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AMELIORATION OF *KARSHYA* (PROTEIN ENERGY MALNUTRITION) IN PRESCHOOL CHILDREN BY ADJUVANT THERAPY OF *KRISHNADI GRANULES* WITH SUPPLEMENTARY NUTRITION UNDER INTEGRATED CHILD DEVELOPMENT SERVICES (ICDS) SCHEME- A RANDOMIZED CONTROLLED CLINICAL STUDY

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Abstract

Background- Protein Energy Malnutrition (PEM) in children is great concern in India and worldwide. India combats this grappling issue through holistic and ambitious Integrated Child Development Services (ICDS). Ayurveda is successfully utilized to manage *Karshya* and PEM. Thus, a novel study was designed to integrate supplementary nutrition of ICDS with Ayurvedic formulation, *Krishnadi* Granules (*Piper longum*, *Withania somnifera*, jaggery and cow ghee). Its adjuvant efficacy was studied in malnourished preschool children compared with only supplementary nutrition.

Methods- 34 children (3-6 years age) with classical signs of *Karshya* and uncomplicated PEM (MAM and uncomplicated SAM) were randomized in 1:1 in study group and control groups. In this 90-days study, children were assessed fortnightly for changes in cardinal features of *Karshya*, anthropometric parameters and PEM gradation and laboratory parameters.

Results- The children from both groups exhibited significant improvement in *Karshya,* with superior effect size in study group. Appetite improved in study group children with 46.7 % superiority. Also, everyone upgraded to appearance grades 0 and 1. Significant improvement in anthropometric parameters (weight, height, and Mid Arm Circumference), was observed with superiority in study group. There was 3x improvement in weight for age and 2x improvement in Body Mass Index (BMI) and weight for height scores. Significant improvement in laboratory parameters, except random blood sugar and serum transferrin in both groups was observed.
Conclusion- The adjuvant treatment of *Krishnadi* Granules with supplementary nutrition improved *Karshya* and PEM grades with superior effect size. Such integration can be useful in towards mitigating PEM issue with expedite.
Study Registration-CTRI/2021/01/030309
Keywords- MAM, Uncomplicated SAM, Child growth, Nutrition disorder, Emaciation, Weight-for-height Z-score

1. Introduction

Health is a multi-aspect state with major focus on physical and psychological domains. It is also understood that, the former influences the latter to a great extent. Adequate nutrition is a major requisite for maintenance of health. Nutritional insufficiencies in children, such as Protein Energy Malnutrition (PEM), give rise to several health issues leading to morbidity, growth impairment and even mortality.[1] As the name suggests, PEM represents an imbalance between a child's requirements and supply of protein and energy, resulting in their suboptimal growth and function. A study of global prevalence of PEM shows that, despite advancements in healthcare and nutrition, it remains a serious burden.[2]

PEM basically results from primary nutritional deficiencies. It can also manifest secondary to certain diseases causing decreased absorption and excessive loss of nutrients from gut.[3] It typically features suboptimal weight, growth stunting and excessive wasting in children.[4] According to Global Nutrition Report-2022 released by WHO,[5] 17.3% of Indian children under five years of age were affected with wasting. Dreadfully, this statistic is one of the highest in the world. Moreover, the report stated that, 34.7 % Indian children were stunted, which is higher than the average of other Asian countries. In pursuance of this prevailing issue, the government of India had adopted a holistic multicentric program, viz., Integrated Child Development Services (ICDS) scheme. Since its inception in 1975, dedicated efforts are being taken to improve nutritional status of young children (< 6 years age) and also pregnant and lactating women. Although multidisciplinary in nature, the major thrust of ICDS is on supplementary nutrition of these beneficiaries.[6] Despite of such mammoth efforts, the status of childhood malnutrition in India still holds on to a worrisome extent.[7] Thus, to further these objectives, the government of India launched '*Poshan Abhiyan'* program in 2018. The newly launched '*Poshan* 2.0' initiative has even designed to include the traditional wellness science, Ayurveda to supplement the nutrition and combat malnutrition along with ICDS guidelines.[8]

