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Dietary and Environmental Determinants of Oesophageal Cancer in Arsi Zone, Oromia, Central Ethiopia: A Case–Control Study

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Purpose: Oesophageal cancer is ranked 5th of all types of malignancies in Ethiopia and highly prevalent in the Arsi Zone. However, no study was conducted to elucidate the dietary and environmental determinants of oesophageal cancer in the Arsi Zone.

Methods: A matched case-control study was conducted from June 1, 2019, to June 30, 2020. A total of 104 cases and 208 controls were interviewed. Data were collected using food frequency questionnaires (structured questionnaires). Binary and multiple logistic regression analyses were conducted to check the association between independent and dependent variables. Adjusted odds ratios and the corresponding 95% confidence intervals were estimated for the strength of association. Statistical significance was declared at a P-value of <0.05.

Results: In multivariable logistic regression, drinking very hot coffee (AOR=5.1,[95% CI: (1.95, 13.71), drinking large volume of coffee (AOR=4.9, [95% CI: (2.03, 12.17), very hot porridge (AOR= 3.1,[95% CI: (1.38,7.03) and eating porridge fast (AOR=7.0, [95% CI: (2.48, 20.14), low intake of dairy products (AOR=6.0, [95% CI: (2.29, 15.95), cooking food in sleeping room (AOR=3.7, [95% CI: (1.22, 11.39), exposure to x-ray (AOR=9.4,[95% CI: (3.94, 22.82), nonalcohol homemade drinks (AOR=5.4,[95% CI: (1.97, 15.14), use of chemical containers (AOR=3.4, [95% CI: (1.48, 8.23) were determinants of oesophageal cancer.

Conclusion: Coffee temperature, coffee drinking volume, porridge consumption temperature, porridge consumption speed, dairy products intake patterns, food cooking place, x-ray exposure, nonalcohol homemade drink, and use of chemical containers were independent determinants of the increased risk of oesophageal cancer in the study community.

Keywords: case-control, oesophageal cancer, determinants, Arsi Zone, Ethiopia

Introduction

The determinants of oesophageal cancer (OC) vary with tissue types, geographical locations, socio-demographic characteristics, economic status, lifestyles, and genetic differences in human beings.[1,2] Foods increase the risk of OC when consumers ingest hot and/or irritant substances.[3] Positive associations were reported between the consumption of hot foods, beverages, pickled vegetables, low intakes of fruit, vegetables, minerals, and squamous cell carcinomas (SCC) of the esophagus.[4–10] According to Islami et al,(2009), the risk increases by 2.1 for hot (65–69°C) and by 8.2 times for very hot (≥70°C) beverage drinkers.[11] Moreover, studies demonstrated a significant positive association between the consumption of

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butter, components of animal source foods, saturated fat, cholesterol, discretionary calorie, salty foods, and oesophageal cancer.[9,12] The other dietary risk factors associated with OC were high intake of red and processed meat,[13] salted fish, fried takeaway foods, food eating speed, and teeth loss.[14,15] Micronutrients and antioxidant substances are protective against cancer. Previous studies have confirmed inverse relationships between the consumption of vitamins, beta carotene from raw fruits, dark green leafy, and cruciferous vegetables, and oesophageal carcinoma.[8–10,16] Likewise, an opposite relationship was reported between higher dietary calcium intake and the risk of oesophageal cancer.[17]

An increased risk of OC was observed with the consumption of aflatoxin-contaminated foods,[18–20] exposure to ionizing radiation,[21–23] environmental carcinogens,[24–26] and tobacco use.[27] For instance, farming, gardening, and agricultural works have been linked to an increased risk of OC in Taiwan and Brazil.[28,29] Being farmers and exposure to herbicides were found to have significant positive associations with oesophageal carcinoma.[30,31] Furthermore, a growing body of evidence has shown a strong relationship between exposure to heavy metals, Poly Aromatic Hydrocarbons (PAHs)emitted from firewood, and increased risk of oesophageal cancer.[32]

