Waterpipe Tobacco Smoking and Risk of Stomach Cancer: A Case-Control Study in Vietnamese Men

Cong Long Nguyen¹,², Khanpaseuth Sengngam³,⁴, Tran Hieu Hoc⁵, Phuoc Hong Lê⁶, Lai Thi Minh Hang⁷, Hang Viet Dao⁸, Le Tran Ngoan⁹,¹⁰*

Abstract

Objective: This study investigated the impacts of waterpipe tobacco (WTP) and cigarette smoking on stomach cancer development in Vietnamese men. Methods: A total of 80 stomach cancer cases and 146 controls were recruited in a hospital-based case-control study. Data on sociodemographic, anthropometric characteristics, tobacco smoking, and the dietary pattern was obtained based on a semi-quantitative food frequency and demographic lifestyle questionnaire; and venous anti-Helicobacter pylori IgG antibodies were tested by ELISA. Unconditional logistic regression analysis with adjustments for potential confounding was performed to estimate the association between target exposures and stomach cancer. Results: Compared to the never tobacco smokers, the risk of stomach cancer significantly increased among tobacco smokers (OR 2.95, 95%CI 1.26-6.90, p=0.013). Those who early started tobacco smoking before 26 years old had a high risk of SC (OR 3.04, 95%CI 1.29-7.20, p for trend=0.011). For types of tobacco, it was increased risk in exclusively cigarette smokers (OR 2.85, 95%CI 1.19-6.85, p=0.019) and in WPT smokers (OR 3.09, 95%CI 1.24-7.68, p=0.015). The daily frequency and longer duration of exclusively WPT or cigarette smoking tended to be significantly higher SC risk. Conclusions: The findings suggest that tobacco smoking, particularly water pipe tobacco smoking, dramatically and independently increased the risk of stomach cancer.

Keywords: Stomach cancer- waterpipe tobacco smoking- cigarette smoking

Introduction

From 2015, WHO has noted that more studies on the role of waterpipe tobacco (WTP) and cancer risk were needed and recommended action for regulators against this type of tobacco usage (WHO, 2015). However, few observational studies on this association have been performed to date. Our previous study findings suggested that WTP is significantly induced stomach development. This study has a limitation of not available data of H. pylori infection that was carcinogenesis of this cancer site (IARC, 2012). This current study investigated the impacts of WTP and cigarette smoking on stomach cancer development in Vietnamese men.

Materials and Methods

Study design and participants

A case-control study was conducted at Bach Mai hospital, a general hospital in northern Vietnam, between January 2018 and December 2018. Cases were Vietnamese men who were first diagnosed with stomach cancer by histopathology, and who underwent surgery for cancer treatment. Controls included all Vietnamese male patients without a history of cancer (of any sites) who spent their operation at the same department with cases during the study period. Controls were randomly selected based on the list of patients who were planned to have surgery in the same week with corresponding cases. Exclusion criteria included participants under 18 years, who were under severe health conditions, or who declined to take a blood test for the Helicobacter pylori (H. pylori) examination.
**H. pylori** infection status was a crucial confounding because it has been well-known as a risk factor for stomach cancer (IARC, 2012), and has considerable influences on the association between tobacco smoking and stomach cancer (Shikata et al., 2008). All participant confirmed their participation by written informed consent. A total of 80 incident stomach cancer cases and 146 eligible controls were recruited in the study.

**Data collection**

Data collection was done by two methods namely questionnaire surveys and clinical data collection. Thereby, trained interviewers face-to-face interviewed participants one day before patients’ surgery based on a structured questionnaire. This questionnaire obtained information on participants’ demographic characteristics; family history of cancer; anthropometric characteristics (height, weight); lifestyle-related habits consisting of tobacco smoking and alcohol intake, and dietary habits. In addition, medical records and blood samples were obtained to collect data on the history of interested comorbidities; histopathological diagnosis of stomach cancer; and status of **H. pylori** infection.

