ARTICLE

Red Meat Consumption and Risk Factors of Lung Cancer Among Never Smokers; A Hospital-Based Case-Control Study in Bangladeshi Population

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ABSTRACT

Background: Lung cancer remains a leading cause of cancer-related deaths worldwide. In Bangladesh, non-smoker lung cancer is rising due to dietary, lifestyle, and environmental factors. **Objective:** This study aims to explore the association between red meat consumption, lifestyle factors, and lung cancer risk among non-smoker populations in Bangladesh. **Methods:** A hospital-based case-control study was conducted at Bangabandhu Sheikh Mujib Medical University and Delta Medical College & Hospital. A total of 332 participants (166 cases, 166 controls) aged 30–65 years were included. A semi-structured questionnaire was used to collect data on socio-demographic characteristics, dietary patterns, behavioral factors, and clinical history. Odds ratios (OR) with 95% confidence intervals (CI). **Results:** This study involved 332 participants, with 166 cases and 166 controls matched by age and gender. The mean age of cases was 48.6±9.2 years, while controls had a mean age of 43.8±8.6 years. The mean BMI was 21.2±2.3 for cases and 22.0±2.5 for controls. Red meat consumption was significantly associated with an increased risk of lung cancer, with 59.6% of cases regularly consuming red meat compared to 45.8% of controls (OR=1.75, p=0.011). Passive smoking increased the risk of lung cancer by four times (OR=4.01, p<0.0001). Protective factors included regular vegetable intake (OR=0.37, p=0.001) and tea or coffee consumption (OR=0.57, p=0.042). **Conclusions:** Red meat consumption and passive smoking are major risk factors for lung cancer in non-smokers. Protective factors include regular intake of vegetables and tea or coffee. Targeted health interventions are necessary to reduce lung cancer risks.

Keywords: Lung Cancer, Non-Smokers, Red Meat, Passive Smoking, Dietary Patterns.

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INTRODUCTION

Lung cancer remains one of the most formidable health challenges worldwide, being the leading cause of cancer-related mortality. It is responsible for more deaths than breast, colon, and prostate cancers combined, despite medical advancements and increased awareness

[1]. Although smoking has long been recognized as the most significant cause of lung cancer, recent studies have identified non-smoker lung cancer as a growing concern. In non-smokers, lung cancer accounts for a substantial proportion of cases, particularly in populations where tobacco use is either low or declining, such as in developed countries and among women [2]. This pattern is also becoming evident in developing countries like Bangladesh, where a complex interplay of environmental, dietary, and lifestyle factors contributes to the increasing incidence of lung cancer among non-smokers. In Bangladesh, lung cancer represents a significant public health burden, with increasing incidence and mortality rates reported annually. According to a study by approximately 1.3 to 1.5 million people in Bangladesh are affected by cancer, with lung cancer being one of the most prevalent forms [3]. Despite the growing recognition of lung cancer's impact, public awareness of the disease, particularly regarding its risk factors among non-smokers, remains limited. Most individuals associate lung cancer solely with smoking, overlooking the contributions of dietary habits, lifestyle choices, and environmental exposures [4]. This study aims to address this knowledge gap by examining the association between red meat consumption, lifestyle factors, and lung cancer risk in non-smoker populations in Bangladesh.

The global incidence of lung cancer has been steadily rising, with approximately 1.8 million new cases and 1.6 million deaths reported in 2012 alone, accounting for 13% of total cancer incidence and 20% of cancer mortality [5]. The highest incidence rates are observed in developed regions such as North America, Europe, and East Asia, where smoking rates historically have been high. However, recent trends suggest a shift, with non-smoking-related lung cancer emerging as a critical public health issue. Studies have demonstrated that non-smokers, particularly women, are disproportionately affected by lung cancer, with risk factors including secondhand smoke, environmental pollution, genetic predispositions, and dietary patterns playing pivotal roles. In developing countries like Bangladesh, the epidemiological transition from communicable to non-communicable diseases (NCDs) has contributed to a double burden of disease, further complicating the public health landscape. As Bangladesh progresses through this transition, the prevalence of NCDs, including lung cancer, continues to rise [6]. This trend is compounded by rapid urbanization, changes in dietary patterns, and the adoption of sedentary lifestyles, all of which contribute to

an increased risk of cancer, particularly among non-smokers. Moreover, Bangladesh's tobacco use remains alarmingly high, with approximately 41% of males and 1.8% of females using tobacco in some form, further exacerbating the lung cancer burden.