In Africa,earlier studies revealed that the rise of OC in endemic areas was attributed to the consumption of crops that had degenerative effects.[33] Particularly, an increased risk was witnessed among populations that consumed maize (corn) and wheat-based staple foods compared to those who consumed diversified and nutritious foods.[32] However, shreds of evidence from recent studies among African populations identified statistically significant associations between the source fuels used for cooking foods, cooking places,[34] consumption of hot foods and an increased risk developing of oesophageal carcinoma.[35–38] Besides, positive associations were found between tobacco use (smoking and sniffing), alcohol drinking,[36] and SCC of the esophagus.[34]

Oesophageal cancer is ranked 5th of all types of malignancies in Ethiopia following uterine, cervical, breast, and colorectal cancers.[39] The findings regarding the risk factors associated with OC at the national level are inconsistent while the determinants of the disease were not elucidated so far at Arsi zone where the disease is highly prevalent. In a small size pilot study, eating salty diets, inadequate vegetable intakes, and chewing khat (Catha edulis) were identified as the independent predictors of the risk of developing oesophageal cancer.[40] On the contrary, a case-control study by Mengesha et al, (2005) documented that eating Kocho (false banana) as the main dietary risk factors of OC opposite to a similar study done by Shewaye et al, (2016) that reported the consumption of hot wheat porridge by rural farmers as the strongest predictor of oesophageal carcinoma.[41,42] Moreover, previous studies did not consider the role of local, culturally specific dietary practices and exposure to potential environmental carcinogens that could misrepresent the association between diet and risk of oesophageal cancer.[43] The present study was carried out to identify the dietary and environmental determinants of OC in the Arsi Zone where OC is endemic in Ethiopia.[1]

Materials and Methods

Setting

Arsi is one of the Zones in the Oromia Regional State of Ethiopia which has a population of about 3.5 million. It is located at 6°45′N to 8°58′N and 38°32′ E to 40°50′ E in Central Ethiopia. The total population is housed within 683,365 households with the ratio of male to female being 1:1. The Zone is considered as the wheat and barley belt in Ethiopia. Among pulses, horse beans, and field peas are grown widely. Vegetables, root crops, and stimulants are also grown. Utilization of herbicides, pesticides, and use of chemical fertilizers in Arsi Zone is among the highest in the country.[44]

Study Design

A case-control study was employed from June 1, 2019, to June 30, 2020, in the Arsi zone of Oromia Regional State in Ethiopia.

Recruitment Strategy

Cases were endoscopically examined and histologically confirmed OC patients who attended referral hospitals. They were consecutively recruited from Asella Teaching and Referral Hospital in Arsi Zone and higher referral hospitals mentioned in a previous epidemiological study.[45] The controls were healthy individuals (absence of any symptom of cancer during data collection) and those who lived in that community for at least 5 years. Controls were recruited from the same kebeles (smallest administrative unit) where the cases have emerged. Lists of eligible controls were prepared and those who gave consent were selected by the lottery method. A ratio of

cases to controls of 1:2 was used to select the sample. Further matching of cases and controls was done by age, sex, and residence. Three cases (two females and one male) were excluded from the study because of serious illness and their unwillingness to give information. The final sample size was 104 cases and 208 controls.