For tobacco smoking, participants were asked about all types of tobacco use (including cigarette, waterpipe tobacco (WPT)); the average number of tobacco consumed per day by types and by the age group of 15-20, 21-25, 26-30, 31-40, 41-50, 51-60, 61-70, 71+; the duration of smoking (for the current smoker); and the duration of quit smoking (for current and ex-smokers). Participants were then categorized as “ever” or “never” smokers. An “ever-smoker” was determined if he consumed completely one tobacco product (of any type). Current smokers were defined if they completely consumed one tobacco product (of any type) within the last six months. Participants who were “ever-smokers” but not current smokers were classified as ex-smokers. For ever-smokers, the information on types of tobacco products including cigarettes, WPT, or both types was obtained. The description of waterpipe smoking equipment commonly used in Viet Nam was introduced elsewhere (Lai et al., 2016). In Viet Nam. WPT tobacco is prepared from the leaves (made from a plant called Nicotiana rustica) which are shredded and sundried or sometimes dried in large bamboo-burning kilns. The smoking method of Vietnamese WPT is similar to that of the Arabian WPT whereby smoke passes through water before being inhaled. A WPT smoking session is about five minutes (She et al., 2014, WHO 2015).

To analyze antibodies to **H. pylori** infection, 3 ml aliquots of overnight fasting blood were collected from both cases and controls. The anti-**H. pylori** serum IgG titer were tested by enzyme-linked immunosorbent assay (ELISA) based on the sandwich principle using **H. pylori** IgG ELISA kit (RE56381) from IBL International (Hamburg, Germany). According to the manufacturer’s instructions, **H. pylori** serostatus was classified into three groups based on Cut-Off Index (COI) including negative (COI <0.8), equivocal (0.8-1.2), and positive (COI >1.2).

Information on the frequency of five common vegetables consumed in Northern Viet Nam including water spinach, mustard greens, Sauropus, Malabar nightshade, and cabbage within the last 12 months was obtained based on a semi-qualitative food frequency questionnaire (Phuong et al., 2020).

**Statistical analysis**

Data were analyzed by Stata version 10.0 (Stata Corp, College Station, Texas). To compare the different impacts of WTP smoking and cigarette smoking on stomach cancer, participants were classified into subgroups of WTP smoking and cigarette smoking. Thereby, WTP smokers were categorized into three-subgroup current WTP smoking only, former WTP smoking only, current and tobacco WTP smoking. Similarly, cigarette smokers were stratified as current cigarette smoking only, former cigarette smoking only, current and former cigarette smoking. For the daily tobacco smoking frequency, participants were categorized into three groups corresponding to three tertiles of distribution of the frequency in controls. Also, WTP smoking and cigarette smoking duration was divided into tertiles based on the distribution of usage years in controls.

Unconditional logistic regression analysis was used to estimate the odds ratio and 95% confidence interval (OR, 95% CI) for the association between WTP smoking, cigarette smoking, and stomach cancer. The association between favor exposures and stomach cancer was adjusted for the age group in the early analysis and then adjusted for potential confounding factors such as **H. pylori** status, age group, education levels, Body Mass Index (BMI), and frequency of five common types of vegetable consumption. All tests were two-slides, and p <0.05 was considered as a statistically significant difference.

**Ethics consideration**

Written informed consent was obtained from all participants. The present study was approved by the Hanoi Medical University (IRB No. 3918/HMUIRB) on 25 December 2018 and by the International University of Health and Welfare, Graduate School, Japan on 27 May 2019.

**Results**

The total number of subjects was 226 recruited in Bach Mai hospital during 2018-2019, in which 80 (35.4%) were stomach cancer and 146 (64.6%) were non-cancer. Stomach cancer cases were in the age group of 60+ years (35.0%), followed by a group of 50-59 years (30.0%), 70+ years (17.5%), and less than 50 years (17.5%). Most of the subjects were at the secondary education level (44.2%, 100/226) and the normal range of BMI (50.9%, 115/226). The rate of subjects smoking tobacco in their lifetime (OR, 95% CI) for the association between WTP smoking, cigarette smoking, and stomach cancer, participants were classified into subgroups of WTP smoking and cigarette smoking. Thereby, WTP smokers were categorized into three-subgroup current WTP smoking only, former WTP smoking only, current and tobacco WTP smoking. Similarly, cigarette smokers were stratified as current cigarette smoking only, former cigarette smoking only, current and former cigarette smoking. For the daily tobacco smoking frequency, participants were categorized into three groups corresponding to three tertiles of distribution of the frequency in controls. Also, WTP smoking and cigarette smoking duration was divided into tertiles based on the distribution of usage years in controls.

