Life Science Informatics Publications

Research Journal of Life Sciences, Bioinformatics, Pharmaceutical and Chemical Sciences

Journal Home page http://www.rjlbpcs.com/

RJLBPCS ISSN 2454-6348

Original Research Article **DOI: 10.26479/2025.1102.02**

EXPLORING DIETARY COUNSELLING AND FLAVONOID RICH FOODS CONSUMPTION ACROSS VARIOUS OCCUPATIONAL GROUPS WITH ELEVATED PROSTATE CANCER RISK IN CHENNAI CITY, INDIA

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ABSTRACT:

Background:

Prostate cancer represents a leading cause of cancer incidence and mortality worldwide, with a notable increase in case, particularly among younger populations. Traditional treatment modalities are frequently associated with significant side effects, emphasizing the urgent need for alternative strategies, such as chemo-prevention. Flavonoid, naturally occurring compounds in fruits and vegetables, have gained attention for their potential anticancer properties, attributed to their antioxidant, anti-inflammatory, and cancer-preventive effects. The present study investigates the intake of flavonoid rich food across different occupational groups, at different follow-up periods.

Materials and method:

This longitudinal study was conducted among patients attending Primary Health Centre, Shakthi Nagar, Chennai, India. Participants were enrolled in the study based on their responses to prostate cancer risk factors. Data were collected via an interviewer-administered questionnaire and the participants were advised to record a 7-day dietary history at the end of three intervals (baseline, 14^{th} day, 21^{st} day) to monitor the intake of flavonoid rich food. Dietary counselling was provided to encourage the consumption of flavonoid-rich foods.

Results:

The results indicated no significant differences in the intake of berries and legumes across various occupational categories. In contrast, significant differences were observed in the consumption of flavonoid-rich fruits [$p < 0.05$] at the 21st day follow-up, nuts [$p < 0.05$] at baseline, and vegetables [$p < 0.001$] at the 14th day follow-up across different occupational categories. There is significant higher consumption of fruits, vegetables and nuts in 'Plant and machine operators and assemblers'

($p < 0.05$) compared to 'Professionals', 'Unemployed', and 'Elementary' groups at the 21st day,14th day and baseline of follow up, respectively. Furthermore, the 'Clerk' group demonstrated significantly higher vegetable consumption ($p < 0.05$) compared to the 'Elementary' group.

Conclusion:

This study identified differences in flavonoid consumption across various occupational groups, emphasising disparities in diet quality and access to health-promoting foods

Keywords: Flavonoids, Prostate cancer, 7-day dietary history, Occupational groups.

Article History: Received: March 28, 2025; Revised: April 10, 2025; Accepted: April 30, 2025

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1.INTRODUCTION

Prostate Cancer is among the leading cancers in male populations especially in the urban Setup such as Chennai India where the rate of occurrence has been on the rise [1]. Based on GLOBOCAN 2020 database, there were estimated to be about 19.3 million new cancer cases and almost 10.0 million cancers in which prostate cancer contributes to about 7.3% in male individuals. It is said that the trend of age-standardised rate (ASR) of prostate cancer in Chennai is 10. 7 per 100,000 men, and this is above the national average for this group of persons [2]. In addition to genetic, biological and environmental factors, ethnicity predisposition, geographic location, structure, metabolism, diet and lifestyle can strongly influence the risk of Prostate Cancer [3][4]. Various studies revealed that postulated diet and lifestyle changes as areas of focus in managing prostate cancer [5][6]. 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 [7]. This instance has called for preventative measures, with rather more importance on the dietary aspects. Flavonoids are a class of secondary metabolites - present in fruits, vegetables and plant-based products that are reported to have role in the prevention of Prostate cancer [8]. Amongst these, the flavonoids which are known to prevent prostate cancer include quercetin, luteolin, anthocyanins, apigenin, silibinin, EGCG and licoricidin [9]. Quercetin is present in apples, onions, grapes and tea [10]. Luteolin is particularly present in celery, parsley and green peppers [11]. Anthocyanins are available in berries, cherries and grapes [12]. Apigenin can be seen in plants such as parsley, pistachios, olive oil and oranges [13]. Silibinin is commonly extracted from the seeds of the plant popularly known as milk thistle [14]. Epigallocatechin gallate (EGCG) is mainly present in green tea, apple, avocado, peach, plum, berries and nuts [15]. Licoricidin is isolated from the root of Glycyrrhiza uralensis Fisch (licorice) [16].

