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Original article

Impact of counseling in knowledge, attitude and practice and association of nutritional status with CD4 count and opportunistic infections of HIV patients of Udupi, India

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SUMMARY

Background and aims: HIV infection and insufficient nutritional intake form a malicious cycle which leads to immunodeficiency and malnutrition. Thus, this research was done to see the effect of nutritional counseling on knowledge, attitude and practice (KAP) of HIV patients of Udupi district. Also, the rational evidence of association of nutritional status with CD4 counts and opportunistic infections combined are limited which led to design of this study.

Methods: This interventional study was done in ART Centre, Udupi, India with a sample size of 66 with 33 each in experimental and control group (EG and CG). At first, the biochemical parameters, KAP, 3 day dietary intake and food group intake over Food Frequency Questionnaire (FFQ) were recorded. PG-SGA (Scored Patient-Generated Subjective Global Assessment) scoring was used to categorize patients' nutritional status. Individual nutritional counseling was provided to EG and change in KAP of EG and CG were recorded after 1 month.

Results: Pre-KAP mean of EG was 151.56 which increased to 169.13 after intervention. The mean KAP score of EG was statistically different from CG after counseling, $P < 0.001$. Of the total, 15 (22.7%) patients were found to be malnourished. The dietary intake of nutrients and food group was significantly lower than RDA. Tukey HSD post hoc analysis showed significant statistical difference for the CD4 count between moderate and severe malnourished category with $P = 0.017$. Statistically significant nutrient intake differences were also observed between PGSGA groups while odds ratio showed no significant association.

Conclusions: Improvement in KAP and poor nutritional status indicates that individual Nutrition and Health Education Counseling be made an integral part in the management of HIV in Udupi. Also, the difference in CD4 count across two PG-SGA stages depicts an association between nutritional status and immune status of HIV patients.

1. Introduction

CD4 cells are impaired by human immunodeficiency virus resulting in dysfunction. Individuals become more susceptible to infections and their immune system becomes weaker as infection advances [1]. Likewise opportunistic infections (OIs) are the infections associated with severe immunodeficiency. Antiretroviral drugs fight by stopping or interfering with the reproduction of the virus in the body resulting in decline of virus load in the body [2].

When highly active antiretroviral therapy was announced, HIV patients could now live longer and more productive lives. It causes

Abbreviations: HIV, human immunodeficiency virus; KAP, knowledge, attitude and practice; ART, antiretroviral therapy; EG, experimental group; CG, control group; FFQ, food frequency questionnaire; PG-SGA, scored patient-generated subjective global assessment; OI, opportunistic infections; BMI, body mass index; SGA, subjective global assessment; ARV, antiretroviral; PAL, physical activity level; RDA, recommended dietary allowance; PLHIV, people living with HIV; OR, odds ratio.

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high metabolic demands thereby increasing requirements for nutrients [3,4].

All the same, most ART centers in India lack committed dietician or a nutrition counselor. Proper dietary practices and consumption of required nutrients can be improved by knowledge of importance of good nutrition for people living with HIV. There are limited studies about nutritional counseling, awareness and good dietary practices followed by HIV patients [5]. In a research conducted among HIV in New Delhi, patients had knowledge of importance of nutrition, had positive attitude but the translation of knowledge into practice was low. Thus, the continuous interventions for behavior change to convert knowledge into dietary practice are essential [6]. Besides, the difference in mean body mass index (BMI) of females was seen to be significant among EG and CG after six months in another study [3].

Diet counseling to the HIV infected subjects regarding nutritional status and reduction of the opportunistic infections is important [7]. A study of Kolkata showed that both energy and protein adequacy was low in HIV patients. Nutritional status was influenced by different factors like presence of opportunistic infections, nutrient intake and chronic disease [8]. Total calories intake of HIV patients has been found to be below 1800 calories/day but no significant correlation was found between CD4 cell count and total calories taken [9]. While, opportunistic infections like episodes of diarrhea, nausea or vomiting, lower respiratory tract infections etc. were each significantly related to an increased risk of wasting [10].