Unconditional logistic regression analysis was used to estimate the odds ratio and 95% confidence interval (OR, 95% CI) for the association between WTP smoking, cigarette smoking, and stomach cancer. The association between favor exposures and stomach cancer was adjusted for the age group in the early analysis and then adjusted for potential confounding factors such as **H. pylori** status, age group, education levels, Body Mass Index (BMI), and frequency of five common types of vegetable consumption. All tests were two-slides, and p <0.05 was considered as a statistically significant difference.

Written informed consent was obtained from all participants. The present study was approved by the Hanoi Medical University (IRB No. 3918/HMUIRB) on 25 December 2018 and by the International University of Health and Welfare, Graduate School, Japan on 27 May 2019.

**Results**

The total number of subjects was 226 recruited in Bach Mai hospital during 2018-2019, in which 80 (35.4%) were stomach cancer and 146 (64.6%) were non-cancer. Stomach cancer cases were in the age group of 60+ years (35.0%), followed by a group of 50-59 years (30.0%), 70+ years (17.5%), and less than 50 years (17.5%). Most of the subjects were at the secondary education level (44.2%, 100/226) and the normal range of BMI (50.9%, 115/226). The rate of subjects smoking tobacco in their lifetime (OR, 95% CI) for the association between WTP smoking, cigarette smoking, and stomach cancer, participants were classified into subgroups of WTP smoking and cigarette smoking. Thereby, WTP smokers were categorized into three-subgroup current WTP smoking only, former WTP smoking only, current and tobacco WTP smoking. Similarly, cigarette smokers were stratified as current cigarette smoking only, former cigarette smoking only, current and former cigarette smoking. For the daily tobacco smoking frequency, participants were categorized into three groups corresponding to three tertiles of distribution of the frequency in controls. Also, WTP smoking and cigarette smoking duration was divided into tertiles based on the distribution of usage years in controls.

Unconditional logistic regression analysis was used to estimate the odds ratio and 95% confidence interval (OR, 95% CI) for the association between WTP smoking, cigarette smoking, and stomach cancer. The association between favor exposures and stomach cancer was adjusted for the age group in the early analysis and then adjusted for potential confounding factors such as **H. pylori** status, age group, education levels, Body Mass Index (BMI), and frequency of five common types of vegetable consumption. All tests were two-slides, and p <0.05 was considered as a statistically significant difference.

Written informed consent was obtained from all participants. The present study was approved by the Hanoi Medical University (IRB No. 3918/HMUIRB) on 25 December 2018 and by the International University of Health and Welfare, Graduate School, Japan on 27 May 2019.

**Results**

The total number of subjects was 226 recruited in Bach Mai hospital during 2018-2019, in which 80 (35.4%) were stomach cancer and 146 (64.6%) were non-cancer. Stomach cancer cases were in the age group of 60+ years (35.0%), followed by a group of 50-59 years (30.0%), 70+ years (17.5%), and less than 50 years (17.5%). Most of the subjects were at the secondary education level (44.2%, 100/226) and the normal range of BMI (50.9%, 115/226). The rate of subjects smoking tobacco in their lifetime (OR, 95% CI) for the association between WTP smoking, cigarette smoking, and stomach cancer, participants were classified into subgroups of WTP smoking and cigarette smoking. Thereby, WTP smokers were categorized into three-subgroup current WTP smoking only, former WTP smoking only, current and tobacco WTP smoking. Similarly, cigarette smokers were stratified as current cigarette smoking only, former cigarette smoking only, current and former cigarette smoking. For the daily tobacco smoking frequency, participants were categorized into three groups corresponding to three tertiles of distribution of the frequency in controls. Also, WTP smoking and cigarette smoking duration was divided into tertiles based on the distribution of usage years in controls.
Table 1. Participant Characteristics

