

An Analysis of Dietary Counseling and Flavonoid Rich Food Consumption Among Different Socioeconomic Groups with Increased Colorectal Cancer Risk, Chennai City, India - A Fact-Finding Study

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ABSTRACT

Background: Colorectal cancer is a major cause of cancer incidence and mortality globally, with an increasing number of cases, particularly among younger individuals. Conventional treatments often involve significant side effects, underscoring the need for alternative approaches like chemoprevention. Flavonoids are natural compounds found in fruits and vegetables, hold promise as anticancer agents due to their antioxidant, anti-inflammatory, and cancer-preventive effects. This study examines the relationship between consumption of flavonoid rich food and various categories of socioeconomic status. (SES)

Materials and methods: Participants completed an interviewer-administered questionnaire consisting of demographic details that elicit the presence or absence of risk factors associated with colorectal cancer. Data were collected from 275 eligible participants at SRM Dental College, Chennai, India, between June and September 2024. Participants were selected and evaluated based on their responses to colorectal cancer risk factors, with inclusion criteria set at more than 50% assertiveness. A sample size of 147 was estimated, based on colorectal cancer prevalence and 10% for attrition. Flavonoid intake was assessed through a 7-day dietary history, at baseline (7th day), day 14, and day 21, followed by dietary counseling to enhance the intake of flavonoid rich food.

Results: Statistical analysis revealed no overall association between legume and vegetable intake with SES. However, significant associations were found between SES and the consumption of specific foods, particularly berries, nuts, and fruits at different follow-up periods.

Berries intake differed significantly across different categories of SES on the 21st day ($p = 0.029$). Fruit intake was significantly differed at baseline ($p = 0.034$), day 14 ($p = 0.03$), and day 21 ($p = 0.023$), while nut intake varied significantly on the 21st day ($p = 0.021$).

Subsequent post-hoc analysis revealed that the 'Upper-lower' group had significantly higher berry intake than the 'Upper' group on the 21st day ($p = 0.021$). The 'Lower middle' group consumed more fruits than the 'Upper middle' group on both the 14th day ($p = 0.048$) and 21st day ($p = 0.041$).

Conclusion: This study found disparities in the consumption of flavonoid rich food across socioeconomic groups, highlighting inequalities in diet quality and access to health-promoting foods.

Keywords: Colorectal cancer, Flavonoids, Dietary counseling.

INTRODUCTION

Colorectal cancer is one of the most common malignancies worldwide. According to the GLOBOCAN Report 2018, colorectal cancer contributes to 9.2% of all major cancer incidence worldwide. (1) In 2020, colorectal cancer was the third most common cancer and the second leading cause of cancer death worldwide, with over 1.9 million new cases and 0.9 million deaths. Incidence and mortality rates vary by country and region, with increasing cases among younger individuals, especially in developed countries. These differences may be due to lifestyle, environmental, and genetic factors. Reducing modifiable risk factors like alcohol, smoking, obesity, and poor diet, while promoting physical activity, certain medications (like aspirin), and a healthy diet, can help lower colorectal cancer rates. (2) The treatment plan for colon cancer typically includes surgery, chemotherapy, radiation, targeted therapy, and immunotherapy. The side effects and treatment limitations underscore the need for innovative, personalized, and less toxic approaches to improve outcomes and address drug resistance in advanced stages. (3) Despite widely available CRC prevention methods and international guidelines, early-onset CRC cases are rising, posing a public health challenge. With global incidence projected to reach 3.2 million by 2040, key barriers include low public awareness and insufficient emphasis on prevention among healthcare providers. (4)

One such strategy used is Chemoprevention, which has been extensively studied over the past several decades and involves using

dietary or pharmaceutical interventions to reduce cancer risk, delay its onset, or reverse carcinogenesis. (5) Natural compounds are promising candidates for anticancer drug development due to their abundance, strong anticancer efficacy, and low toxicity. Among these, flavonoids stand out for their potential as anticancer agents, with numerous studies highlighting their significant roles in cancer chemoprevention and chemotherapy.

Flavonoids are plant compounds found in fruits, vegetables, and plant-based foods, which offer numerous health benefits including their antioxidant, anti-inflammatory, cardiovascular enhancing, immune-boosting, and cancer-preventive benefits. There are more than 9000 flavonoids identified. (6) Myricetin, Apigenin, Anthocyanins, EGCG Quercetin, and Genistein are the major flavonoids that help in the prevention of colorectal cancers. (7)

Walnuts, grapes, Blackberry, cranberry, blueberry, and fermented grapes like red wine are the main sources of Myricetin. (8) Apigenin is found in parsley, oranges, olive oil, pistachios, and herbs. (9) Anthocyanins and anthocyanidins are a group of water-soluble pigments which are responsible for the blue, red, purple, and orange colors present in many fruits and vegetables, such as red-skinned grapes, apples, pears, radishes, and red/purple cabbage. (10) Green tea, apples, avocados, peaches, pears, plums, berries, and nuts are the main sources of EGCG. (11) Quercetin is found abundantly in various vegetables and fruits, such as berries, lovage, capers, cilantro, dill, apples, and onions (12) Genistein is a

prominent phytoestrogen found in soybeans and soy products. (13) Several mechanisms of action have been identified, including the inactivation of carcinogens, inhibition of cell proliferation, cell cycle arrest, induction of apoptosis and differentiation, suppression of angiogenesis, antioxidation, and the reversal of multidrug resistance, among others. These findings suggest that flavonoids could be promising candidates as anticancer agents. (14)

A higher intake of specific flavonoids significantly reduced colorectal cancer risk ranging from 22% to 32% with higher intake of flavonols, quercetin, catechin, and other flavonoids. (15,16) Higher catechin intake also reduced risk of rectal cancer in postmenopausal women for over 12 years. (17) However, little evidence supporting an association between flavonoid intake and colorectal cancer risk was also observed. (18) These findings suggest that results are not consistent across all studies.

