

Dietary Determinants of Esophageal Cancer in Arsi Zone, Central Ethiopia: A Case-Control Study

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Research

Keywords: Diets, risk factors, esophageal cancer, Arsi, Ethiopia

Posted Date: December 10th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-123027/v1>

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Abstract

Background: Esophageal cancer is ranked 5th of all types of malignancies in Ethiopia following uterine, cervical, breast, and colorectal cancers. The findings regarding the dietary risk factors associated with an increased incidence of esophageal cancer were inconsistent.

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 involved. Cases were consecutively recruited from higher referral hospitals and matched to two population-based controls (1:2 ratio) on age, sex, and residence/altitude. Data were collected using structured questionnaires, coded and entered into the EPI info version 7, and transported to SPSS software version 23. Binary and multiple logistic regressions were conducted to check the association between independent and dependent variables. Adjusted odds ratios and the corresponding 95% confidence intervals were estimated to assess the strength of association. P-values <0.05 were used to declare statistical significance.

Results: Cooking foods in a living room (AOR=2.8, [95% CI: (1.11, 7.38)], teeth loss (AOR= 4.4, [95% CI: (1.87, 10.56)], consumption of very hot porridge (AOR=4.2 [95% CI: (2.08, 8.72)], drinking very hot coffee (AOR=3.9 [95% CI: (1.70, 8.93)], drinking large volume of coffee at a time (AOR=6.3 [95% CI: (2.93, 13.78)], eating porridge fast (AOR=9.2 [95% CI: (2.98, 28.88)]) were positively associated with esophageal cancer.

Conclusion: Multiple dietary practices were associated with an increased risk of esophageal cancer. The findings imply the need for behavior change communication targeting cooking and consumption behaviors to curb the problem of esophageal cancer in the study community.

Background

Human diets have been linked to about twenty percent of all cancers in developing countries(1). Diets have decisive roles as a protective or in the initiation and progression of chronic diseases(2, 3). Nutrients in the diets control the transcription factors that transform the gene expression while human genetic make can delineate susceptibility to diet-dependent health disorders(4).

Epidemiologic studies found strong significant associations between diets and esophageal cancer (EC) (5). Consumptions of red and processed meat, saturated fat, discretionary calorie in the highest category of intakes were significantly associated with increased risk of esophageal cancer (5, 6). Similarly, an elevated risk of EC was found among high-risk populations who consumed hot coffee, mate, tea, barbecued, and fried meat(7–12). The other dietary related practices associated with an increased risk of EC were eating salted fish, fried takeaway foods, food eating speed, and teeth loss (13, 14).

The associations between hot foods consumption patterns and risk of EC were not always consistent. The study in Sweden identified no significant association between drinking hot beverages and EC either independently or after adjusting for other causes(15). According to Wu et. al(2006) opinion, the oral cavity

could adjust the heat so that the hot liquid foods temperature could fall too rapidly to cause injury to the esophageal mucosa(16).

Micronutrients and antioxidant substances are protective against esophageal cancer(17, 18). Previous studies discovered the strongest inverse relationships between the consumption of vitamins, beta carotene from raw fruits, dark green leafy, and cruciferous vegetables and esophageal carcinoma (19, 20). Likewise, an inverse significant relationship was found between higher dietary calcium intake and the risk of esophageal cancer(21).

Earlier studies in Africa revealed that the rise of EC incidences in endemic areas over the past decades were attributed to the consumption of crops that had degenerative effects(22). An increased risk was observed among populations that consumed maize (corn) and wheat-based staple foods compared to those who consumed diversified and nutritious foods (23). However, recent studies reported Polycyclic Aromatic Hydrocarbons(PAHs) emitted from partially combustible source fuels used for cooking foods, cooking places (24), consumption of hot foods as independent determinants of esophageal cancer among populations living in high-risk areas in Africa (10, 25–27).