| Variables       | Stomach cancer | Non-cancer |
|-----------------|----------------|------------|
|                 | n   | %     | n   | %    | n   | %     |
| Age group (ages)|     |       |     |       |     |       |
| 20-49           | 14  | 17.5  | 47  | 32.19 |     |       |
| 50-59           | 24  | 30    | 53  | 36.3  |     |       |
| 60-69           | 28  | 35    | 31  | 21.23 |     |       |
| ≥70             | 14  | 17.5  | 15  | 10.27 |     |       |
| Total           | 80  | 100   | 146 | 100   |     |       |
| Education (years)|     |       |     |       |     |       |
| <6              | 15  | 18.75 | 18  | 12.33 |     |       |
| 6-9             | 36  | 45    | 64  | 43.84 |     |       |
| 10-12           | 15  | 18.75 | 46  | 31.51 |     |       |
| >12             | 13  | 16.25 | 17  | 11.64 |     |       |
| Unknown         | 1   | 1.25  | 1   | 0.68  |     |       |
| Total           | 80  | 100   | 146 | 100   |     |       |
| BMI (kg/m²) a   |     |       |     |       |     |       |
| 18.5 to <23     | 42  | 52.5  | 73  | 50    |     |       |
| 23 to <25       | 9   | 11.25 | 30  | 20.55 |     |       |
| ≥25             | 5   | 6.25  | 18  | 12.33 |     |       |
| <18.5           | 24  | 30    | 22  | 15.07 |     |       |
| Unknown         | 0   | 0     | 3   | 2.05  |     |       |
| Total           | 80  | 100   | 146 | 100   |     |       |
| Lifetime tobacco smoking |     |       |     |       |     |       |
| Never           | 9   | 11.25 | 38  | 26.03 |     |       |
| Ever            | 71  | 88.75 | 108 | 73.97 |     |       |
| Total           | 80  | 100   | 146 | 100   |     |       |
| H. pylori serostatus b |     |       |     |       |     |       |
| Negative (COI <0.8) | 25  | 31.25 | 63  | 43.15 |     |       |
| Equivocal (COI 0.8-1.2) | 15  | 18.75 | 27  | 18.49 |     |       |
| Positive (COI >1.2)    | 40  | 50    | 56  | 38.36 |     |       |
| Total           | 80  | 100   | 146 | 100   |     |       |

aBMI, Body Mass Index (BMI= weight (kg) / height (m)²); bClassification according to the manufacturer's instructions; cClassification according to anti-H. pylori IgG concentration of the Cut-off Index (COI) quantitative associated with SC risk (OR=2.95, 95%CI=1.26-6.90, p=0.013). The early start of smoking was also related to the higher risk of SC. Those who started smoking before 26 years old had a high risk of SC (OR=3.04, 95%CI=1.29-7.20, p for trend=0.011) in comparison with never smokers.

We further examined the association of WPT smoking with SC risk using exclusively WPT smokers (Table 3). The high SC risk was found in total exclusively WPT smokers (OR 3.09, 95%CI 1.24-7.68, p=0.015), in which current WPT smokers (OR 2.90, 95%CI 1.05-7.97, p=0.039) and former WPT smokers (OR 4.55, 95%CI 1.23-16.85, p=0.023). For the dose-respond, those who smoked WPT 8 or more times per day showed a significantly high SC risk (OR 3.12, 95%CI 1.24-7.85, p for trend=0.025. The daily frequency and longer duration of WPT smoking tended to be significantly higher in SC risk.

We also examined the association of cigarette smoking with SC risk using exclusively cigarette smokers in Table 4. SC risk was significantly high in a total of current and former cigarette smoking (OR 2.85, 95%CI 1.19-6.85, p=0.019) and especially in current cigarette smoking (OR 3.26, 95%CI 1.24-8.55, p=0.017). Those who currently smoked cigarettes 20 or more times per day increased significantly SC risk (OR 4.17, 95%CI 1.27-13.70, p for trend=0.012). The higher SC risk was found among those who formerly smoked cigarettes for 38 or more years when compared to never smokers (OR=5.79, 95%CI=1.40-23.92, p for trend=0.018). The daily frequency and longer duration of cigarette smoking tended to be significantly higher SC.

Discussion

This is a hospital-based case-control study to examine the association of tobacco smoking with SC risk among Vietnamese men, which was conducted at Bach Mai hospital in Northern Viet Nam. The present study showed a significantly high SC risk among tobacco smokers, and this association was much stronger among WPT smokers only after excluding cigarette smokers. Furthermore, SC risk tended to be significantly higher with the daily frequency and duration of WPT smoking only.