The purpose of the present study is to evaluate the consumption of flavonoid rich food, which is associated with colorectal cancer prevention by recording dietary history over 7 days at three follow-up periods, post-dietary counseling. Due to lack of evidence, this study aims to explore variations in flavonoid intake among different socioeconomic groups, as dietary habits and access to certain foods can be influenced by socioeconomic factors. We also hypothesize that significant differences in flavonoid consumption will emerge between different socioeconomic groups, potentially highlighting disparities in diet quality and access to health-promoting foods.

MATERIALS & METHODS

Study design and population:

This longitudinal study was designed to examine the relationship between Flavonoid intake and SES by recording a dietary history over 7 days at three follow-up periods: At baseline, 14th, and 21st day and to identify any changes in flavonoid consumption post-dietary counseling. The

study population was recruited between June 2024 and September 2024 attending SRM Dental College, Ramapuram, Chennai, India. The participants were selected and evaluated based on the assertiveness of their responses to colorectal cancer risk factors.

Data collection:

Data were collected from participants using an interviewer-administered questionnaire that included demographic information and risk factors for colorectal cancer, as defined by the CDC. (19) The risk factors considered included being over 50 years of age, a history of Crohn's disease or ulcerative colitis, a personal or family history of colorectal cancer or polyps, a history of Familial Adenomatous Polyposis (FAP) or Hereditary Non-Polyposis Colorectal Cancer (Lynch syndrome), a diet low in fruits and vegetables but high in fat or processed meats, a sedentary lifestyle, and the use of alcohol or tobacco. The study included male and female participants over the age of 30 who exhibited more than 50% of the risk factors for colorectal cancer. Participants under 30 years of age and those with fewer than 50% of the identified risk factors were excluded from the study.

The dietary history of these participants was recorded over 7 days at three intervals: baseline, 14th day, and 21st day, to assess their flavonoid intake. Participants were instructed to log the content, timing, and quantity of their food intake, to ensure accurate data collection. After receiving the 7-day dietary history, it was evaluated for flavonoid intake, and dietary counseling was provided to encourage increased consumption of flavonoids like Myricetin, Apigenin, Anthocyanins, EGCG, Quercetin, and Genistein -rich foods which are known to help prevent colorectal cancer. Additionally, information on participants' highest educational qualification, occupation, and monthly family income was recorded to determine their socioeconomic status using the modified Kuppuswamy scale.

Sample size estimation:

A sample size of 133 was estimated based on a reported prevalence of colorectal cancer of 9.2% (1). This calculation was performed using the formula: $4 * p * q / L^2$ where p represents the prevalence of Colon cancer, q equals 1 minus p, and L is the desired precision level set at 5%. To account for potential attrition, the sample size was inflated by 10%, resulting in a final sample size of 147.

STATISTICAL ANALYSIS

All statistical analyses were conducted using Statistical Package for Social Sciences (SPSS) version 24 (IBM, Chicago, USA). Initially, the data was evaluated for normality using the Kolmogorov-Smirnov test, which revealed non-normal distribution. Consequently, non-parametric tests were employed for significance testing. Descriptive statistics were utilized to summarize the characteristics of the study sample. To compare means and examine the correlation between flavonoid-rich food intake and socio-economic status, the

Kruskal-Wallis test was performed. The significance level was set at 5%.

RESULTS

A longitudinal follow-up study was conducted in Ramapuram, Chennai, among men and women attending SRM Dental College, to evaluate the impact of dietary counseling on flavonoid-rich food intake over three time periods: baseline, 14 days, and 21 days, between June 2024 and September 2024. Of the 275 eligible participants, 83 were excluded based on the inclusion criteria, and 47 declined to participate. Four participants were lost to follow-up, resulting in a final sample size of 141 for statistical analysis. Flavonoid-rich food intake was categorized into five groups for enhanced data analysis: Berries (blueberry and blackberry), Fruits (pomegranate, guava, apple, grapes, and avocado), Nuts (pistachio and hazelnut), Legumes (soybeans), and Vegetables (broad beans, broccoli, cabbage, bell pepper, lady's finger, cauliflower, carrot, radish, and brinjal).

Table 1: Demographic characteristics of study participants

Groups		Frequency (n)	Percentage %
Age (in years)	<20	3	2.1
	20-29	27	19.1
	30-39	37	26.2
	40-49	30	21.3
	>50	44	31.2
Gender	Male	75	53.2
	Female	66	46.8
Religion	Hindu	75	53.2
	Christian	43	30.5
	Muslim	23	16.3
Educational qualification	Illiterate	9	6.4
	Primary school	13	9.2
	Middle school	21	14.9
	High school	27	19.1
	Intermediate / diploma	32	22.7
	Graduate	23	16.3
	Professional	16	11.3
Occupation	Unemployed	8	5.7
	Elementary occupation	10	7.1
	Plant and machine operators and assemblers	16	11.3
	Craft and related trade workers	23	16.3
	Skilled agricultural and fishery workers	22	15.6
	Skilled workers, shop and market	20	14.2
		12	8.5
	13	9.2	

	sales	14	9.9
	Clerk	3	2.1
	Technician /Associate professors		
	Professional		
	Legislatures, senior officials,		
	Manager		
Monthly family income (in Rupees)	>1,46,104	3	2.1
	1,09,580-1,46,103	5	3.5
	73,054-1,09,579	8	5.7
	68,455-68,454	17	12.1
	59,252-63,853	24	17.0
	54,651-59,251	21	14.9
	45,589-54,650	20	14.2
	36,527-45,588	18	12.8
	21,914-36,526	7	5.0
	7,316-21,913	8	5.7
	<7,316	10	7.1
Socio-economic status (SES)	Upper	19	13.5
	Upper middle	28	19.9
	Lower middle	40	28.4
	Upper lower	48	34.0
	Lower	6	4.3
Body Mass Index (BMI)	Severely underweight: <16	2	1.4
	Underweight: 16-17	4	2.8
	Mildly underweight: 17-18.5	6	4.3
	Normal weight: 18.5-24.9	39	27.7
	Overweight: 25-29.9	40	28.4
	Obese class I: 30-34.9	30	21.3
	Obese class II: 35-39.9	17	12.1
	Obese class III: >40	3	2.1

