International Journal of Health Sciences and Research
[Indexed, Peer-Reviewed Journal]
Volume 15; Issue: 6; June 2025
Website: www.ijhsr.org
ISSN: 2249-9571
Original Research Article

Assessment of Oral Cancer Preventive Action Using Dietary Record of EGCG, Silibinin and Anthocyanin Containing Food Consumption Followed by a Targeted Dietary Intervention and Post Interventional Dietary Assessment - A Novel Investigative Study

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DOI: https://doi.org/10.52403/ijhsr.20250602

ABSTRACT

Background: Oral cancer remains a significant public health concern, particularly in regions with high tobacco use and limited access to preventive care. Early identification of risk factors and effective community-based interventions are essential to reduce disease burden and improve prognosis.
Aim: This study aimed to evaluate the impact of behavioural risk factors and dietary practices associated with oral cancer among a defined population.
Materials and Methods: A community-based interventional study was conducted among adults aged 18 years and above. Baseline data on dietary practices related to prevention of oral cancer were collected using a structured questionnaire. The intervention included health education sessions, tobacco cessation and dietary counselling. Post-intervention assessments were carried out to evaluate changes in dietary practices.
Results: The findings revealed a marked improvement in the intake of flavonoid-rich foods following dietary counselling, with a significant rise in berry consumption ($p<0.05$) among smokeless tobacco users and over 20% of participants reporting vegetable intake more than seven times per week by the end of 21st day. At both baseline and on the 21st day of follow-up, statistically significant differences were observed in vegetable ($p < 0.01$) and nut ($p < 0.05$) consumption respectively across the various smoking behavior groups.

Additionally, among participants using smokeless tobacco, berry intake differed significantly on the 14th ($p < 0.05$) and 21st ($p < 0.01$) days of follow-up. At baseline, nut consumption also varied significantly among alcohol-consuming groups ($p < 0.05$). Post-hoc comparisons indicated that individuals who did not engage in harmful habits such as smoking or alcohol use consumed substantially higher quantities of vegetables, nuts, and berries compared to those exhibiting such behaviors ($p < 0.05$).
Conclusion: This study highlights the need for comprehensive public health approaches that prioritize dietary changes to lower cancer risk, especially among high-risk groups. The results emphasize the value of personalized dietary guidance in fostering long-term healthy eating patterns and reducing the likelihood of chronic conditions such as oral cancer. Enhancing health literacy, supporting lifestyle modifications, and promoting routine screenings can facilitate early detection and better prognosis.

Keywords: Flavonoids, oral cancer, dietary counselling

INTRODUCTION

Based on the latest GLOBOCAN data, oral cancer ranks among the top 15 cancers worldwide, with varying prevalence in different regions [1]. At the global level, there are approximately 377,000 new cases of oral cancer reported each year [2]. The highest incidence rates are typically located in regions like South Asia, particularly in a country like India which accounts for approximately 30%, where tobacco and betel quid use is prevalent (3).
Treatment for oral cancer typically involves a combination of therapies tailored to the individual's condition, including surgical procedures, radiation therapy, chemotherapy, targeted therapy, immunotherapy, and supportive care [4].
Chemotherapy is a relatively new field for prevention of cancer and refers to the use of dietary or pharmaceutical interventions to slow or reverse the progression from pre-malignancy to invasive cancer [5]. Flavonoids are polyphenolic compounds derived from plants that have a wide range of biological activities, including antioxidants and anticancer properties [6]. Key flavonoids that have demonstrated a protective effect against oral cancer include anthocyanin, silibinin and EGCG [7]. Red wine, purple cabbage, berries, and grapes are the main sources of Anthocyanins [8]. Silibinin, a flavonolignan, is the major biologically active constituent of silymarin, isolated from the dried fruits and seeds of Silybum marianum (milk thistle) [9]. Green tea is a widely used beverage with healthy effects on several diseases, including cancer [10]. The bioactive compounds of green tea are mainly catechins, and epigallocatechin-gallate (EGCG) [11]. These natural flavonoids possess antioxidant, anti-inflammation, as well as anti-cancerous activities through multiple pathways [12].
Several studies highlight the impact of natural flavonoids on oral cancer cells, inducing apoptosis, and confirming their potential [13]. The intake of flavonoids has been decreasing the risk of various common neoplasms, but scant data exist on oral cancer [14].
Additionally, emerging evidence suggests that dietary components such as fermented rice may beneficially alter the gastrointestinal microbiota and exhibit anti-cancer effects, potentially contributing to systemic protective mechanisms, including against oral cancers. [15]
Schabath et al. suggest that flavonoids and phytoestrogens are associated with reduced oral cancer, ischemic heart disease, and other conditions by counteracting the growth through inhibition of cell cycle progression, apoptosis induction and the modulation of intracellular pathways [16,17].They have been proved to counteract the growth of several types of cancer through multiple mechanisms