Dietary habits have been identified as a crucial factor in the development of lung cancer, especially among non-smokers. Several studies have shown a positive association between the consumption of red meat and an increased risk of lung cancer [7]. Red meat, particularly when processed or cooked at high temperatures, contains carcinogenic compounds such as heterocyclic amines (HCAs) and polycyclic aromatic hydrocarbons (PAHs), which are known to induce DNA damage and promote cancer development. In contrast, a diet rich in fruits, vegetables, and fish has been associated with a reduced risk of lung cancer, highlighting the protective effects of certain dietary components. In Bangladesh, where dietary patterns are rapidly changing due to urbanization and economic growth, understanding the role of red meat consumption in lung cancer risk is crucial for developing effective public health interventions. Lifestyle factors, including physical activity levels, alcohol consumption, and exposure to environmental toxins, also contribute to lung cancer risk among non-smokers. Sedentary lifestyles and increased consumption of fast foods, both of which are prevalent in urbanized areas, are associated with higher cancer risks [8]. Additionally, exposure to secondhand smoke and air pollution, particularly in densely populated urban regions, has been shown to significantly increase the risk of lung cancer among non-smokers. In Bangladesh, where air quality in urban areas is poor due to industrial emissions and vehicular pollution, these environmental factors represent a significant public health concern.

Despite the clear link between lifestyle, dietary factors, and lung cancer risk, there remains a paucity of population-based research on non-smoker lung cancer in Bangladesh. Most studies have focused on smoking as the primary cause of lung cancer, with little attention given to non-smokers, particularly in developing countries where the risk factors may differ significantly from those in developed regions [9]. This study aims to fill this gap by investigating the association between red meat consumption, lifestyle factors, and lung cancer among non-smokers in Bangladesh. By identifying modifiable risk factors, this research has the potential to inform public health strategies aimed at reducing lung cancer incidence and mortality in this population. lung cancer

among non-smokers is an emerging public health issue in Bangladesh, driven by a combination of dietary, lifestyle, and environmental factors. As the country continues to undergo rapid urbanization and lifestyle changes, it is essential to understand the specific risk factors contributing to lung cancer in non-smoker populations. This study will provide valuable insights into the role of red meat consumption and other lifestyle factors in lung cancer development, ultimately contributing to the design of effective prevention strategies.

OBJECTIVE

General Objective
To determine the association of red meat consumption and risk factors with developing lung cancer among never smoker.

Specific Objectives
To determine dietary habit and life style factors that contribute to the development of lung cancer.
To determine associated clinical factors on lung cancer
To find out interaction effect of red meat consumption and risk factors on the development of lung cancer.

Inclusion Criteria
Participants eligible for this study included individuals aged between 30 and 65 years who attended the Oncology Outpatient Department (OPD) at Bangabandhu Sheikh Mujib Medical University (BSMMU) and Delta Medical College & Hospital. Both male and female patients were included, provided they had a confirmed diagnosis of lung cancer (for cases) or no history of lung cancer (for controls). Participants had to be physically and psychologically able to provide a history and give informed consent to participate in the study.

Exclusion Criteria
Exclusion criteria included individuals younger than 30 years or older than 65 years. Participants were excluded if they had a history of smoking or if the diagnosis of lung cancer could not be confirmed for cases. Additionally, individuals who refused to participate or were unable to provide informed consent, as well as those with unconfirmed cancer status in the control group, were excluded from the study.

Data Collection
Data were collected through a semi-structured questionnaire administered to participants at Bangabandhu Sheikh Mujib Medical University (BSMMU) and Delta Medical College & Hospital. The questionnaire gathered information on socio-demographic characteristics, dietary habits, lifestyle factors, and clinical history. Trained personnel conducted interviews with participants after obtaining informed consent. Confidentiality was strictly maintained, and completed questionnaires were checked for consistency and completeness before data entry.