The study sample comprised 31.2% individuals aged 50 years or older. The gender distribution was relatively equal, with a slight predominance of Male. The majority of participants (53.2%) identified as Hindu, followed by Christians (30.5%). Socio-economic status was assessed using the Modified Kuppuswamy scale, which categorized participants into their respective groups. In terms of education, 22.7% held a

diploma degree, while 6.4% were illiterate. The employment status of the participants revealed that 5.7% were unemployed, and 2.1% held senior leadership positions. The socio-economic status distribution showed that 34% of participants belonged to the upper-lower category. Body mass index (BMI) classification indicated that 27.7% of participants were normal weight, and 28.4% were overweight. [Table 1]

Table 2: Distribution of exposure to risk factor: Chi-Square Goodness-of-Fit test

Exposure to risk factor		N (%)	χ^2	p-value
Age >50 years	Yes	44 (31.2)	19.922	<0.001**
	No	97 (68.8)		
Any history of Crohn's disease or ulcerative colitis	Yes	5 (3.5)	121.709	<0.001**
	No	136 (96.5)		
Any personal or family history of colorectal cancer or colorectal polyps	Yes	6 (4.3)	118.021	<0.001**
	No	135 (95.7)		
Any history of familial adenomatous polyposis (FAP) or hereditary non polyposis colorectal cancer	Yes	3 (2.1)	129.255	<0.001**
	No	138 (97.9)		
Consumption of diet low in fruits and vegetables	Yes	67 (47.5)	0.348	0.556
	No	74 (52.5)		
Consumption of low-fiber and high-fat diet or a diet high in processed meats	Yes	60 (42.6)	3.128	0.077
	No	81 (57.4)		
Sedentary lifestyle	Yes	56 (39.7)	5.965	<0.05*

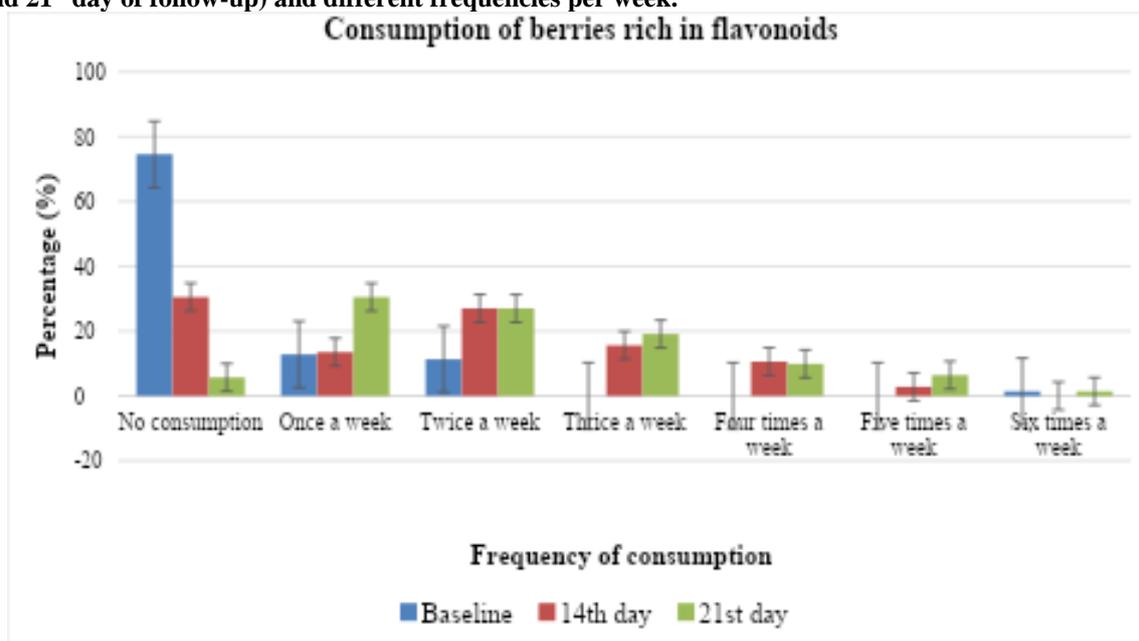
	No	85 (60.3)		
Alcohol consumption	Yes	40 (28.4)	26.390	<0.001**
	No	101 (71.6)		
Any form of tobacco usage	Yes	107 (75.9)	37.794	<0.001**
	No	34 (24.1)		

-N= number of study participants; χ^2 =chi square with a df(degree of freedom)1
 -** $p < 0.001$, * $p < 0.05$ is considered as statistically significant

A Chi-Square Goodness-of-Fit test was conducted to examine the distribution of participants with exposure to risk factors, including history of Crohn's disease or ulcerative colitis, personal or family history of colorectal cancer or colorectal polyps, history of familial adenomatous polyposis (FAP) or hereditary non-polyposis colorectal cancer, alcohol consumption, and tobacco use. The results indicated a

significant deviation from the expected equal proportions ($p < 0.001$), suggesting that the sample's distribution of risk factors differed significantly from the expected distribution. However, this deviation suggests that the sample's distribution is consistent with the expected proportions, indicating that the sample is representative of the population with respect to these risk factors. [Table 2]