Data Collection Instrument and Procedures

Data were collected by five trained BSc nurses using interviewer-administered questionnaires that comprised of socio-demographic, habitual dietary practices, exposures to environmental and other potential carcinogens. The data collection tool for dietary practices was adapted from a validated Food Frequency Questionnaire (FFQs),[46–48] to 27 to local food items. Habitual dietary practices include food and beverage intake patterns, food consumption temperatures, and the volume of coffee drunk. The speed of eating porridge was assessed by taking into account an anecdotal report of consuming porridge in a shared manner from serving utensils and preference to very hot porridge. A fast eater was defined as a person who is first to finish when eating porridge with a group of people, a normal eater is neither first nor last to finish when eating porridge with a group of people.[6] The volume of coffee drinking at a time was checked in a survey preceding this study (unpublished data). The smallest coffee drinking (coffee cup) contains 80mL to 140 mL of coffee and is labeled as a low volume coffee intake. Glasses, beakers, and gourd bottles (Quluu in the local language) contain about 300 mL of coffee and categorized as high volume coffee intake.Very hot foods were reported as the foods and beverages that cause burn to the throat, and esophagus while hot foods and beverages were described as the foods that burn tongue during consumption. Participants` frequency of food consumption was recorded as within a day, within weeks, and within a month. Exposure to potential carcinogens were ascertained by asking the participants history of drinking of alcohol, use of any forms of tobacco (smoking, pipe, sniffing), khat chewing, exposure to ionizing radiations if cases underwent x-ray investigations before symptoms of current illness and controls were exposed to any forms of radiations in their life. Exposures to occupational risk factors were identified by asking for a place of cooking foods, contacts with herbicides, pesticides, and use of chemical containers for storing food items and drinking water. Hereditary risk of cancer was recorded by requesting a history of any type of cancer of the first degree relatives (parent, sibling, or child) and the presence of parental consanguinity. Wealth index was calculated from the scores given based on the number and kinds of consumer goods and other belongings (household durable goods, cattle and land) they own. Participants` responses were categorized as yes or no. The participants' response was coded "1" for yes and "0" for no responses. Cases were interviewed at the oncology department, separate café, and home while the interviews for controls took place in subjects' homes.

Quality Assurance

The adapted questionnaires were prepared in English, translated to local language (Afaan Oromo), and later back to English by two different experts qualified in MSc and fluent in local languages. Two days of training were provided for data collectors and supervisors regarding study objectives and interview techniques. Pretesting was conducted on 5% of the proposed sample size and amendments were made accordingly. The supervisors strictly followed the data collection procedures and feedback was given daily.

Data Processing and Analysis

Data were coded and checked for completeness, consistency and entered into the EPI info version7. Then, it was imported into the statistical package for social sciences (SPSS) software version 21 for data processing and analysis. The wealth index scores were derived using principal component analysis and the distribution was ranked into terciles as low, medium and high terciles. The food items were categorized into cereal-based foods, milk, and dairy products, meat, eggs, legumes and pulses, vegetables and fruits, fats and oils, and sweets. The cumulative weekly intake of each food group was found by summing the frequency of consumption of individual food items in the same group and ranked into terciles as low, medium, and high terciles. Independent variables that had a p-value of <0.25 in the binary logistic regression were considered a candidate for the multiple logistic regression analyses. Descriptive statistics were computed and presented in frequencies and percentages for categorical variables, and means with standard deviations for continuous variables. Multicollinearity was checked using standard error < 2.0. The multivariable logistic regression model was adjusted for the confounding effects of independent variables.

Adjusted odds ratios (AOR) and the corresponding 95% confidence intervals (CI) were estimated to assess the strength of association. P-values <0.05 were used to declare statistical significance. All analyses were performed using SPSS for windows version 23.0 (SPSS, Illinois Chicago, USA).

Results

Socio-Demographic Characteristics

A total of 312 participants, 104 cases, and 208 controls were included in this study. The mean (±SD) age of cases was 55.2(±11.0) and that of controls was 57.3(±11.2) [P=0.11] years. The majority (92.3%) of participants were from rural areas. On the other hand, 95(91.3%) cases and 192(92.3%) controls were Muslims. Besides, 101(97.1%) and 192(92.3%) cases and controls were from the Oromo ethnic group, respectively. In terms of the level of education, 90(86.5%) cases and 177 (85.1%) controls were unable to read and write. The majority of the cases and controls (64.4%vs53.8%) had ≥5 family members (Table 1).

Dietary Intake Patterns of the Participants

The majority of the cases (58.7%) and less than half of the controls (49%) consumed dinner between 7:30 to 8:30 PM local time. The proportion of cereal foods consumption was higher among the cases (36.5%) compared to controls (30.3%). Near to half (49%) of cases were in the lowest terciles of vegetable and fruit consumptions compared to controls (44%). Of the total participants, 249 (79.8%) reported egg and poultry intakes. From the total participants who reported the consumption dairy products, the majority of the cases (52.1%) had a low intake of dairy products while the majority (56.3%) controls were in the highest terciles of dairy products intake patterns. The frequency of meat intake among cases and controls was very rare and thus excluded from the analysis. The weekly intakes of legumes and pulses, fats and oils, sweets, and sweet foods were lower for cases than controls. Nearly 2/3rd (65.4%) of cases and 114(54.8%) controls reported drinking Kennetoo (brewed local non-alcoholic homemade drinks made from deeply roasted barley with added sugar or Coca-Cola as a sweetener).