including the inhibition of cell cycle progression, apoptosis induction, and the modulation of intracellular pathways [18]. These chemo-preventive agents can also be used in combination with other cancer treatments, such as chemotherapy, to increase their efficacy due to their relatively minimal side effects and non-toxic property [19].

The aim of the present study is to ascertain the difference in the intake of the flavonoid rich food that are beneficial in preventing oral cancer, post dietary counselling. We hypothesize that there would be a significant difference in the intake of flavonoid rich food among the participants with the habit of tobacco use.

MATERIALS & METHODS

Study Design and Population:

This longitudinal study was carried out at SRM Dental College, Ramapuram, Chennai, India between June 2024 to October 2024.The study Participants were evaluated for their risk for developing oral cancer and men and women over 25 years of age who demonstrated more than 50% of the indicated risk factors for oral cancer and who gave informed consent were included in the study. The study eliminated participants who were younger than 25 or fewer than 50% of the risk variables. Dietary history over a 7-day period was recorded and assessed at baseline,14th day and 21st day post dietary counselling.

Data Collection:

Data were collected from participants via an interviewer-administered questionnaire that contained demographic information as well as oral cancer risk factors questions as defined by the CDC which included history on cigarette smoking history of oral cancer survival, having a first degree relative with oral cancer, exposure to hazardous workplaces (such as those involving asbestos, arsenic, diesel exhaust, certain forms of silica, and chromium), and living in high pollution areas were all risk factors[20]. Participants with more than 50% of these risk factors were included in the study whereas those under the age of 25 or with less than 50% of exposure to the risk factors were excluded from the study. The Participants dietary history was documented throughout a 7-day period at three intervals: baseline, 14th and 21st day for their intake of flavonoid rich food requested to document content and timing of their diet to guarantee reliable data collection. At the end of 7th and 14th day were analyzed, and dietary counselling was provided to encourage increased consumption of flavonoid-rich foods, that are rich in silibinin, anthocyanin, EGCG, which are known to aid in oral cancer prevention.

Sample size estimation:

Using the formula 4*p*q/L2 (p = oral cancer prevalence, q = 1-p, and L = 5% precision), the sample size was calculated to be 114 based on the reported prevalence of mouth cancer in men of 7.7% [21]. With 10% attrition taken into account, the sample size was increased to 127.

STATISTICAL ANALYSIS

The Statistical Package for Social Sciences (version 24, IBM, Chicago, USA) was used for all analyses. The Kolmogorov-Smirnov test was used to check for normality in the data; if it did not, non-parametric tests of significance were conducted. The study sample's characteristics were described using descriptive statistics. The Kruskal-Wallis test was used to compare means and investigate the relationship between eating foods high in flavonoids and harmful behaviors. A significance level (α) of 5% was established

RESULT

Men living in Ramapuram, Chennai, participated in a longitudinal follow-up study design to evaluate and compare their consumption of foods high in flavonoids at three different follow-up points following dietary counseling: baseline, the fourteenth day, and the twenty-first day between

February 2024 and August 2024. Twenty-three of the 206 potential individuals chose not to take part in the study, and 57 of them did not fit the inclusion requirements. The remaining 122 participants underwent statistical analysis after 4 were lost to follow-up at the end of the trial. For better data insights, the consumption of foods high in flavonoids was divided into the following categories: berries (blueberries, cranberries, blackberries, and raspberries), fruits (pomegranate, apple, avocado, peach, pear, and plums), nuts (pista and hazelnut), and vegetables (broccoli, cabbage, carrot, and radish).

