Attributable Causes of Cancer in Vietnam

Thuy Phuong Nguyen, MPH1; Hung N. Luu, MD, PhD2,3; Mai Vu Tuyet Nguyen, MPH4; Mo Thi Tran, MA4; Thuy Thi Van Tuong, PhD4; Chi Thi Du Tran, PhD4; and Paolo Boffetta, MD, MPH5,6

abstract

PURPOSE Vietnam is undergoing rapid socio-economic transition with an increasing cancer burden. The contribution of modifiable risk factors to cancers in Vietnam has not been studied. Therefore, we sought to evaluate the attributable causes of cancer in Vietnam.

METHODS We reviewed the data on burden of cancer in Vietnam from 2 cancer registries in Hanoi and Ho Chi Minh City between 1995 and 2012. Next, we calculated the fractions of cancers occurring in 2018 attributable to established modifiable risk factors whose impact could be quantified. Data on exposure prevalence were obtained for the period from 2000 to 2010 from national sources wherever possible.

RESULTS Cancer incidence in Vietnam has decreased slightly in both sexes. Cancer related to infectious agents decreased sharply, whereas cancer related to nutrition and metabolism has increased. In 2018, established carcinogens included in the analysis explained 47.0% of cancer burden in Vietnam. Chronic infections accounted for 29.1% of cancers (34.7% in men and 22.1% in women), tobacco smoking for 13.5% (23.9% in men and 0.8% in women), and alcohol drinking for 10.3%. Passive smoking was responsible for 8.8% of cancers in women. Other risk factors, including overweight or obesity, nulliparity, and low vegetable and fruit intake, accounted for < 1% of all cancers each.

CONCLUSION Cancer incidence is slowly decreasing in Vietnam, and the causes of more than half of cancers remain unexplained. This result underlines the need for further epidemiologic and fundamental research. Our findings confirm the notion that controlling oncogenic infections and decreasing tobacco smoking are the most effective approaches to reduce the burden of cancer in Vietnam, but other risk factors, including alcohol drinking and diet, should not be neglected.

JCO Global Oncol 6:195-204. © 2020 by American Society of Clinical Oncology

INTRODUCTION

Vietnam has undergone rapid and far-reaching economic development during the past decades. Over the past 30 years, average growth of the gross national product has been 6.7% per year, one of the highest in the world.1 In parallel, the country has experienced impressive progress toward improving the health status of the population; estimated life expectancy in Vietnam in 2018 was 76.3 years (71.7 years for men and 80.9 years for women),2 a level that is higher than that in many countries with similar levels of gross domestic product per capita. As in other less developed countries that underwent a rapid socioeconomic and health transition, the increase in life expectancy was primarily a result of a decline in mortality from communicable and maternal and childhood diseases. Consequently, noncommunicable diseases, and cancer in particular, have increased their contribution to the burden of disease.3

Although there have been several efforts to evaluate the role of modifiable risk factors for cancer in Vietnam,4-7 systematic study on such issues is unavailable. Under this evolving scenario, we aim to provide a comprehensive assessment of the burden of cancer and the role of its main causes in Vietnam today by calculating population attributable fractions (AFs).

METHODS

We reviewed the data on the burden of cancer in Vietnam. Next, we calculated the fractions of cancers in Vietnam in 2018 attributable to known modifiable causes of cancer for which sufficient data were available.

Burden of Cancer: Sources of Data

The Cancer Incidence in Five Continents program compiles data from cancer registries around the world that satisfy a set of quality criteria, including the proportion of microscopically verified cancers, the proportion of cancers identified from death certificates, and
Almost half of all cancer cases in Vietnam in 2018 are attributable to known modifiable risk factors and therefore can be prevented, at least in theory. Infectious agents, tobacco (including passive smoke) and alcohol consumption are leading causes for cancer in Vietnam.

**Relevance**

This result underlines the need for further epidemiological and fundamental research. Controlling oncogenic infections and tobacco smoking are the most effective approach to reduce the burden of cancer in Vietnam, but other risk factors, including alcohol drinking and diet, should not be neglected.