The strengthening of the present study included the new method of tobacco smoking assessment in advanced detail. Types of WPT and cigarette tobacco smoking

Table 2. Tobacco Usage Including Pipe, Cigarette, and Risk of Stomach Cancer

| Tobacco usage including pipe and cigarette | Control | Cancer | Total | Age adjusted OR (95% CI) | p     | Multivariable OR (95% CI)& p |
|-------------------------------------------|---------|--------|-------|--------------------------|-------|-----------------------------|
| No                                        | 9       | 47     |       | >1.00                    |       |                             |
| Yes                                       | 108     | 71     | 179   | 3.21 (1.42, 7.29)        | 0.005 | 2.95 (1.26, 6.90)           | 0.013 |
| Total                                     | 146     | 80     | 226   |                          |       |                             |
| Age at started smoking                    |         |        |       |                          |       |                             |
| No                                        | 9       | 47     |       | >1.00                    |       |                             |
| 26+                                       | 13      | 8      | 21    | 2.68 (0.82, 8.70)        | 2.40  | (0.71, 8.06)                |
| <26                                       | 95      | 63     | 158   | 3.30 (1.44, 7.56)        | 0.005 | 3.04 (1.29, 7.20)           | 0.011 |
| Total                                     | 146     | 80     | 226   |                          |       |                             |

*p for trend; & Adjusted for age groups (20-49, 50-59, 60-69, ≥70 ages), education levels (primary school, secondary school, high school or higher), BMI (<18.5, 18.5 to <23, 23 to <25, ≥25 kg/m²), consumption of five common types of vegetables (water spinach, mustard greens, sauropus, Malabar nightshade, cabbage); and H. pylori infection, OR (95% CI), odds ratio 95% confidence interval.
Our findings are consistent with the result of several previous studies on WPT smoking and SC risk. In the Iranian cohort study, more than three-fold increased SC risk was reported in hookah smokers. This result was slightly higher than that of our study, which might be because of their target high-risk population namely \textit{H. pylori}-infected subjects (Sadjadi et al., 2014). In the other Vietnamese case-control study, SC risk increased significantly nearly three times in current exclusively WPT smokers when compared to never smokers. It was lower than our results, which might be explained by the lacking of examination on \textit{H. pylori} infection in their study (Lai et al., 2016) and the method of tobacco smoking assessment was more detailed and better in the present study.

The present study observed a significant association of cigarette smoking with SC risk, exclusively cigarette smokers. Our results were consistent with that of a systematic review among the Japanese population, which showed a significantly elevated risk for cigarette smoking among men in case-control studies (Nishino et al., 2006). The Iranian study also reported a significant increase in SC risk for cigarette smoking (Sadjadi et al., 2014). The smoke of Arabian WPT contains a large range of carcinogenic and toxic substances such as tar, nicotine, CO, PAH, aldehydes, and heavy metals (Jacob et al., 2011; Eissenberg and Shihadeh, 2009). The levels of them in the smoke of one Hookah session (one-hour exposure) were equal to or higher than those in the smoke of 10 cigarettes (equivalent to 50-min exposure): tar, CO, PAHs, aldehydes, chromium, and lead (Maziak, 2013).

Vietnamese/Chinese WPT may have lower carcinogenic effects than Arabian WPT because of the non-use of charcoal and generally shorter smoking duration (approximately 5 minutes). However, a
significantly high level of CO was also identified in the exhalation of Chinese WPT smokers (She et al., 2014) despite charcoal, a suspected main source of CO and PAHs (Monzer et al., 2008), not being used. It is also true for a cigarette which type of tobacco smoking is not required charcoal, however, CO and PAHs levels are still high among cigarette smokers. Vietnamese/Chinese WPT smoking may have similar carcinogenic effects to Arabian WPT smoking. Further examinations in the content of Vietnamese/Chinese WPT smoke are necessary to estimate the levels of carcinogens in the development of SC.