PG-SGA is one of the suitable tools to assess the nutritional status of patients [11]. It is an amendment of the nutrition assessment tool, the Subjective Global Assessment (SGA) [12]. Comparison of nutritional status by global PG-SGA rating and body mass index showed most of HIV infected adults to be malnourished and this prevalence was much higher as indicated by global PG-SGA rating than that by BMI. There is also an association between the two nutritional status assessment tools but correlation was weak [11].

There have been very few studies where nutritional status of HIV individuals receiving retroviral therapy has been correlated with existing opportunistic infections and CD4 count. It has been found that patients who were in WHO clinical stage IV and those patients with 2 & more previous opportunistic infections had higher proportion BMI score less than 17 kg/m^2. Although the proportion of malnutrition was higher, the association between CD4 cell count category and malnutrition was not statistically significant [13]. Likewise, statistically significant differences in CD4 count were found in relation to BMI of the HIV patients [14].

There is no study documented to see the effect of nutritional counseling on KAP of HIV patients. Accordingly, the purpose of the present study was set to observe the effects of nutritional counseling on knowledge, attitude and practice of HIV patients of Udupi and perceive the link between nutritional status, CD4 count and opportunistic infections in a combined way.

2. Materials and methods

This interventional study was carried out from September–December 2014 on patients who had been receiving antiretroviral drugs from District ART Centre, Ajjargad, Udupi on regular basis. A total of 66 patients between age group of 20–55 years were included for the study. The exclusion criteria were pregnant and lactating mothers and patients with other medical complications. Patient medical record file was used to access their medical condition and other biochemical parameters. A structured interview schedule was prepared in English and Kannada (local language) and all the subjects were examined and interviewed using the questionnaire. PG-SGA tool was used to categorize the patients' nutritional status. Permission to use the PG-SGA was obtained from the copyright holder before conducting the study. Digital weighing scale machine (GH180KL) and stadiometer was used to take the weight and height of the individual to obtain BMI (wt/ht^2). Physical activity of the individual was noted for each and every hour of the day in order to calculate the Physical Activity Level (PAL).

2.1. Sample size calculation

The following formula was used for calculation of sample size:

$$n = \frac{(A+B)^2 \times ([p1 \times \{1-p1\}] + [p2 \times \{1-p2\}])}{(p1-p2)^2}$$

where, n = sample size required in each group,
$A = 1.96$, the level of significance;
$B = 0.84$, desired power at 80%;
$p1 = 0.75$, the estimated proportion of HIV patients that would receive a nutrition intervention;
$p2 = 0.40$, the estimated proportion of HIV patients that would not receive a nutrition intervention
$p1-p2 = 0.35$, the level of change or difference from nutritional intervention chosen to be of clinical importance [3].

$$\mathrm{n} = \frac{7.84 \times (0.1875 + 0.24)}{0.1225} = 27.4$$

The calculated sample size was 27 patients in each group. 20% of the original sample size was added to cater for loss to follow up making the sample of 33 in each EG and CG.

2.2. Assessment of knowledge, attitude and practice (KAP)

For KAP, the participants were randomly taken into EG and CG but age matching was taken care of roughly to divide them equally in both groups. The EG patients were provided Nutrition and Health Education Counseling and counseling leaflet (pictorial health and nutrition tips and sample menu) after assessment in 1st visit while the CG patients were not provided any counseling in 1st visit. After 1 month intervention period, both the EG and CG patients were assessed for follow up regarding KAP questions and compliance to counseling. The CG patients were then provided Nutrition and Health Education Counseling and Counseling leaflet (pictorial health and nutrition tips and sample menu). The leaflet was made on their own local language, Kannada.