Risk factors for each cancer type were included in the estimate of AFs if they were classified either as established human carcinogens (Group 1) by the International Agency for Research on Cancer (IARC) or as agents with convincing or probable evidence by the World Cancer Research Fund (WCRF). The main risk factors included in the analysis were infectious agents, tobacco smoking, alcohol drinking, passive smoking, pollutants (particulate matter < 2.5 μm [PM2.5]), overweight and obesity, nulliparity, and low vegetable and fruit intake. Although it has never been evaluated by either IARC or WCRF, nulliparity, as a reproductive factor, was included in the review because a large body of evidence supports its role in breast cancer. Other reproductive factors linked to cancer in humans were not included as a result of insufficient exposure data in Vietnam. Some established carcinogens were not included in the analysis because exposure is rare (eg, radionuclides, radium and its decay products) or because data on the prevalence of such exposures were unavailable (eg, exposure to occupational carcinogens, exogenous hormones, x-ray radiation, γ-radiation, or UV light). Genetic factors for cancer were also excluded because they are unavoidable. The risk factors retained in the analysis are listed in Table 1.

**Risk Factors: Exposure Prevalence**

We obtained the sex-specific prevalence of exposure to the risk factors from census data or representative nation-scaled surveys. Where nationally representative data were unavailable, we obtained data on prevalence of exposure from the most robust epidemiologic studies conducted in Vietnam. Data sources are listed in Table 1. The cancer burden observed at any given time reflects past exposures’ cumulative effect. The time between the relevant exposure and the development of cancer (commonly defined as latency) varies by cancer and risk factor and is not always well defined. For most associations between cancers and risk factors, we chose a latency of 10-15 years between exposure and cancer onset (ie, we considered exposures occurring around 2000-2010), if relevant exposure data were available.

**Relative Risks**

Because of the unavailability of robust studies to determine the association between carcinogens and cancers in Vietnam by the time we conducted this analysis, we obtained relative risks (RRs) from recent published meta-analyses, with preference given to studies in Asia. If meta-analyses were unavailable, results from pooled analyses, cohort studies, and case-control were considered in the respective order. If > 1 RR for the same risk factor was available, preference was given to the study with largest sample size and with results most comprehensively adjusted for confounders. Where there was a statistically significant difference between RRs among males and females, sex-specific RRs were extracted. Otherwise, total RRs were applied for both sexes.

**AF Calculation**

AF estimates the proportion of cancer that could be avoided if exposure to a given agent were eliminated. We used the AF formula proposed by Levin, which is widely used by
| Risk Factor                  | Specific Exposures                                      | Data Source                                      | Comments                                                                 |
|-----------------------------|---------------------------------------------------------|--------------------------------------------------|--------------------------------------------------------------------------|
| Tobacco smoking             | Current smoking; former smoking                         | The Global Adult Tobacco Survey Vietnam 2010<sup>27</sup> | Estimated excess risk in former smokers was 50% of current smoker<sup>39</sup> |
| Passive tobacco smoking     | Involuntary smoking at home; involuntary smoking at workplace | The Global Adult Tobacco Survey Vietnam 2010<sup>27</sup> |                                                                           |
| Alcohol drinking            | Level of drinking on daily average                      | Van Bui et al<sup>40</sup> and National Survey on the Risk Factors of Non-Communicable Diseases (STEPS) Viet Nam 2015<sup>33</sup> | Risk levels different for men and women                                  |
| Infectious agents           | Epstein-Barr virus; human papillomavirus; hepatitis B virus; hepatitis C virus; Helicobacter pylori | Most robust epidemiologic studies<sup>41-43</sup> |                                                                           |
| Overweight and obesity      | Overweight defined as BMI > 25 kg/m<sup>2</sup>; obesity defined as BMI > 30 kg/m<sup>2</sup> | National Survey on the Risk Factors of Non-Communicable Diseases (STEPS) Viet Nam 2015<sup>33</sup> |                                                                           |
| Vegetable and fruit intake  | Consumption of < 5 portions (400 g) of vegetables and fruit daily | National Survey on the Risk Factors of Non-Communicable Diseases (STEPS) Viet Nam 2015<sup>33</sup> |                                                                           |
| Air pollution               | PM<sub>2.5</sub> level                                   | Ambient Air Pollution Exposure Estimation for the Global Burden of Disease 2013, Vietnam data from 2010<sup>45</sup> |                                                                           |
| Reproductive factors        | Nulliparity                                             | Vietnam Demographic and Health Survey 2002<sup>46</sup> | Risk was estimated for all nulliparous women regardless of age            |