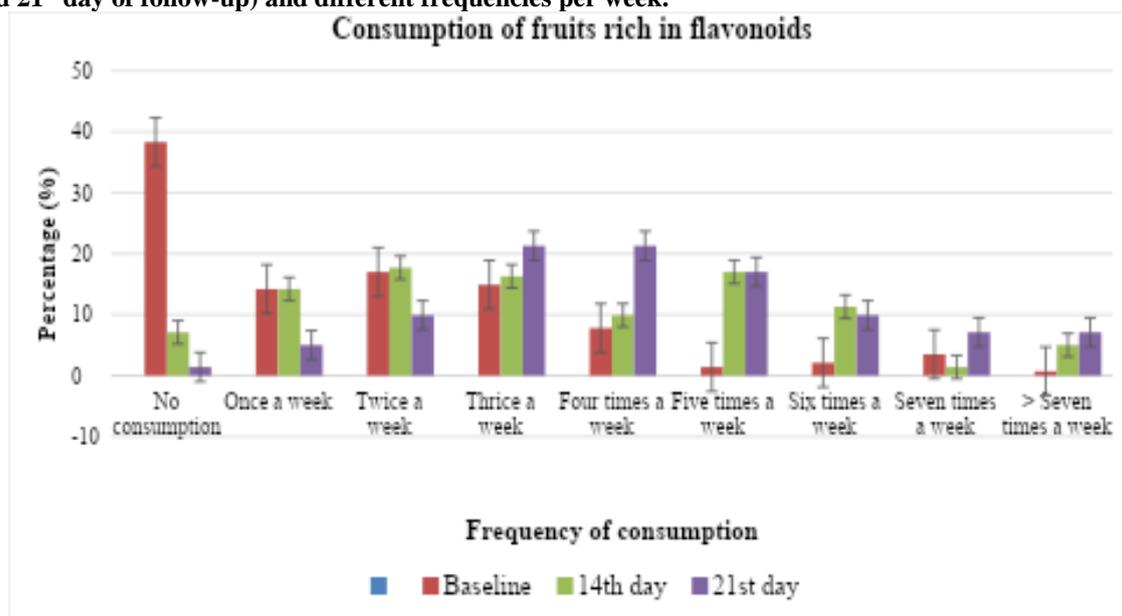
Figure 1: Distribution of berries consumption across three-time intervals (baseline, 14th day of follow-up and 21st day of follow-up) and different frequencies per week.



Dietary counseling significantly increased berry consumption among participants. At baseline, 74.5% of participants reported no berry consumption, whereas by the end of the study, this percentage significantly

decreased to 5.7% ($p < 0.001$). This represents a remarkable 93.3% reduction in the proportion of participants with no berry consumption, indicating a successful intervention. [Figure 1]

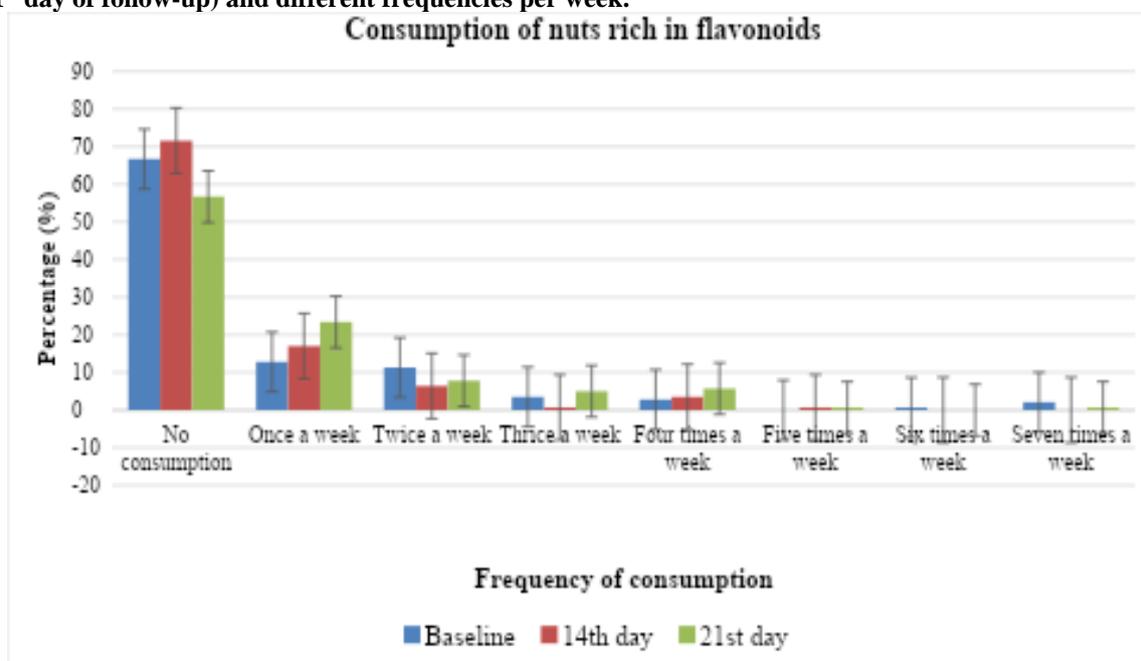
Figure 2: Distribution of fruit consumption across three-time intervals (baseline, 14th day of follow-up and 21st day of follow-up) and different frequencies per week.



A significant increase in fruit consumption was observed among participants following the intervention. At baseline, 38.3% of participants reported no fruit consumption, which decreased dramatically to 1.4% by

the end of the study ($p < 0.001$). Moreover, by day 21, 17.7% of participants reported consuming fruits twice a week, indicating a stable habit formation and a sustained increase in fruit consumption. [Figure 2]

Figure 3: Distribution of nut consumption across three-time intervals (baseline, 14th day of follow-up and 21st day of follow-up) and different frequencies per week.