Genistein is obtained from soy beans and soy products [17]. Fabrizio et.al, discussed that the natural compounds such as quercetin, resveratrol and curcumin modulated specific molecular pathways influencing cancer growth apoptosis in prostate cancer [18]. Another study discovered that, polyphenol rich foods such as green tea and soy-based products might have protection against cancer however more studies are warranted due to lack of vigorous clinical trials [19]. The present study evaluated the intake of flavonoid rich food by recording, assessing and comparing the dietary history over 7 days at three follow up periods following dietary counselling. Since, dietary habits are significantly influenced by occupation, we hypothesise that disparities in the intake of flavonoid rich food are inherent.

2. MATERIALS AND METHODS

Study design and population:

This longitudinal study was conducted by recording a dietary history over 7 days at three follow-up periods: at baseline, 14^{th} and 21^{st} day to assess the intake of flavonoid rich food. The study population was recruited between June 2024 to September 2024 at Primary Health Centre, Shakthi Nagar, Chennai, India. The selection of participants was evaluated based on their assertiveness to Prostate cancer risk factors.

Data collection:

Data were collected from participants using an interviewer-based questionnaire which included the demographic details and risk factors for prostate cancer following guidelines from CDC [20]. The key risk factors included men over 55 years of age, first degree relatives with history of prorate cancer or other family members diagnosed with breast, ovarian or pancreatic cancer. Participants with more than 50% of these risk factors were included in this study and those with fewer than 50% of these risk factors were excluded from the study. The dietary history of participants was recorded over 7 days at three intervals: baseline, the 14^{th} and the 21^{st} day, to assess their flavonoid intake. The participants were instructed to record the content, timing and quantity of their food intake. Upon reviewing the 7-day dietary history at the end of 7 days(baseline) for the intake of specific flavonoid rich food, dietary counselling was provided to encourage the increased consumption of flavonoid rich foods in quercetin, luteolin, anthocyanins, apigenin, silibinin, EGCG and licoricidin rich foods. Follow up was done at the end of the 7^{th}, 14^{th} and 21^{st} day to assess the improvement in consumption of flavonoid rich foods post dietary counselling.

Sample size estimation:

The sample size was calculated using the formula $4pq/L^2$, where the prevalence of prostate cancer (p) was 6.2%, q=1-p, and L is the desired precision of 5%. This resulted in an estimated sample size of 94. To account for a 10% attrition rate, the sample size was increased to 104 [21].

Statistical analysis:

All analyses were conducted using the Statistical Package for Social Sciences (SPSS) version 24

(IBM, Chicago, USA). The data were tested for normality using the Kolmogorov-Smirnov test. As the data did not follow a normal distribution, non-parametric tests were used to assess statistical significance. Descriptive statistics were used to characterize the study sample. To compare means and assess the correlation between flavonoid-rich food intake and BMI, the Kruskal-Wallis's test was applied. The significance level (α) was set at 5%.

3. RESULTS AND DISCUSSION

A longitudinal follow-up study was conducted in Primary Health Centre, Shakthi Nagar, Chennai, among men and women to evaluate and compare flavonoid-rich food intake across three time points: baseline, 14 days, and 21 days, following dietary counselling. Data collection occurred between June 2024 and September 2024.Out of 223 eligible participants, 59 failed to meet inclusion criteria and 57 declined participation. An additional six participants were lost to follow-up (three at 14 days and three at 21 days). Consequently, statistical analysis was performed for the remaining 101 participants. Flavonoid-rich food intake was categorised into five groups for enhanced data analysis: (1) Berries (blueberry, blackberry, cranberry, and raspberry), (2) Fruits (pomegranate, guava, apple, red grapes, peach, pear, plum, banana, and avocado), (3) Nuts (pistachio and hazelnut), (4) Legumes (soybeans), and (5) 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	18-25 years	11	10.9
	26-35 years	14	13.9
	36-45 years	15	14.9
	46-55 years	16	15.8
	>55 years	45	44.6
Religion	Hindu	61	60.4
	Christian	22	21.8
	Muslim	18	17.8
Educational qualification	Illiterate	8	7.9
	Primary school	10	9.9
	Middle school	12	11.9