Data Analysis
Data were analyzed using SPSS version 26. Descriptive statistics were calculated for socio-demographic and clinical variables. Categorical variables were compared between cases and controls using chi-square tests. Odds ratios (OR) with 95% confidence intervals (CI) were calculated to assess the association between red meat consumption, lifestyle factors, and lung cancer risk. Logistic regression analysis was performed to adjust for potential confounding variables. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations
The study adhered to the ethical guidelines set by the World Health Organization (WHO) and the Bangladesh Medical Research Council (BMRC). Informed consent was obtained from all participants before data collection, ensuring their voluntary participation. Participants were informed about the study's objectives, and their confidentiality and anonymity were maintained throughout the research process. They had the right to withdraw at any stage without any consequences. Ethical approval was obtained from the relevant institutional review boards prior to the study.

RESULT
Total 332 subjects participated in this study according to selection criteria, who were divide into case and control group. 166 subjects were in each group by their eligibility criteria and was matched with sex. The age of the subjects was between 31 to 65 years with a mean age of 48.6±9.2 years in case and 43.8±8.6 years in control. Their mean BMI was 21.2±2.3 in case and 22.0±2.5 in control. The box plots for age and BMI are given in Figure 1 and Figure 2 respectively. Figure 1 shows that the mean age in cases was slightly higher than the controls and the cases were matched to control by age which is expected. According to Figure-II, the mean BMI was found slightly higher in controls than the cases.

This presentation is expected as the nutritional

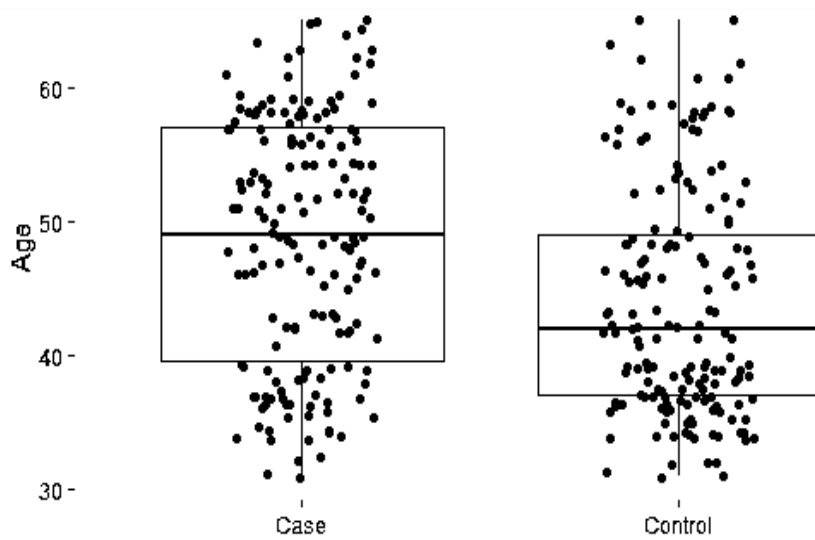status was found poor in the patients with lung cancer.
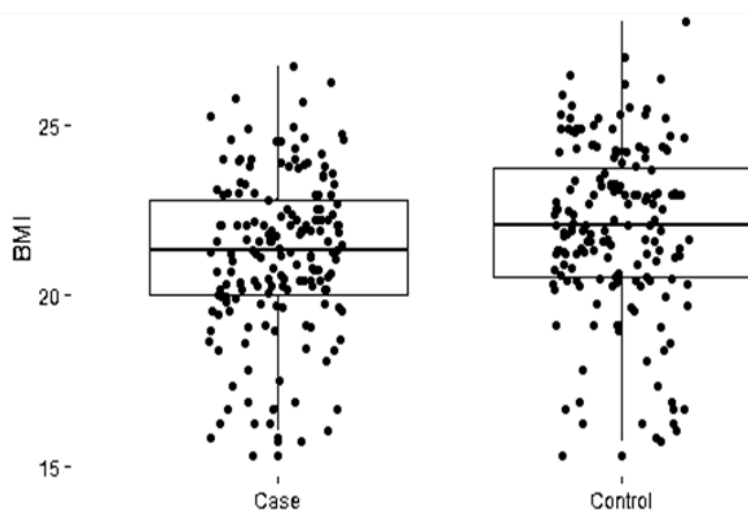

Figure 1: The box plot for age.