Porridge and coffee were reported as the commonest hot food and beverage, respectively. Near to 2/3rd of the cases (64.4%) preferred very hot porridge compared to

Table 1 Socio-Demographic Characteristics of the Study Participants in Arsi Zone, Ethiopia, 2020

Characteristics	Cases (%)	Controls (%)
	n=104	n=208
Mean age (±SD)	55.2(11.0)	57.3(11.2)
Age category		
20–29	3(2.9)	2(1)
30–39	3(2.9)	2(1)
40–49	23(22.1)	83(39.9)
50–59	34(32.7)	59(28.4)
60–69	24(23.1)	39(18.8)
70–79	17(16.3)	23(11.1)
Residence		
Urban	8(7.7)	16(7.7)
Rural	96(92.3)	192(92.3)
Marital status		
Married	97(93.3)	179(86.1)
Others (single, widow, and divorce)	7(6.7)	29(13.9)
Sex		
Male	47(45.2)	94(45.2)
Female	57(54.8)	114(54.8)
Occupations		
Farmers	45(43.3)	92(44.2)
Housewives	57(54.8)	112(53.8)
Government & private employee	2(2)	4(2)
Religion		
Muslim	95(91.3)	192(92.3)
Orthodox	9(8.7)	16(7.7)
Ethnicity		
Oromo	101(97.1)	192(92.3)
Others (Amhara, Argoba)	3(2.9)	16(7.7)
Level of education		
Unable to read and write	90(86.5)	177(85.1)
Able to read and write	10(9.6)	13(6.3)
Primary(1–8) and above	4(3.8)	18(8.7)
Family Size		
<5	37(35.6)	96(46.2)
≥5	67(64.4)	112(53.8)
Wealth index		
1st	31(29.8)	76(36.5)
2nd	35(33.7)	61(29.3)
3rd	38(36.5)	71(34.1)

more than 3/4th (77.9%) of controls that favored hot porridge. Concerning the speed of porridge consumptions, a greater proportion (42.4%) cases were fast eaters compared to controls (11.1%). The majority (72.1%) cases reported drinking a large volume of coffee at a time compared to the majority (73.1%) controls who reported drinking a small volume of coffee at a time (Table 2).

Family history of cancer

Ten (9.6%) cases and 21(10.1%) controls reported a history of oesophageal cancer (24), breast cancer (2), cervical cancer (4), and unexplained cancer (1) in the family. Four cases (3.8%) and 6(2.9%) controls reported the presence of consanguinity between their parents.

Exposure to Potential Carcinogens

The food preparation places were variable among the participants. Accordingly, 34(32.7%) cases and 14(6.7%) controls cooked their foods in the sleeping rooms. Regarding cooking fuels, 95(91.3%) of cases and 142 (68.3%) of controls reported cooking foods using firewood. From the total cases and controls, 9(8.7%) and 11 (5.3%) smoked tobacco respectively. Furthermore, 26 (25%) cases and 44(20.2%) of controls reported khat chewing. Fewer cases reported drinking alcoholic beverages compared to controls. Of the total participants, 15 (14.4%) cases and 16(7.7%) controls participated in chemical (herbicidal, pesticidal, and DDT) spray. Greater than 3/4th (77.9%) cases and more than half (51.4%) of the controls used chemical containers for in house services (as a utensil for drinking water and storing food items). Greater than 2/3rd (76.9%) of cases and 61(29.3%) controls reported exposure to x-ray. The use of rodenticide chemicals was higher (68.3%) among cases compared to controls (46.2%). (Table 3).