	High school	13	12.9
	Intermediate / diploma	16	15.8
	Graduate	31	30.7
	Professional	11	10.9
Occupation	Unemployed	10	9.9
	Elementary occupation	5	5
	Plant and machine operators and assemblers	16	15.8
	Craft and related trade workers	15	14.9
	Skilled agricultural and fishery workers	9	8.9
	Skilled workers, shop and market sales	9	8.9
	Clerk	11	10.9
	Technician /Associate professors	11	10.9
	Professional	11	10.9
	Legislatures, senior officials, Manager	4	4
Body Mass Index (BMI)	Normal weight: 18.5-24.9	14	13.9
	Overweight: 25-29.9	53	52.5
	Obese class I: 30-34.9	24	23.8
	Obese class II: 35-39.9	10	9.9

Approximately half of the study participants were aged 55 or older. The study population was predominantly Hindu, accounting for 60.4% (n = 61) of the total participants. Socioeconomic status was assessed using the Modified Kuppuswamy scale, categorizing participants by educational qualification and occupation. The educational profile revealed that 30.7% (n = 31) of the participants held a graduate degree. Occupation-wise, 9.9% (n = 10) were unemployed, while 4% (n = 4) held senior leadership positions. Notably, 52.5% (n = 53) of the participants were classified as overweight (Table 1).

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

EXPOSURE TO RISK FACTOR		N (%)	X^2	DF	*P*-VALUE
Age ≥55 years	Yes	45	1.19	1	0.27
	No	56			
First degree relative with history of Prostate cancer	Yes	34	10.78	1	**<0.05***
	No	67			
Other family members diagnosed with Breast, Ovarian, or Pancreatic cancer	Yes	27	21.87	1	**<0.001****
	No	74			

-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 revealed significant deviations from expected equal proportions for participants with a family history of prostate cancer in first-degree relatives ($p < 0.05$) and those with a family history of breast, ovarian, or pancreatic cancer ($p < 0.001$). These findings indicate that the observed distribution of risk factors in the sample differed significantly from the expected distribution. However, when age was considered, no significant differences were observed (Table 2).

Table 3: Kruskal-Wallis test for intake of flavonoid rich food among different occupational groups

GROUPS	SUBGROUPS	OCCUPATION	N	MEAN RANK	X^2	DF	*P* VALUE
FRUITS	21st day follow-up	Unemployed	10	37.10	22.06	9	**<0.05***
		Elementary occupation	5	33.50			
		Plant and machine operators and assemblers	16	36.66			
		Craft and related trade workers	15	54.77			

		Skilled agricultural and fishery workers	9	50.39			
		Skilled workers, shop and market sales	9	50.83			
		Clerk	11	65.64			
		Technician /Associate professors	11	57.68			
		Professional	11	74.18			
		Legislatures, senior officials, Manager	4	30.25			
NUTS	Baseline	Unemployed	10	38.00	19.27	9	**<0.05***
		Elementary occupation	5	49.90			
		Plant and machine operators and assemblers	16	67.38			
		Craft and related trade workers	15	52.87			
		Skilled agricultural and fishery workers	9	49.11			
		Skilled workers, shop and market sales	9	50.17			
		Clerk	11	47.95			

		Technician /Associate professors	11	47.95			
		Professional	11	38.00			
		Legislatures, senior officials, Manager	4	71.00			
VEGETABLES	14th day follow-up	Unemployed	10	72.15	30.10	9	**<0.001****
		Elementary occupation	5	89.00			
		Plant and machine operators and assemblers	16	33.44			
		Craft and related trade workers	15	41.83			
		Skilled agricultural and fishery workers	9	49.11			
		Skilled workers, shop and market sales	9	70.22			
		Clerk	11	37.27			
		Technician /Associate professors	11	42.32			
		Professional	11	60.45			
		Legislatures, senior officials, Manager	4	51.88			

-N= number of study participants; χ^2=chi square; df=degree of freedom

-*p<0.05, **p<0.001 is considered as statistically significant.