Figure 2: The box plot for BMI.

Socio-demographic characteristics of the cases and the controls are given in Table 1. Among all the variables, primary and higher secondary & above education leveled were found statistically significant (p <0.05) association with lung cancer status according to the unadjusted odds ratios values.

Table 1: Socio demographic characteristics and unadjusted odds ratio of each covariate and case- control

Variables	Case (n=166)	Control (n=166)	Unadjusted OR (CI)	P-Value
Sex				
Female	97 (58.4%)	97 (58.4%)	Reference	
Male	69 (41.6%)	69 (41.6%)	0.993 (0.646 – 1.547)	0.998
Marital Status				
Married	137 (82.5%)	136 (81.9%)	Reference	
Unmarried/Divorced/Widow	29 (17.5%)	30 (18.1%)	0.9596 (0.545 – 1.685)	0.887

Education				
Illiterate	42 (25.3%)	31 (18.7%)	Reference	
Primary	31 (18.7%)	45 (27.1%)	0.508 (0.265 – 0.976)	0.04
Secondary	74 (44.6%)	58 (34.9%)	0.942 (0.528 – 1.677)	0.841
Higher Secondary & Above	19 (11.4%)	32 (19.3%)	0.438 (0.211 – 0.912)	0.026
Occupation				
Unemployed/Housewife	114 (68.7%)	110 (66.3%)	Reference	
Employed	36 (21.7%)	39 (23.5%)	0.891 (0.527 – 1.503)	0.663
Business	16 (9.6%)	17 (10.2%)	0.908 (0.437 – 1.886)	0.791
Monthly Household Income				
< 20000	53 (31.9%)	58 (34.9%)	Reference	
20000-50000	79 (47.6%)	69 (41.6%)	1.253 (0.765 – 2.051)	0.371
> 50000	34 (20.5%)	39 (23.5%)	0.954 (0.528 – 1.724)	0.887

According to Table 1, patients who completed their primary education (OR= 0.508; 95% CI: 0.265, 0.976)), secondary (OR= 0.942; 95% CI: 0.528, 1.677)) , higher secondary and above (OR= 0.438; 95% CI: 0.211, 0.912) were less likely to have lung cancer in relation to illiterate. In this study, male was 41.6% which lower than female (58.4%). Though male was 1% less likely to have cancer compare to female but it is not statistically significant. Compare to married person, unmarried/divorced/widow have 5% less chance to develop lung cancer. It is also shown that in compare to unemployed/housewife, employed & business person has 10% less chance and in compare to low-income family, middle-income family person has 1.25 times more chance to develop lung cancer. But all of these shows no statistical significance in association with lung cancer. Behavioral status of the participants is shown in Table 2. All covariates of the table are found significant association with lung cancer according to unadjusted odds ratios.

Table 2: Behavioral status of the participants and unadjusted odds ratio of each covariate and case-control

Variables	Case (n=166)	Control (n=166)	Unadjusted OR (95% CI)	P Value
History of smoking				
No	25 (15.1%)	69 (41.6%)	Reference	
Yes	141 (84.9%)	97 (58.4%)	4.012 (2.372 – 6.786)	<0.0001
Betel leaf/nut use (smokeless tobacco)				
No	74 (44.6%)	102 (61.4%)	Reference	
Yes	92 (55.4%)	64 (38.6%)	1.981 (1.279 – 3.069)	0.002
Current walking habit (at least 15 minutes)				
No	76 (45.8%)	95 (57.2%)	Reference	
Yes	90 (54.2%)	71 (48.8%)	1.584 (1.027 – 2.445)	0.037
Previous sports habit				
No	102 (61.4%)	79 (47.6%)	Reference	
Yes	64 (38.6%)	87 (52.4%)	0.569 (0.368 – 0.881)	0.011