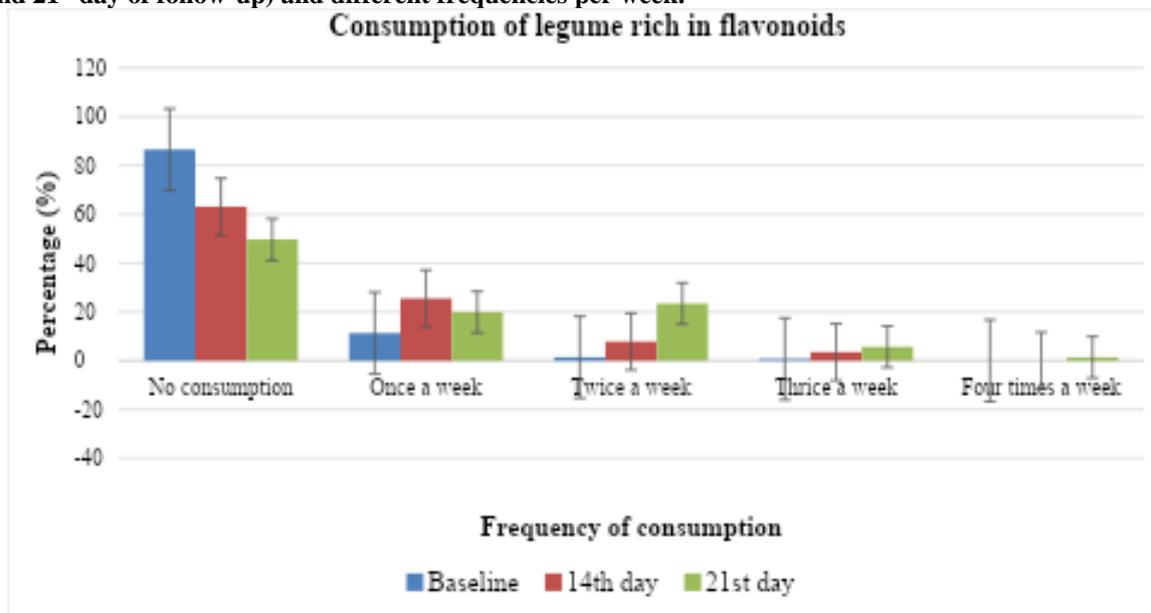


A significant increase in nut consumption was observed between baseline and day 21, with a frequency of once a week. Specifically, the proportion of participants

reporting zero nut intake decreased by 10% (from 66.7% to 56.7%, $p < 0.05$). This suggests a positive shift in nut consumption

habits among participants over the 21-day study period. [Figure 3]

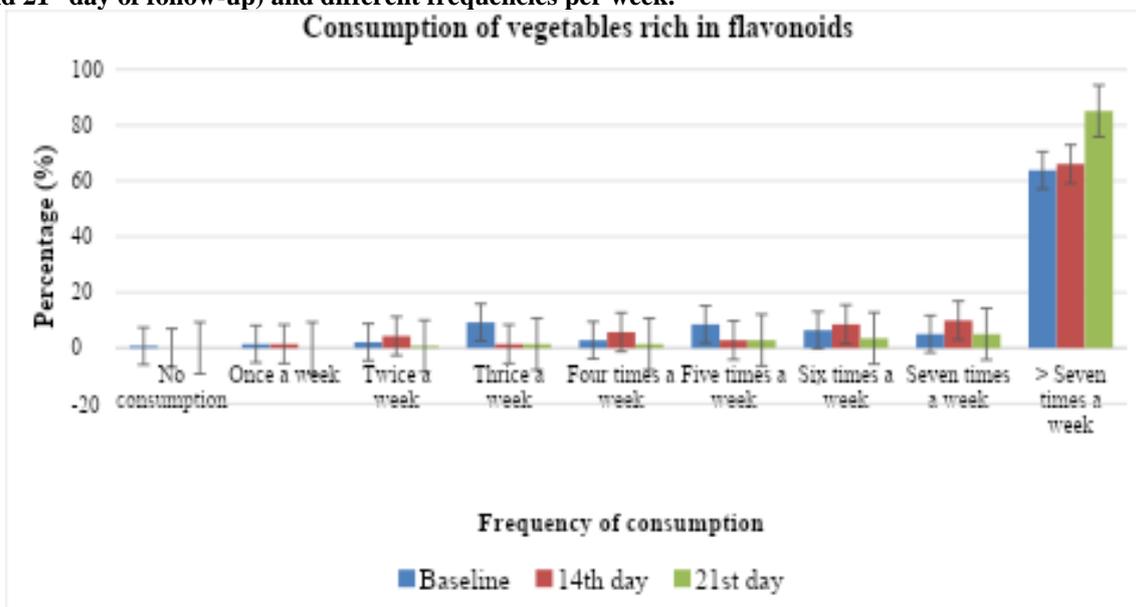
Figure 4: Distribution of legume consumption across three-time intervals (baseline, 14th day of follow-up and 21st day of follow-up) and different frequencies per week.



A significant increase in soybean consumption was observed between baseline and the 21st day of follow-up. Specifically, the proportion of participants consuming soybean twice a week increased

markedly from 1.4% at baseline to 23.4% at day 21 ($p < 0.001$). This represents a 16.4-fold increase in soybean consumption over the 21-day study period. [Figure 4]

Figure 5: Distribution of fruits consumption across three-time intervals (baseline, 14th day of follow-up and 21st day of follow-up) and different frequencies per week.



Prior to the study initiation, a vast majority (99.3%) of participants reported consuming vegetables, indicating a prevalent pre-existing habit. Following diet counseling, a

significant proportion (85.1%) of participants increased their weekly vegetable consumption to more than 7 times per week by day 21, representing a

substantial boost in vegetable intake. [Figure 5]

Table 3: Kruskal-Wallis test for intake of flavonoid rich food among different socio-economic status groups.