Determinants of Oesophageal Cancer

Hierarchical logistic regressions were computed to find the candidate variables for multiple logistic regression analysis. The first level comprises the socio-demographic determinants of esophageal cancer. The second and third levels comprised the dietary intake patterns and exposure to environmental factors respectively. Accordingly, marital status and family sizes from socio-demographic characteristics showed a significant association with oesophageal cancer (p-value <0.05). Similarly, the binary logistic analyses revealed that dinner time, dairy products, fats and oils, sweet foods, legumes

Table 2 Dietary Intake Patterns of the Study Participants in Arsi Zone, Oromia, Ethiopia, 2020

Characteristics	Cases (%)	Controls (%)
	n=104	n=208
Dinner time		
Before 7:30 PM	3(2.9)	27(13)
7:30–8:30 PM	61(58.7)	102(49)
Just before bed	40(38.5)	79(38)
Cereal foods intake patterns		
Low	38(36.5)	75(36.1)
Moderate	28(26.9)	70(33.7)
High	38(36.5)	63(30.3)
Vegetables and fruits intake patterns		
Low	51(49.0)	92(44.2)
Moderate	33(31.7)	72(34.6)
High	20(19.2)	44(21.2)
Egg and poultry intake patterns		
Low	40(48.2)	71(42.8)
Moderate	14(16.9)	59(35.5)
High	29(34.9)	36(21.7)
Dairy products intake patterns		
Low	50(52.1)	49(26.8)
Moderate	23(24.0)	31(16.9)
High	23(24.0)	103(56.3)
Legumes and pulses		
Low	48(46.2)	42(20.2)
Moderate	36(34.6)	63(30.0)
High	20(19.2)	103(49.5)
Fats and oils intake patterns		
Low	58(55.8)	45(22.3)
Moderate	30(28.8)	48(23.8)
High	16(15.4)	109(53.9)
Porridge temperature		
Hot	37(35.6)	162(77.9)
Very hot	67(64.4)	46(22.1)
Coffee temperature		
Hot	58(55.8)	169(81.2)
Very hot	46(44.2)	39(18.8)
Coffee volume		
Small	29(27.9)	152(73.1)
Larger	75(72.1)	56(26.9)
Porridge consumption speed		

(*Continued*)

Table 2 (Continued).

Characteristics	Cases (%)	Controls (%)
	n=104	n=208
Neither slow nor fast eater	62(59.6)	187(89.9)
Fast eaters	42(40.4)	21(10.1)

and pulse, coffee drinking patterns, coffee drinking temperature, the volume of coffee drunk, porridge consumption temperature, nonalcoholic homemade drink intake patterns appeared to have statistically significant associations with oesophageal cancer. Among environmental factors, the place for cooking foods, source fuels, participating in chemical spray, use of chemical containers, x-ray exposure, and rodenticide use were significantly associated with oesophageal cancer.

The independent variables were sequentially computed in a block by taking 10 independent variables simultaneously for multiple logistic regression analysis. The effects of multicollinearity and interactions were tested for coffee temperature, volume of coffee consumed,porridge consumption temperature, and porridge eating speed but none of the variables showed correlations, synergistic and/or multiplicative increased risk of developing oesophageal cancer. Finally, the final model that best predicted the determinants of OC was selected based on the theoretical and statistical significance of the predictors. After adjusting for the potential confounders, coffee drinking temperature, coffee drinking volume at a time, porridge consumption temperature, porridge consumption speed, dairy intake patterns, nonalcoholic homemade drink, food cooking place, use of chemical containers, and x-ray exposure were variables that persisted as significant determinants of OC in the multivariable analysis. Hence, drinkers of very hot coffee had higher (AOR=5.1,[95% CI: (1.95, 13.71) odds of developing OC compared to hot coffee drinkers. Besides, the odds of developing OC was almost 5 times (AOR=4.9, [95% CI: (2.03, 12.17) higher for a large volume of coffee drinkers compared to a small volume of coffee drinkers at a time. On the other hand, the odds of developing OC was more than 3 times (AOR= 3.1[95% CI: (1.38,7.03) higher for very hot porridge consumers compared to hot porridge consumers. Porridge consumption speed was associated with an increased risk of OC; fast eaters had higher (AOR=7.0 [95% CI: (2.48, 20.14) odds of developing OC compared to their counterparts. Furthermore, odds of developing OC were higher for those who had a low intake of dairy products (AOR=6.0, [95% CI: (2.29,