Esophageal cancer is ranked 5th of all types of malignancies in Ethiopia following uterine, cervical, breast, and colorectal cancers(28). Arsi Zone is one of the EC endemic areas in Ethiopia(29). The findings regarding the dietary risk factors associated with an increased incidence of esophageal cancer were inconsistent. For example, in a small size pilot study, eating salty diets and inadequate vegetable intakes were identified as the independent predictors of risk of esophageal cancer(30). A case-control study by Magnesia et.al, (2005) documented eating Kocho (false banana) as the main dietary risk factors of EC opposite to a similar study by Shewaye(2016) which reported consumption of hot wheat porridge as the strongest predictor of the risk of esophageal carcinoma(31, 32). Furthermore, no study exists whether a fermented homemade traditional beverage that contains a high concentration of the carcinogenic chemical(acrylamide) would contribute to an increased risk of esophageal cancer(33). The present study was carried out to identify the dietary determinants of EC in the Arsi Zone.

Methods

Arsi Zone is located in Oromia National Regional State in central Ethiopia. The zone lies between 60 45' N to 80 58'N and 380 32 E to 400 50' E. Assela is the capital town of the Zone located at 175 km from Addis Ababa. Barley, wheat, and maize are the pre-dominant cereals and among pulses, horse beans, and field peas are grown widely. Vegetables, root crops, and stimulants are also grown(34).

Study design

A case-control study was employed from June 1, 2019, to June 30, 2020.

Sampling procedures

Cases were endoscopically examined and histologically confirmed EC patients who attended referral hospitals. They were consecutively recruited from Asella Teaching and Referral Hospital in Arsi Zone and other higher referral hospitals mentioned in a previous epidemiological study(35). The control were healthy individuals (absence of any symptom of cancer during data collection) and 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 ratios was used to select the sample. Further matching of cases and controls was done by age and sex. 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 and Measurement

Data were collected by five trained BSc nurses using interviewer-administered questionnaires. The data collection tool for dietary practices was adapted from a validated Food Frequency Questionnaire (FFQs) (36–38) to local food items by researchers. The questionnaire comprised of socio-demographic and economic characteristics, habitual dietary practices, and food cooking places, source of fuels, and the presence of ventilation in a cooking area, food consumption temperatures, and volume of hot drinks. The volume of coffee drinking volume at a time was checked in a survey preceding this study (**unpublished data**). The smallest coffee drinking (coffee cup) contains 80 ml 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. Furthermore, all participants were requested about the speed of eating porridge with a group of people taking into account an anecdotal report of consumption of hot porridge in a shared manner from a serving utensil. Fast eater was defined as a person who is first to finish when eating porridge with a group of people, normal eater if neither first nor last to finish, and slow eater if the person last to finish when eating food with a group of people respectively(8). Finally, drinking of alcohol and non-alcohol beverages, and use of any forms of tobacco, and history of cancer in a family were collected and their responses were categorized as yes or no. Participants were asked their usual dietary habits and frequency of consumption within a day, within weeks, and within months over the past five years before developing dysphagia. 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 version 7, and transported to SPSS software version 21 for data processing and analysis. The frequencies of dietary intakes were converted into a continuous variable and computed as mean dietary intake per week. Furthermore, dietary patterns were computed using principal component analysis (PCA). The criteria used for selection variables for PCA analysis were sample size greater than 50, a ratio of cases to variables of 5 to 1 or larger, the correlation matrix for the variables that contain 2 or more correlations of 0.30 or greater, sampling adequacy greater than 0.50 in anti-image correlations and Bartlett test of sphericity is statistically significant ($P < 0.05$), the commonality of the components greater than 0.50, variables that had no loadings, or correlations, of 0.40 or higher for more than one component, components that had no only one variable in it (39). Descriptive statistics were computed and presented in frequencies and percentages for categorical variables, and means with standard deviations for continuous variables. Binary and multiple logistic regressions were conducted to check the association between each independent and dependent variable. Independent variables that have associations with the outcome variable in the bivariate logistic regression and those with a p-value of ≤ 0.25 were considered a candidate for the final Logistic regression model. The Hosmer Lemeshow test was used to check the goodness of model fitting. Multicollinearity was checked using standard error < 2.0 . The multivariable logistic regression model was adjusted for the confounding effects of independent variables. Odds ratios (OR) 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