Table 1: Demographic characteristics of study participants

Groups		Frequency (n)	Percentage %
Age (in years)	<25	5	4.1
	26-39	23	18.9
	40-54	35	28.7
	>55	59	48.4
Religion	Hindu	83	68
	Christian	25	20.5
	Muslim	14	11.5
Educational qualification	Illiterate	15	12.3
	Primary school	17	13.9
	Middle school	17	13.9
	High school	30	24.6
	Intermediate / diploma	19	15.6
	Graduate	18	14.8
	Professional	8	6.6
Occupation	Unemployed	5	4.1
	Elementary occupation	12	9.8
	Plant and machine operators and assemblers	17	13.9
	Craft and related trade workers	19	15.6
	Skilled agricultural and fishery workers	15	12.3
	Skilled workers, shop and market sales	18	14.8
	Clerk	9	7.4
	Technician /Associate professors	6	4.9
	Professional	14	11.5
	Legislatures, senior officials, Manager	7	5.7
Body Mass Index (BMI)	Normal weight: 18.5-24.9	32	26.2
	Overweight: 25-29.9	43	35.3
	Obese class I: 30-34.9	35	28.7
	Obese class II: 35-39.9	12	9.8

Of the study participants, approximately 48.4% were older than 55. Sixty-eight percent of the study population were Hindus, including more than half of the study participants.

12.3% of research participants were illiterate, compared to 8% who were professionals. Of the participants, 5.7% held high leadership roles, and less than 5% were unemployed. The percentage of study participants who were overweight or obese was around 35.3% and 38.5%, respectively. [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 >55 years	Yes	59 (48.4)	0.13	0.71
	No	63 (51.6)		
Cigarette smoking	Yes	68 (55.7)	1.60	0.20
	No	54 (44.3)		

Smokeless tobacco	Yes	78 (63.9)	9.47	<0.05*
	No	44 (36.1)		
Alcohol consumption	Yes	86 (70)	20.49	<0.001**
	No	36 (30)		
Consumption of diet low in fruits and vegetables	Yes	67 (54.9)	1.18	0.27
	No	55 (45.1)		

-N= number of study participants; χ²=chi square with a df(degree of freedom)1
-***p***<0.001, ****p***<0.05 is considered as statistically significant**

The observed distribution of participants exposed to risk variables, such as alcohol and smokeless tobacco use, deviated considerably from the expected equal proportions ($p<0.05$ and $p<0.001$ respectively), according to a Chi-Square Goodness-of-Fit test. [Table 2]

Table 3: Kruskal-Wallis test for intake of flavonoid rich food among the users of cigarettes

Groups	Subgroups	Cigarette users	N	Mean Rank	χ²	*p* value
Berries	Baseline	Yes	68	60.93	0.06	0.79
		No	54	62.22		
	14th day of follow-up	Yes	68	59.89	0.38	0.53
		No	54	63.53		
	21st day of follow-up	Yes	68	58.93	0.89	0.34
		No	54	64.73		
Fruits	Baseline	Yes	68	57.17	2.63	0.10
		No	54	66.95		
	14th day of follow-up	Yes	68	57.43	2.23	0.13
		No	54	66.63		
	21st day of follow-up	Yes	68	57.99	1.69	0.19
		No	54	65.93		
Nuts	Baseline	Yes	68	57.24	6.98	<0.05*
		No	54	66.86		
	14th day of follow-up	Yes	68	61.90	0.02	0.88
		No	54	60.99		
	21st day of follow-up	Yes	68	59.60	0.48	0.48
		No	54	63.89		
Vegetables	Baseline	Yes	68	60.46	0.13	0.71
		No	54	62.81		
	14th day of follow-up	Yes	68	61.43	0.26	0.97
		No	54	61.59		
	21st day of follow-up	Yes	68	61.80	7.29	<0.01**
		No	54	61.12		

N= number of study participants; χ²=chi square with a df(degree of freedom) 1
-**p***<0.05, *****p***<0.01 is considered as statistically significant**

The results of a Kruskal-Wallis test showed that the intake of fruits and berries was not significantly different. The consumption of vegetables [21st day of follow-up: 7.29 (1), N=122, $p<0.01$] and nuts [Baseline: 6.98 (1), N=122, $p<0.05$] varied significantly throughout smoking habit groups [Table 3]