Table 3 Exposure to Potential Environmental Carcinogens Among the Participants, Arsi Zone, Oromia, Ethiopia, 2020

Characteristics	Cases (%)	Controls (%)
	N=104	N=208
Food preparation places		
In the kitchen	70(67.3)	194(93.3)
In living rooms	34(32.7)	14(6.7)
Source fuels for cooking foods		
Animal muck	9(8.7)	66(31.7)
Firewood	95(91.3)	142(68.3)
Khat chewing		
No	78(75.0)	166(79.8)
Yes	26(25.0)	42(20.2)
Ventilation in the room		
No	70(67.3)	194(93.3)
Yes	34(32.7)	14(6.7)
Alcohol intake		
No	89(85.6)	163(78.4)
Yes	15(14.4)	45(21.6)
Tobacco use		
No	95(91.3)	197(94.7)
Yes	9(8.7)	11(5.3)
Chemical containers for in house use		
Safely disposed	23(22.1)	101(48.6)
Used for in house services	81(77.9)	107(51.4)
Exposure to radiations		
No	24(23.1)	147(70.7)
Yes	80(76.9)	61(29.3)
Participating in a chemical spray		
No	89(85.6)	192(92.3)
Yes	15(14.4)	16(7.7)
Years working in chemical spray		
< 10 years	40(38.5)	39(18.8)
≥ 10 years	64(61.5)	169(81.3)
Rodenticide use		
No	33(31.7)	112(53.8)
Yes	71(68.3)	96(46.2)

15.95), to those who cook food in sleeping room (AOR=3.7, [95% CI: (1.22, 11.39), exposed to x-ray radiation (AOR=9.4,[95% CI: (3.94, 22.82), nonalcoholic homemade drinkers (AOR=5.4, [95% CI: (1.97, 15.14) compared to those who had a higher intake of dairy products, cook food in the kitchen, no history of x-ray exposure and did not consume nonalcoholic drinks respectively. Besides, the users of chemical containers for in house services had higher (AOR=3.4, [95% CI: (1.48, 8.23) odds of developing OC compared to those who reported safe disposal of chemical containers (Table 4).

Discussion

The main purpose of this study was to identify the dietary and environmental determinants of oesophageal cancer. The study revealed that cooking food in a living room was significantly associated with an increased risk of oesophageal cancer. The finding is consistent with the study in Malawi that identified cooking foods in a sleeping room as a significant predictor of oesophageal cancer.[34] Indoor air pollutants that may contain carcinogen contaminants such as benzopyrene, PAHs, and acrylamide in wood fires or flame grilling may deposit on foods during cooking foods in sleeping rooms.[34,36] A study in Iran reported contamination of foods with PAHs as a significant risk factor of OC among the populations living in the endemic area.[11] The finding has practical applicability as the majority of populations in Ethiopia use their living houses for a cooking place.[49]

Another remarkable finding in this study was that drinking non-alcoholic homemade drinks described as kennetoo appears to be positively associated with the risk of oesophageal cancer. Homemade drinks were reported as an independent determinant of OC elsewhere.[7,36] Barely is known for its higher fiber content that is protective against cancer. The probable risk in relation to the consumption of barley-based homemade drinks might be linked to added sweeteners and/or the formation of harmful chemicals during the brewing process of homemade nonalcoholic drinks. For instance, a study in Ethiopia found high concentrations of carcinogenic contaminant (acrylamide) in a local homemade drink (Keribo) brewed from deeply roasted high starch containing barley.[50] The reason could be because of the fact that roasting starchy foods at a very higher temperature creates acrylamide which is a toxic substance to genes, nerves and is reported as a risk factor for cancer.[51,52]

Other independent determinants of OC in the present study were food and beverage consumption temperatures. The odds of developing OC were higher for very hot porridge consumers compared to those who consumed hot porridge. The association between porridge consumption temperature and the risk of OC is consistent with the study findings in Ethiopia.[42,45]

Besides, there was a significant positive association between the speed of consuming porridge and oesophageal cancer. Consequently, fast eaters were more likely to develop OC compared to those who eat porridge at normal speed with a group of people. The finding supports the study that found fast eating as a significant predictor of oesophageal cancer.[6] Case report studies revealed severely damaged esophageal linings after individuals hurriedly swallowed bolus of hot foods.[53,54] The reason could be fast eaters may swallow a very hot bolus of porridge without moderating the temperature through the air or by mixing with saliva in the oral cavity.