2.3. Dietary intake calculation

Dietary assessment was done by 3 day dietary recall for the common daily consumption. Food group consumption was assessed using semi-quantitative FFQ. Standard measuring spoon, cups and glasses was used to quantify the amount of food and beverages consumed at every meal of the day. This quantified food was documented in Diet Cal software (version 3.0) [15] to calculate the nutrient and food groups' intake per day. After quantification, Recommended Dietary Allowance (RDA) for total energy, carbohydrate, protein and fat was computed using PAL, Harris-Benedict equation for calculating Basal Metabolic Rate and Total Energy Expenditure [16]. RDA for other vitamins and minerals was taken as per Dietary Guidelines for Indians while RDA for each food group was computed as number of portions of each food group to be consumed by a sedentary man in a week as per Dietary Guidelines

for Indians [17]. PAL was computed for each individual using Physical Activity Ratio values for different daily activities within 24 h of a day. The factorial calculations are done as expressed in Table 5.1 of FAO Joint Report [18]. Food group adequacy was computed using FFQ to calculate portion of food group consumed in a week and compared with RDA.

SPSS Inc. Released 2007 (version 16.0) [19] was used for entry of collected data, coding of data and statistical analysis of data. Chi square, Odds Ratio (OR) from Binary Logistic Regression and ANOVA were used in order to find out the association between different factors. The patients were categorized into two categories according to their nutritional status, CD4 count and number of opportunistic infections present in them to find out the OR.

Permission to carry out study in ART center was obtained from District Hospital, Udupi. Then ethical clearance was obtained from the Institutional Ethics Committee, Kasturba Hospital prior to the data collection. The patients were explained about the purpose and objectives of the study. Prior to entry into the study, written consent was obtained from each patient.

3. Results

3.1. Patient characteristics

Table 1 shows the sociodemographic characteristics of the subjects. There were equal number of male and female among which 70% were above age of 40. There were 18 male and 15 female in EG while 15 male and 18 female in CG respectively. The prevalence of HIV was observed to be 60% among married individuals depicting increased risk for their partners as well. Socioeconomic status classification of the patients was done by Modified Kuppuswamy's Socioeconomic Scale [20]. Almost 70% of the patients emanated from below middle class level of Indian society.

3.2. Nutrition and health profile

The BMI classification for HIV population was done conferring to a toolkit of National AIDS and STI'S Control Programme [21]. Table 2 shows that there were maximum patients with normal BMI. Only 1 patient was in obese category whereas there were 10 overweight patients. 15 patients were malnourished with BMI below 18.5 among which 4 patients were found severely malnourished. The minimum BMI noted in this study was 12.89 kg/m^2 which showed severe malnutrition. The PG-SGA category also depicts that 22 patients (around 33%) were in malnourished stage.

The classification of patients on the basis of immunosuppression was done according to WHO Immunological Staging of HIV Infection [22]. Only 65 patients' CD4 count could be collected as one patient was transferred to different ART center and his ART medical file couldn't be assessed. Table 2 also shows that 29 (44%) patients were in immunosuppressant category with CD4 count below 350. There were least patients 7 (10.8%) in severe immunosuppressant category. In addition, 19 (29.20%) patients were in not significant immunosuppressant category. Opportunistic infections of Recurrent Respiratory Infections, Upper Respiratory Tract Infections, mouth ulcers, Urticaria, Candidiasis, Herpes zoster, Genital herpes, Apthous ulcer, angular cheilosis were reported by the patients' record file. Majority 27 (40.9%) of the patients had no record of opportunistic infections. Secondly, there were 24 patients with one infection reported and only 5 patients with report of 3 and more OIs.