Abbreviations: BMI, body mass index; PM<sub>2.5</sub>, particulate matter of < 2.5 μm.
epidemiologists worldwide, to calculate the AF of an association between a dichotomous exposure and a cancer:

$$AF_p = \frac{PF_1 \times RR - 1}{1 + (RR - 1)PF_1},$$

where $PF_1$ is the underlying prevalence of the risk factor in the population and $RR$ is the RR of developing a type of cancer when exposed to the risk factor.

For polytomous exposures, we used the formula described by Hanley to calculate the total AF for that exposure:

$$AF_p = \frac{PF_1 \{RR \times RR - 1\} + PF_2 \{RR \times RR - 1\}}{1 + PF_1 \{RR \times RR - 1\} + PF_2 \{RR \times RR - 1\}},$$

which can be extended to more than 2 exposure categories.

For some infections, AFs were obtained from generally accepted results from published studies because no data for RR were available. This applied to AFs for Epstein-Barr virus (EBV) for nasopharyngeal cancer and Hodgkin lymphoma, Helicobacter pylori for stomach cancer, and HIV for Kaposi sarcoma and non-Hodgkin lymphoma.

Combining AFs

For each type of cancer, the individual AFs for different risk factors cannot be numerically added together because a patient may have been exposed to more than one of them. With insufficient information on the nature of risk factors' interactions and their combined distributions, to estimate the total AFs, we assumed that there was independence of both exposure prevalence and carcinogenic action between risk factors and applied the following formula:

$$\text{Total AF} = 1 - \prod_{i=1}^{n} (1 - AF_i).$$

RESULTS

Burden of Cancer

The overall incidence of cancer (age-standardized rates, excluding nonmelanoma skin cancer) in HCMC during 2008-2012 was 130.1 per 100,000 in men and 105.8 per 100,000 in women. The incidence for 1995-1998 was 143.1 per 100,000 in men and 108.6 per 100,000 in women, equivalent to an average decline in cancer incidence of 0.7% in men and 0.2% in women.

Figures 1A and 1B report incidence rates of specific cancers in 2008-2012 and 1995-1998 in HCMC by sex. Among men, the 3 most common cancers are lung, liver, and stomach cancer; the incidence of the 2 latter cancers decreased remarkably during the 2 time periods, whereas that of lung cancer remained stable. Among women, a remarkable shift took place in the period under study. Cervical cancer was the most common cancer in 1995-1998, but it was reduced by half in 2008-2012. The incidence of breast cancer increased by 76%, and this was the most common cancer in women in 2008-2012. The incidence of stomach and liver cancer decreased in both sexes.

The overall incidence of cancer in Hanoi during 1993-1997 was 151.7 per 100,000 in men and 99.1 per 100,000 in women (6% higher than in HCMC in the same period in men and 9% lower in women). The incidence of lung cancer in men was 28% higher in Hanoi than in HCMC, whereas the incidence of liver cancer was 26% lower. Among women, the incidence of breast cancer was 54% higher in Hanoi than in HCMC, that of cervical cancer was 42% lower, and that of lung cancer was 4% lower (data not shown).

The estimated number of cancers in 2018 in Vietnam was 164,671 (55% in men). The estimated number of cancer deaths was 114,871 (62% in men), and the number of 5-year prevalent cases of cancer was 300,033 (Table 2). The top 5 causes of cancer death in 2018 were liver cancer (25,404 estimated deaths, 22.1% of the total), lung cancer (20,710 deaths, 18.0%), stomach cancer (15,065 deaths, 13.1%), breast cancer (6,103 deaths, 5.3%), and leukemia (4,923 deaths, 4.3%; data not shown).