Sociodemographic characteristics

A total of 312 participants, 104 cases, and 208 controls were included in this study. The mean (\pm SD) age of cases was 55.2(\pm 11.0) and that of controls was 57.3(\pm 11.2) [$P = 0.11$] years. Two third of (66.7%) participants were from rural areas. On the other hand, 95(91.3%) cases and 192(92.3%) controls were Muslims. Besides, 101(97.7%) 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. The proportion of Teeth loss was higher (57.7%) among cases than controls (34.1%). Ten (9.6%) cases and 21(10.1%) controls reported a history of esophageal cancer (24), breast cancer (2), cervical cancer (4), and unexplained cancer (1) in the family (Table 1).

Table 1
Sociodemographic characteristics of the study participants in Arsi Zone,
Ethiopia, 2020

Characteristics	Cases (%)	Controls (%)
	n = 104	n = 208
Mean age (\pm SD) 55.2(11.0) 57.3 (11.2)		[P = 0.11]
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		

Characteristics	Cases (%)	Controls (%)
	n = 104	n = 208
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	15(14.4)	52(25.0)
2nd	26(25)	34(16.3)
3rd	21(20.2)	36(17.3)
4th	27(26.0)	39(18.8)
5th	15(14.4)	47(22.6)

Food cooking place and dinner time

Thirty four (32.7%) cases and 14(6.7%) controls cooked food in living rooms. The vast majority (91.3%) of cases and 142(68.3%) controls used firewood as source fuels. The majority of the cases (58.7%) and less than half of the controls (49%) consumed dinner between 7:30 to 2:30 PM local time (Table 2).

Table 2
Food cooking place and dinner time of the study
participants, Arsi Zone, Oromia, Ethiopia

Characteristics	Cases (%)	Controls (%)
	n = 104	n = 208
Food preparation place		
In separate kitchen	70(67.3)	194(93.3)
In living rooms	34(32.7)	14(6.7)
Ventilation of cooking places		
No	51(49)	130(62.5)
Yes	53(51)	78(37.5)
Source fuels		
Animal muck	9(8.7)	66(31.7)
Firewood	95(91.3)	142(68.3)
Dinner time		
Before 1:30 PM	3(2.9)	27(13)
1:30 – 2:30 PM	61(58.7)	102(49)
Just before bed	40(38.5)	79(38)
*** P-Value < 0.0001		

Dietary intake patterns

In PCA analysis, the dietary patterns of the study subjects were loaded onto two components. The components were grouped as diversified diets (legumes, egg, vegetables, and milk) and cereal foods consumed with fats (butter) and oils. Accordingly, 73(70.2%) cases and 131(63%) controls consumed diversified foods. The proportion of cereal foods with fats and oils consumption was lower among the cases (29.8%) compared to controls (37.0%). The mean (\pm SD) frequency of cereal food consumption per week for cases and controls was 4.9(1.1) and 4.5(1.2) respectively. The frequency of vegetable consumption was comparable between cases and controls. Cases consumed meat more frequently than controls. The mean weekly intakes of legumes and pulses, milk and dairy products, fats and oils, sweets, Garlic, and onions consumptions were lower for cases than controls (Table 3).