3.3. Effect of nutritional counseling on KAP

44 KAP Questions were asked to all the 66 patients regarding HIV knowledge, nutrition knowledge, personal hygiene and food and drug interaction. There were 11 knowledge questions, 14 attitude questions and 19 practice related questions. Each question was given a mark of 5 and the question had option of strongly agree, agree, neutral, disagree and strongly disagree. There were both positive and negative type questions. Here, the number of patients with good knowledge was found to be 3 (9.10%) in both EG and CG patients before intervention which increased to 13 (40.60%) in EG patients and 4 (12.90%) in CG patients after intervention. Similarly, the number of patients with good attitude was 5 (15.20%) in EG and 7 (21.20%) in CG before intervention which rose to 17 (53.10%) in EG and 8 (25.80%) in CG after intervention. Also, similar trend was observed in practice score where the number of patients with good practice habit was found to be 13 (39.40%) in EG and 18 (54.50%) in CG before intervention which increased to 27 (84.40%) in EG and 19 (61.30%) in CG after intervention. As in overall, the number of patients with good KAP score was found to be 8 (24.20%) in EG and 10 (30.30) in CG pre intervention which increased to 24 (75.0%) in EG and 13 (41.90%) in CG after intervention. Hence, this significantly improved EG patients KAP. We observed that the patients were not able to implement their knowledge into practice due to some reasons like carelessness and unaware of the bad impacts of it which was reported as being tried to implement after intervention in EG. Table 3 shows statistically significant difference in mean knowledge, attitude, practice and overall KAP score of EG before and after intervention while insignificant difference is observed in case of CG

Table 1
Sociodemographic characteristics of the subjects.

Sociodemographic Characteristics		N (%)
(Mean Age ± SD)		43.4 ± 7.61
Age in years	20–29 years	4 (6.10)
	30–39 years	16 (24.20)
	40–49 years	28 (42.40)
	50–55 years	18 (27.30)
Gender	Male	33 (50)
	Female	33 (50)
Marital status	Married	40 (60.6)
	Unmarried	10 (15.20)
	Divorced	4 (6.10)
	Widowed	9 (13.60)
	Separated	3 (4.50)
SES class	Lower (V)	7 (10.60)
	Upper Lower (IV)	40 (60.60)
	Middle/Lower Middle (III)	14 (21.20)
	Upper Middle (II)	5 (7.60)

SD, Standard deviation; SES, Socioeconomic status.

Table 2
Nutrition and Health characteristics of the subjects.

Characteristics		N (%)
BMI Classification	Severe Malnutrition (less than 16)	4 (6.10)
Mean BMI Value (kg/m^2)	Moderate Malnutrition (16–16.9)	3 (4.50)
(21.13 ± 3.75)	Mild Malnutrition (17–18.4)	8 (12.10)
Range: 12.89–30.85	Normal Weight (18.5–24.9)	40 (60.60)
(N = 66)	Overweight (25–29.9)	10 (15.20)
	Obese (>30)	1 (1.50)
PG-SGA Stage (N = 66)	A (Well nourished)	44 (66.70)
	B (Moderately malnourished)	14 (21.20)
	C (Severely malnourished)	8 (12.10)
CD4 Count Classification (cells/μL)	Severe Immunosuppression (<200)	7 (10.8)
(Mean ± SD: 416.3 ± 206.5)	Advanced Immunosuppression (200–349)	22 (33.80)
(N = 65)	Mild Immunosuppression (350–499)	17 (26.20)
	Not Significant Immunosuppression (>500)	19 (29.20)
No. of Current Opportunistic Infections Reported (N = 66)	0	27 (40.90)
	1	24 (36.4)
	2	10 (15.20)
	3	4 (6.10)
	4	1 (1.50)

BMI, body mass index; CD4, cluster of differentiation 4.

Table 3
Comparison of Pre and post KAP Scores of EG and CG after intervention.

Group	Total Score	Mean Pre score ± SD	Mean Post Score ± SD	t value	P value
EG	Knowledge	36.38 ± 4.65	40.5 ± 2.76	6.436	0.000**
	Attitude	46.03 ± 1.01	52.22 ± 3.33	7.199	0.000**
	Practice	69.16 ± 10.97	76.41 ± 5.64	5.625	0.000**
	KAP	151.56 ± 16.52	169.13 ± 7.96	8.292	0.001**
CG	Knowledge	35.65 ± 4.02	37.29 ± 3.78	2.085	0.046*
	Attitude	46.90 ± 6.65	47.19 ± 7.18	0.417	0.68
	Practice	70.71 ± 10.78	71.81 ± 10.82	1.166	0.253
	KAP	153.26 ± 18.27	156.29 ± 19.24	1.586	0.123

Significant difference between mean pre score and mean post score, paired sample *t*-test (two-tailed); *P < 0.05; **P < 0.001.

excluding knowledge of CG. Supportively, Table 4 shows that there is statistically significant mean difference between EG and CG's K, A, P and KAP, P < 0.001 after nutritional counseling. But no significant difference existed between the groups before intervention. This clearly confirmed an increase in KAP of EG after intervention.