It is found that passive smoking or environmental smoke is responsible for 4 times higher risk to develop lung cancer compare to the person who are not exposed to environmental or passive smoking and shows statically significant (p<0.0001). This study shows statistically significant (p=0.002) 1.98 (OR) times higher risk in those persons who were habituated with smokeless tobacco products like betel nut, tobacco leaf, gull, jarda etc to lung cancer status in compare to non-consumers. Among the participant, 54.2% of cases and 48.8% of control had current walking habit of at least 15 minutes. It was found inversely related with the risk of lung cancer (OR=1.584, 95% CI: 1.027, 2.445) and also found statistically significant (p=0.037). Moreover,

previous sports history in childhood was responsible to 43% (OR=0.569, 95% CI: 0.368, 0.881) less chance to develop lung cancer which was statistically significant (p=0.011) according to unadjusted odds ratios. Dietary patterns of the participants are presenting in Table 3. Regular consumptions of red meat, vegetables and Tea &

Coffee shows statistically significant relation to develop lung cancer. Regular red meat consumptions found 1.75 times increases the risk of lung cancer compare to no or irregular consumptions (OR=1.749; 95% CI: 1.132, 2.704) and showed significant (p=0.011) according to un adjusted odds ratio.

Table 3: Dietary Patterns of the Participants and Unadjusted Odds Ratio of Each Covariate and Case-Control

Variables	Case (n=166)	Control (n=166)	Unadjusted OR (CI)	P-Value
Red Meat				
No/Irregular	67 (40.4%)	90 (54.2%)	Reference	
Regular	99 (59.6%)	76 (45.8%)	1.749 (1.132 – 2.704)	0.011
Chicken Meat				
No/Irregular	42 (25.3%)	35 (21.1%)	Reference	
Yes	124 (74.7%)	131 (78.9%)	0.788 (0.473 – 1.315)	0.362
Fish				
No/Irregular	38 (22.9%)	25 (15.1%)	Reference	
Yes	128 (77.1%)	141 (84.9%)	0.597 (0.342 – 1.044)	0.068
Vegetables				
Irregular	39 (23.5%)	17 (10.2%)	Reference	
Regular	127 (76.5%)	149 (89.8%)	0.371 (0.201 – 0.689)	0.001
Fast Food				
No/Irregular	119 (71.7%)	124 (74.7%)	Reference	
Regular	47 (28.3%)	42 (25.3%)	1.167 (0.717 – 1.896)	0.538
Fatty Food				
No/Irregular	62 (37.3%)	76 (45.8%)	Reference	
Regular	104 (62.7%)	90 (54.2%)	1.416 (0.914 – 2.196)	0.119
Tea & Coffee				
No/Irregular	42 (25.3%)	27 (16.3%)	Reference	
Regular	124 (74.7%)	139 (83.7%)	0.573 (0.334 – 0.985)	0.0424

Chicken meat and fish regular consumptions were found 21% (OR=0.788; 95% CI: 0.473, 1.315) and 40% (OR=0.597; 95% CI: 0.342, 1.044) respectively less likely to develop lung cancer compare to irregular or no consumer, but showed no statistically significant result. Again, regular intake of fast food and fatty food found 1.17 (OR=1.167; 95% CI: 0.717, 1.896) and 1.41 (OR=1.416; 95% CI: 0.914, 2.196) times more risk for lung cancer development compare to no or irregular consumptions, but showed non-significant result. However, regular consumptions of vegetables and tea or coffee were found relation with lung cancer risk and reduced risk 63% (OR= 0.371; 95% CI:.0.201, 0.689) and 43% (OR= 0.573; 95% CI:.0.334, 0.985) respectively compare to no or irregular consumers and it was found statistically significant result

(p =0.001 & p=0.0424 respectively) according to unadjusted odds ratio. Clinical history of the patients about lung diseases other than lung cancer and family history of cancer are given in Table-IV. Patients suffered from lung diseases other than lung cancer were 1.84 (OR= 1.837; 95% CI:.1.188, 2.840) times more likely risky to develop lung cancer compare to no lung disease person which showed significant (p=0.006) according to unadjusted odds ratio. Moreover, family history of any type of cancer showed significant association with the development of lung cancer. Person who had positive family history, had 1.63 (OR) (95% CI: 1.015, 2.612; p=0.042) times more risk to develop lung cancer compare no cancer in family history.