Table 3
Mean dietary intakes by participants, Arsi Zone, Oromia,
Ethiopia, 2020

	Participants status	
	Cases	Controls
Food frequency per week	Mean(\pm SD)	Mean(\pm SD)
Cereal foods	4.9(1.1)	4.5(1.2)
Vegetables	3.5(1.2)	3.6(1.3)
Meat consumption	1.8(1.4)	1.4(0.9)
Egg consumption	2.9(1.8)	2.7(1.4)
Legumes and pulses	4.1(1.5)	4.8(1.3)
Milk and dairy products	3.0(1.7)	3.8(1.6)
Fats and oils	4.6(1.7)	5.5(1.7)
Sweet consumptions	2.2(1.2)	4.3(2.2)
Garlic and onions	3.8(1.5)	4.6(1.9)

Hot food consumption patterns

Porridge and coffee were reported as the commonest hot food and beverage, respectively. More than half of cases (52.5%) and 119(62.6%) controls favored wheat porridge. Nearly, 2/3rd of the cases (64.4%) preferred very hot porridge compared to more than 3/4th (77.9%) of controls that favored hot porridge. Concerning the speed of porridge consumptions, 42 (42.4%) cases and 21 (11.1%) controls were fast eaters. Cases began drinking coffee at a mean (\pm SD) of 8.2(4.7) years while controls started at 11.5(4.5) years of age. Regarding coffee drinking rounds, 69(66.3%) of cases and 108(51.9%) of controls reported drinking coffee three times a day. The majority of cases (62.5%) and controls 115 (55.3%) drank ≥ 3 cups of coffee at a time. Close to 3/4th (72.1%) cases reported drinking a large volume of coffee while (73.1%) controls drank a small volume of coffee (Table 4).

Table 4
Participants` hot foods consumption practices, Arsi Zone,
Oromia, Ethiopia

Characteristics	Cases (%)	Controls (%)
	n = 104	n = 208
Porridge temperature		
Hot	37(35.6)	162(77.9)
Very hot	67(64.4)	46(22.1)
Coffee drinking patterns		
Once per day	29(27.9)	67(32.2)
Twice per day	6(5.8)	33(15.9)
Three times per day	69(66.3)	108(51.9)
Amount of coffee drank at a time		
< 2 coffee cups/glasses or beakers	39(37.5)	93(44.7)
≥ 3 coffee cups/glasses or beakers	65(62.5)	115(55.3)
Types of coffee		
Pure(black coffee)	35(33.7)	52(25)
Coffee with milk	69(66.3)	156(75)
Coffee temperature		
Hot	58(55.8)	169(81.3)
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		
Slow eaters	14(14.1)	64(33.7)
Neither slow nor fats	43(43.4)	105(55.3)
*** P-Value < 0.0001		

Characteristics	Cases (%)	Controls (%)
	n = 104	n = 208
Fast eaters	42(42.4)	21(11.1)
*** P-Value < 0.0001		

History of exposure to potential carcinogens

Nearly 2/3rd (65.4%) of cases and 114(54.8%) controls reported drinking Kennetoo (Kennetto is brewed from deeply roasted (burned) barley and added sugar or soft drink (Coca-Cola) as a sweetener) as nonalcoholic homemade drinks. The majority of the cases and controls did not drink alcoholic beverages. Less than 1/4th of cases (26%) and 41(19.7) had a history of chewing Khat. Eight cases (7.7%) and 12(5.8%) controls have ever used some forms of tobacco (**Fig. 1**).

Determinants of esophageal cancer

Independent variables were sequentially computed in a block to find the model that best predicts the determinants of esophageal cancer. As a result, ethnicity and family size from the background variables; a place for food preparation, source fuels for cooking foods, types of porridge, inputs added into porridge, porridge temperature, speed during porridge consumption, coffee drinking patterns, coffee temperature, the volume of coffee drunk, dinner time, and nonalcoholic homemade drinks had a p-value < 0.25. The interaction between dietary practices, alcohol drinking, tobacco use, and khat chewing was checked but no significant association was observed. The final model was selected based on the theoretical and statistical significance of the predictors. Hence, cooking foods in a living room (AOR = 2.8, [95% CI: (1.11,7.38), teeth loss (AOR = 4.4, [95% CI: (1.87, 10.56), consumption of very hot porridge(AOR = 4.2[95% CI:(2.08, 8.72), drinking very hot coffee(AOR = 3.9[95% CI:(1.70,8.93), drinking large volume of coffee (AOR = 6.3[95% CI:(2.93,13.78) and eating porridge fast (AOR = 9.2[95% CI:(2.98, 28.88) were positively associated with esophageal cancer(Table 5).