The present study has certain limitations. First, the information on the tumor location was not collected completely in our study. However, numerous previous studies including case-control and cohort studies reported no difference in the effects of tobacco smoking on SC risk by tumor location (Ladeiras-Lopes et al., 2008; Chow et al., 1999; Sung et al., 2007; Sasazuki et al., 2002). Second, the lack of the information on histological type of SC (intestinal or diffuse type) was not able to examine the effect modification by histological type of tumor. A study on histopathological characteristics of SC patients in Hanoi Oncology hospital, 2010-2012 showed most Vietnamese SC cases were intestinal type (82.7%) (Anh, 2013). This result suggested that our findings might be mainly from the results of the intestinal type of SC. The study sample size was minimized and only focused on men. Further study in both men and women with a large sample size is highly recommended.

**Author Contribution Statement**

Conceptualization: KS, THH, LTN. Data curation: CLN. Formal analysis: CLN. Funding acquisition: CLN. Methodology: LTN, KS. Project administration: CLN, KS, THH. Visualization: THH, CLN. Writing - original draft: CLN, LHP, LTMH, DVH. Writing - review and editing: CLN, LHP, LTMH, DVH.

**Acknowledgments**

We used a research grant No.: 18/FIRST/1a/HMU, under the Project: “Fostering Innovation through Research, Science and Technology”.

**Table 4. Cigarette Smoking and Risk of Stomach Cancer**

|                | Control | Cancer | Total | Age adjusted OR (95% CI) | p  | Multivariable OR (95% CI) & | p  |
|----------------|---------|--------|-------|-------------------------|----|-----------------------------|----|
| Current cigarette smoking only |          |        |       |                         |    |                             |    |
| No             | 38      | 9      | 47    | >1.00                   |    | >1.00                       |    |
| Yes            | 45      | 31     | 76    | 3.51 (1.42, 8.71)       | 0.007 | 3.26 (1.24, 8.55)         | 0.017 |
| Total          | 83      | 40     | 123   |                         |    |                             |    |
| Former cigarette smoking only |          |        |       |                         |    |                             |    |
| No             | 38      | 9      | 47    | 1                       |    | >1.00                       |    |
| Yes            | 39      | 20     | 59    | 2.53 (0.95, 6.76)       | 0.063 | 2.75 (0.93, 8.18)         | 0.069 |
| Total          | 77      | 29     | 106   |                         |    |                             |    |
| Current and former cigarette smoking only |          |        |       |                         |    |                             |    |
| No             | 38      | 9      | 47    | 1                       |    | 1                           |    |
| Yes            | 84      | 51     | 135   | 3.01 (1.29, 7.00)       | 0.01 | 2.85 (1.19, 6.85)         | 0.019 |
| Total          | 122     | 60     | 182   |                         |    |                             |    |
| Number of cigarettes a day among current and former smoking only (Missing data of 4 participants) |          |        |       |                         |    |                             |    |
| No             | 38      | 9      | 47    | >1.00                   |    | >1.00                       |    |
| 4              | 28      | 15     | 43    | 2.58 (0.96, 6.95)       | 2.64 (0.95, 7.35) |    |
| 15             | 50      | 32     | 82    | 3.11 (1.28, 7.55)       | 0.015* | 2.85 (1.14, 7.15)         | 0.035* |
| Total          | 116     | 56     | 172   |                         |    |                             |    |
| Former cigarette smoking years (Missing data of 1 participant) |          |        |       |                         |    |                             |    |
| No             | 38      | 9      | 47    | >1.00                   |    | >1.00                       |    |
| 19             | 28      | 9      | 37    | 1.48 (0.48, 4.57)       | 1.87 (0.54, 6.43) |    |
| 38             | 10      | 10     | 20    | 5.45 (1.57, 18.96)      | 0.011* | 5.79 (1.40, 23.92)        | 0.018* |
| Total          | 76      | 28     | 104   |                         |    |                             |    |
| Number of cigarettes smoking a day among current cigarettes smoking only |          |        |       |                         |    |                             |    |
| No             | 38      | 9      | 47    | >1.00                   |    | >1.00                       |    |
| 6              | 33      | 19     | 52    | 2.97 (1.12, 7.83)       | 2.80 (0.98, 8.02) |    |
| 20             | 12      | 12     | 24    | 4.89 (1.59, 15.01)      | 0.004* | 4.17 (1.27, 13.70)        | 0.012* |
| Total          | 83      | 40     | 123   |                         |    |                             |    |

*p for trend; & Adjusted for age groups (20-49, 50-59, 60-69, ≥70 ages), education levels (primary school, secondary school, high school or higher), BMI (<18.5, 18.5 to <23, 23 to <25, ≥25 kg/m²), consumption of five common types of vegetables (water spinach, mustard greens, saurupus, Malabar nightshade, cabbage); and H. pylori infection, OR (95% CI), odds ratio 95% confidence interval.
It is a part of a Ph.D. student research thesis that was approved by the Hanoi Medical University academic committee dated 13 July 2018 and by the Ethical Committee No. of approval 3918/HMUIRB dated 25 December 2018.