Table 4: Kruskal-Wallis test for intake of flavonoid rich food among the users of smokeless tobacco

Groups	Subgroups	Smokeless tobacco	N	Mean Rank	χ²	*p* value
Berries	Baseline	Yes	78	59.82	0.80	0.36
		No	44	64.48		
	14th day of follow-up	Yes	78	57.83	5.79	<0.05*
		No	44	68.01		
	21st day of follow-up	Yes	78	57.52	6.04	<0.05*

		No	44	68.56		
Fruits	Baseline	Yes	78	60.59	0.16	0.68
		No	44	63.11		
	14th day of follow-up	Yes	78	60.47	0.20	0.65
		No	44	63.32		
	21st day of follow-up	Yes	78	59.38	0.86	0.35
		No	44	65.25		
Nuts	Baseline	Yes	78	59.44	0.98	0.32
		No	44	65.15		
	14th day of follow-up	Yes	78	62.01	0.05	0.82
		No	44	60.59		
	21st day of follow-up	Yes	78	60.60	0.15	0.69
		No	44	63.10		
Vegetables	Baseline	Yes	78	60.59	0.14	0.70
		No	44	63.11		
	14th day of follow-up	Yes	78	61.12	0.02	0.87
		No	44	62.17		
	21st day of follow-up	Yes	78	60.65	0.12	0.72
		No	44	63.00		

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

The consumption of fruits, nuts, and vegetables did not differ significantly, according to the results of a Kruskal-Wallis test. Nonetheless, there was a noteworthy variation in the amount of berries consumed by the smokeless tobacco groups [14th day of follow-up: 5.79 (1), N=122, p<0.05 and 21st day of follow-up: 6.04 (1), N=122, p<0.01]. [Table 4]

Table 5: Kruskal-Wallis test for intake of flavonoid rich food among the users of alcohol

Groups	Subgroups	Alcohol consumption	N	Mean Rank	χ^2	p value
Berries	Baseline	Yes	86	60.04	0.14	0.70
		No	36	62.11		
	14th day of follow-up	Yes	86	57.43	0.81	0.36
		No	36	63.20		
	21st day of follow-up	Yes	86	59.61	0.16	0.68
		No	36	62.29		
Fruits	Baseline	Yes	86	65.29	0.67	0.41
		No	36	59.91		
	14th day of follow-up	Yes	86	60.51	0.04	0.83
		No	36	61.91		
	21st day of follow-up	Yes	86	64.90	0.52	0.46
		No	36	60.08		
Nuts	Baseline	Yes	86	53.86	5.19	0.05*
		No	36	64.70		
	14th day of follow-up	Yes	86	58.04	0.55	0.45
		No	36	62.95		
	21st day of follow-up	Yes	86	61.39	0.001	0.98
		No	36	61.55		
Vegetables	Baseline	Yes	86	61.08	0.007	0.93
		No	36	61.67		
	14th day of follow-up	Yes	86	62.19	0.02	0.88
		No	36	61.21		
	21st day of follow-up	Yes	86	61.47	0.001	0.99
		No	36	61.51		