Emaciation of body and related maladies are described in Ayurveda as the disease, '*Karshya.'* There is a close resemblance of characteristics of '*Karshya'* with the aforementioned PEM features. For instance, Dalhana, the commentator of Ayurveda classic- Sushruta Samhita equates *Karshya* to muscular wasting (*Mamsa Kshaya*).[9] This can be further corelated with increased muscle catabolism in PEM, resulting in wasting. The Charak Samhita has even included its morbid form (*Ati Karshya*) among eight despicable personae (*Ashta Nindita*), representing serious metabolism issues.[10] Similarly, various deleterious metabolic changes occur as the PEM condition progresses.[11]

The etiopathogenesis of *Karshya* involves vitiation of *Vata Dosha* along with impairment of digestion (*Agni Dushti*). As a result, there is wasting and improper formation of body elements (*Dhatu*). Thus, its

management is focused on not just supplementing nutrition for building body elements, but also fixing the digestive mechanism to facilitate its absorption.

Considering this etiopathogenesis and current need, we planned a clinical study to assess efficacy of an Ayurveda formulation as adjuvant with supplementary nutrition from ICDS guidelines, among preschool children suffering from *Karshya* and characterized with moderate acute malnutrition (MAM) and uncomplicated severe acute malnutrition (SAM).[12] An herbal formulation was selected from *Chakradatta*, a classical Ayurveda text. The original dosage form was basically a linctus (*Leha*) containing powders of *Krishna* (*Piper longum*) and *Ashwagandha* (*Withania somnifera*) mixed with cow ghee and honey.[13] This formulation was selected on basis of nourishing (*Brimhana*), digestion stimulating (*Agnidipana*) as well as body channel cleansing (*Srotoshodhana*) properties of ingredients. However, to enhance the palatability, acceptance, and ease of usage, it was modified and converted it to a granular form. The ingredients of this modified dosage form, *Krishnadi* granules (KG) were powders of *Krishna* (*Piper longum*) and *Ashwagandha* (*Withania somnifera*), jaggery and cow ghee.

Our main aim was to assess efficacy of adjuvant treatment of KG with supplementary nutrition (ICDS guidelines) to improve the condition of preschool children suffering with malnutrition. For this, various subjective and objective parameters denoting recuperation from *Karshya* and PEM were selected. We measured the efficacy on basis of clinical improvement in cardinal features, anthropometric measurements as well as key laboratory investigations. This was a pioneer effort to integrate fundamentals of Ayurveda and childhood nutrition to design a novel approach, with focus on provision as well as absorption of essential nutrition to tackle the condition.

2. Materials and Methods

2.1 Study Design

The present study was an open-labelled, randomized (1:1 allocation ratio), parallel, comparative, active-controlled clinical study conducted in Wardha district, Maharashtra, India.

2.2 Study setting

The study was conducted among children from VCDC (Village Child Development Centers), and Anganwadi Centers (AWCs), enrolled under ICDS scheme for supplementary nutrition in rural areas of Wardha district in Maharashtra state, India. This region is reported to have a high burden of childhood malnutrition.[14] The protocol of this study is published previously.[15] In this open-labelled study of two months duration, participants were randomized into study arm and control arm. The outcome assessment was done at baseline and at fifteen days interval, i.e., day 15, day 30, day 45 and day 60. After one month of completion of study duration, (i.e., day 90) follow-up for long term effects was taken. (CONSORT flow diagram- Annexure 1)

2.3 Ethical Considerations and Registration Details

Approval of institutional ethics committee was obtained. (MGACGRC/IEC/2020/14) The study was then registered in Clinical Trial Registry-India (CTRI) (CTRI/2021/01/030309; registered on-07/01/2021). Assent of all study participants and consent of their parent/ guardian were obtained before performing any study related procedure. No funding was received for this study. The findings of study were reported according to CONSORT statement guidelines. (Annexure-1)

2.4 Selection of study participants

Preschool children between three to six years age and presenting with classical signs of *Karshya* (emaciated buttocks, abdomen, and neck) and uncomplicated PEM according to Indian Academy of Pediatrics (IAP) classification (Gradation 1 to 3- midarm circumference below 13.5cm to 11.5 cm),[16] were screened irrespective of their sex and socio-economic status. Children with MAM and uncomplicated SAM as per

WHO standards (Weight for height Z score ≥ −2 SD to −3 SD and 70-79 % of the expected weight),[17] were considered eligible for enrolment. Children suffering with major infections (tuberculosis, HIV), systemic disorders, anaemia (Hb < 8 gm%), hyperthyroidism, malabsorption syndromes such as irritable bowel syndrome, metabolic disorders, gastrointestinal tract disorders, and congenital heart disease were excluded. Also, low birth weight, and prematurely delivered children were not considered. Non-assenting children and those with non-consenting parent/guardians were also excluded from the study.