Groups	Subgroups	Socio-economic status	N	Mean Rank	χ^2	p value
Berries	Baseline	Upper	19	65.95	3.308	0.508
		Upper middle	28	76.18		
		Lower middle	40	71.80		
		Upper lower	48	71.56		
		Lower	6	53.00		
	14 th day of follow-up	Upper	19	62.74	8.364	0.079
		Upper middle	28	89.80		
		Lower middle	40	64.50		
		Upper lower	48	68.56		
		Lower	6	72.25		
	21 st day of follow-up	Upper	19	50.71	10.797	0.029*
		Upper middle	28	66.93		
		Lower middle	40	67.20		
		Upper lower	48	83.86		
		Lower	6	76.67		
Fruits	Baseline	Upper	19	69.74	10.399	0.034*
		Upper middle	28	77.80		
		Lower middle	40	57.03		
		Upper lower	48	75.16		
		Lower	6	103.17		
	14 th day of follow-up	Upper	19	69.76	10.732	0.030*
		Upper middle	28	86.93		
		Lower middle	40	58.84		
		Upper lower	48	68.99		
		Lower	6	97.75		
	21 st day of follow-up	Upper	19	76.92	11.373	0.023*
		Upper middle	28	88.46		
		Lower middle	40	63.51		
		Upper lower	48	61.90		
		Lower	6	93.50		
Nuts	Baseline	Upper	19	69.66	7.538	0.110
		Upper middle	28	81.82		
		Lower middle	40	75.24		
		Upper lower	48	61.15		
		Lower	6	75.33		
	14 th day of follow-up	Upper	19	65.03	1.712	0.789
		Upper middle	28	76.07		
		Lower middle	40	72.41		
		Upper lower	48	68.78		
		Lower	6	74.58		
	21 st day of follow-up	Upper	19	77.84	11.599	0.021*
		Upper middle	28	85.02		
		Lower middle	40	59.13		
		Upper lower	48	67.28		
		Lower	6	92.83		
	Baseline	Upper	19	72.95	1.612	0.807
		Upper middle	28	74.14		
		Lower middle	40	70.13		
		Upper lower	48	70.31		
		Lower	6	61.50		
	14 th day of follow-up	Upper	19	69.68		
		Upper middle	28	78.50		

Legumes		Lower middle	40	76.65	5.279	0.260
		Upper lower	48	64.39		
		Lower	6	55.42		
	21 st day of follow-up	Upper	19	72.00	3.970	0.410
		Upper middle	28	71.93		
		Lower middle	40	78.43		
		Upper lower	48	62.96		
		Lower	6	78.33		
Vegetables	Baseline	Upper	19	69.32	1.091	0.896
		Upper middle	28	72.88		
		Lower middle	40	74.89		
		Upper lower	48	67.56		
		Lower	6	69.17		
	14 th day of follow-up	Upper	19	67.74	1.046	0.903
		Upper middle	28	70.66		
		Lower middle	40	73.90		
		Upper lower	48	68.94		
		Lower	6	80.08		
	21 st day of follow-up	Upper	19	69.74	0.089	0.999
		Upper middle	28	71.25		
		Lower middle	40	70.88		
		Upper lower	48	71.59		
		Lower	6	69.92		

-N= number of study participants; χ^2 =chi square with a df(degree of freedom) 4
 -* $p < 0.05$, ** $p < 0.001$ is considered as statistically significant

A Kruskal-Wallis test was conducted to examine the differences in food intake across various socio-economic status groups. The results showed no significant differences in legume and vegetable intake across the groups. However, significant differences were observed in the intake of certain food groups, including berries, fruits, and nuts. Specifically, the intake of berries was significantly different across the groups

on the 21st day of follow-up ($p = 0.029$). Similarly, the intake of fruits was significantly different at baseline ($p = 0.034$), 14th day ($p = 0.03$), and 21st day ($p = 0.023$). Additionally, the intake of nuts was significantly different on the 21st day ($p = 0.021$). These findings suggest that socio-economic status may play a role in shaping food intake patterns, particularly for certain food groups. [Table 3]

Table 4: Post-hoc analysis of Kruskal-Wallis test: Pairwise comparisons of intake of flavonoid rich food across different socio-economic groups.

		Reference group	Comparison group	Mean difference	p-value
Berries consumption	21 st day of follow-up	Upper	Upper lower	-33.154	0.021*
Fruits consumption	14 th day of follow-up	Lower middle	Upper middle	28.091	0.048*
Nuts consumption	21 st day of follow-up	Lower middle	Upper middle	25.893	0.041*

Post-hoc analysis revealed significant between-group differences in food intake at various time points. The 'Upper-lower' group showed a significantly higher intake of berries compared to the 'Upper' group at the 21st day of follow-up ($p = 0.021$). Additionally, the 'Lower middle' group had

a significantly higher intake of fruits compared to the 'Upper middle' group at both the 14th day ($p = 0.048$) and 21st day ($p = 0.041$) of follow-up. These findings suggest that socio-economic status is associated with differences in food intake patterns, particularly for berries and fruits,

at various time points during the study. [Table 4]

