 5: Learning abilities determined on human maze learning in mild degree of PEM children in relation to deha-prakriti

Type of prakriti	Sex	No. of Cases	Errors			Av.diff 1st trial vs 5th trial	Time taken (in minutes)			Av.diff 1st trial vs 5th trial
			1st trial	3rd trial	5th trial		1st trial	3rd trial	5th trial	
Vattic	Male	08	32.42 ±4.82	28.23 ±3.18	22.62 ±2.10	9.80	4.03 ±1.10	3.58 ±1.35	3.30 ±1.20	0.73
	Female	06	30.50 ±4.35	26.62 ±3.62	20.80 ±2.42	9.70	4.20 ±1.18	3.52 ±1.29	3.52 ±1.35	0.78
Paittic	Male	12	26.75 ±3.76	21.82 ±4.80	18.65 ±5.18	8.10	3.54 ±1.28	3.36 ±1.26	3.12 ±1.38	0.42
	Female	09	28.86 ±3.40	23.85 ±5.65	20.42 ±4.24	8.44	3.46 ±1.40	3.28 ±1.38	3.10 ±1.29	0.36
Kaphaj	Male	08	22.82 ±3.40	19.82 ±5.95	15.65 ±4.82	7.17	3.08 ±1.20	2.52 ±1.40	2.38 ±1.45	0.76
	Female	07	24.35 ±4.26	20.85 ±6.80	17.27 ±3.62	7.08	3.00 ±1.41	2.50 ±1.35	2.41 ±1.25	0.59

		Errors		Time taken	
*Vs**	Male	P<0.001	P<0.01	P>0.05	P>0.05
	Female	P<0.001	P<0.01	P>0.05	P>0.05
*Vs***	Male	P<0.001	P<0.001	P<0.05	P<0.05
	Female	P<0.001	P<0.001	P<0.05	P<0.05
Vs*	Male	P<0.05	P<0.05	P>0.05	P>0.05
	Female	P>0.05	P<0.05	P>0.05	P>0.05

Table 6: Patterns of short and long term memory span in mild degree of PEM children belonging to different prakriti groups

Type of prakriti	Sex	No. of Cases	Short term memory (Score)			Av.diff 3 sec vs 18 sec	long term memory (Score)		Av.diff
			After 3 sec	After 9 sec	After 18 sec		Repition of words 1 time	Repition of words 4 time	
Vattic	Male	08	4.28 ±1.52	4.10 ±1.02	3.12 ±0.75	1.16	1.01 ±0.45	1.54 ±0.92	0.53
	Female	06	4.10 ±1.35	4.98 ±0.82	3.05 ±0.62	1.05	1.13 ±0.52	1.60 ±0.86	0.47
Paittic	Male	12	4.92 ±1.32	3.85 ±1.25	3.80 ±0.85	1.12	1.20 ±0.82	1.45 ±1.20	0.25
	Female	09	4.10 ±1.85	3.62 ±1.32	2.88 ±0.96	1.02	1.28 ±0.96	2.21 ±1.35	0.93
Kaphaj	Male	08	5.40 ±0.52	4.20 ±1.75	3.10 ±1.25	2.30	1.68 ±1.20	2.68 ±1.82	1.00

	Female	07	5.30 ±0.49	4.25 ±1.80	2.98 ±1.30	2.32	1.70 ±1.15	2.50 ±1.92	0.80

		Short term memory		Long term memory	
*Vs**	Male	P>0.05	P>0.05	P>0.05	P>0.05
	Female	P>0.05	P>0.05	P>0.05	P>0.05
*Vs***	Male	P<0.05	P<0.05	P<0.05	P<0.05
	Female	P<0.05	P<0.05	P<0.05	P<0.05
Vs*	Male	P<0.05	P<0.05	P>0.05	P>0.05
	Female	P>0.05	P<0.05	P>0.05	P>0.05

Discussion

A poor cognitive function particularly memory and learning performance was found to be associated with mal-nourished children in relation to type of prakriti i.e. vatic, paitic and kaphaj. Kaphaj group of mal-nourished children showed comparatively better cognitive performance in comparison to vatic and paitic. In the present study it has been observed that PEM is one of the major causative factors for cognitive deficits particularly learning disabilities and poor attention among children. It is noticed that apart from genetic factor various socio-cultural and ecological settings are responsible for PEM. Inadequate dietary intake, anorexia, mal-absorption, micro-nutrient deficiency, early cessation of breast feeding, maternal illiteracy, maternal malnutrition, poverty etc. are responsible for mal-nutrition which is the leading cause of poor school performance of the children. Further, mal-nutrition is also responsible for the susceptibility towards a variety of physical and mental diseases including development of various infectious diseases among the children showing evidence of mal-nutrition. In the present series of investigation a group of children showing different degree of mal-nutrition showed cognitive deficits when studied in relation to their body type. It was noticed that vatic traits were more associated with learning disabilities than the paittic and kaphaj. A poor mental health status of such mal-nourished children recorded in terms of attention and memory span, poor learning abilities suggested that vatic children are susceptible to suffer more from protein energy mal-nutrition and they have significant mental deficiency due to deteriorated memory and learning abilities than the paittic and kaphaj.

As our focus in this study is to prevent the children from mal-nutrition living in different ecological conditions a specific dietary regimen was advised to those children considering their constitution (prakriti). A training session for children parents were performed to trained them for proper nutritional supplement as well as medical care. In the view of the above it is speculated that the school performance of such children can be improved. Further, the future consequences of malnutrition particularly poor learning, deficient psychomotor performance, development of various psychiatric disorders like abnormal adolescent behavior and attention deficit hyperactivity disorders etc. can be prevented to a great extent. The mal-nourished children can also be prevented from future development of various type of infectious diseases like tuberculosis, diarrhea, etc.

