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Association of Feeding Types with Body Mass Index and Esophageal Cancer Risk Factors in Gezira State, Sudan (2021-2022)

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Abstract

This study investigated the association between feeding types, body mass index (BMI), and esophageal cancer risk factors in Gezira State, Sudan. A cross-sectional analysis of 50 participants revealed a significant association between feeding type and BMI (p=0.003), with gastrostomy tube feeding linked to higher rates of underweight individuals. No significant association was found between meal frequency and BMI (p=0.099). These findings underscore the importance of considering feeding methods in nutritional assessments for esophageal cancer patients.

Keywords: Feeding types; Body mass index; Esophageal cancer; Risk factors; 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). Dietary habits, including feeding types, play a crucial role in shaping an individual's nutritional status and overall health. A growing body of evidence suggests that specific dietary patterns may influence the risk of developing various cancers, including esophageal cancer, (Kubo *et al.,* in 2016). However, limited research has been conducted to explore the association between feeding types, body mass index (BMI), and esophageal cancer risk in Sudan. This study aims to investigate the relationship between feeding types, BMI, 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.

2. Material and methods

2.1. Study Design

A case-study was conducted to investigate the association between feeding types, body mass index (BMI), and esophageal cancer risk in Gezira State, Sudan. This research was conducted at the National Cancer Institute (NCI) in *WadMedani*, Gezira State, Sudan, from 2021 to 2022. The NCI is a national center providing comprehensive cancer care.

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2.2. Study Population

A cross-sectional study assessed the association between various feeding types, BMI, and the risk of esophageal cancer prevalence among men and women aged 20 to over 60 years attending the NCI during the study period.

2.3. Inclusion Criteria

Participants were eligible for inclusion in the study if they met all predefined study criteria and had a confirmed diagnosis of esophageal cancer.

2.4. Exclusion Criteria

Individuals were excluded from participation if they had a prior diagnosis of any other form of cancer before the diagnosis of esophageal cancer. Furthermore, individuals with a family history of esophageal cancer in a first-degree relative (parent, sibling, or offspring) were also excluded.

2.5. Data Collection and Statistical Analysis

A structured questionnaire was administered to assess potential risk factors for esophageal cancer among participants at the NCI clinics in *Wad-Medani* following diagnosis. This instrument facilitated the collection of comprehensive data, including detailed information on dietary habits (food types, quantities, and meal frequency), methods of nutritional intake (including oral, enteral, or parenteral feeding, where applicable), and anthropometric measurements. Fifty participants completed the questionnaire, providing a substantial dataset for analysis. Data were statistically analyzed using SPSS version 22.

2.6. Ethical Approval

Ethical clearance was granted by the NCI and the Gezira State Ministry of Health. Informed verbal consent was obtained from all participants, encompassing consent for the collection and analysis of personal information through questionnaires.

2.7. Anthropometric Measurements

Body Mass Index (BMI), calculated from weight and height measurements (using a Detecto scale), is used to classify individuals as underweight, normal weight, overweight, or obese (Nuttall, 2015). BMI is calculated as weight in kilograms divided by height in meters squared (kg/m^2) or, using imperial units, as weight in pounds divided by height in inches squared, multiplied by 703 ($703\ lbs/in^2$). WHO and CDC cut-off points are used to define BMI categories. The World Health Organization (WHO) classifies BMI as follows: severely underweight (<16 kg/m^2), underweight (16.0-18.4 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2), moderately obese (30.0-34.9 kg/m^2), severely obese (35.0-39.9 kg/m^2), and morbidly obese (≥40.0 kg/m^2 ; Bhaskaran *et al.,* 2014).

3. Results

3.1. Demographic Characteristics of respondents

Table (2) details the demographic characteristics of the study participants. The largest age group was over 60 years (46%), followed by 40-60 years (36%) and 20-40 years (18%). Age did not correlate significantly with esophageal cancer (EC) ($p = 0.056$). However, gender was a significant factor ($p = 0.021$), with a female predominance (64%) among EC patients. The result shows the distribution of respondents in terms of educational level: illiterate (70%) compared to (36%) for the primary stage, followed by (6%) for each of the secondary and university stages, and finally (2%) for the intermediate stage.

3.2. The Role of Hydration in Esophageal Cancer Management

As shown in Table (2), the majority of patients (58%) consumed a moderate amount of fluid (1000-2000 ml) daily. A smaller proportion (20%) consumed either less (500-1000 ml) or more (2000-4000 ml) fluid, while only 2% consumed less than 500 ml. The chi-square test revealed no significant association ($p=0.322$) between hydration levels and EC risk.

Table 1 Demographic Characteristics of participants (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	
Education Level	Illiterate	35	70	-
	Intermediate	1	2	
	Elementary	8	16	
	Secondary	3	6	
	Collegiate	3	6	
Total		50	100	

*P-value considered significant at less than 0.05 levels

Table 2 Fluid consumption and esophageal cancer (n=50).