Estimation of AFs

Estimation of AFs by risk factors in Vietnam is provided in Table 3. Infectious agents (29.1%) and tobacco smoking (13.5%) were accountable for the largest proportion of cancers in Vietnam. Among men, chronic infections accounted for one third of cancers, whereas tobacco smoking accounted for one fourth of all cancers. One of every 10 cancers could be attributed to drinking alcohol. In women, the 2 leading risk factors were infectious agents (22.1%) and passive smoking (8.8%). The remaining factors included in the analysis accounted for a relatively small fraction of cancers. Overall, the risk factors selected for the analysis were responsible for 59.2% of cancers in men and 32.0% in women (47% in both sexes).

Table 4 lists the summary results of AFs for individual cancers, EBV, human papillomavirus, and HIV accounted for 100% of nasopharyngeal cancers, cervical cancers, and Kaposi sarcomas, respectively. Large AFs (≥70%) were observed for cancers strongly associated with tobacco smoking, alcohol drinking, and chronic infections (eg, head and neck, cervical cancers, liver, stomach). For lung cancer, the AF was 65%, with a large difference between men and women. AFs in the range of 20% to 60% were observed for cancer with ≥1 important, but not predominant, risk factor (eg, esophagus, lymphoma, reproductive system, bladder, and pancreas). AFs < 10% were observed for several common cancers (eg, colorectum, gallbladder, prostate, kidney, and ovary), for which the etiology is largely unknown.

DISCUSSION

To our knowledge, this analysis was the first systematic assessment of cancers attributable to modifiable risk
Incidence rates (per 100,000) of specific cancers in men in 2008-2012 and 1995-1998 in Ho Chi Minh City

Incidence rates (per 100,000) of specific cancers in women in 2008-2012 and 1995-1998 in Ho Chi Minh City

FIG 1. (A) Incidence rates (per 100,000) of specific cancers in men in 2008-2012 and 1995-1998 in Ho Chi Minh City. (B) Incidence rates (per 100,000) of specific cancers in women in 2008-2012 and 1995-1998 in Ho Chi Minh City.
TABLE 2. Estimated Number of Incident Cancers, Cancer Deaths, and 5-Year Prevalent Cancers in Vietnam, 2018, by Sex (Globocan 2018)

| Measure            | Men     | Women    | Total    |
|--------------------|---------|----------|----------|
| Incident cancers   | 90,822  | 73,849   | 164,671  |
| Cancer deaths      | 70,888  | 43,983   | 114,871  |
| 5-year prevalent cases of cancer | 138,602 | 161,431  | 300,033  |

Factors in Vietnam. Cancer incidence in Vietnam observed a minor decline over a 20-year period. Overall, cancer morbidity and mortality were higher among men than women. Lung cancer remained the most common cancer among men over the years, whereas breast cancer replaced cervical cancer to become the most common cancer among women. Cancers related to infectious agents (ie, stomach, liver, and cervical cancer) decreased, whereas cancers related to nutrition and metabolism (ie, breast, ovarian, and colorectal cancer) were on the rise. This changing pattern reflects the changes in risk factor prevalence for Vietnam, a country undergoing socioeconomical development, rapid urbanization, and lifestyle changes. This pattern is similar to China’s and that of most other Asian countries.

Infectious agents are the most common cancer risk factors in Vietnam. In our analysis, we could not include several relatively minor oncogenic infections, such as Opisthorchis viverrini, Clonorchis sinensis, human herpesvirus B, and liver flukes because of lack of exposure data. Chronic infections had a larger contribution to the total number of cancers in Vietnam than in global analyses (23.4% of total cancers in less developed regions, regional analyses (19.6% in Asian countries), and results from other Asian countries such as China (25.3%), Japan (17.5%), and Korea (17.8%). This disparity could be explained by the fact that Vietnam is one of the countries with the highest prevalence of hepatitis B virus (10%) and H. pylori (> 70%) in Asia. There is no national surveillance to monitor the trend of carcinogenic infections over time, but ad hoc epidemiologic studies showed a decreasing trend for most infectious agents included in our analysis (Appendix Table A1). These trends parallel those observed for infection-related cancers such as liver, stomach, and cervical cancer (Figs 1A and 1B).