Results of the Kruskal-Wallis's test indicated no significant differences in the intake of berries and legumes across various occupational categories. In contrast, significant differences were observed in the consumption of flavonoid-rich fruits [22.06 (9), N = 101, $p < 0.05$] at the 21st day follow-up, nuts [19.27(9), N = 101, $p < 0.05$] at baseline, and vegetables [30.10(9), N = 101, $p < 0.001$] at the 14th day follow-up across different occupational categories (Table 3).

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

		REFERENCE GROUP	COMPARISON GROUP	MEAN DIFFERENCE	SIG
FRUIT CONSUMPTION	21^{st} day of follow-up	Plant and machine operators and assemblers	Professionals	-37.52	<0.05*
NUTS CONSUMPTION	Baseline	Professionals	Plant and machine operators and assemblers	29.37	<0.05*
VEGETABLE CONSUMPTION	14^{th} day of follow-up	Plant and machine operators and assemblers	Unemployed	38.71	<0.05*
		Plant and machine operators and assemblers	Elementary occupation	55.56	<0.05*
		Clerk	Elementary occupation	51.72	<0.05*

-*p<0.05 is considered as statistically significant

Post-hoc analysis revealed significant differences in dietary intake among occupational groups. Specifically, the 'Plant and machine operators and assemblers' group showed significantly higher consumption of fruits, vegetables and nuts ($p < 0.05$) compared to 'Professionals', 'Unemployed', and 'Elementary' groups at the 21st day,14th day and baseline of follow up, respectively. Furthermore, the 'Clerk' group demonstrated significantly higher vegetable consumption ($p < 0.05$)

compared to the 'Elementary' group (Table 4).

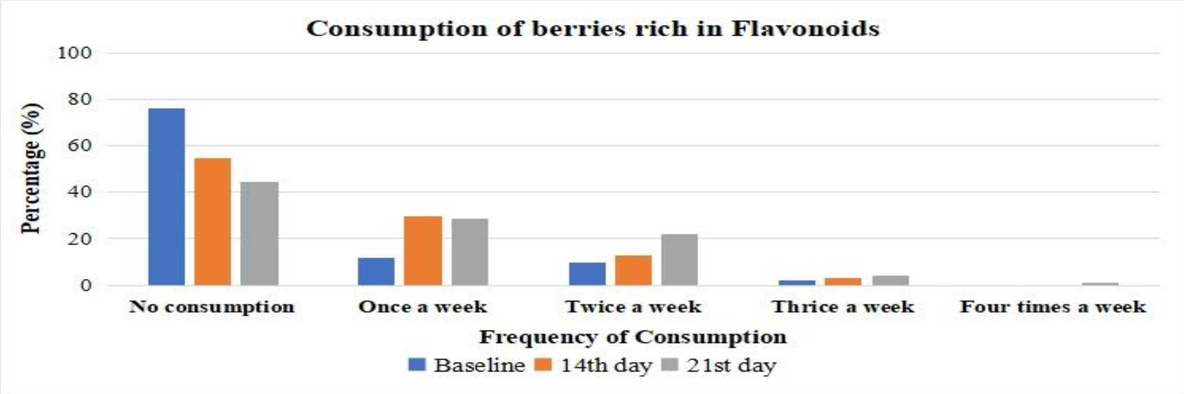

Figure 1: Distribution of berries consumption across three-time intervals (baseline, 14th day of follow-up and 21st day of follow-up) and different frequencies per week

Following dietary counselling, a substantial increase in berry consumption was observed, with the percentage of participants reporting no consumption decreasing from 76.2% at baseline to 44.6% by the end of the study (Figure 1).