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

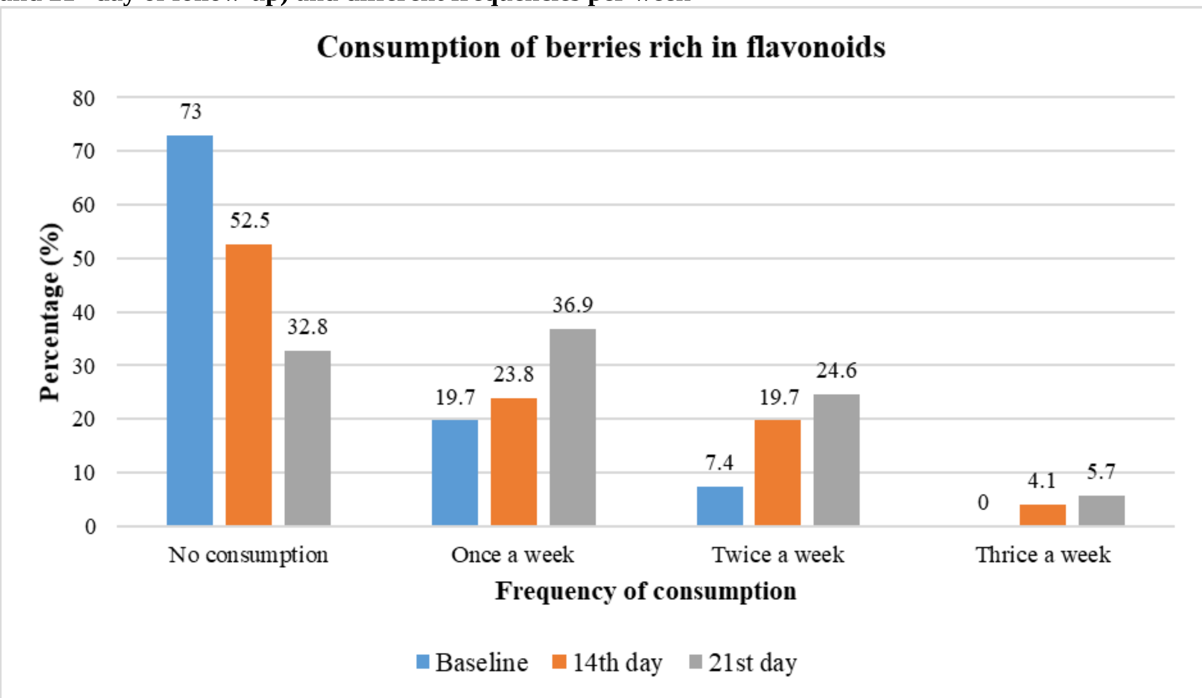
The consumption of berries, fruits, and vegetables did not differ significantly, according to the results of a Kruskal-Wallis test. Nonetheless, there was a noteworthy variation in the amount of nuts consumed by groups who drank alcohol [Baseline: 5.19 (1), N=122, p<0.05]. [Table 5]

Table 6: Post-hoc analysis of Kruskal-Wallis test: Pairwise comparisons of intake of flavonoid rich food across different deleterious habits

		Reference group	Comparison group	Mean difference	p-value
Nuts consumption	Baseline	Cigarette users	Non-cigarette users	-32.17	0.03*
Vegetable consumption	21st day of follow-up	Cigarette users	Non-cigarette users	-29.63	0.02*
Berries consumption	14th day of follow-up	Smokeless tobacco users	Non-smokeless tobacco users	-33.69	0.02*
	21st day of follow-up	Smokeless tobacco users	Non-smokeless tobacco users	-25.29	0.02*
Nuts consumption	Baseline	Alcohol users	Non-alcohol users	-34.16	0.04*

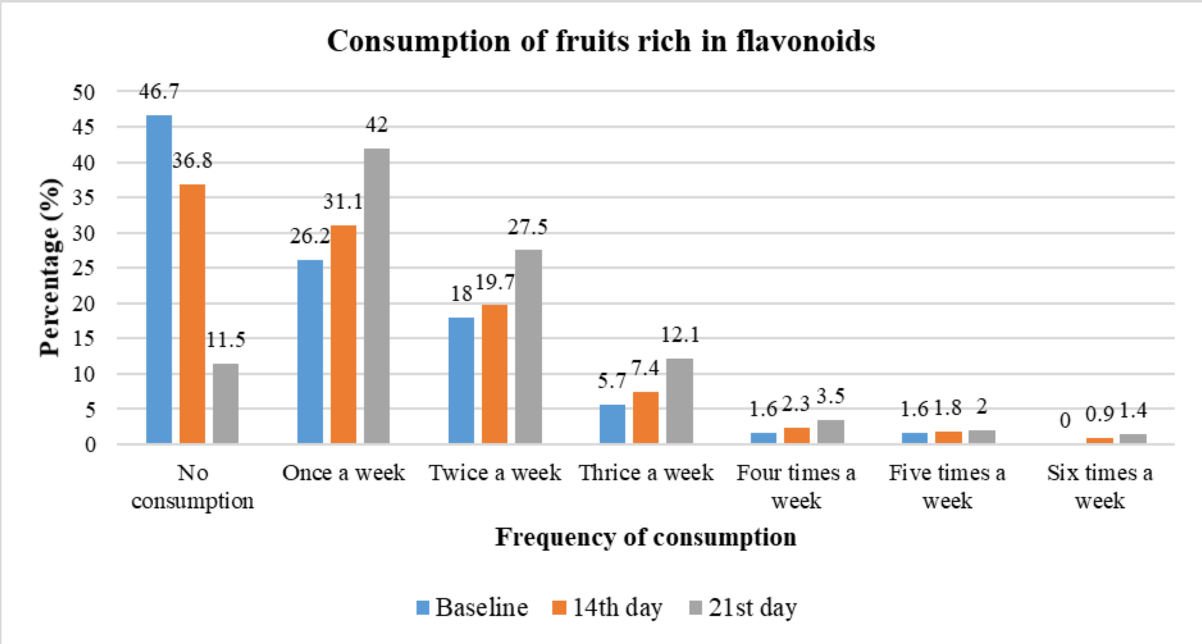
Participants without harmful behaviours consumed considerably more nuts, vegetables, and berries than those with harmful habits, according to post-hoc analysis (p<0.05). [Table 6]