Water Intake (ml/day)	Frequency (n)	Percentage (%)	p-value
100-500	1	2	0.039*
500-1000	10	20	
1000-2000	29	58	
2000-4000	10	20	
Total	50	100	

*P-value considered significant at less than 0.05 levels

3.3. Food Categories Intake and Esophageal Cancer

Table (3) highlights the diversity of food categories consumed by patients with esophageal cancer, as they consume a quantity and quality that is consistent with the symptoms of the disease in order to live with it. It is also noted that there is a greater reliance on liquid, semi-liquid and soft foods to facilitate their movement through the esophagus. However, there was a significant correlation (0.041) between the protein food category and esophageal cancer, while the other categories did not record a significant difference.

3.4. Association of Feeding Type with Body Mass Index

Table (4) demonstrates a statistically significant association between feeding type and Body Mass Index (BMI) ($p = 0.003$). The distribution of BMI categories varied across the three feeding types: normal feeding, nasogastric tube, and gastrostomy tube. Notably, the gastrostomy tube group showed a higher prevalence of individuals in the underweight category (<18.5 kg/m^2) compared to the other groups. The normal feeding and nasogastric tube groups had a more dispersed distribution across the BMI categories, with a significant portion in the normal and overweight ranges.

Table 3 Food categories intake and esophageal cancer (n = 50)

Food Category	Types of food	p-value
Liquids	Water, soups, fruit juices, starch juices, milk, yoghurt, coffee, tea, carbonated beverage.	0.199
Soft Food	Potatoes, rice, porridge.	0.201
Protein	M Meats (chicken, beef, fish), beans, lentils.	0.041*
Fruits and Vegetables	Orange, guava, banana, tomato, carrots, cucumber, others.	0.601
Carbohydrates	Potatoes, rice, porridge, starch juices.	0.114
Grains	B Beans, lentils, rice.	0.193

*P-value considered significant at less than 0.05 levels

Table 4 Body Mass Index (BMI) Distribution by Feeding Type (n=50)

BMI (kg/m^2)	Feeding type				p- value
	Normal feeding(n)	Nasogastric tube (n)	Gastrostomy tube (n)	Total (n)	
< 18.5 (Underweight)	2	2	8	12	0.003*
18.5 - 24.9 (Normal)	3	6	10	19	
25 - 29.9 (Overweight)	5	5	5	15	
30 - 34.9 (Obese I)	1	1	0	2	
35 - 39.9 (Obese II)	1	0	0	1	
≥ 40 (Obese III)	1	0	0	1	
Total	13	14	23	50	

*P-value considered significant at less than 0.05 levels

3.5. Association between Meal Intake per Day and Body Mass Index

Table (5) presents the distribution of BMI categories according to meal frequency (three meals per day vs. more than three meals per day). The majority of participants (n=46) reported consuming more than three meals per day. The distribution of BMI categories was observed across both meal frequency groups. The p-value for the association between meal frequency and BMI was 0.099, indicating no statistically significant association.

Table 5 Body Mass Index (BMI) Distribution by Meal Frequency (n=50)

BMI (kg/m^2)	3 Meals/Day (n)	>3 Meals/Day (n)	Total (n)	p- value
< 18.5 (Underweight)	1	11	12	0.099
18.5-24.9 (Normal)	2	17	19	
25-29.9 (Overweight)	1	14	15	
30-34.9 (Obese I)	0	2	2	
35-39.9 (Obese II)	0	1	1	
> 40 (Obese III)	0	1	1	
Total	4	46	50	

*P-value considered significant at less than 0.05 levels

4. Discussion

This study aligns with established literature demonstrating associations between advanced age, low education, and esophageal cancer (EC) risk. Consistent with Conway et al., (2023), Ahmed et al., (2022), and Sara et al., (2020), our findings underscore the importance of socioeconomic factors and public health interventions. Similar to Najla et al., (2015) in Sudan, we observed increased EC incidence with age, particularly peaking around 60-69 years, and a female predominance. Furthermore, our data corroborate Mathers et al., (2022) regarding increased EC incidence in older postmenopausal women. The observed EC prevalence in Gezira State, with a higher female representation, mirrors findings by Najla et al., (2015).

In this study, no significant association was found between hydration levels and EC risk (p=0.322), suggesting fluid intake may not be a primary risk factor. This contrasts with Fredman et al., (2022), who observed benefits of regimented hydration during EC radiation therapy. However, our findings partially align with Yuan et al., (2019) and Guadagnoli et al., (2022), emphasizing the importance of hydration for managing gastroesophageal reflux disease (GERD), a known EC risk factor. While our data do not demonstrate a direct link between hydration and EC risk, the broader benefits of hydration for EC patients, including improved digestion, reduced treatment side effects, and enhanced renal function, remain relevant.