The seers of Indian system of medicine was the first who observed the role of constitutional factor in health and disease. Type of body is not only responsible for development of specific disease condition rather than the course, complications and ultimate prognosis of diseases also depend upon the type of body of a person. After comprehensive review of charak samhita it is evident that both mental and physical aspects of a person is involved with every disease condition in varying degree (Charak Samhita, Viman sthan, 6: 8).

The ayurvedic classification of human being into these distinct categories is vata, pitta and kapha and is valid as the human body is made up of structural, functional and behavioural dimensions of living organisms. Various genetic and environmental factors play a role in the determination of body type which includes both mental as well as physical dimensions of human personality. The cognitive development of a person is the part of mental phenomena (manasika dosha pg 93).

The Vat, Pitta and Kapha are the morbidic factors affecting function of the mind. The principles of genetic factor suggest that there is graded intermediate activities in relation to the population, It is pointed out that gene limits the boundary of normalcy which is always arbitrary in nature. Similarly, the neuro-endocrine axis which controls the normal homeostatic mechanism is also under control of genetic factor, In the present study, a wide variation in the development of malnutrition as well as status of cognitive performance is observed in three prakriti groups viz, vata, pitta and kapha. Vatic group of malnourished children have shown comperatively poor cognitive performance in

comparison to pattic and kaphaj. As type of prakriti has genetic predisposition it influences the physical as well as mental performance.

Further, there is relationship between type of body, cognitive function including behavioural variations

References.

- Agnivesha, Charak Samhita, Vidyotini Hindi Commentary by Pt. Kashinath Shastri and Dr. Gorakhanath Chaturvedi. Vimansthan, 8/97. Varanasi Chaukhamba Bharti Academy; 1998.
- Agnivesha, Charak Samhita, Vidyotini Hindi Commentry by Pt. Kashinath Shastri and Dr.Gorakhanath Chaturvedi. Vimansthan, 8/96-100.Chaukhamba Bharti Academy; 1998.
- Astang Sangraha, commented by Arunadutta, Chaukhambha Sanskrit Series, Varanasi, Sutra Sthana Chapter 20.
- Agnivesha, Charak Samhita, Vidyotini Hindi Commentary by Pt. Kashinath Shastri and Dr.Gorakhanath Chaturvedi. Vimansthan, 8/95.Chaukhamba Bharti Academy; 1998.
- Charaka(700 BC) Charaka Samhita(text with English Dipika). Edited by Sharma RK, Bhagwan Dash. Chaukhambha Sanskrit Series Office. Vol II Vimana Sthana 8/96 p 263. Varanasi: Reprint 2009.
- Charaka(700 BC) Charaka Samhita(text with English Dipika). Edited by Sharma RK, Bhagwan Dash. Chaukhambha Sanskrit Series Office. Vol II Vimana Sthana 8/96 p 263. Varanasi: Reprint 2009
- Charaka(700 BC) Charaka Samhita(text with English Dipika). Edited by Sharma RK, Bhagwan Dash. Chaukhambha Sanskrit Series Office. Vol I Sutra Sthana 12/11 p 240, 18/50 p 346. Varanasi:Reprint 2009.
- De Onis M, Bloessner M: The World Health Organization Global Database on Child Growth and Malnutrition: methodology and applications. Int J Epidemiol 2003, 32:518-26
- Dobbing J. Vulnerable periods in the developing brain. In: Dobbing J, ed. Brain, behavior and iron in the infant diet. London, United Kingdom: Springer, 1990:1–25.
- De Onis M. Child growth and development. In: Semba RD, Bloem MW (eds). Nutrition and Health in Developing Countries. Totowa, NJ: Humana Press, 2001, pp. 71–91.
- GeorgieffMK,Rao R. The role of nutrition in cognitive development. In: Nelson CA, Luciana M, eds. Handbook in developmental cognitive neuroscience. Cambridge, MA: MIT Press, 2001:491–504.
- Mendez MA, Adair LS. Severity and timing of stunting in the first two years of life affect performance on cognitive tests in late childhood. J Nutr 1999;129:1555–62.
- Rao R, GeorgieffMK.Early nutrition and brain development. In: Nelson CA, ed. The effects of early adversity on neurobehavioral development. Minnesota Symposium on Child Psychology. Vol 31. Hillsdale, NJ: Erlbaum Associates, 2000:1–30.
- The Economic Cost of Malnutrition - Vitamins in motion www.vitaminsinmotion.com/fileadmin/data/pdf/.../RTGN_chapter_05.
- Sharangdhara Samhita Commented by Damodaracharya, 4th edition 2000, Pu. Kha.5/29,33.
- Sushruta, Sushruta Samhita, Ayurvedatatvasandipika Hindi Commentary by Kaviraj Dr. Ambikadutt Shastri. Sharirsthana, 4/62. Varanasi: Chaukhamba Sanskrit Samsthana; 2001
- Sushruta, Sushruta Samhita, Ayurvedatatvasandipika Hindi Commentary by Kaviraj Dr. Ambikadutt Shastri. Sharirsthana, 4/64-75. VaranasiChaukhamba Sanskrit Samsthana; 2001.

- Vagbhatta(300 AD), Ashtang Hridaya with commentaries Sarvangasundari of Arunadutta. Vagbatt, Ashtang Hridya, Vidvanamanoranjini Hindi Commentary by Pt. Kashinath Shastri, edited by Dr. Indradev Tripathi and Dr. SrikantTripathi. Sharirsthan, 3/84-103. Varanasi: Krishnadas Academy; 1994.
- World Health Organization. A Critical Link. Interventions for Physical Growth and psychological development. a review. Doc WHO/CHS/CAH/ 99.3. Geneva: WHO, 1999.