2.5 Intervention details

The sixty-four children enrolled in the study were randomized to either study group (Group K) or control group (Group C). Both groups received supplementary nutrition according to ICDS guidelines. The details of supplementary nutrition are provided in Annexure-2. Children in group K additionally received study drug, i.e., *Krishnadi granules* with a cup of milk every day, before breakfast and before evening snacks, for 2 months duration. The dose fixation for KG was done according to Young's rule.[18] Before commencing with intervention, all children were given Tab. Albendazole (400 mg single dose) for deworming.

The SOPs for preparation of study drug, KG were formed on basis of previous work, [19] and discussion with experts. Course powders of *Krishna* (*Piper longum*) and *Ashwagandha* (*Withania somnifera*) were soaked overnight in eight parts of water. A decoction of this mixture was prepared by reducing it to $1/4^{th}$ by heating on mild heat. Jaggery (2.5 parts) was added in filtrate. It was again heated on mild fire till a syrup with more than two thread consistency was attained. Lastly, cow ghee was added to it and heating was stopped. This dense mass was dried in a hot air oven at 60^0 C for four hours. The dried mixture was sieved in multi mill in sieve no. 2 to obtain granules. The analysis of KG was carried out in in-house quality control laboratory of the institute. The microbial limit tests were done to ensure absence of microbial contamination. (Annexure 3). The granules packed and sealed in labelled containers were dispensed to Group K participants. The administration procedure was explained to parents/guardians.

2.6 Outcome assessment

2.6.1 Primary outcome with assessment method-

a) Cardinal features of *Karshya*- Subjective assessment with grading and scoring as per predefined proforma was carried out. Under this, features such as debility (*Daurbalya*), appetite (*Agni*) and emaciation (*Deha Kshaya*) were assessed before and after the treatment, according to a pre-designed proforma. (Annexure 4)

2.6.2 Secondary outcome variables and their assessment methods-

a) Anthropometric Parameters and PEM gradation-

Parameters viz., Weight for age, Height for age, Mid-arm Circumference (MAC), Body Mass Index (BMI) Z score, and Weight for height, were assessed before treatment, at every follow-up visit and after treatment. The weight in Kg was measured with calibrated electronic weighing scale with usual clothes and without footwear. The height was measured with a wall-mounted stature meter with the child's head, shoulders, buttocks, and heel touching the wall. The BMI and weight for height ratio were calculated from these measurements. The MAC was measured at mid-upper arm level by Shakir's tape method.[20] According to these parameters, the children were classified into PEM grades 0, I, II and III as per IAP classification of malnutrition. The change in the grades was also observed at the end of study.

b) Laboratory Investigations-

Investigations viz., complete blood count (CBC), Random blood sugar (RBS), Total cholesterol, C-reactive protein (CRP), Serum protein, and Serum transferrin were carried out before and after treatment for all

children in both groups. Estimation of serum pre-albumin (Transthyretin) was also done in 10% children selected by random sampling method, before and after treatment.

2.7 Sample size determination

The sample size was estimated using the following formula-
n = 2 (Za + Z1–β)2 σ2, where
Zα= 1.64 (α= Type I error at 5 %)
Zβ= 0.84 (β= Type II error at 20 %)
δ= Clinically relevant difference at 30 % superiority control (HPF -Home Prepared food) group improvement in PEM (recovery)[21] = 48 %
Experimental improvement in PEM (recovery) = 78 % (Expected)

N= (1.64+ 1.28) ^2 *((0.48) (1 -0.48) + 0.78 (1- 0.78))/ (0.30) ^2 = 29
Required sample size = 29 per group
However, by considering 10% dropout rate and availability of patients from Anganwadi; for better accuracy and higher validity of the study, sample size of 32 participants per arm was finalized.

2.8 Details of randomization

Simple randomization was done through computer-generated list of random allocation numbers to avoid bias in the study. According to this list, the investigators allocated children to study group or control group in 1:1 allocation ratio. Due to nature of the study, it was an open-labelled design.