Coffee drinking temperature demonstrated a significant positive association with an increased risk of oesophageal cancer. The finding concurs to studies that reported positive associations between coffee drinking temperatures and an increased risk of oesophageal cancer,[4,35] but contrary to a study in Europe that did not find a significant association between drinking hot coffee and oesophageal cancer.[55] The disparity between the study findings can be explained by the fact that populations in Europe usually add cold milk to hot coffee before drinking it. Besides, there are remarkable differences in the histological types and etiological factors of OC across the geographical locations and racial patterns.[55–57] Consumption of foods at an elevated temperature has been linked to the formation of endogenous reactive nitrogen species, nitrosamines, TP53 gene mutations, the diminished barrier function of the esophageal epithelium to carcinogenic materials.[3,5,58,59]

In this study, the risk of developing OC was further increased with the volume of coffee consumed. As a result, drinkers of a large volume of coffee at a time had higher odds of developing OC compared to small volume coffee drinkers. The findings regarding coffee drinking volume and risk of OC were inconsistent. In a systematic review, only three of twenty studies showed positive associations[5] while a meta-analysis study among East Asian populations did not find a relationship between coffee drinking volume and risk of Oesophageal cancer (4). Whereas, an experimental study confirmed a raised intraesophageal

Table 4 Dietary and Environmental Determinants of Oesophageal Cancer in Arsi Zone, Oromia, Ethiopia, 2020

Characteristics	Case (%)	Controls (%)	COR(95% CI)	AOR(95% CI)	
	n=104	n=208			
Coffee drinking temperature					
Hot	58(55.8)	158(80.2)	1	1	
Very hot	46(44.2)	39(19.8)	3.2(1.90, 5.41)	5.1(1.95, 13.71)	***
Coffee drinking volume					
Small	29(27.9)	152(73.1)	1	1	
Large	75(72.1)	56(26.9)	7.0(4.14,11.88)	4.9(2.03, 12.17)	****
Porridge consumption temperature					
Hot	37(35.6)	162(77.9)	1	1	
Very hot	67(64.4)	46(22.1)	6.3(3.79,10.70)	3.1(1.38, 7.03)	***
Porridge consumption speed					
Normal	62(59.6)	187(89.9)	1	1	
Fast	42(40.4)	21(10.1)	6.0(3.319, 10.963)	7.0(2.48, 20.14)	****
Dairy intake patterns					
Low	50(52.1)	49(26.8)	4.5(2.50, 8.32)	6.0(2.29, 15.95)	****
Medium	23(24.0)	31(16.9)	3.3(1.64, 6.71)	2.0(0.69, 5.84)	
High	23(24.0)	31(16.9)		1.00	
Food cooking places					
In kitchen	70(67.3)	194(93.3)	1	1	
In living rooms	34(32.7)	14(6.7)	6.7(3.41, 13.28)	3.7 (1.22, 11.39)	**
Use of chemical containers					
Safe dispose	23(22.1)	101(48.6)	1	1	
Use for inhouse services	81(77.9)	107(51.4)	3.3(1.94, 5.68)	3.4(1.48, 8.23)	***
History of cancer in the family					
No	94(90.4)	187(89.9)	1	1	
Yes	10(9.6)	21(10.1)		0.9(0.27, 3.42)	
History of chewing khat					
No	78(75.0)	166(79.8)	1	1	
Yes	26(25.0)	42(20.2)	1.3(0.75, 2.30)	1.2(0.51, 3.25)	
Exposure to x-ray					
No	24(23.1)	147(70.7)	1	1	
Yes	80(76.9)	61(29.3)	8.0(4.65,13.85)	9.4(3.94, 22.82)	****
Participating in chemical spray					
No	89(85.6)	192(92.3)	1	1	
Yes	15(14.4)	16(7.7)	2.0(0.95, 4.27)	3.3(0.97, 11.80)	
Homemade nonalcoholic drinks					
No	36(34.6)	94(45.2)	1	1	
Yes	68(65.4)	114(54.8)	1.5(0.95, 2.53)	5.4(1.97, 15.14)	***

(*Continued*)

Table 4 (Continued).