DISCUSSION

In this longitudinal study examining dietary patterns among women and men, we conducted repeated assessments over time to explore the relationship between intake of flavonoid rich food and socioeconomic status (SES). Our findings indicate that there was no overall association between the intake of legumes and vegetables with participants' socioeconomic status. However, we did identify significant associations between SES and the consumption of specific food items, particularly berries, nuts, and fruits, at various points during the study. Notably, we observed a significant correlation between socioeconomic status and berry consumption specifically at the 21st day of follow-up. Additionally, nuts showed a similar association at the 21st day, while fruit consumption was influenced by socioeconomic factors at baseline, as well as on the 14th and 21st days of follow-up. These results suggest that socioeconomic status plays a critical role in shaping dietary intake patterns, particularly concerning berries and fruits over the course of the study. A closer examination of berry consumption revealed a significant decrease in the percentage of individuals not consuming berries from baseline to the 21st day of follow-up. Interestingly, the percentage of participants who reported consuming berries twice a week remained consistent between the 14th and 21st days of follow-up. In contrast, we noted a substantial decrease in the percentage of individuals not consuming fruits when comparing baseline data to the 21st day of follow-up. Furthermore, there was a gradual increase in the proportion of individuals consuming fruits three times a week during this period. When looking at nut consumption, we observed a fluctuating trend in the percentage of individuals not consuming nuts, alongside a steady increase in the percentage of participants consuming

nuts at least once a week. Regarding legume intake, there was a gradual decline in the percentage of individuals not consuming legumes from baseline to the 21st day of follow-up, coupled with a marked increase in the percentage of participants consuming soybeans twice a week over the same timeframe. Finally, it is noteworthy that the majority of participants reported consuming vegetables more than seven times a week, indicating a pre-existing habit of high vegetable intake.

The relationship between fruit and vegetable intake and the incidence of colon and rectal cancer has been extensively investigated in numerous epidemiological studies, with many concluding that substantial evidence supports a protective dietary effect (20). A review of the literature indicates significant associations between the consumption of flavonoid-rich foods and reduced colorectal cancer risk. For instance, a study conducted by Shibata et al. indicated that there's no protective dietary effects for men; however, among women, there was a notable reduction in the incidence of colon cancer associated with higher intakes of vegetables, fruits, and dietary vitamin C. This suggests a potential gender difference in the impact of dietary factors on cancer risk. (21) In another study by Steinmetz et al., revealed inverse associations between total vegetable intake and dietary fiber with colon cancer incidence, although the associations with other specific groups of vegetables and fruits were less pronounced. (22) Moreover, research conducted by Fadelu et al. highlighted that higher nut consumption was linked to reduced rates of cancer incidence, recurrence, and mortality. This finding emphasizes the potential role of nut consumption in cancer management. (23) Additionally, a study by Yang et al. indicated an inverse relationship between total soy intake and colorectal cancer risk, further supporting the protective dietary factors in cancer prevention. (24) Our findings also indicate that sufficient variation in the consumption of fruits, nuts, and berries among study participants is

crucial for understanding these associations. While some individuals reported low intake of fruits, others consumed fruits more than four times a week (Fig. 2). Notably, the majority of participants reported consuming vegetables more than seven times a week (Fig. 5). However, it is important to note that this does not rule out the possibility of an increased risk of colorectal cancer associated with very low consumption of fruits and vegetables. Unhealthy Dietary and lifestyle habits are linked to an increased risk of cancer on their own next only to prominent risk factors like alcohol and smoking. (25)

Flavonoid consumption varies across different occupational groups, reflecting disparities in diet quality and access to health-promoting foods. A flavonol-rich diet, particularly one high in quercetin from non-tea sources, may help reduce the risk of advanced adenoma recurrence and lower the likelihood of developing colon cancer. (26,27) Additionally, the intake of dietary flavonoids is inversely correlated with the severity of inflammatory bowel disease (IBD), with patients experiencing milder forms of IBD consuming more flavonoids compared to those with severe disease, suggesting that low flavonoid intake is linked to a significantly higher risk of severe IBD. (28)

There are few limitations inherent in our study. Firstly, the follow-up periods were relatively short, which may restrict our ability to capture long-term dietary impacts on health outcomes. Additionally, the study did not include a quantitative assessment of food intake, which could have provided more precise insights. Moreover, the generalizability of our findings is limited by the characteristics of the study population. Participants may have dietary preferences influenced by the availability of foods within their specific demographic and cultural context. This limitation means that our results may not accurately reflect the dietary habits or health outcomes of broader populations with different food environments or cultural practices.

Consequently, caution should be exercised when attempting to extrapolate our findings to other groups or settings.

CONCLUSION

Promoting dietary changes to increase flavonoid intake, alongside broader public health efforts could be key in addressing the growing incidence of colorectal cancer in India. The findings of this study revealed disparities in flavonoid consumption across different socioeconomic groups, highlighting potential inequalities in diet quality and access to health-promoting foods. However, long-term follow-up and clinical studies are necessary to confirm the effectiveness of flavonoid rich food in the prevention of colorectal cancer through dietary counseling.