Table 5
Dietary determinants of esophageal cancer in Arsi Zone, Ethiopia, 2020

Characteristics	Cases	Controls	COR(95% CI)	AOR(95% CI)
	N = 104	N = 208		
	No. (%)	No. (%)		
History of cancer in a family				
No	94(90.4)	187(89.9)	1	1
Yes	10(9.6)	21(10.1)	1.0(.42,2.09)	1.0(.32,3.15)
Types of porridge				
Barley porridge	26(26.8)	30(15.8)	1	1
Maize porridge	21(21.6)	41(21.6)	.60(.28, 1.24)	.41 (.12, 1.23)
Wheat porridge	50(51.5)	119(62.6)	.49(.26, .90)	.51(.19, 2.13)
Food cooking place				
In Kitchen	70(67.3)	194(93.3)	1	1
In living house	34(32.7)	14(6.7)	6.7(3.41, 13.28)	2.8(1.11,7.38)
Teeth loss				
No	44(42.3)	137(65.9)	1	1
Yes	60(57.7)	71(34.1)	2.6(1.62, 4.26)	4.4 (1.87, 10.56)
Porridge temperature				
Hot	31(29.8)	144(69.2)	1	1
Very hot	66(63.5)	46(22.1)	6.7(3.88,11.44)	4.2 (2.08, 8.72)
Coffee temperature				
Hot	58(55.8)	158(80.2)	1	1
Very hot	46(44.2)	39(19.8)	3.2(1.90,5.41)	3.9(1.70,8. 93)
Coffee volume				
Small	29(27.9)	152(73.1)	1	1
Large	75(72.1)	56(26.9)	7.0(4.14,11.88)	6.3 (2.93, 13.78)
Porridge consumption speed				
Slow	14(14.1)	64(33.7)	1	1
Neither slow nor fast	48(46.2)	123(59.1)	1.8(.91,3.47)	1.8(.67, 4.89)

Characteristics	Cases	Controls		
	N = 104	N = 208		
	No. (%)	No. (%)	COR(95% CI)	AOR(95% CI)
Fast	42(40.4)	21(10.1)	9.1(4.19,19.95)	9.2(2.98, 28.88)
Dietary consumption patterns				
Diversified foods	73(70.2)	131(63.0)	1	1
Cereal with fats and oils	31(29.8)	77(37.0)	.7 (.43, 1.19)	.6 (.30, 1.42)
Khat chewing				
No	77(74.0)	167(80.3)	1	1
Yes	27(26.0)	41(19.7)	1.4(.81, 2.49)	1.6 (.71,3.83)
Nonalcoholic homemade drinks(Kennetoo)				
No	36(34.6)	94(45.2)	1	1
Yes	68(65.4)	114(54.8)	1.6(.95 ,2.53)	2.0 (.87,4.60)
Variable(s) in equations: Coffee temperature, food preparation place, nonalcoholic drinks, teeth loss, Temp porridge, Khat chewing, Coffee volume, Types porridge, Speed porridge consumed, dietary patterns, Cancer history.				

Discussion

The study findings showed variables including food cooking place, teeth loss, porridge consumption temperature, coffee drinking temperature, the volume of coffee drank and speed during porridge consumption were significantly associated with increased risk of EC after adjusting for other variables.

The place of cooking foods was significantly associated with an increased risk of esophageal cancer. The finding is consistent with the study in Malawi that identified cooking foods in a living room as a significant predictor of esophageal cancer(40). Food cooking places were reported as one of the causes of indoor air pollutants and carcinogens found in foods (40, 41). For instance, a study in Iran reported contamination of foods with PAHs as a risk factor of EC among the populations living in the EC endemic area(42). The finding has practical applicability as the majority of populations in Ethiopia use their living houses for a cooking place(43).