Characteristics	Case (%) n=104	Controls (%) n=208	COR(95% CI)	AOR(95% CI)	
History of drinking alcohol					
No	89(85.6)	163(78.4)	1	1	
Yes	15(14.4)	45(21.6)	0.61(0.32,1.15)	1.5(0.43, 5.89)	

Notes: Variable(s) in the model: Coffee temperature, Non-alcoholic drinks, Porridge temperature, milk and dairy products, Food preparation place, Use of chemical containers, History of cancer, Khat chewing, Radiation exposure, Participating in chemical spray, Alcohol drinking, Porridge consumption speed, and coffee 0drinking volume. **, ***, **** are P-value <0.05, < 0.001, and <0.0001 respectively.

temperature with a volume of coffee consumed than by coffee temperature.[59]

Low intake of dairy products has shown a significantly increased risk of OC compared to the high intake of dairy products. The reason could be, individuals with an inadequate intake of milk and dairy products may be deficient of calcium mineral that helps the control of cell cycles, cell divisions, and apoptosis of cancer cells.[17]

The present study revealed that the odds of developing OC was higher for individuals who reported the use of chemical containers for inhouse services compared to those who reported safe disposal of the chemical containers. Agrochemical exposure was positively associated with an increased risk of OC,[60] and contamination of food and drinking water from the reuse of pesticide residues was reported as the greatest risk to human health.[61]

In this study, exposure to x-ray radiations demonstrated the strongest significant association with an increased risk of oesophageal carcinoma. The finding is consistent with the study in Srilanka that identified a history of ever exposure to x-ray as a significant risk factor of oesophageal cancer.[60] The association between exposure to x-ray radiation and risk of developing OC was also documented among patients treated with radiation for other illnesses.[62,63]

Strength and Limitation of the Study

The strength of this study is that it is the first case-control study conducted among a study population entirely represented from OC endemic area in Ethiopia. Cases and controls were comparable in terms of residential areas and matched by sex and age. Moreover, the study revealed multiple risk factors associated with OC that may contest the overriding hypothesis that linked a hot wheat porridge and its consumption temperature as the only dietary risk factors associated with an increased risk of oesophageal in the Arsi Zone. The unavoidable limitations of this study are recall and information biases due to recall of past experiences and participants' self-reported practices.

Conclusions

Coffee temperature, coffee drinking volume, porridge consumption temperature, porridge consumption speed, dairy products intake patterns, food cooking place, x-ray exposure, nonalcohol homemade drink, and use of chemical containers for in house services were independent determinants of increased risk oesophageal cancer in Arsi Zone. The findings imply the need for behavior change communication targeting food cooking place, consumption temperature, and environmental safety measure to curb the problem of OC in the study community. Future studies should focus on assessing hot food consumption temperature, the source, and the level of potential carcinogens in the foods, crops, and living environment in the study area.

Abbreviations

AOR, adjusted odds ratio; CI, Confidence Interval; COR, crude odds ratio; FFQs, Food Frequency Questionnaire; IRB, Institutions Research Board; OC, oesophageal cancer; OR, odds ratios; PHAs, polycyclic aromatic hydrocarbons; SCC, squamous cell carcinomas; SD, standard deviations; SPSS, Statistical package for social sciences.

Data Sharing Statement

The datasets supporting the conclusions of this article are included in the article.

Ethics Approval and Consent to Participate

This study was conducted in accordance with the Declaration of Helsinki. Ethical permission to carry out the study was obtained from the Institutions Research Board (IRB) of Jimma University by ethical approval research protocol letter IHRPEG/597/2019. The approval of the research activities was

sought from the administration of the health facilities involved in the study. The study objectives were explained in a local language and written consent was obtained with a signature or thumbprint. Confidentiality of the information was maintained by excluding personally identifiable information on the questionnaires.

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Author Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no conflicts of interest for this work.

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