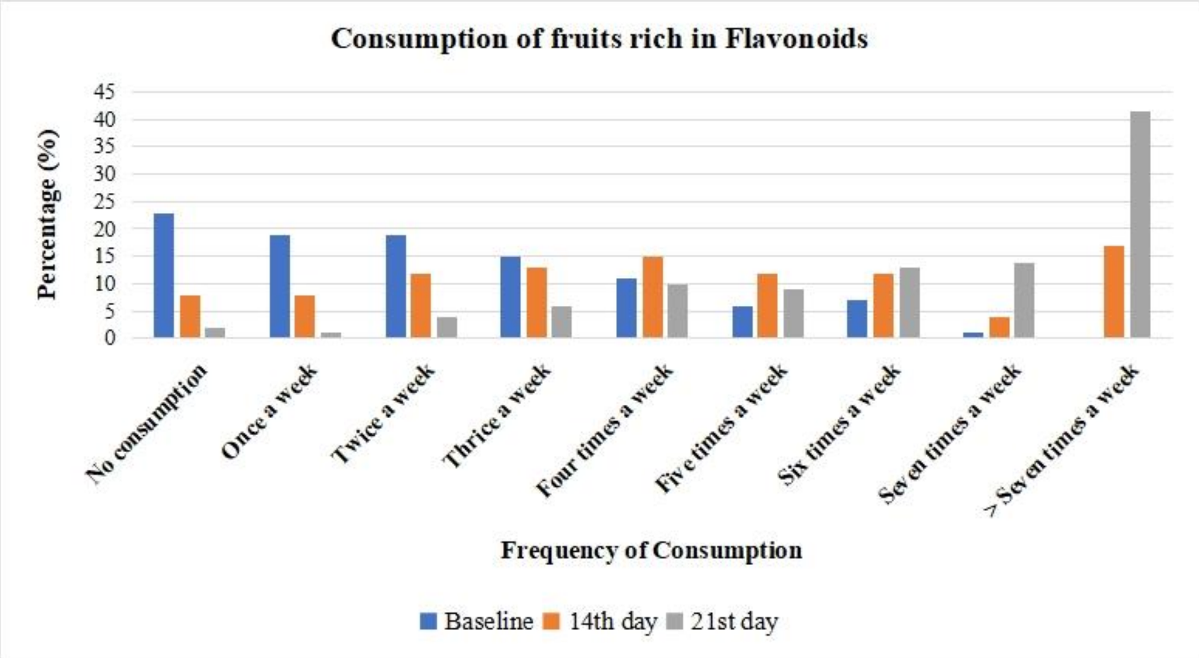

Figure 2: Distribution of fruits consumption across three-time intervals (baseline, 14th day of follow-up and 21st day of follow-up) and different frequencies per week

A significant enhancement in fruit consumption was observed, with the proportion of participants reporting no consumption decreasing from 22.8% at baseline to 2% by study completion. Notably, by day 21, nearly half (41.6%) of the participants reported consuming fruits more than seven times a week, indicating successful habit formation (Figure 2).

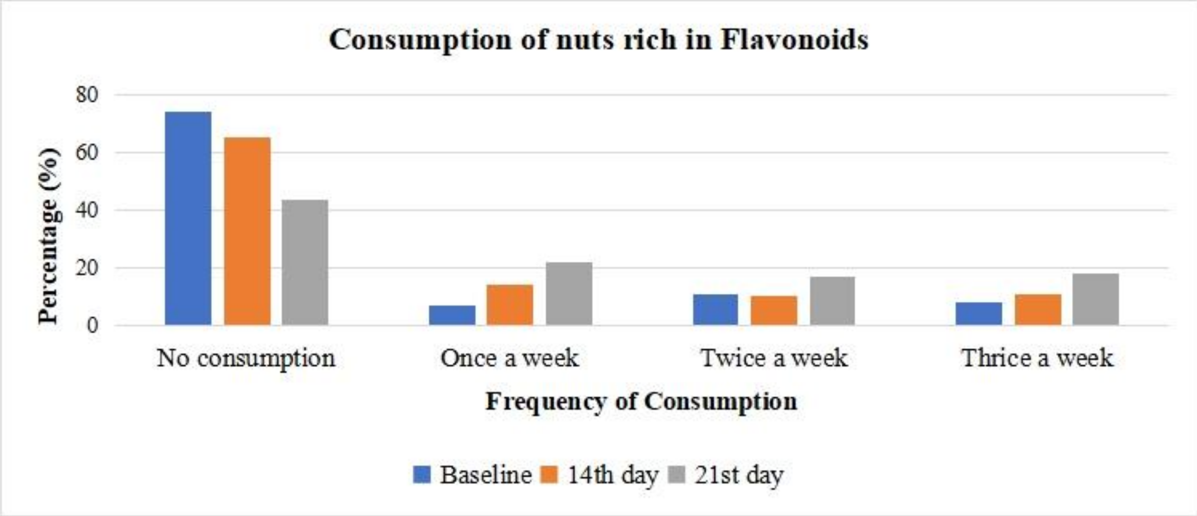

Figure 3: Distribution of nuts consumption across three-time intervals (baseline, 14th day of follow-up and 21st day of follow-up) and different frequencies per week

