GSC Advanced Research and Reviews

eISSN: 2582-4597 CODEN (USA): GARRC2

Cross Ref DOI: 10.30574/gscarr

Journal homepage: https://gsconlinepress.com/journals/gscarr/

(RESEARCH ARTICLE)

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Nutritional Factors and Esophageal Cancer Risk among Sudanese Patients

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GSC Advanced Research and Reviews, 2025, 23(01), 097-103

Publication history: Received on 18 February 2025; revised on 13 April 2025; accepted on 15 April 2025

Article DOI: https://doi.org/10.30574/gscarr.2025.23.1.0093

Abstract

This study investigated the relationship between nutritional factors and esophageal cancer (EC) risk among Sudanese patients at the National Cancer Institute in Gezira State. A cross-sectional study of 50 EC patients examined dietary intake of carbohydrates, fats, proteins, vegetables, and fruits using a food frequency questionnaire. Statistical analysis revealed significant associations between EC and gender (p=0.021), saturated fat intake (p=0.050), protein intake (p=0.041), and vegetable/fruit consumption (p=0.039). Specifically, female gender, higher saturated fat and protein intake, and lower vegetable/fruit consumption were associated with increased EC risk. No significant association was found between carbohydrate intake and EC (p=0.114). This study highlights the potential role of dietary factors in EC etiology among Sudanese patients, emphasizing the need for further research to elucidate these relationships and inform public health interventions.

Keywords: Nutrition; Risk factors; Esophagus; Cancer; Sudan

1. Introduction

Esophageal cancer is a significant global health burden, particularly in developing countries. While the exact etiology remains complex and multifactorial, dietary factors have been implicated as important risk factors. In Sudan, esophageal cancer is a major public health concern, especially in regions like Gezira State, (Mohamed *et al.,* in 2016). A growing body of evidence suggests that specific dietary patterns, including the consumption of fruits, vegetables, and whole grains, can influence the risk of developing esophageal cancer. Conversely, diets high in red and processed meat, as well as excessive alcohol consumption, have been linked to increased risk, (Kubo *et al.,* in 2016). However, the specific dietary factors contributing to esophageal cancer risk in Sudan remain poorly understood (Mohamed *et al.,* in 2016). This study aims to investigate the association between dietary factors and the risk of esophageal cancer among Sudanese individuals in Gezira State. By examining the dietary patterns of patients with esophageal cancer and a control group, we hope to identify specific dietary risk factors and contribute to the understanding of the etiology of esophageal cancer in this region. The findings of this study may have important implications for public health interventions and cancer prevention strategies in Sudan.

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2. Material and methods

2.1. Study area

This study was carried out at the National Cancer Institute (NCI) in *Wad-Medani*, Gezira State, Sudan, between the years 2021 and 2022. The NCI, provides comprehensive cancer care to patients throughout Sudan.

2.2. Study population

All patients at NCI during the study period were included in a cross-sectional study to assess the relationship between diet, type and quantity of food intake, and the prevalence of esophageal cancer for adults aged 20 to > 60 years.

2.3. Inclusion criteria

All cases that matched the study specifications and were confirmed to have esophageal cancer were selected.

2.4. Exclusion criteria

Cases suffering from any other type of cancer before being diagnosed with esophageal cancer, cases with a family history of the disease, were excluded

2.5. Data Collection

A questionnaire was administered to assess potential risk factors for esophageal cancer. Cases were interviewed at NCI clinics in *WadMedani* following confirmation of their esophageal cancer diagnosis. Interviews were conducted in the local language and took approximately 15 minutes per patient. The five-page questionnaire included a food frequency questionnaire to determine the frequency of food consumption over the past year. Patients were personally interviewed about their dietary habits, including the types and quantities of food consumed, meal frequency, lifestyle factors, medical history, physical activity, and dietary patterns. Food frequency questionnaires were used to assess the quantity and type of carbohydrate, protein, and lipid intake from each food item. A total of 50 participants agreed to complete the questionnaire, providing information about their dietary patterns for the past year and their current dietary practices. Additionally, their height and weight were measured.

2.6. Ethical approval

Ethical approval was obtained from the NCI and the Gezira State Ministry of Health. All participants provided informed verbal consent, including consent for personal information collection and analysis via questionnaire.

2.7. Energy Calculation

Daily caloric needs (basal metabolic rate, BMR) were calculated using the Mifflin-St Jeor equation (Mifflin *et al.,* 1990), which considers age, height, weight, and gender. Total daily calorie needs were determined by multiplying BMR by a physical activity factor. Estimated carbohydrate calories (50% of total daily calories) were compared to actual carbohydrate intake (calculated as 4 calories per gram of consumed carbohydrate) to assess dietary adequacy.

2.8. Protein Requirements

Protein requirements are calculated based on body weight and activity level. The recommended daily protein intake for adults is a minimum of 0.8 grams per kilogram of body weight (Mangano *et al.,* 2017). This requirement increases with physical activity, with athletes recommended to consume between 1.2 and 2.0 grams of protein per kilogram of body weight daily (Vitale, 2019).