Table 4: Clinical history of the patients and unadjusted odds ratio of each covariate and case-control

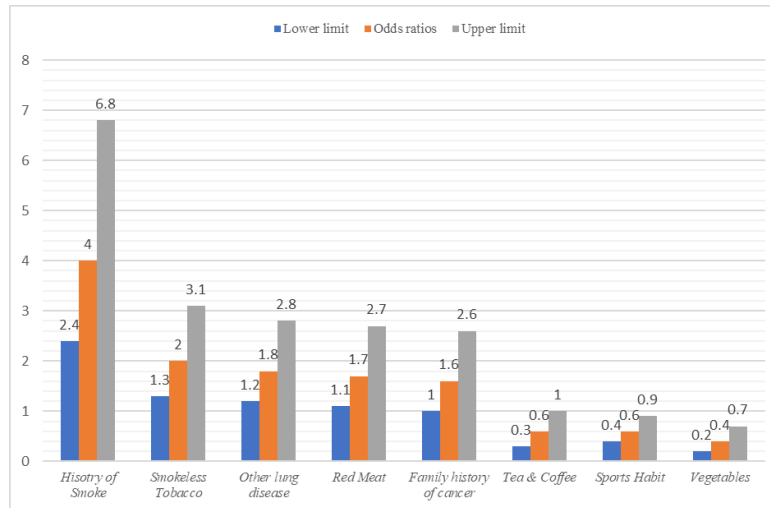| Variables	Case (n=166)	Control (n=166)	Unadjusted OR (95% CI)	P Value
History of lung diseases				
No	74 (44.6%)	99 (59.6%)	Reference	
Yes	92 (55.4%)	67 (40.4%)	1.837 (1.188 – 2.840)	0.006
Family history of cancer				
No	107 (64.5%)	124 (74.7%)	Reference	
Yes	59 (35.5%)	42 (25.3%)	1.627 (1.015 – 2.612)	0.042

Figure 3: Graphical presentation of statistically significant odd ratio of risk factor for lung cancer in nonsmokers

Figure 3 shows graphical presentation of statistically significant unadjusted odds ratios of risk factor for development of lung cancer in nonsmoker patients. Passive or environmental smoking showed the highest value which means most important risk factor in nonsmoker lung cancer. Others important risk factors found smokeless tobacco, previous lung diseases, red meat consumption and family history of cancer with odds ratios more than 1.6 significantly related with lung cancer in non-smokers. Childhood sports habits, regular intake of vegetables and tea or coffee were found protective factors to develop lung cancer in the study population.

DISCUSSION

This study provides significant insights into the relationship between red meat consumption, lifestyle factors, and lung cancer risk among non-smokers in the Bangladeshi population [10,11]. The findings revealed that regular red meat consumption, exposure to passive smoking, and the use of smokeless tobacco were significantly associated with an increased risk of lung cancer in non-smokers. Conversely, regular intake of vegetables, tea, and coffee showed a protective effect against lung cancer. These results are consistent with global literature, but there are notable differences that warrant a more in-depth exploration, especially given the unique socio-cultural and environmental context of Bangladesh [12].

Red Meat Consumption and Lung Cancer Risk
Our study found a significant association between regular red meat consumption and an increased risk of lung cancer among non-smokers, with a 1.75-fold increase in risk (p=0.011). This finding aligns with previous studies that have highlighted the role of red meat, particularly processed and high-temperature-cooked meats, in increasing cancer risk. For example, Prasath *et al.*, demonstrated a 35% increase in lung cancer risk with red meat consumption [13]. The carcinogenic compounds formed during cooking, such as heterocyclic amines (HCAs) and polycyclic aromatic hydrocarbons (PAHs), have been identified as major contributors to cancer development. However, our study's results show a slightly higher risk compared to similar studies conducted in Western populations, which might be explained by several factors. First, cooking methods in

Bangladesh, such as grilling or barbecuing meat at higher temperatures, might increase the formation of carcinogenic compounds compared to traditional Western cooking methods like boiling or baking. Additionally, differences in meat quality and food safety standards between developed and developing countries may lead to a higher exposure to harmful chemicals and preservatives used in meat processing. Moreover, socio-economic factors may contribute to dietary patterns that further increase cancer risks in Bangladesh. In urban areas, the growing middle class often adopts Western-style diets, including increased consumption of red and processed meats, while lacking awareness of the associated health risks. In contrast, previous studies conducted in Western countries, such as Alshahrani *et al.*, observed that people had access to a more varied diet, including healthier alternatives such as fish, poultry, and plant-based proteins, which might mitigate the risks associated with red meat consumption [14].