A notable increase in nut consumption was observed over the 21-day period, with the percentage of participants reporting zero intake decreasing significantly (74.3% at baseline vs 43.6% at day 21), representing a 30.7% reduction [Figure 3].

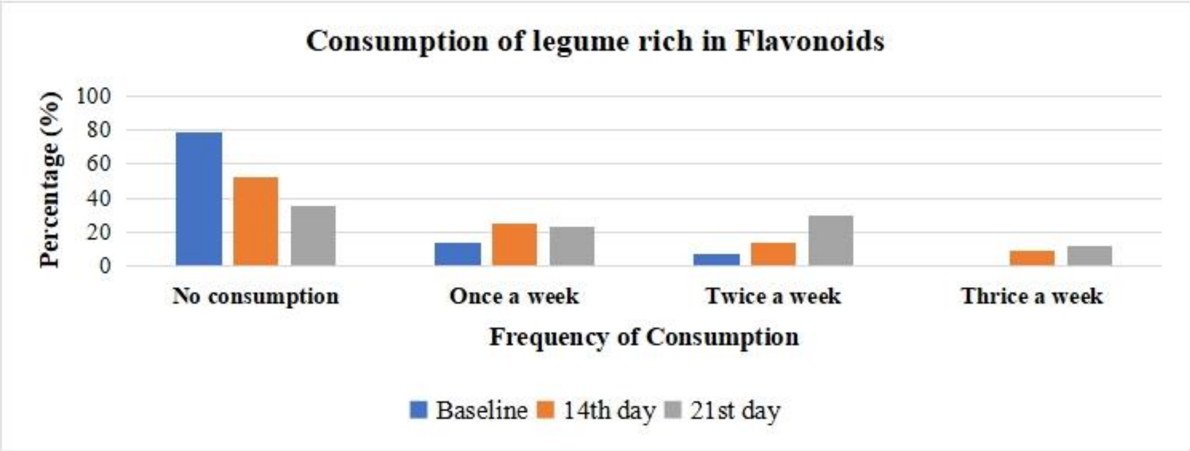

Figure 4: Distribution of legume consumption across three-time intervals (baseline, 14th day of follow-up and 21st day of follow-up) and different frequencies per week

A significant enhancement in legume consumption was observed following dietary counselling, characterised by a 43.6% decrease in participants reporting no consumption (79.2% at baseline vs 35.6% at study end), indicating a significant shift towards regular legume intake [Figure 4].