2.9 Statistical methods

The data obtained from subjective parameters was presented as frequencies. It was analysed by Wilcoxon signed rank test and Wilcoxon rank sum test. Categorical data was analysed using chi-square test. The data for objective parameters was presented as mean ± standard deviation and analysed by paired t-test & unpaired t-test. IBM SPSS Statistics for Windows, (Version 26.0. Armonk, NY: IBM Corp) was used for statistical data analysis. The level of significance was considered at $p< 0.05$

3. Results

3.1 Baseline Data

3.1.1 Demographic data

Total 64 eligible children were recruited in the study and equally randomized in study group and control group. Four participants (2 from each group), dropped out of the study due to personal reasons. Thus, 30 participants in each group (n=60) completed the study. Of them, maximum (64.34 %) belonged to age group of 4.5-5 years. The male: female ratio was almost 1:1 in both groups. Parents of maximum children (Group C- 53.33% and Group K- 70%) were illiterate and belonged to lower economic status. Majority (93.33 %) were residing in rural area. Majority of children (n=32) had *Vata-Kapha Prakriti*. Mixed diet was consumed by majority Group C- 56.67 % and Group B 66.67 %) of children.

3.1.2 Birth and infancy details

The birth weight of more than half the children was between 2-2.5 kg. However, majority of them were born at completion of full term. In both groups, weaning started at one month age and breast feeding was completely stopped at 1-2 months age, for majority of children. Almost all the children reported of recurrent upper respiratory tract infections. However, their immunization was complete according to schedule.

3.1.3 Ayurveda physiological parameter details

All the children reported signs of weak digestion (*Mandagni*) and majority of them had low physical endurance (*Bala*) (n=58). Also, majority (n=40) of them were having tendency to pass hard stools (*Baddha Mala*). However, sleep pattern was normal in most of these children.

3.2 Effect on Primary outcome parameters

The children from both groups exhibited significant improvement in gradations of subjective parameters of

Karshya, viz., *Daurbalya*, *Agni* and *Deha Kshaya*. The decrease in *Daurbalya* was more pronounced in Group K with 53.30% more children with grade 0, at end of study duration. Similarly, improvement in status of *Agni* was better in children from Group K, with 46.70 % superiority. Also, children from Group K exhibited a substantial improvement in most important feature, i.e., *Deha Kshaya*. At the end of study duration, all children from this group exhibited good improvement in their body appearance by upgrading to grades 0 and 1. The percentage of frequencies of these parameters with gradations and their statistical analysis is presented in table 1.

Table No. 1 – Pre and post treatment effect in subjective parameters of *Karshya*

Grade	**Pre-Treatment Frequency (%)**			**Post-Treatment Frequency (%)**			**Superiority (%)**
	Group C	**Group K**	**Total**	**Group C**	**Group K**	**Total**	
Daurbalya							
0	0	0	0	0	53.30	26.70	53.30%
1	0	0	0	23.30	36.70	30	
2	0	0	0	23.30	36.70	30	
3	43.30	36.70	40	23.30	0	11.70	
Chi Sq = 0.278 P-value =0.598				Chi Sq 32.784 P-value <0.01			
Agni							
0	0	0	0	0	46.70	23.30	46.70
1	0	0	0	6.70	40	23.30	
2	56.70	63.30	60	63.30	13.30	38.30	
3	43.30	36.70	40	30	0	15	
Chi Sq = 0.278 P-value =0.598				Chi Sq = 39.925 P-value <0.01			
Deha Kshaya							
0	0	0	0	0	33.30	16.70	33.30
1	0	0	0	20	63.30	41.70	
2	60	60	60	50	3.30	26.70	
3	40	40	40	30	0	15	
Chi Sq = 0.278 P-value =0.598				Chi Sq = 30.010 P-value <0.01			

3.3 Effect on secondary outcome parameters

3.3.1 Effect on anthropometric parameters and PEM gradation

Children from both the groups exhibited significant improvement in anthropometric parameters related to weight, height, and MAC. However, the improvement in Group K was much superior when both groups were compared. Improvement in weight for age in this group was three times superior, while improvement in BMI as well as weight for height score was twice superior than the control group. The statistical analysis of effect on anthropometric parameters is presented in table 2.