3.4. Compliance to nutritional counseling

Compliance of the patients towards provided Health and Nutrition counseling was evaluated and individual score was given for each patient based on the 15 follow up questions. Then the patients were categorized into low (less than 40%), moderate (40–70%) and good compliance group (above 70%). The mean compliance score was found to be 7.57 ± 1.93. The mean compliance score of EG (9.06 ± 1.5) was significantly different in comparison with CG (6.03 ± 0.75) at 1% level of significance which is a result of counseling given to EG and proper follow up.

Table 4
Comparison of KAP Scores of EG and CG before and after intervention.

KAP Score Types	EG	CG	t value	P value
	Mean ± SD	Mean ± SD		
PRE K TOTAL	36.42 ± 4.58	35.72 ± 3.98	0.660	0.512
PRE A TOTAL	46.06 ± 5.64	46.87 ± 6.49	0.546	0.587
PRE P TOTAL	69.24 ± 10.81	70.33 ± 11.32	0.400	0.69
PRE KAP TOTAL	151.73 ± 16.29	152.94 ± 18.64	0.281	0.779
POST K TOTAL	40.50 ± 2.76	37.29 ± 3.78	3.859	0.000**
POST A TOTAL	52.22 ± 3.33	47.19 ± 7.18	3.582	0.001*
POST P TOTAL	76.41 ± 5.64	71.81 ± 10.82	2.126	0.041*
POST KAP TOTAL	169.13 ± 7.96	156.29 ± 19.24	3.480	0.001*

Significant difference between mean score of EG and mean score of CG, independent sample *t*-test (two-tailed); *P < 0.05; **P < 0.001.

3.5. Dietary adequacy

Table 5 shows the dietary adequacy of HIV patients receiving ART. Mean energy intake (1929.03 (±256.67)) was much lower than RDA and was significantly lower (P < 0.05). Similarly, mean intake of each nutrient was significantly lower than RDA except protein. Mean protein and fat intake in daily diet was comparable to RDA with no significant difference (P > 0.05). Likewise, the mean food group consumption/week for different food groups was significantly lower (P < 0.05) than RDA except meat and meat products (906.36 ± 552.51), fats and oilseeds which was significantly higher (P < 0.05) than RDA.

3.6. Association between nutritional status and other variables

Association of CD4 count with number of opportunistic infections and PG-SGA stage of all the 66 patients included in the study was computed. It was observed that there is insignificant association of PG-SGA Stage B and C with CD4 count and number of opportunistic infections. But, there is significant association of PG-SGA Stage A with CD4 count and number of opportunistic infections (P < 0.05). Further, upon computation of chi square post hoc test, it revealed that only subgroup with severe immunosuppression and having 3 opportunistic infections in Stage A category was statistically significant after adjusting to Bonferroni corrected p value, $\chi^2 = 13.69$, p = 0.00022 while others were non-significant.

For computation of odds ratio, PG-SGA Stage A patients were kept under well-nourished category and Stage B and C patients were included in malnourished category. Similarly, patients with CD4 count less than 500 were kept in significant immunosuppression category while greater than 500 were included in the other category. Here, opportunistic infections had no significant association with nutritional status and CD4 count as P > 0.05.

Table 5
Nutrient or food group intake and adequacy of the subjects.