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



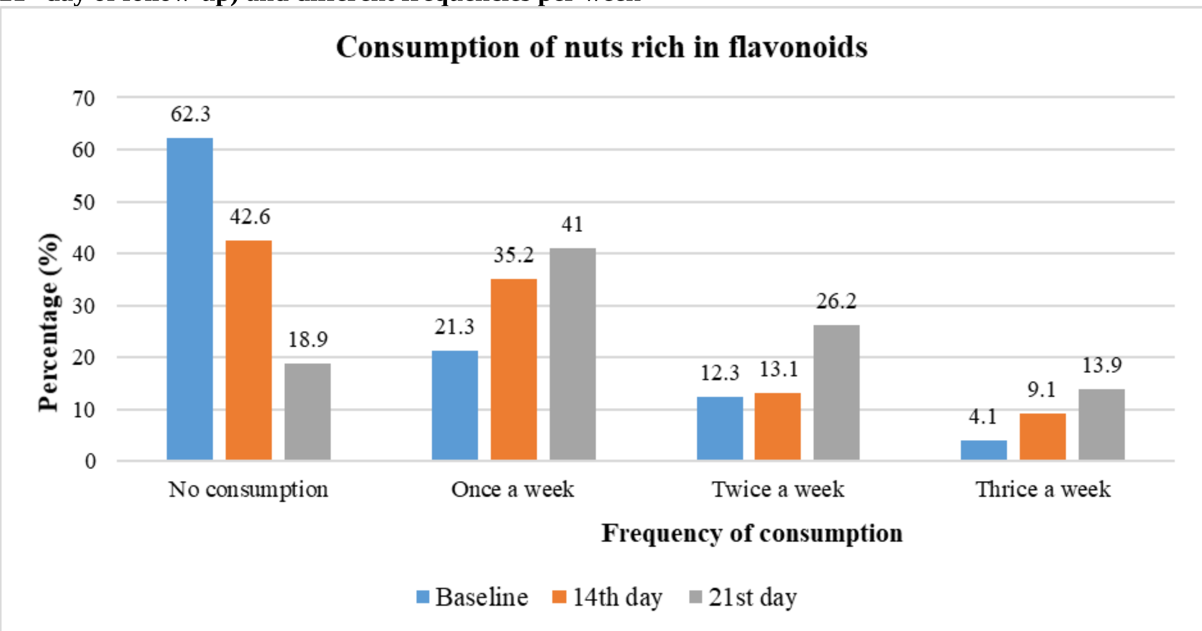
Berry consumption increased significantly as a result of dietary counseling; by the end of the trial, 32.8% of participants reported consuming berries, down from 73% who reported not doing so at baseline. Approximately 36.9% of study participants reported eating berries once a week at the conclusion of the trial. [Figure 1]