Table No. 2 – Pre and post treatment effect on anthropometric parameters

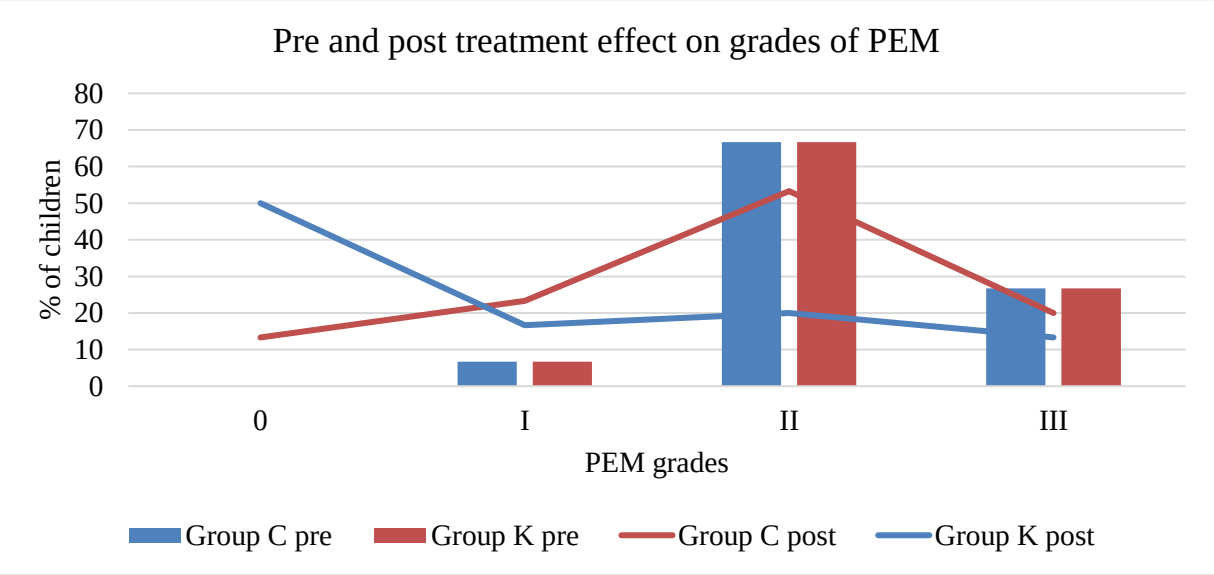
Parameter	**Group**	**Visit**	**Mean± SD**	**p value**	**% Improvement**	**% Superiority**	**Effect Size**
Weight for Age (Z Score)	Group C	Pre-Treatment	12.450 ± 1.194	<0.01	6.425	304.427	0.634
		Post-	13.250				

		Treatment	± 1.330				
	Group K	Pre-Treatment	12.070± 1.733	<0.01	25.987		1.723
		Post-Treatment	15.207± 1.909				
Height For Age (Z Score)	Group C	Pre-Treatment	97.833± 4.927	<0.01	2.265	57.5658761	0.456
		Post-Treatment	100.05± 4.792				
	Group K	Pre-Treatment	95.796± 6.532	<0.01	3.57		0.606
		Post-Treatment	99.216± 4.755				
Mid Upper Arm Circumference (Z Score)	Group C	Pre-Treatment	11.540± 0.431	<0.01	5.632	72.829	1.929
		Post-Treatment	12.190± 0.242				
	Group K	Pre-Treatment	11.436± 0.41	<0.01	9.734		3.241
		Post-Treatment	12.550± 0.276				
BMI (Z Score)	Group C	Pre-Treatment	12.560± 0.562	<0.01	7.072	121.178	1.632
		Post-Treatment	13.448± 0.526				
	Group K	Pre-Treatment	12.636± 0.569	<0.01	15.642		3.551
		Post-Treatment	14.613± 0.544				
Weight for Height (Z Score)	Group C	Pre-Treatment	12.056± 1.259	<0.01	7.83	116.991	0.748
		Post-Treatment	13± 1.265				
	Group K	Pre-Treatment	11.83± 1.625	<0.01	16.99		1.153
		Post-Treatment	13.84± 1.86				

There was significant improvement in PEM grades in children from both groups. However, this improvement was superior in children from group K.

The effect of treatment on PEM grades is presented in figure 1.

Figure 1- Pre and post treatment effect on grades of PEM



3.3.2 Effect on laboratory investigations

In children of group C, decrease in levels of all laboratory parameters was observed, except increase in CRP levels, at completion of study duration. This effect was statistically significant except for RBS and Sr. Transferrin. However, in Group K children, there was significant improvement in every parameter, with increasing levels except decrease in CRP. The table 3 presents a statistical analysis of this effect pre- and post-treatment.