Declaration by Authors

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REFERENCES

1. Labani S, Asthana S, Khenchi R. Incidence of colorectal cancers in India: A review from population-based cancer registries. *Current Medicine Research and Practice*. 2021;11(2):91.
2. Roshandel G, Ghasemi-Kebria F, Malekzadeh R. Colorectal Cancer: Epidemiology, Risk Factors, and Prevention. *Cancers*. 2024 Jan 1;16(8):1530.
3. Nelson H, Petrelli N, Carlin A, Couture J, Fleshman J, Guillem J, et al. Guidelines 2000 for colon and rectal cancer surgery. *Journal of the National Cancer Institute*. 2001 Apr 18;93(8):583–96.
4. Madugula S, Prabu D, Sindhu R, Dhamodhar D, Rajmohan M, Bharathwaj VV, Sathiyapriya S, Devdoss P, Jayaraman Y. A Holistic, Evidence-Based Approach to Preventing Colorectal Cancer with a Focus on Early Detection, Risk Factor Management, Diet, and Lifestyle Modification with an Emphasis on Oral Dysbiosis, Chemoprevention, and Immunoprevention. *Trop Gastroenterol*. 2024; 45(2):71-84.
5. Katona BW, Weiss JM. Chemoprevention of Colorectal Cancer. *Gastroenterology*. 2020 Jan 1;158(2):368–88.
6. Pyo Y, Ki Han Kwon, Yeon Ja Jung. Anticancer Potential of Flavonoids: Their Role in Cancer Prevention and Health Benefits. *Foods*. 2024 Jul 17;13(14):2253–3.
7. Weng CJ, Yen GC. Flavonoids, a ubiquitous dietary phenolic subclass, exert extensive in vitro anti-invasive and in vivo anti-metastatic activities. *Cancer and Metastasis Reviews*. 2012 Feb 8;31(1-2):323–51.
8. Sanaz Koosha, Alshawsh MA, Chung Yeng Looi, Atefehalsadat Seyedan, Mohamed Z. An Association Map on the Effect of Flavonoids on the Signaling Pathways in Colorectal Cancer. 2016 Jan 1;13(5):374–85.
9. Fernández J, Silván B, Entrialgo-Cadierno R, Villar CJ, Capasso R, Uranga JA, et al. Antiproliferative and palliative activity of flavonoids in colorectal cancer. *Biomedicine & Pharmacotherapy*. 2021 Nov 1; 143:112241.
10. Li Y, Zhang T, Chen G. Flavonoids and Colorectal Cancer Prevention. *Antioxidants*. 2018 Dec 10;7(12):187.
11. Yahia EM, García-Solís P, Celis MEM. Contribution of Fruits and Vegetables to Human Nutrition and Health. *Postharvest Physiology and Biochemistry of Fruits and Vegetables*. 2019;19–45.
12. Dhanalekshmi Unnikrishnan Meenakshi, Gurpreet Kaur Narde, Ahuja A, Khalid Al Balushi, Arul Prakash Francis, Shah Alam Khan. Therapeutic Applications of Nanoformulated Resveratrol and Quercetin Phytochemicals in Colorectal Cancer—An Updated Review. *Pharmaceutics*. 2024 Jun 4;16(6):761–1.
13. Qin J, Chen JX, Zhu Z, Teng JA. Genistein Inhibits Human Colorectal Cancer Growth and Suppresses MiR-95, Akt and SGK1. *Cellular Physiology and Biochemistry*. 2015;35(5):2069–77.
14. Ren W, Qiao Z, Wang H, Zhu L, Zhang L. Flavonoids: Promising anticancer agents. *Medicinal Research Reviews*. 2003 Apr 17;23(4):519–34.
15. Rossi M. Flavonoids and Colorectal Cancer in Italy. *Cancer Epidemiology Biomarkers & Prevention*. 2006 Aug 1;15(8):1555–8.
16. Theodoratou E, Kyle J, Cetnarskyj R, Farrington SM, Tenesa A, Barnetson R, et al. Dietary Flavonoids and the Risk of Colorectal Cancer. *Cancer Epidemiology Biomarkers & Prevention*. 2007 Apr 1;16(4):684–93.
17. Arts IC, Jacobs DR Jr, Gross M, Harnack LJ, Folsom AR. Dietary catechins and cancer incidence among postmenopausal women: the Iowa Women's Health Study (United States). *Cancer Causes Control*. 2002 May;13(4):373-82. doi: 10.1023/a:1015290131096. PMID: 12074507.
18. Lin J, Zhang SM, Wu K, Willett WC, Fuchs CS, Giovannucci E. Flavonoid Intake and Colorectal Cancer Risk in Men and Women. *American Journal of Epidemiology*. 2006 Aug 21;164(7):644–51.
19. CDC. Colorectal Cancer Risk Factors. *Colorectal Cancer*. 2024.
20. Michels KB. Prospective Study of Fruit and Vegetable Consumption and Incidence of Colon and Rectal Cancers. *Journal of the National Cancer Institute*. 2000 Nov 1;92(21):1740–52.
21. Shibata A, Paganini-Hill A, Ross R, Henderson B. Intake of vegetables, fruits, beta-carotene, vitamin C and vitamin supplements and cancer incidence among

- the elderly: a prospective study. *British Journal of Cancer*. 1992 Oct;66(4):673–9.
22. Steinmetz KA, Kushi LH, Bostick RM, Folsom AR, Potter JD. Vegetables, Fruit, and Colon Cancer in the Iowa Women's Health Study. *American Journal of Epidemiology*. 1994 Jan 1;139(1):1–15.
23. Fadelu T, Zhang S, Niedzwiecki D, Ye X, Saltz LB, Mayer RJ, et al. Nut Consumption and Survival in Patients with Stage III Colon Cancer: Results from CALGB 89803 (Alliance). *Journal of Clinical Oncology*. 2018 Apr 10;36(11):1112–20.
24. Yang G, Shu XO, Li H, Chow WH, Cai H, Zhang X, et al. Prospective cohort study of soy food intake and colorectal cancer risk in women. *The American Journal of Clinical Nutrition*. 2008 Dec 10;89(2):577–83.
25. Anjum AR, Prabu D, Madugula S, Sindhu R, Dhamodhar D, Rajmohan M. Role Of Fermented Rice In Modifying Gastrointestinal Microbiome and Its Anti-Carcinogenic Effects: A Systematic Review. *AJBR*. 2024 Nov. 9;27(4S):227-3.
26. Kyle JAM, Sharp L, Little J, Duthie GG, McNeill G. Dietary flavonoid intake and colorectal cancer: a case-control study. *British Journal of Nutrition*. 2009 Sep 7;103(3):429–36.
27. Bobe G, Sansbury LB, Albert PS, Cross AJ, Kahle L, Ashby J, et al. Dietary Flavonoids and Colorectal Adenoma Recurrence in the Polyp Prevention Trial. *Cancer Epidemiology, Biomarkers & Prevention*. 2008 Jun 1;17(6):1344–53.
28. Lu SY, Dan L, Sun S, Fu T, Chen J. Dietary quercetin intake is associated with lower ulcerative colitis risk but not Crohn's disease in a prospective cohort study and *in vivo* experiments. *Food & Function*. 2024 Jan 1;15(12):6553–64.
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