2.9. The Energy Intake from Fats

To determine the grams of fat representing 30% of daily caloric intake, multiply total daily calories by 0.30 to calculate fat calories. Then, divide fat calories by 9 (since 1 gram of fat provides 9 calories) to obtain the recommended daily fat intake in grams (Anonymous, 2020).

2.10. Statistical Analysis

Macronutrient and micronutrient intakes were compared to recommended levels. Statistical analyses, including descriptive statistics, and Chi-square tests, were performed using SPSS version 22 to assess differences in means and relative risks

3. Results

3.1. Demographic Characteristics of respondents

Table (1) summarizes the demographic characteristics of the respondents. According to the results, the majority of the respondents (46%) were over 60 years of age, compared to the rest of the ages in the study group, which amounted to (36%) for the age group (40-60) years and (18%) for the age group (20-40) years. While age group was not statistically significant (p = 0.056), gender was significantly associated with the development of (EC) esophageal cancer (p = 0.021), at (P<0.05). Most of the patients were women (64%) compared to (36%) for men. Accordingly, the occupation of housewife (60%) was the highest, followed by (12%) for self-employment, (10%) for farmers, and (18%) for other occupations.

3.2. Carbohydrates intake and the risk of esophageal cancer

The results in Table (2) showed that 88% of EC patients consumed less than 300 grams of carbohydrates per day, while only 12% consumed more than 300 grams per day. Statistical analyses of these data also showed an association between carbohydrate intake and the risk of EC, and there were statistically not significant differences at the probability (P<0.05) compared to the statistical chi-square value (p = 0.114).

3.3. Fats intake and the risk of esophageal cancer

In table (3) the results showed that 46% of patients were taking no more than 20 mg of saturated fat per day, while 54% were taking more than 20 mg per day. However, there was a statistically significant relationship between higher intake of saturated fat and the EC patients (chi square test; p = 0.050). Compared to 80% of patients consumed less than or equal to 45 mg of trans fat per day, while 20% consumed more than 45 mg per day. However, there was a statistically not significant relationship between higher intake of saturated fat and the EC patients (chi square test; p = 0.384).

Table 1 Distribution of respondents according to their demographic characteristics: gender, age and occupation. (n=50)

Characteristic	Category	Frequency (n)	Percentage (%)	p- value
Gender	Male	18	36	0.021*
	Female	32	64	
Age (years)	20 – 40	9	18	0.056
	40 – 60	18	36	
	> 60	23	46	
Occupation	Housewife	30	60	-
	Free work	6	12	
	Farmer	5	10	
	Worker	4	8	
	Teacher	2	4	
	Student	1	2	
	Police man	1	2	
	Doctor	1	2	
Total		50	100	

*P-value considered significant at less than 0.05 levels

Table 2 Carbohydrates intake and the risk of esophageal cancer (n=50)

Carbohydrate Intake (mg/day)	Frequency (n)	Percentag (%)	p-value
≤ 300	44	88	0.114
>300	6	12	
Total	50	100	

*P-value considered significant at less than 0.05 levels

Table 3 Fats intake and the risk of esophageal cancer (n=50)

Fat Intake (g/day)	Frequency (n)	Percentage (%)	p-value
Saturated Fat			0.050*
≤ 20	23	46	
>20	27	54	
Un-saturated Fat			0.384
≤ 45	40	80	
>45	10	12	
Total	50	100	

*P-value considered significant at less than 0.05 levels

3.4. Protein intake and the risk of esophageal cancer

Table (4) shows the daily protein consumption of the patients under study, where the highest percentage (38%) was recorded in the group that consumes an amount greater than or equal to 50 grams per day, while (62%) consume less than 50 grams per day. However, there was statistically significant relationship between protein intake rates and EC at the probability level (P = 0.05); the chi-square test recorded (p = 0.041).

Table 4 Protein intake and the risk of esophageal cancer (n=50)

Fat Protein (g/day)	Frequency (n)	Percentage (%)	p-value
≤ 50	19	38	0.041*
> 50	31	62	
Total	50	100	

*P-value considered significant at less than 0.05 levels

3.5. Vegetables and fruits intake and the risk of esophageal cancer

Table (5) highlights a concerning trend, (88%) of esophageal cancer patients were found to have a suboptimal intake of vegetables and fruits, consuming less than 400 grams daily, while only (12%) of them consume more than 400 grams daily. However, there was statistically positive relationship between vegetables and fruits intake rates and EC at the probability level (P = 0.05); the chi-square test recorded (p = 0.039).

Table 5 Vegetables and fruits intake and the risk of esophageal cancer (n=50)

Vegetables and fruits (mg/day)	Frequency (n)	Percentage (%)	p-value
≤ 400	44	88	0.039*
> 400	6	12	
Total	50	100	

*P-value considered significant at less than 0.05 levels

3.6. Association between nutritional factors and esophageal cancer

Table (6) highest prevalence of advanced local cancer was observed among patients with high unsaturated fat intake (39/50), followed by protein and carbohydrate intake (30/50 each), and then saturated fat intake (27/50). A significant association was found between Esophageal cancer stages and both protein and carbohydrate intake (p = 0.000), but not with saturated (p = 0.274) or unsaturated fat intake (p = 0.614).