Table 3- Pre and post treatment effect on laboratory parameters

Group	**Laboratory Parameter**	**Paired Differences Mean**	**SD**	**t -test**	**P value**	**Effect size**
Group C	RBC (mill/cu.mm)	-0.227	0.241	-5.160	<0.01	-0.942
	HB (gm/dL)	-0.340	0.297	-6.278	<0.01	-1.146
	WBC (cells/cu.mm)	-247.667	482.019	-2.814	0.009	-0.514
	Platelets (1000/ µl)	-19.667	27.447	-3.925	<0.01	-0.717
	CRP (mg/L)	0.280	0.542	2.831	0.008	0.517
	RBS (mg/dL)	-1.433	2.956	-2.656	0.013	-0.485
	Total Cholesterol (mg/dL)	-7.967	11.494	-3.796	0.001	-0.693
	Serum Protein (g/dL)	-0.240	0.203	-6.484	0.000	-1.184
	Transferrin (mg/dL)	-8.800	18.567	-2.596	0.015	-0.474
Group K	RBC (mill/cu.mm)	0.327	0.363	4.931	<0.01	0.900
	HB (gm/dL)	0.597	0.488	6.582	<0.01	1.222
	WBC (cells/cu.mm)	62.667	880.971	0.390	<0.01	0.071

	Platelets (1000/ µl)	19.367	24.877	4.264	<0.01	0.778
	CRP (mg/L)	-0.826	0.604	-7.492	<0.01	-1.368
	RBS (mg/dL)	7.067	6.617	5.849	<0.01	1.068
	Total Cholesterol (mg/dL)	15.133	14.822	5.592	<0.01	1.021
	Serum Protein (g/dL)	0.634	0.361	9.619	<0.01	1.756
	Transferrin (mg/dL)	28.467	14.785	10.546	<0.01	1.925

Estimation of Pre-albumin levels in 10% sample size (n=3 from each group) showed a slight increase in these levels in Group K, whereas they remained unchanged in Group C children. No significance was drawn due to very small sample size.

Overall efficacy of subjective and objective parameters, it was observed that children in group K, receiving adjuvant treatment of KG along with supplementary nutrition presented a better outcome than those in group C, receiving only supplementary nutrition according to ICDS guidelines. Also, no adverse events were reported.

4. Discussion

The adjuvant treatment of KG with supplementary nutrition exhibited better outcome on basis of various subjective parameters of *Karshya* as well as objective parameters of PEM. This integration of Ayurveda with childhood nutrition proved to be advantageous and thus, noteworthy.

India is tackling the issue of childhood malnutrition with great efforts. No stones are being left unturned to achieve the target of 'health for all.' However, it is still far from sight. Ayurveda, the indigenous medical science, has been proven effective in preventive as well as curative health. Many researchers have also worked on utilizing Ayurveda formulation in management of PEM in this regard. A systematic review and meta-analysis of 27 such randomized controlled studies with data of 6,442 children was carried out by Khedekar *et al*. [22] This review documented efficacy of various Ayurveda interventions in successful management of PEM (grade I and II). However, it was noted that none of these studies utilized integrative approach in their design. Our study was a unique effort in initiating such integrative consideration.

Ayurveda considers diet and nutrition as means to secure sustenance of health and life.[23] Ayurveda also emphasizes that digestive capacity (*Agni*) as the final regulator of ideal diet proportions (*Ahara Matra*), irrespective of the actual requirements.[24] The etiopathogenesis of *Karshya* in Ayurveda stresses upon malfunctioning of *Agni* as well as formation of undigested toxins (*Ama*). Thus, along with metabolism enhancers (*Deepana*), there is requirement of digestion of these toxins (*Ama Pachana*). Subsequently, nourishment promoters (*Brimhana*) come in picture. Thus, it would be inappropriate to provide nutritious diet to a malnourished child without ensuring properness of digestive status.