Another remarkable finding in this study was that teeth loss appears to be a risk factor for esophageal cancer. The finding is similar to previous studies that reported teeth loss as an independent determinant of esophageal cancer(8, 25, 44–47). Measuring the effects of tooth loss after the development of EC may be prone to reverse causation. However, the persistent significant association of teeth loss with an increased risk of EC after adjusting for potential confounders in this study and pooled meta-analysis

study conducted among other populations (46) make it an important risk factor of esophageal cancer. Several mechanisms were postulated on the role of teeth loss in the pathogenesis of cancer. Chronic inflammations and periodontitis caused by bacterial infections may create a pocket of toxic metabolites while poorly masticated hard foods may injure the esophageal linings during swallowing (45). Besides, individuals who lost teeth may avoid the consumption of hard texture foods such as fruits and vegetables which are protective against cancer (44). On the other hand, individuals who lost teeth may modify their diets to soft foods such as hot porridge and soup that can induce thermal injury to the esophagus.

Other independent determinants of EC in the present study were food and beverage consumption temperatures. The odds of developing EC were higher for very hot porridge consumers compared to those who consumed hot porridge. The association between porridge consumption temperature and the risk of EC is consistent with the study findings in Ethiopia(32, 48).

The strongest association was observed between the speed of consuming porridge and the risk of esophageal cancer. Consequently, fast eaters were 9.2 times more likely to develop EC compared to slow eaters. The finding supports the study that found fast eating as a significant predictor of esophageal cancer(8). Case report studies revealed severely damaged esophageal linings after individuals swallowed large bolus of hot foods (49, 50). 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 esophageal cancer. The likelihood of developing EC was 3.9 times higher for very hot coffee drinkers compared to hot coffee drinkers. The finding is alike to studies that reported positive associations between coffee drinking temperatures and risk of esophageal cancer (10, 51)but contrary to a study in Europe that did not find a significant association between drinking hot coffee and esophageal cancer(52). 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 EC across the geographical locations and racial patterns (52–54). The pathophysiological processes that linked hot foods to the risk of EC were described in numerous experimental and observational studies(55). 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 (7, 56–58).

In this study, the risk of developing EC was further increased with the volume of coffee consumed. As a result, drinkers of a large volume of coffee at a time were 6.3 times more likely to develop EC compared to small volume coffee drinkers. The findings regarding coffee drinking volume and risk of EC were inconsistent. In a systematic review, only three of twenty studies showed positive associations(7) while a meta-analysis study among East Asian populations did not find a relationship between coffee drinking volume and risk of esophageal cancer(51). Whereas, an experimental study confirmed a raised intraesophageal temperature with a volume of coffee consumed than by coffee temperature(57).

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 EC endemic area in Ethiopia. The study revealed multiple dietary practices associated with EC that may contest the overriding hypothesis that linked porridge consumption as the only dietary risk factors associated with an increased risk of esophageal in the Arsi Zone. The unavoidable limitations of this study are recall and information biases because of collecting data based on past experiences and participants' self-reported practices.

Conclusion

Multiple dietary practices are associated with an increased risk of esophageal cancer. Food cooking place, teeth loss, porridge consumption temperature, coffee drinking temperature, the volume of coffee drank, speed during porridge consumption were independent determinants of risk of esophageal cancer. The findings imply the need for behavior change communication targeting cooking and consumption behaviors to curb the problem of esophageal cancer in the study community.

Abbreviations

AOR

Adjusted odds ration

CI

Confidence Interval

COR

Crude odds ratio

EC

Esophageal cancer

FFQs

Food Frequency Questionnaire

IRB

Institutions Research Board

OR

Odds ratios

PCA

Principal component analysis

PHAs

Polycyclic Aromatic Hydrocarbons

SD

Standard deviations

Declarations

Acknowledgments

The authors would like to thank health facilities for their enormous help in providing important information and facilitating every activity during data collection. We are very grateful to data collectors and participants who were very cooperative.