Passive Smoking and Lung Cancer Risk

Passive smoking emerged as a significant risk factor in our study, increasing lung cancer risk by four times (OR=4.01, p<0.0001) among non-smokers. This finding is consistent with a large body of evidence that underscores the dangers of secondhand smoke. According to Halms *et al.*, non-smokers exposed to secondhand smoke face a 20-30% higher risk of developing lung cancer compared to those who are not exposed [15]. However, the effect size in our study is notably larger, which could be explained by several factors unique to Bangladesh. First, despite the implementation of anti-smoking laws in public places, enforcement in Bangladesh remains weak, particularly in densely populated urban areas. This leads to widespread exposure to secondhand smoke in both public and private settings, such as restaurants, offices, and even homes. Moreover, the high prevalence of smoking among men in Bangladesh, estimated at 41%, further exacerbates the exposure of non-smoking individuals, particularly women and children, to passive smoke [16]. In contrast, countries with stricter smoking regulations, such as the United States and the United Kingdom, have seen a significant reduction in passive smoking-related lung cancer cases due to better enforcement and public awareness campaigns. Another potential factor contributing to the higher risk in our study is the cultural acceptance of smoking in social settings. In many Bangladeshi households, it is not uncommon for family members or guests to smoke indoors, thereby increasing the exposure of non-smokers to harmful smoke.

Additionally, the indoor air quality in many urban areas is already compromised due to pollution from industrial activities and vehicular emissions, further compounding the respiratory risks for non-smokers.

Smokeless Tobacco and Lung Cancer Risk

The use of smokeless tobacco products, such as betel nut, jarda, and tobacco leaf, also showed a significant association with lung cancer risk, with a 1.98-fold increase (p=0.002). This finding aligns with other studies conducted in South Asia, where smokeless tobacco use is prevalent [17]. Smokeless tobacco contains nitrosamines and other carcinogens, which have been linked to cancers of the oral cavity, esophagus, and lung. The widespread use of smokeless tobacco in Bangladesh, especially among women and rural populations, contributes to the high cancer burden. While smokeless tobacco is often perceived as a less harmful alternative to smoking, research has shown that it carries significant health risks, including cancer. Unlike in Western countries, where smokeless tobacco use is relatively rare, in Bangladesh, cultural practices and lack of awareness about its dangers perpetuate its use. Moreover, the informal and unregulated production of smokeless tobacco products in Bangladesh may expose users to higher levels of harmful chemicals, further increasing the cancer risk.

Protective Effects of Vegetables, Tea, and Coffee

Our study found that regular vegetable intake was associated with a 63% reduced risk of lung cancer (OR=0.371, p=0.001). This protective effect is supported by previous research, which highlights the role of antioxidants and other bioactive compounds in vegetables in reducing oxidative stress and inflammation, both of which are key mechanisms in cancer development [18]. Green leafy vegetables, which are a staple in the Bangladeshi diet, are particularly rich in antioxidants, such as vitamins C and E, which may contribute to the observed protective effect. Similarly, the regular consumption of tea and coffee was associated with a 43% reduction in lung cancer risk (OR=0.573, p=0.042). Tea, particularly green tea, has been shown to contain high levels of polyphenols, which have anti-carcinogenic properties. Studies conducted in China, such as Seow *et al.,* found that green tea consumption was associated with a significantly lower risk of lung cancer in non-smokers [19]. In Bangladesh, where tea consumption is widespread, this protective effect may be more pronounced due to the high intake of tea, which provides regular exposure to these beneficial compounds. The

consumption of coffee has also been linked to a reduced risk of various cancers, including lung cancer, due to its high content of antioxidants and anti-inflammatory properties [20]. However, the exact mechanisms by which coffee exerts its protective effects are not fully understood and may vary depending on the population and type of coffee consumed. In Bangladesh, coffee is becoming more popular, particularly in urban areas, which may explain its emerging role as a protective factor in our study.