Nutrient/Food Group	Mean Intake ± SD	RDA ± SD	P value
Energy (Kcal)	1929.03 ± 256.67	2501.33 ± 410.85	0.000**
Carbohydrate (gm)	293.44 ± 54.25	406.47 ± 66.76	0.000**
Protein (gm)	61.74 ± 16.3	60.0 ± 9.29	0.409
Fat (gm)	56.41 ± 10.16	54.39 ± 11.26	0.288
Iron (mg)	11.87 ± 4.16	19 ± 2.01	0.000**
Calcium (mg)	767.81 ± 310.22	600 ± 0.0	0.000**
Zinc (mg)	5.71 ± 1.46	11.0 ± 1.0	0.000**
Folic Acid (μg)	129.98 ± 43.34	200.0 ± 0.0	0.000**
Vitamin A (μg)	422.64 ± 315.65	4800 ± 0.0	0.000**
Vitamin C (mg)	60.8 ± 38.98	40.0 ± 0.0	0.000**
Vitamin B12 (μg)	0.29 ± 0.26	1 ± 0.0	0.000**
Fiber (gm)	23.26 ± 4.69	27.0 ± 3.6	0.000**
Cereals (gm)	2012.95 ± 395.29	2625 ± 0.0	0.000**
Pulses And Legumes (gm)	383.71 ± 74.96	420 ± 0.0	0.000**
Green Leafy Vegetables (gm)	179.55 ± 83.66	700 ± 0.0	0.000**
Roots And Tubers (gm)	502.27 ± 127.98	1400 ± 0.0	0.000**
Other Vegetables (gm)	849.09 ± 276.75	1400 ± 0.0	0.000**
Fruits (gm)	192.95 ± 166.75	700 ± 0.0	0.000**
Meat, Fish And Poultry (gm)	906.36 ± 552.51	350 ± 0.0	0.000**
Milk And Milk Products (ml)	1183.48 ± 1296.72	2100 ± 0.0	0.000**
Sugar (gm)	165.45 ± 50.83	210 ± 0.0	0.000**
Fats And Oils (gm)	218.71 ± 31.80	175 ± 0.0	0.000**
Nuts And Oilseeds (gm)	191.74 ± 46.58	105 ± 0.0	0.000**

**Significant difference between mean intake and RDA, paired sample *t*-test (two-tailed), $P < 0.001$.

One way ANOVA was used to compare the CD4 count between the three stages of PG-SGA and it showed a significant statistical difference with P value 0.022. Further, result of Tukey HSD post hoc test revealed that moderately malnourished patients had significantly different CD4 cell count than severely malnourished category, $F(2, 64) = 4.046$, $p = 0.017$. Whereas immunity of well-nourished patients was no different when compared with moderately and severely malnourished. Table 6 shows that the mean CD4 count of severely malnourished stage was 264.88 which is least in comparison with other stages.

Table 7 shows that there was insignificant difference in mean energy across three PGSGA groups while a significant difference in mean protein intake was observed. After performing Games-Howell post hoc test for unequal variances, it was clear that severely malnourished group had significant difference in protein intake in comparison with well-nourished, ($F(2,64) = 3.524$, $p = 0.002$) and moderately malnourished group, ($F(2,64) = 3.524$, $p = 0.017$). Thus, it was obvious that there was difference in nutrient intake across different groups leading to variation in nutritional status as well.

4. Discussion

The aim of this study was to see the effect of nutritional counseling on KAP and to find out the nutritional status of HIV patients of Udupi district and its association with other factors. Main finding of this study is that individual Health and Nutritional counseling is effective to increase the KAP of HIV patients and promote behavior change in them for improving immunity and health. Research also further suggests that nutritional counseling interventions focused to improve the health and nutritional practices are crucial and may help in the prevention of progression of HIV [5]. Findings also showed that the nutritional status of patients becomes weak and is more deteriorated with less dietary intake than required by them. A patient with BMI as low as 12.89 kg/m^2 clearly illustrates the scenario of nutritional grade of HIV patients of Udupi. Similar study conducted in North India highlighted the lowest BMI of a HIV patient to be 13.6 kg/m^2 depicting the scenario of PLHIV in India [9]. But the prevalence of malnutrition in HIV was shown to be more by PG-SGA than BMI. Consulting to a research, PG-SGA rating can be used to denote nutritional status of HIV patients so PG-SGA was used in this study [11].