Table 6 Association between nutritional factors and esophageal cancer (n = 50)

Nutritional Factor	Stage			Total	p- value
	Early	Metastatic	Local advance		
Saturated Fats (g/day)					0.274
≤ 20	0	1	22	23	
>20	0	0	27	27	
Total	0	1	49	50	
Unsaturated Fats (g/day)					0.614
≤45	0	1	39	40	
>45	0	0	10	10	
Total	0	1	49	50	
Carbohydrate (g/day)					0.000*
≤ 300	0	0	19	19	
>300	0	1	30	31	
Total	0	1	49	50	
Protein (g/dL)					
≤5.0	0	0	19	19	0.000*
>5.0	0	1	30	31	
Total	0	1	49	50	

*P-value considered significant at less than 0.05 levels

4. Discussion

While age distribution among participants approached significance (p=0.056), gender demonstrated a significant association with esophageal cancer (EC) development (p=0.021), with a higher prevalence observed in females (64%). The predominant occupation among participants was housewife (60%), followed by self-employment (12%), farming (10%), and other occupations (18%). These findings suggest a potential link between female gender and EC, while occupational patterns may reflect underlying socioeconomic factors influencing disease risk.

The majority of esophageal cancer (EC) patients (88%) reported carbohydrate consumption below 300 grams/day. While a higher percentage of patients consumed less than 300 grams of carbohydrates, statistical analysis did not reveal a significant association between carbohydrate intake and EC risk (χ^2; p=0.114). Ghada *et al.,* (2023) conducted a study in Sudan and found a significant positive correlation between carbohydrate intake and breast cancer stage (p = 0.015), which similar to our findings.

The analysis revealed a statistically significant association between saturated fat intake exceeding 20 mg/day and esophageal cancer (EC) (χ^2; p=0.050). Specifically, 54% of EC patients reported consuming over 20 mg/day of saturated fat. In contrast, while 20% of patients consumed over 45 mg/day of trans fat, no significant association with EC was observed (χ^2; p=0.384). These findings suggest that higher saturated fat consumption may be a contributing factor to EC development, whereas trans-fat intake, within the observed ranges, did not demonstrate a significant correlation.

Similar to our study, Zhang *et al.,* (2020) examined the role of dietary fat in EC risk, identifying saturated fat as a risk factor and trans-fat as a potential protective factor.

A significant association was observed between daily protein intake and esophageal cancer (EC) (χ^2; p=0.041). Specifically, while 62% of patients consumed less than 50 grams of protein/day, 38% consumed 50 grams or more, demonstrating that higher levels of protein consumption was significantly correlated to EC. These findings suggest a potential relationship between protein intake levels and EC risk. Chen *et al.,* (2020) conducted a research study on the relationship between protein intake and the risk of EC. The study found that there is a complex relationship between protein intake and cancer risk, with high protein intake associated with a slight increase in risk, especially in people who rely on animal protein. While the results of plant protein intake showed no clear association with an increased risk. This study is similar in some parts to the results of our current study. According to Kong *et al.,* (2020) reported that, dietary protein intake had no significant association with EC risk in the overall analysis; but protein intake may be associated with the risk of esophageal squamous cell carcinoma.

A statistically significant inverse association was observed between vegetable and fruit intake and esophageal cancer (EC) (χ^2; p=0.039). Specifically, 88% of EC patients reported consuming less than 400 grams of vegetables and fruits daily, indicating a suboptimal intake. This finding suggests that inadequate consumption of vegetables and fruits may be a significant risk factor for EC. A study conducted by Zhang *et al.,* (2020), it found that eating large amounts of fruits and vegetables can reduce the risk of EC by 15% to 25%.

Advanced local esophageal cancer was most prevalent among patients with high unsaturated fat intake, followed by protein and carbohydrate intake. However, statistical analysis revealed a significant association between esophageal cancer stage and protein and carbohydrate intake ($p<0.001$), but not with saturated or unsaturated fat intake (p=0.274 and p=0.614, respectively). These findings suggest a strong correlation between protein and carbohydrate consumption and advanced local disease progression, whereas fat intake, within the measured parameters, did not demonstrate a significant association.

5. Conclusion

This study provides evidence of a significant association between several nutritional factors and esophageal cancer (EC) risk among Sudanese patients. Specifically, gender, saturated fat intake, protein intake, and vegetable/fruit consumption were identified as potential risk factors for EC. These findings underscore the importance of dietary interventions and public health initiatives aimed at promoting healthy dietary patterns to reduce the burden of EC in Sudan. Further research, including larger studies and randomized controlled trials, is warranted to validate these findings and explore the underlying mechanisms linking nutritional factors and EC risk.

Compliance with ethical standards

Acknowledgments

The authors would like to thank the followings: The administrators of the National Cancer Institute in Gezira state for their help in conducting this study and thanks extend to all participants for their time and participation in the study.

Disclosure of conflict of interest

All authors have no conflict of interest .

Statement of informed consent

Informed verbal consent was obtained from all individual participants included in the study.

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