Comparison with Other Studies

The results of our study are consistent with much of the global literature on dietary, behavioral, and environmental risk factors for lung cancer, but there are notable differences that may be explained by regional and cultural factors. For example, Western studies, such as those by Yu *et al.,* often report a more moderate association between red meat consumption and lung cancer [21]. This discrepancy could be due to differences in sample size, dietary patterns, and cooking methods. In Western countries, individuals tend to consume a more varied diet that includes poultry, fish, and plant-based proteins, which may dilute the effects of red meat consumption on cancer risk. In contrast, in Bangladesh, red meat is a dominant protein source, particularly in urban areas, and is often prepared using methods that increase the formation of carcinogens, such as frying or grilling at high temperatures. Additionally, the higher association between passive smoking and lung cancer observed in our study may be attributed to the unique socio-cultural context of Bangladesh, where anti-smoking regulations are not strictly enforced, and smoking in public spaces remains common [22]. In contrast, countries like the United States and the United Kingdom have implemented stricter smoking bans and public health campaigns that have significantly reduced passive smoking exposure. The strong association between smokeless tobacco use and lung cancer risk in our study is also consistent with other research conducted in South Asia but differs from studies conducted in Western populations, where smokeless tobacco use is less prevalent. In Bangladesh, the cultural acceptance of smokeless tobacco, particularly among rural populations and women, contributes to its widespread use and the resulting health risks. Unlike Western countries, where smoking is the primary focus of tobacco control efforts, in Bangladesh, more attention needs to be given to smokeless tobacco products to reduce the cancer burden.

Implications of Research Findings

The findings of this study have several important implications for public health in Bangladesh and other developing countries. The significant association between red meat consumption and lung cancer risk suggests that dietary interventions should be prioritized as part of cancer prevention strategies. Public health campaigns should raise awareness about the risks associated with excessive red meat consumption and promote healthier alternatives, such as fish, poultry, and plant-based proteins. The strong association between passive smoking and lung cancer highlights the need for stricter enforcement of anti-smoking laws in public places. Public education campaigns aimed at reducing exposure to secondhand smoke, particularly in homes and workplaces, could play a crucial role in reducing lung cancer incidence among non-smokers. The use of smokeless tobacco also warrants targeted interventions, as it remains a significant risk factor for lung cancer in Bangladesh. Culturally appropriate public health campaigns that address the risks of smokeless tobacco use and promote cessation could help reduce the burden of tobacco-related cancers. The protective effects of vegetables, tea, and coffee observed in this study offer valuable insights for promoting healthier dietary habits. Encouraging increased consumption of antioxidant-rich foods and beverages could be an effective strategy for reducing lung cancer risk, particularly in populations with high exposure to environmental and dietary risk factors. This study provides compelling evidence that red meat consumption, passive smoking, and smokeless tobacco use significantly increase the risk of lung cancer among non-smokers in Bangladesh, while regular consumption of vegetables, tea, and coffee exerts a protective effect. These findings are consistent with global research but also highlight unique regional factors that contribute to lung cancer risk in the Bangladeshi population. Public health strategies that focus on dietary improvements, tobacco control, and environmental risk reduction are essential to combatting the rising burden of lung cancer in Bangladesh.

CONCLUSION

This study demonstrates that red meat consumption, passive smoking, and smokeless tobacco use significantly increase lung cancer risk among non-smokers in Bangladesh, while regular intake of vegetables, tea, and coffee shows a protective effect. These findings highlight the importance of dietary and lifestyle changes in reducing lung cancer risks among non-smokers. Effective public health interventions are essential.

Recommendations
Promote awareness about the risks of red meat consumption and encourage healthier dietary habits.
Enforce stricter anti-smoking laws to reduce passive smoking exposure.
Launch educational campaigns on the dangers of smokeless tobacco.

Article at a Glance
Study Purpose
To investigate the association between red meat consumption, lifestyle factors, and lung cancer risk among non-smokers in the Bangladeshi population.

Key Findings
Red meat consumption and passive smoking significantly increase lung cancer risk in non-smokers. Regular intake of vegetables, tea, and coffee reduces the risk. Smokeless tobacco use also contributes to a higher lung cancer risk.

Newer Findings Added to What Is Known
This study provides region-specific insights, highlighting that cultural factor, such as smokeless tobacco use, and dietary patterns, like high red meat consumption, play a critical role in lung cancer risk among non-smokers in Bangladesh.

Conflict of interest: None declared

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