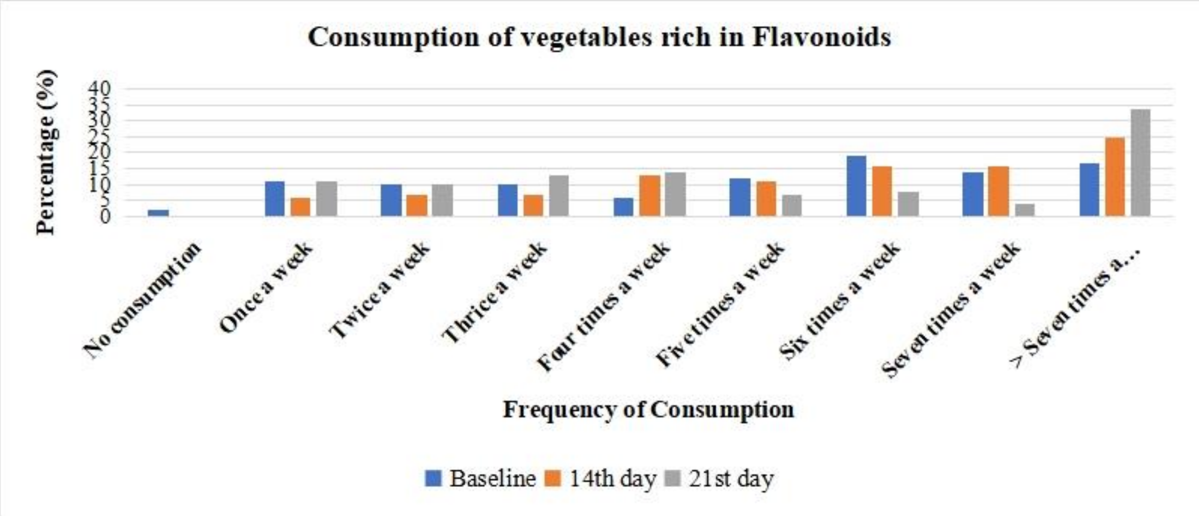

Figure 5: Distribution of vegetables consumption across three-time intervals (baseline, 14th day of follow-up and 21st day of follow-up) and different frequencies per week

The study found that 98% of participants reported vegetable consumption at baseline, indicating a pre -existing habit. Dietary counselling resulted in a significant enhancement, with nearly one third (33.7%) of participants reporting increased vegetable consumption to over 7 times per week [Figure 1].

Our study revealed significant associations across different occupation categories of dietary patterns at various follow-up points. These findings suggest that occupational factors may play a crucial role in shaping participants' dietary behaviours, with potential implications for tailored nutrition interventions based on occupation. A comprehensive approach to risk reduction and early intervention involves effective strategies such as diet and lifestyle modifications, supplementation based on deficiencies, proper use of phytochemical to modify risk factors, and chemoprevention for high-risk populations [22]. A study by Kirsh et al. found no overall association between vegetable and fruit consumption and prostate cancer risk. However, higher vegetable intake, especially cruciferous vegetables like broccoli and cauliflower, was associated with a lower risk of extra prostatic prostate cancer [23]. In our study, majority of participants reported consuming vegetables including cruciferous vegetables more than seven times a week which may have a protective effect against prostate cancer. In contrast, a study conducted by Stam D.O. et al found no protective effect of fruits on prostate cancer risk [24]. While some of our participants consumed fruits more than 7 times a week. Another study by Jones M.K. et al. investigated the impact of whole-body vibration (WBV) exposure across different occupational categories, finding that men in Natural and Applied Sciences occupations exposed to WBV had an increased risk of prostate cancer, while those in Trades and Transport occupations had a reduced risk. Additionally, small but significant differences in risk were observed across various occupational groups, independent of WBV exposure [25]. In our study, we identified significant differences in dietary intake among occupational groups, particularly within the 'Plant and machine operators and assemblers' group. Our findings emphasise the importance of variation in the consumption of fruits, nuts, and vegetables among study participants belonging to different categories of occupation. Our study has few inherent limitations. First, the follow-up periods, which were conducted at baseline, 14th day, and the 21st day, are relatively brief, potentially limiting our ability to observe the long-term effects of diet on health outcomes. Additionally, the study did not include a quantitative analysis of food intake, which would have offered more detailed insights into the link between diet and cancer incidence. Furthermore, the applicability of our findings is constrained by the specific characteristics of the study population. The dietary preferences of participants may be shaped based on the availability of food options within their particular demographic and cultural context. As a result, our findings may not accurately reflect the dietary patterns or health outcomes of larger, more diverse populations with different food environments or cultural practices. Therefore, caution is recommended when trying to apply our findings to other groups or settings.

4. CONCLUSION

Encouraging dietary modifications to boost flavonoid consumption, along with wider public health initiatives, may play a crucial role in tackling the rising rates of prostate cancer in India. The results of this study revealed variations in flavonoid intake across different occupational groups, pointing to possible inequalities in diet quality and access to nutritious foods. However, further long-term research and clinical trials are needed to validate the role of flavonoid-rich foods in preventing prostate cancer through dietary guidance.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

HUMAN AND ANIMAL RIGHTS

No animals or humans were used for the studies that are based on this research.

CONSENT FOR PUBLICATION

Not applicable.

FUNDING

None.

ACKNOWLEDGEMENT

Nil

CONFLICT OF INTEREST

The authors declare that no conflict of interest exists.

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