Tobacco smoking is the second leading cause for cancer in Vietnam. Notably, > 97% of cancers caused by tobacco smoking occurred among men, reflecting a low tobacco smoking prevalence in women (1.9%) compared with men (60.1%). Despite the low prevalence of active smoking, passive smoking is a significant cancer risk factor for women in Vietnam, causing 8.8% of all cancers among women. Overall, smoking-related cancers accounted for one fifth of all cancers in Vietnam (27.5% in men and 9.6% in women). Our findings might underestimate the true burden of tobacco-related cancer in Vietnam because cancers with established but weak association with tobacco smoking (eg, colorectal and kidney cancer) were not included in the analysis. Ever-smoking as cancer risk factor accounted for a significantly smaller proportion of cancers among women in Vietnam (0.8%) than among women of other Asian populations (5% in China and 5.2% in Korea and Japan). This could be explained by the low rate of active smoking among Vietnamese women (1.9%) compared with that of women in other studies (10.5% in Japan and 4.1% in Korea). Smoking prevalence in Vietnam is decreasing slowly, by only 5% over a 10-year period; hence, tobacco-related cancer will remain a major burden in the future.

Alcohol drinking was the third most important risk factor for cancer in Vietnam included in our analysis and accounted for 6% of cancers. Similar to tobacco smoking, a majority of alcohol drinking–related cancers (95.2%) occurred among men. Our estimation is higher than results from studies in China (3.63% to 4.4% of cancers caused by drinking alcohol) and previous global studies (3%-5% of cancer deaths caused by drinking alcohol across the globe). The risk of developing cancer increases with higher levels of drinking. Studies in China did not disaggregate by alcohol

TABLE 3. Cancers Attributable to Selected Risk Factors in Vietnam in 2018

| Risk Factor                  | Men AF (%) | No. | Women AF (%) | No. | Both Sexes AF (%) | No. |
|------------------------------|------------|-----|--------------|-----|------------------|-----|
| Tobacco smoking              | 23.9       | 21,695 | 0.8 | 617 | 13.5 | 22,312 |
| Passive smoking              | 3.6        | 3,290  | 8.8 | 6,522 | 6.0 | 9,812 |
| Alcohol drinking             | 10.3       | 9,342  | 0.6 | 469 | 6.0 | 9,811 |
| Infectious agents            | 34.7       | 31,506 | 22.1 | 16,345 | 29.1 | 47,851 |
| Overweight and obesity       | 0.7        | 654    | 0.8 | 598 | 0.8 | 1,252 |
| Low vegetable and fruit intake | 0.7       | 679    | 0.1 | 49  | 0.4 | 728 |
| Air pollution (PM2.5)        | 2.0        | 1,791  | 1.0 | 744 | 1.5 | 2,535 |
| Nulliparity                  | —          | —      | 1.7 | 1,280 | 0.8 | 1,280 |
| All of the above             | 59.2       | 53,773 | 32.0 | 23,637 | 47.0 | 77,410 |

Abbreviations: AF, attributable fraction; PM2.5, particulate matter of < 2.5 μm.
consumption level, which may lead to underestimation of AFs. However, differences in AFs for alcohol drinking could mainly be explained by a remarkable higher prevalence of alcohol consumption among men in Vietnam (82% in Vietnam compared with 39% in China\(^{30}\) and 55% globally\(^{32}\)). Strikingly, alcohol consumption in Vietnam observed a remarkable increase of 21% between 2010 and 2015,\(^{33}\) suggesting that alcohol consumption may have played a small role in total cancer burden in Vietnam, accounting for just 0.4% of all cancers. Globally, consuming an insufficient amount of fruit and vegetables daily could cause 14% of GI cancer deaths worldwide.\(^{36}\) Other dietary factors potentially associated with cancer\(^{14}\) (eg, red meat intake, salting-preserved food consumption, high-dose \(β\)-carotene supplements) were not included in our study, which might hamper our current analysis on diet and nutrition component. Nulliparity is the only reproductive factor included in this analysis and accounted for < 2% of all cancers in women; again, underestimation of the role of reproductive and hormonal factors on the cancer burden in Vietnam is likely to have occurred.

Although we understand well the role of infections and tobacco smoking in cancer, leading to opportunities for cancer prevention in the future, we understand less well the causes of hormonal and metabolic-related cancers. Because these factors are emerging in societies under transition, such as Vietnam, it is important to conduct further studies to investigate their contribution to cancer in the country.