Available data
The original database will be available upon appropriate request.

Conflict of interest
There are no conflicts to disclose.

References

Anh PM, Le TT (2013). Histopathological characteristic of gastric cancer patient in Hanoi Oncology hospital 2010-2012. *Pract Med*, 876, 112-5.

Chow WH, Swanson CA, Lissowska J, et al (1999). Risk of stomach cancer in relation to consumption of cigarettes, alcohol, tea and coffee in Warsaw, Poland. *Int J Cancer*, 81, 871-6.

Eissenberg T, Shihadeh A (2009). Waterpipe tobacco and cigarette smoking: direct comparison of toxicant exposure. *Am J Prev Med*, 37, 518-23.

IARC (2012). Biological agents. Volume 100 B. A review of human carcinogens. In IARC Monogr Eval Carcinog Risks Hum, Vol. 100 (Pt B), pp 1-441.

Jacob P, Abu Raddaha AH, Dempsey D, et al (2011). Nicotine, carbon monoxide, and carcinogen exposure after a single use of a water pipe. *Cancer Epidemiol Biomarkers Prev*, 20, 2345-53.

Ladeiras-Lopes R, Pereira AK, Nogueira A, et al (2008). Smoking and gastric cancer: systematic review and meta-analysis of cohort studies. *Cancer Causes Control*, 19, 689-701.

Lai HT, Koriyama C, Tokudome S, et al (2016). Waterpipe Tobacco Smoking and Gastric Cancer Risk among Vietnamese Men. *PLoS One*, 11, e0165587.

Maziak W (2013). The waterpipe: an emerging global risk for cancer. *Cancer Epidemiol*, 37, 1-4.

Monzer B, Sepetdjian E, Saliba N, Shihadeh A (2008). Charcoal emissions as a source of CO and carcinogenic PAH in mainstream narghile waterpipe smoke. *Food Chem Toxicol*, 46, 2991-5.

Nishino Y, Inoue M, Tsuji I, et al (2006). Tobacco smoking and gastric cancer risk: an evaluation based on a systematic review of epidemiologic evidence among the Japanese population. *Jpn J Clin Oncol*, 36, 800-7.

Phuoc LH, Sengngam K, Ogawa T, et al (2020). Fruit and Vegetable Intake and Stomach Cancer among Male Adults: A Case-Control Study in Northern Viet Nam. *Asian Pac J Cancer Prev*, 21, 2109-15.

Sadjadi A, Derakhshian MH, Yazdanbod A, et al (2014). Neglected role of hookah and opium in gastric carcinogenesis: a cohort study on risk factors and attributable fractions. *Int J Cancer*, 134, 181-8.

Sasazuki S, Sasaki S, Tsugane S (2002). Cigarette smoking, alcohol consumption and subsequent gastric cancer risk by subsite and histologic type. *Int J Cancer*, 101, 560-6.

She J, Yang P, Wang Y, et al (2014). Chinese water-pipe smoking and the risk of COPD. *Chest*, 146, 924-31.

Shikata K, Doi Y, Yonemoto K, et al (2008). Population-based Prospective Study of the Combined Influence of Cigarette Smoking and Helicobacter pylori Infection on Gastric Cancer Incidence: The Hisayama Study. *Am J Epidemiol*, 168, 1409-15.

Sung NY, Choi KS. Park EC, et al (2007). Smoking, alcohol and gastric cancer risk in Korean men: the National Health Insurance Corporation Study. *Br J Cancer*, 97, 700-4.

WHO (2015). Advisory note: Waterpipe tobacco smoking: health effects research needs and recommended actions for regulators pp. 23-28. World Health Organization: Geneva.

This work is licensed under a Creative Commons Attribution-Non Commercial 4.0 International License.