Figure 2: 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



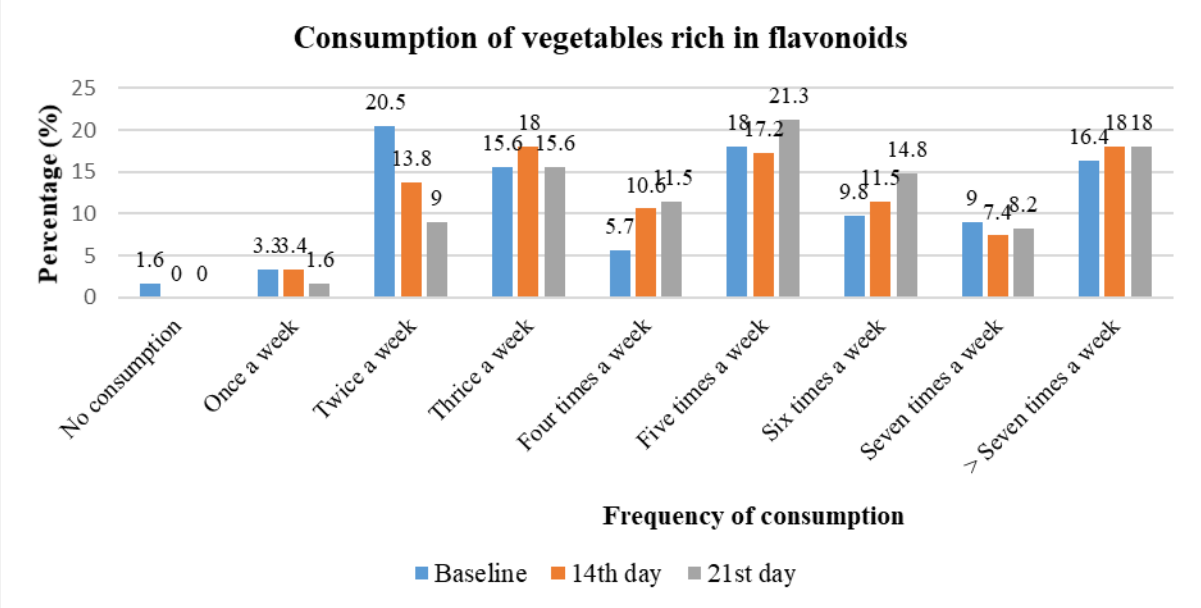
With 46.7% of individuals reporting no consumption at baseline dropping to 11.5% by the end of the trial, there was a noticeable rise in fruit consumption. Nearly half (42%) of individuals said they ate fruits once a week by day 21. [Figure 2]

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



Between baseline and day 21, there was a notable rise in nut consumption, with a 43.4% decrease in subjects reporting zero intake (62.3% vs 18.9%). [Figure 3]

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



There were widespread pre-existing practices, as seen by the astounding 98.4% of participants who reported eating vegetables before the study started. Following diet coaching, nearly one-fifth of individuals (21.3%) increased their weekly vegetable consumption to five times per week. [Figure 4]

DISCUSSION

This longitudinal study assessed the influence of dietary counseling on the intake of flavonoid-rich foods—berries, fruits, nuts, and vegetables—among men at risk for oral cancer in Ramapuram, Chennai. Data collected at three time points (baseline, 14th day, and 21st day) provided insights into dietary behavior shifts, particularly in the context of high-risk habits such as tobacco and alcohol use.

The results revealed a marked improvement in the consumption of flavonoid-rich foods following dietary intervention. By the 21st day, berry intake increased significantly, with only 27% of participants reporting no consumption compared to 73% at baseline. Fruit consumption also showed encouraging trends, with nearly 42% of participants consuming fruits once a week by the end of the study. Most notable was the substantial increase in nut consumption, where zero-consumption rates dropped from 62.3% at baseline to 18.9% by the 21st day. Vegetable intake remained consistently high, but follow-up assessments revealed that a greater proportion of participants (21.3%) increased consumption frequency to five times per week.

Despite these overall improvements, the presence of deleterious habits posed barriers to dietary change. Participants who smoked cigarettes showed significantly lower intake of nuts and vegetables at baseline and on the 21st day, respectively. Smokeless tobacco users consumed significantly fewer berries at both 14th and 21st-day follow-ups. Alcohol consumption was also associated with lower nut intake at baseline. These associations suggest that harmful behaviors may impair the adoption of healthier dietary habits, possibly due to diminished taste sensitivity, motivation, or co-existing lifestyle factors.