Our study has several strengths, including being the first effort, to our knowledge, to systematically assess the role of established cancer risk factors in Vietnam. In addition, most of the exposure data included in our analysis were derived from large-scale representative studies of the Vietnamese population. However, there were several drawbacks to our study. First, cancer diagnosis in Vietnam has many challenges. Access to quality pathology services has been limited in the past. Modern technologies for cancer diagnosis have become available in a few comprehensive cancer centers in recent years.\(^{37}\) In addition, the accuracy of pathology testing is also limited.\(^{38}\) These limitations may hinder the accuracy of data for the cancer registries. Second, we lack data for several important established risk factors. Third, some prevalence of exposure either might not be representative of the country (ie, infectious agents) or was based on the estimation outside of Vietnam (ie, exposure to outdoor pollution). Fourth, risk factors were referring to a time period that may not be fully relevant to cancer development. Finally, RRs were obtained from non-Vietnamese population studies,

### TABLE 4. Cancers Attributable to Known Risk Factors by Type of Cancer, Vietnam 2018

| Cancer                     | Men   | Women | Both Sexes |
|----------------------------|-------|-------|------------|
|                            | No. AF (%) | No. AF (%) | No. AF (%) |
| Oral cavity                | 1,163 89.0 | 337 59.4 | 1,500 79.9 |
| Pharynx                    | 2,132 89.2 | 308 60.4 | 2,440 84.1 |
| Nasopharynx                | 4,559 100.0 | 1,653 100.0 | 6,212 100.0 |
| Esophagus                  | 1,222 59.0 | 64 19.2 | 1,286 53.3 |
| Stomach                    | 9,393 84.2 | 5,042 79.2 | 14,435 82.4 |
| Colorectum                 | 936 12.3 | 342 4.8 | 1,278 8.7 |
| Liver                      | 17,674 90.3 | 4,789 83.0 | 22,463 88.7 |
| Gallbladder                | 8 3.4 | 7 3.2 | 15 3.0 |
| Pancreas                   | 169 32.3 | 24 5.6 | 193 20.0 |
| Larynx                     | 1,210 83.9 | 139 57.7 | 1,349 80.1 |
| Lung                       | 13,244 79.2 | 2,114 30.4 | 15,358 64.9 |
| Breast                     | 597 100.0 | 33 70.0 | 630 79.9 |
| Kaposi sarcoma             | 3,968 26.1 | 3,968 26.1 | 7,936 27.3 |
| Cervix uteri               | 4,177 100.0 | 4,177 100.0 | 8,354 100.0 |
| Ovary                      | 11 0.7 | 11 0.7 | 22 0.7 |
| Vulva                      | 80 43.0 | 80 43.0 | 160 71.8 |
| Vagina                     | 33 70.0 | 33 70.0 | 66 70.0 |
| Prostate                   | 51 1.3 | 51 1.3 | 102 0.7 |
| Penis                      | 165 50.0 | 165 50.0 | 330 50.0 |
| Urinary bladder            | 384 32.8 | 3 1.1 | 387 25.8 |
| Kidney                     | 20 1.6 | 2 0.2 | 22 0.9 |
| Non-Hodgkin lymphoma       | 632 32.1 | 326 21.3 | 958 27.3 |
| Hodgkin lymphoma           | 214 50.0 | 151 50.0 | 365 50.0 |
| Other, unspecified         | 0 0.0 | 0 0.0 | 0 0.0 |
| All cancers                | 53,773 59.2 | 23,637 32.0 | 77,410 47.0 |

Abbreviation: AF, attributable fraction.
which may lead to potential under- or overestimation of certain risk factors specifically for the Vietnamese population.

Overall, approximately half of cancers in Vietnam can be attributed to known risk factors and therefore can be prevented, at least in theory. The effect of risk factors excluded from the analysis on the burden of cancer in Vietnam remains unknown. Therefore, it is important to monitor the exposures to such risk factors and to study the effect of these factors on cancer because there are no robust studies on the association between different risk factors and cancer in Vietnam currently available. Our findings once again confirmed the notion that controlling oncogenic infections and decreasing tobacco smoking are the most effective approaches to reduce the burden of environmental cancer in Vietnam, but other risk factors, including alcohol use, diet, and indoor and outdoor air pollution should not be neglected.