Authors' Contributions

Haji Aman Deybasso designed the research conception, conducted the research, analyzed the data, and wrote the final report. Kedir Teji Roba, Berhanu Nega and Tefera Belachew have provided advisory support during the whole research process, edited and critically evaluated the final report. All authors have read and approved the manuscript.

Funding

Not applicable

Availability of data and materials

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

Ethics approval and consent to participate

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.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Figures

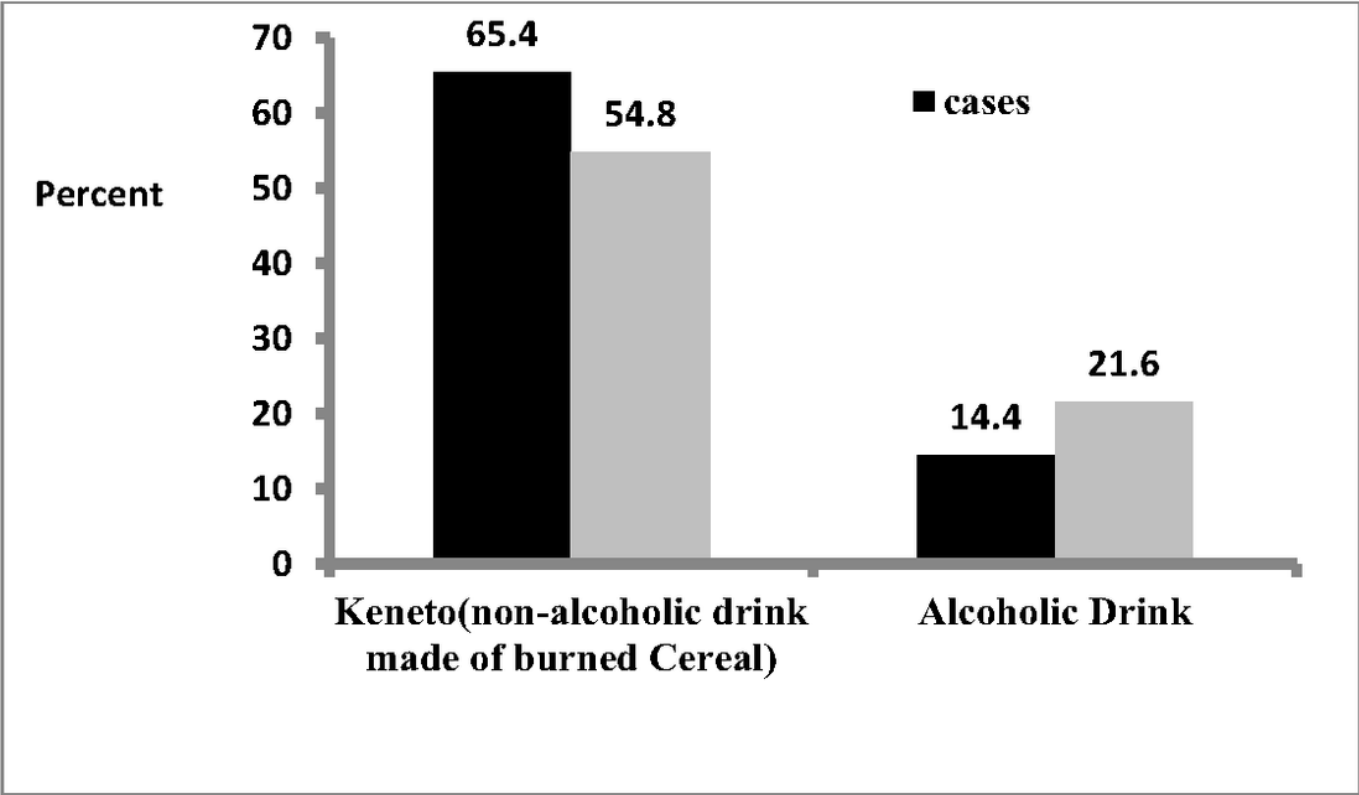


Figure 1

Alcohol and non-alcohol drinks reported by participants, Arsi Zone, Oromia, Ethiopia