The demographic analysis also indicated that older age, lower education, and socioeconomic status were correlated with poorer initial intake of flavonoid-rich foods, reinforcing the need for targeted interventions. These populations may face unique barriers, such as limited access, affordability, or awareness, which must be addressed through community-level nutrition programs.

Overall, the study underscores the value of dietary counseling in promoting flavonoid intake—a chemopreventive strategy with potential to reduce oral cancer incidence. While short-term changes were promising, future research should focus on long-term adherence and integration of counseling into broader oral cancer prevention programs.

A study by Sun et al. emphasized the potential of flavonoids such as EGCG, silibinin, and anthocyanins in regulating key cellular pathways involved in cancer prevention [22]. This is particularly relevant in the context of our study, which used counseling to encourage the intake of such compounds through natural dietary sources like green tea, berries, nuts, and cruciferous vegetables. The observed dietary improvements indicate the feasibility of using food-based strategies as part of broader oral cancer prevention frameworks.

Importantly, our study demonstrates that even a relatively short, structured dietary intervention can yield meaningful improvements in dietary patterns among high-risk groups. This aligns with findings by Sharma et al. [23], who highlighted the value of continuous dietary reinforcement in cancer prevention strategies. Moreover, the visible dietary improvements over the three time points suggest that repeated follow-ups enhance retention and adherence, a finding also supported by Kessler et al. [24].

However, it is worth noting that the positive changes observed in dietary habits among those with risk behaviors were relatively less pronounced. This finding is supported by previous research, including that of Schabath et al., which highlighted how addictive behaviors impair health motivation and reduce the efficacy of preventive interventions [25]. These results underscore the importance of adopting multi-modal strategies that simultaneously address dietary habits and substance use.

In addition, Madugula et al. emphasized that oral dysbiosis—a microbial imbalance in the oral cavity—plays a significant role in systemic carcinogenesis, including colorectal and potentially oral cancers [26]. Their findings support the notion that preventive strategies should be holistic, integrating dietary counseling with approaches targeting the microbiome, chemoprevention, and lifestyle modification. This broader framework may further enhance the effectiveness of oral cancer prevention efforts in high-risk populations.

This study presents several inherent limitations that merit consideration. Firstly, the follow-up duration—limited to assessments at baseline, 14 days, and 21 days—may not have been sufficient to evaluate the long-term effects of dietary patterns on health outcomes. Secondly, the absence of a quantitative measure of food consumption restricted the ability to draw more precise associations between dietary intake and cancer risk. Additionally, the external validity of the study is constrained by the nature of the participant group. Dietary behaviours may have been shaped by the local availability of food and cultural preferences, which may not align with those of more diverse or geographically varied populations. As a result, the findings should be interpreted with caution when considering their applicability to other demographic or environmental contexts.

CONCLUSION

Oral cancer is a major public health concern in India, with its burden disproportionately affecting individuals from lower socioeconomic strata, largely due to lifestyle factors such as tobacco and alcohol use, inadequate nutrition, and poor oral hygiene practices. Early diagnosis and timely intervention are crucial to improve survival outcomes. While a significant proportion of cases are preventable through behavioural modifications and health education, awareness regarding early signs and the importance of regular dental screenings remains limited in the general population. There is an urgent need to empower communities with knowledge about risk factors and preventive strategies. Strengthening community-based programs and integrating oral cancer screening into primary healthcare services could play a pivotal role in reducing disease incidence and improving early detection rates. This study underscores the need for collaborative efforts involving policymakers, healthcare professionals, and educators to effectively address the modifiable risk factors and enhance access to timely oral health services.

Declaration by Authors

Ethical Approval: Approved
Acknowledgement: None
Source of Funding: None
Conflict of Interest: The authors declare no conflict of interest.

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How to cite this article: S.P. Srimit Prethish, E. Ragavapriya, Gayathiri R, Sindhu R, Lubna Fathima, Prabu D et.al. Assessment of oral cancer preventive action using dietary record of EGCG, Silibinin and Anthocyanin containing food consumption followed by a targeted dietary intervention and post interventional dietary assessment - a novel investigative study. *Int J Health Sci Res.* 2025; 15(6): 9-20. DOI: *https://doi.org/10.52403/ijhsr.20250602*

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