Many studies support this conclusion, as they emphasize the importance of eating specific food groups or categories that are compatible with esophageal cancer, such as vegetables and fruits, because they contain antioxidants and dietary fibers that contribute to enhancing the health of the body and proteins that enhance the body's immunity and build cells. Avoid eating hot, very cold, spicy, acidic, and irritating foods for the esophagus and stomach. According to Yuan et al., (2019); Guadagnoli et al., (2022) in China reported that, adopting a dietary pattern that includes smaller, more frequent meals may help mitigate stomach pressure, while ensuring proper hydration between meals is crucial for effectively managing GERD. Nutritional interventions play a crucial role in improving patient outcomes, treatment tolerance, and quality of life. GERD can manage through dietary modifications, smaller, frequent meals, low-fat diet, avoidance of trigger food (spicy foods, caffeine, alcohol, citrus fruits). Cavin et al., (2002); Kamangar et al., (2009) reported that, coffee is considered to decrease the incidence of cancer through the effect of its anti-carcinogenic constituents such as polyphenols (chloro-genic acid, caffeic acids, among others) and di-terpenes. Mayne et al., (2001), reported that, dietary cholesterol, animal protein, and vitamin B12 were significantly positively associated with the risk of EC. These studies were agreeing with our findings in the present study.

The significant association between feeding type and BMI ($p = 0.003$) highlights the potential influence of feeding method on nutritional status in this study population. The observed higher prevalence of underweight individuals in the gastrostomy tube group may reflect underlying medical conditions necessitating this feeding method, or potential challenges in achieving adequate nutritional intake through this route. Conversely, the distribution of BMI in the normal feeding and nasogastric tube groups suggests a broader range of nutritional statuses, potentially reflecting diverse dietary habits and clinical conditions.

Our findings align with existing research demonstrating the impact of feeding type on nutritional status in esophageal cancer patients. Consistent with Garcia et al., (2022) and Sara et al., (2020), our study highlights the high prevalence of malnutrition and dysphagia, particularly during chemoradiotherapy. Notably, we observed that gastrostomy tube feeding was associated with better BMI maintenance, corroborating Jie et al., (2023) and supporting its efficacy in managing nutritional deterioration. While nasogastric feeding and oral intake present challenges, including potential fluctuations in nutritional status, gastrostomy tubes offer a more stable and controlled nutritional delivery. Beyond feeding type, individual factors, including psychological well-being and underlying health conditions, significantly influence BMI. Therefore, personalized nutritional interventions, including careful monitoring and tailored feeding plans, are crucial for optimizing patient outcomes. It is important to acknowledge that this cross-sectional analysis cannot establish causality. Further research, including longitudinal studies, is needed to investigate the temporal relationship between feeding type and BMI, and to explore the potential impact of esophageal cancer risk factors on these associations. Additionally, future studies should consider detailed dietary assessments and clinical evaluations to better understand the factors contributing to the observed BMI distribution across feeding types. The results of this study emphasize the importance of tailored nutritional interventions based on the feeding modality, especially for individuals with advanced esophageal cancer in whom it is difficult to take in nutrients naturally through the mouth and esophagus.

While a numerical trend appears to show higher BMI categories in the more than 3 meals per day group, the analysis revealed no statistically significant association between meal frequency and BMI ($p = 0.099$). This suggests that in this study population, the number of meals consumed per day did not significantly influence BMI. The lack of a significant

association may be attributed to several factors. Firstly, the study's cross-sectional design limits the ability to establish a causal relationship between meal frequency and BMI. Secondly, other factors, such as dietary composition, portion sizes, and individual metabolic rates, may have a more substantial impact on BMI than meal frequency alone. Additionally, the limited sample size (n=50), with a notably uneven distribution between the two meal frequency groups (4 vs. 46), could have influenced the statistical power of the analysis. It is important to acknowledge that while meal frequency may not have been a significant predictor of BMI in this study, it does not negate the potential role of dietary patterns in overall health and nutritional status. Future research with larger sample sizes, longitudinal designs, and detailed dietary assessments is needed to further investigate the relationship between meal frequency, dietary habits, and BMI in individuals with esophageal cancer risk factors. Furthermore, considering potential confounders such as physical activity levels and underlying comorbidities would provide a more comprehensive understanding of the factors influencing BMI in this population.

5. Conclusion

This study highlights a significant association between feeding type and BMI in esophageal cancer patients in Gezira State, Sudan. Gastrostomy tube feeding was associated with a higher prevalence of underweight individuals, suggesting potential challenges in nutritional management with this method. Meal frequency did not significantly influence BMI. These findings emphasize the need for tailored nutritional interventions based on feeding type for individuals with esophageal cancer risk factors.

Compliance with ethical standards

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Disclosure of conflict of interest

All authors have no conflict of interest.

Statement of ethical approval

Ethical approval was obtained from Faculty of Agricultural Sciences, University of Gezira ethical committee as well as Ministry of Health Gezira State ethical committee.

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Statement of informed consent

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

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