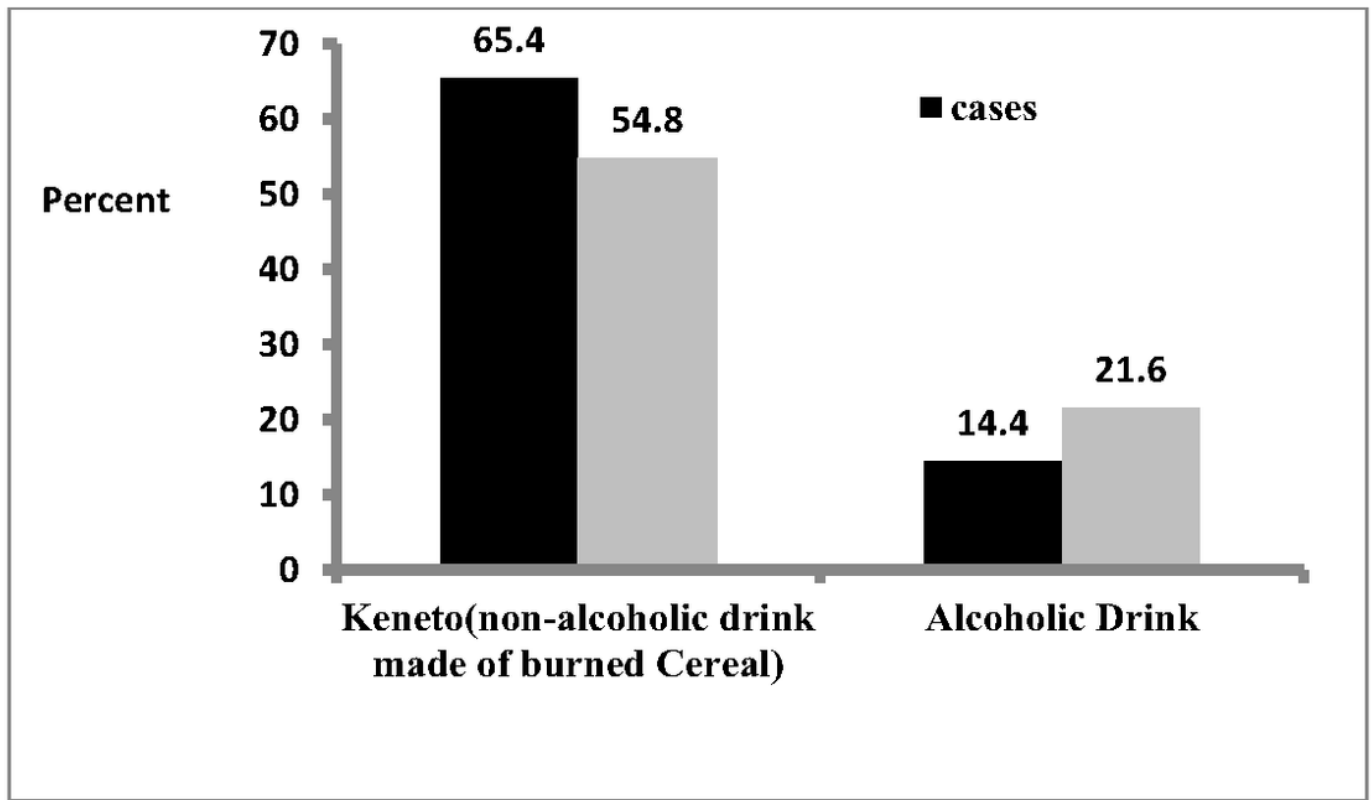


Figure 1

Alcohol and non-alcohol drinks reported by participants, Arsi Zone, Oromia, Ethiopia