Regarding the dominance of HIV, most of the married female subjects had reported that they had contacted HIV from their spouse. Hence the prevalence of HIV was seen more among married individuals in this study. It was also observed that majority of patients' belonged to lower economic status making them difficult to fulfill their current dietary requirements and hence poor nutrition. Similar findings were reported by two other study of India with majority of PLHIV having lower socioeconomic status [5,7].

Prominently, this study also tells that the nutrients and food group intake is lower than RDA in PLHIV. The consumption of green leafy vegetables and fruits is very low which caused reduction in intake of Vitamin A and iron significantly. Study findings here suggest that importance of fruits and vegetables should be emphasized to HIV patients as it helps to fight infections and build already compromised immunity. A similar finding on poor intake of fruits and vegetables was also observed in PLHIV [23]. Although HIV care centers counsel patients regarding nutrition but it isn't being stressed as to its real necessity. Likewise, deficit intakes of most nutrients and food groups have been reported by prior studies highlighting the importance of individual nutrition counseling to HIV patients [7,24].

This study was designed for clinicians to know the importance of individual nutritional counseling and assess the relationship between nutrition, immunity and opportunistic infections. PG-SGA as nutritional status is associated with CD4 count. This association is real as malnourished category patients have lowest CD4 count as shown by Tukey post hoc analysis while other categories have higher CD4 count. Although nutrient intake differences was observed between PGSGA groups and was statistically significant, insignificant association was observed as indicated by OR. There might be several reasons and limitations in this study which resulted in lack of association. But prior researchers have showed significant association between lower CD4 cell count and thinness and CD4 cell count and BMI respectively [14,25]. In another study, number of previous OIs also showed a significant association with malnutrition after fully adjusting it for all variables [13].

There are restrictions to the studies. This study is conducted at a single ART center with limited number of patients as it was difficult to obtain consent from most of them due to fear of stigma. Therefore, results may not be generalized to entire PLHIV of India. Future research including large number of patients from different ART centres is needed to see the exact association of nutritional status with other factors and also to ensure whether to include PG-SGA tool to assess the overall health and nutritional status of HIV patients in all ART centres and HIV care centres. Majorly, the study highlights the importance of individual Nutrition and Health Education Counseling for the management of HIV in Udupi district.

Table 6
Association of CD4 count with nutritional status.

PG-SGA Stages	Mean ± SD of CD4 count	95% CI	F value	P value
A (well nourished)[a,b]	413.02 ± 172.81	359.84, 466.21	4.046	0.022*
B (moderately malnourished)[a]	513.07 ± 277.42	352.9, 673.25		
C (severely malnourished)[b]	264.88 ± 206.48	138.9, 390.85		

*Significant difference, one way ANOVA, $P < 0.05$.
Group with different superscript are significantly different with $P < 0.05$ with respect to Tukey HSD post hoc analysis.

Table 7
Nutrient intake differences across PGSGA groups.

PG-SGA Stages	Mean ± SD of Energy	95% CI	F value	P value
A (well nourished)	1954.12 ± 38.88	1876.43, 2031.82	0.692	0.505
B (moderately malnourished)	1894.05 ± 68.93	1756.32, 2031.79		
C (severely malnourished)	1852.24 ± 91.18	1670.04, 2034.45		
PG-SGA Stages	Mean ± SD of Protein	95% CI	F value	P value
A (well nourished)[a]	63.39 ± 2.37	58.66, 68.12	3.524	0.035*
B (moderately malnourished)[a,c]	64.45 ± 4.20	56.07, 72.84		
C (severely malnourished)[b]	47.98 ± 5.55	36.89, 59.07		

*Significant difference, one way ANOVA, $P < 0.05$.
Group with different superscript are significantly different with $P < 0.05$ with respect to Games-Howell post hoc analysis with unequal variances.

Conflict of interest

The Authors declare that there is no conflict of interest.

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Dataset

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CRediT authorship contribution statement

Pratik Pokharel: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Visualization, Writing - original draft, Writing - review & editing. **Pallavi G. Shettigar:** Conceptualization, Methodology, Project administration, Resources, Supervision, Validation, Writing - original draft, Writing - review & editing.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clnesp.2018.11.001.

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