REFERENCES
1. The World Bank: Vietnam at a glance. http://www.worldbank.org/en/country/vietnam/overview
2. WHO: Vietnam country profile. https://www.who.int/countries/vnm/en/
3. Institute for Health Metrics and Evaluation: Findings from the Global Burden of Disease Study 2017. Seattle, WA, Institute for Health Metrics and Evaluation, 2018
4. Van Hoang D, Lee AH, Pham NM, et al: Prostate cancer risk reduced by physical activity even among men with prolonged sitting time: A study from Vietnam. Asia Pac J Public Health 30:227-234, 2018
5. Binh TT, Tuan VP, Dung HQD, et al: Advanced non-cardia gastric cancer and Helicobacter pylori infection in Vietnam. Gut Pathog 9:46, 2017
6. Lai HT, Koriyama C, Tokudome S, et al: Waterpipe tobacco smoking and gastric cancer risk among Vietnamese men. PLoS One 11:e0165587, 2016
7. Trieu PD, Mello-Thoms C, Peat JK, et al: Inconsistencies of breast cancer risk factors between the northern and southern regions of Vietnam. Asian Pac J Cancer Prev 18:2747-2754, 2017
8. Bray F, Colombet M, Mery L, et al: Cancer Incidence in Five Continents Volume XI. International Agency for Research on Cancer. http://iarc.fr
9. Parkin DM, Whelan SL, Ferlay J, et al: Cancer Incidence in Five Continents, Volume VIII. Lyon, France, International Agency for Research on Cancer, 2002
10. Ferlay J, Ervik M, Lam F, et al: Global Cancer Observatory (GCO): Cancer today. International Agency for Research on Cancer. https://gco.iarc.fr/today
11. Bray F, Ferlay J, Soerjomataram I, et al: Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 68:394-424, 2018
12. Ferlay J, Colombet M, Soerjomataram I, et al: Estimating the global cancer incidence and mortality in 2018: GLOBOCAN sources and methods. Int J Cancer 144:1941-1953, 2019
13. International Agency for Research on Cancer: Agents classified by the IARC monographs, volumes 1–123. IARC Monographs on the Identification of Carcinogenic Hazards to Humans. https://monographs.iarc.fr/agents-classified-by-the-iarc/
14. World Cancer Research Fund, American Institute for Cancer Research: Continue Update Project: Diet, nutrition, physical activity and the prevention of cancer—Summary of strong evidence. https://www.wcrf.org/sites/default/files/Matrix-for-all-cancers-A3.pdf
15. Opdahl S, Alsaker MDK, Janszky I, et al: Joint effects of nulliparity and other breast cancer risk factors. Br J Cancer 105:731-736, 2011
16. Fioretti F, Tavani A, Bosetti C, et al: Risk factors for breast cancer in nulliparous women. Br J Cancer 79:1923-1928, 1999
17. Levin ML: The occurrence of lung cancer in man. Acta Unio Int Contra Cancrum 9:531-541, 1953