The study drug, *Krishnadi Granules* is a modified dosage form designed to suite preferences of pediatric population and ensure easy administration. The major herbs in this formulation are *Krishna (Piper longum)* and *Ashwagandha (Withania somnifera*), supplemented by jaggery and cow ghee. *Ashwagandha* is a well-known herb with '*Brimhana'* property. It has been successfully used to increase muscle mass and physical endurance.[25] Moreover, by improving cell-mediated immunity, it strengthens host defense mechanism and in turn prevents opportunistic infections. [26] It was also most common ingredient across various formulations according to the before-mentioned systematic review by Khedekar *et al*. [22] Jaggery, a natural sweetener, is a rich source of minerals, antioxidants, vitamins, and proteins. Addition of jaggery makes diet energy dense, without the downsides of empty calories like white sugar.[27] Cow ghee is a great nourisher, that pacifies vitiated *Vata Dosha* and rekindles diminished *Agni*.[28] This Indian superfood is a rich source of essential fatty acids, fat-soluble vitamins, amino acids, and antioxidants.[29] All these nutrition-rich ingredients are supported by *Krishna* as '*Yogavahi'* i.e., potentiator of bioavailability and efficacy.[30] The

probiotic potential of *Piper longum* might also help here for its ability for beneficial alteration of gut microbiota.[31]
It improves the digestion status and thus, facilitates better absorption of nutrients.
The importance of supplementary nutrition in managing PEM is very crucial. Thus, we designed an add-on clinical study to enhance its effectiveness. As presentation of study drug was just like a palatable food-supplement, it was possible to seamlessly use it without disturbing the routine nutrition intake as per ICDS guidelines. It was successfully administered even when the majority parents had poor educational status.
The most popular method for diagnosing and classifying PEM is anthropometry. It also serves as a useful indicator of assessing efficacy of its management measures. In addition to this, we assessed the efficacy on basis of parameters of '*Karshya'* as per Ayurveda. These subjective parameters helped to clearly observe the implicit status by knowing about changes in appetite and debility. Along with these clinical parameters, laboratory parameters were also included. They presented an objective picture of a child's health, immunity as well as probable immune status.
The demographic details denoted homogenous nature of sample. Some key causative factors of malnutrition, such as low birth weight, early weaning was also observed. The following Social and individual factors which led to the Early weaning in the present study can be minimised in the cases of PEM. Social Reasons- poor socio-economic status and Lack of Education about the importance of breast milk.Individual Reasons: Malnourished mother, Illiteracy, maternal belief that the amount of milk was insufficient to meet the needs of the infant, working mother, Failure of lactation, cracked nipple etc. were some reasons for an early weaning and starting of formula feed.
The malnutrition status of all children was comparable. Overall, the addition of study drug improved all these parameters. The formation of healthy *Rasa Dhatu* and its proper dissemination to form subsequent *Dhatu*, was ensured by the ingredients of *Ashwagandha* and *Krishna*. Thus, there was improved body appearance and reduced debility. Improvement in appetite also helped in better consumption of supplementary nutrition. The weight gain in study group was better than the control group, probably due to abundance of nutrition enhancers in KG, viz., *Ashwagandha*, jaggery and ghee. MAC, a common measurement for musculature and fat deposition, showed better improvement in study group. Such remarkable changes were not observed in height of children, probably due to short study duration. However, there was sizeable improvement in BMI of children from study group. Efficacy of immunomodulatory effect of *Ashwagandha* by increasing Hb, RBC, WBC and platelets has been established.[32] Absorption of iron is increased in presence of *Piper longum*.[33] The children in study group presented a better haematological profile due to additive effect of study drug with their nutritious diet. Total serum protein is a good indicator of PEM and is usually low in malnourished children. The significant rise in its levels in study group children was suggestive of better effect of this adjuvant therapy.
Despite these promising results, there were some limitations with our study. Our sample size and study duration were small due to limitations of funding, supporting staff etc. In this short period, it was difficult to establish existence of long-term sustainable improvement of study drug. If performed in multiple PEM-prevalent areas with large sample size for a longer duration, such inferences can be obtained.
A healthy mind resides in a healthy body. This well-known expression is especially true for children, who learn and thrive better when in good health. Such productive and energetic children will emerge as competent citizens of tomorrow. The promising results obtained from this study can be useful in identifying the evidence-based efficacy of Ayurveda interventions in the Management of PEM to achieve this goal. Herbal formulations, such as, *Krishnadi Granules* as an adjuvant, can be effectively included in various nutritional programs to combat PEM effectively.

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Declaration of generative AI in scientific writing
No generative AI is used in scientific writing for present work.