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST
The following represents disclosure information provided by authors of this manuscript. All relationships are considered compensated unless otherwise noted. Relationships are self-held unless noted. I = Immediate Family Member, Inst = My Institution. Relationships may not relate to the subject matter of this manuscript. For more information about ASCO’s conflict of interest policy, please refer to www.asco.org/ncw or ascopubs.org/go/site/misc/authors.html.
Open Payments is a public database containing information reported by companies about payments made to US-licensed physicians (Open Payments).
No potential conflicts of interest were reported.
18. Hanley JA: A heuristic approach to the formulas for population attributable fraction. J Epidemiol Community Health 55:508-514, 2001
19. de Martel C, Ferlay J, Franceschi S, et al: Global burden of cancers attributable to infections in 2008: A review and synthetic analysis. Lancet Oncol 13:607-615, 2012
20. Huang H, Hu X-F, Zhao F-H, et al: Estimation of cancer burden attributable to infection in Asia. J Epidemiol 25:626-638, 2015
21. Wang JB, Jiang Y, Liang H, et al: Attributable causes of cancer in China. Ann Oncol 23:2983-2989, 2012
22. Sankaranarayanan R, Ramadas K, Qiao YL: Managing the changing burden of cancer in Asia. BMC Med 12:3, 2014
23. Plummer M, de Martel C, Vignat J, et al: Global burden of cancers attributable to infections in 2012: A synthetic analysis. Lancet Glob Health 4:e609-e616, 2016
24. Inoue M, Sawada N, Matsuda T, et al: Attributable causes of cancer in Japan in 2005: Systematic assessment to estimate current burden of cancer attributable to known preventable risk factors in Japan. Ann Oncol 23:1362-1369, 2012
25. Razavi-Shearer D, Gamkrelidze I, Nguyen MH, et al: Global prevalence, treatment, and prevention of hepatitis B virus infection in 2016: A modelling study. Lancet Gastroenterol Hepatol 3:383-403, 2018
26. Hooi JKY, Lai WY, Ng WK, et al: Global prevalence of Helicobacter pylori infection: Systematic review and meta-analysis. Gastroenterology 153:420-429, 2017
27. Ministry of Health of Vietnam, Hanoi Medical University, General Statistics Office, et al: Global Adult Tobacco Survey (GATS) Vietnam 2010. https://www.who.int/tobacco/surveillance/en_gats_vietnam_report.pdf
28. Park S, Jee SH, Shin H-R, et al: Attributable fraction of tobacco smoking on cancer using population-based nationwide cancer incidence and mortality data in Korea. BMC Cancer 14:406, 2014
29. Katano K, Matugame T, Saika K, et al: Population attributable fraction of mortality associated with tobacco smoking in Japan: A pooled analysis of three large-scale cohort studies. J Epidemiol 18:251-264, 2008
30. Liang H, Wang J, Xiao H, et al: Estimation of cancer incidence and mortality attributable to alcohol drinking in China. BMC Public Health 10:730, 2010
31. Danaei G, Vander Hoorn S, Lopez AD, et al: Causes of cancer in the world: Comparative risk assessment of nine behavioural and environmental risk factors. Lancet 366:1784-1793, 2005
32. Boffetta P, Hashibe M, La Vecchia C, et al: The burden of cancer attributable to alcohol drinking. Int J Cancer 119:884-887, 2006
33. Ministry of Health of Vietnam: National Survey on the Risk Factors of Non-Communicable Diseases (STEPS) Viet Nam 2015. https://www.who.int/ncds/surveillance/steps/VietNam_2015_STEPS_Report.pdf
34. Boffetta P, Tubiana M, Hill C, et al: The causes of cancer in France. Ann Oncol 20:550-555, 2009
35. Arnold M, Pandeya N, Byrnes G, et al: Global burden of cancer attributable to high body-mass index in 2012: A population-based study. Lancet Oncol 16:36-46, 2015
36. WHO: Promoting fruit and vegetable consumption around the world. https://www.who.int/dietphysicalactivity/fruit/en/index2.html
37. Nguyen BD: Results of the national cancer program 2011-2014. Vietnam Oncol J 2:8, 2014
38. Pham T, Bui L, Kim G, et al: Cancers in Vietnam: Burden and control efforts—A narrative scoping review. Cancer Control 26:1073274819863802, 2019 CHECK PAGE REF
39. WHO: Fact sheet about health benefits of smoking cessation. Tobacco Free Initiative (TFI). https://www.who.int/tobacco/quitting/benefits/en/
40. Van Bui T, Blizzard CL, Luong KN, et al: Alcohol consumption in Vietnam, and the use of “standard drinks” to measure alcohol intake. Alcohol Alcohol 51:186-195, 2016
41. Hipgrave DB, Nguyen TV, Vu MH, et al: Hepatitis B infection in rural Vietnam and the implications for a national program of infant immunization. Am J Trop Med Hyg 69:288-293, 2003
42. Tran HT-T, Ushijima H, Quang VX, et al: Prevalence of hepatitis virus types B through E and genotypic distribution of HBV and HCV in Ho Chi Minh City, Vietnam. Hepatol Res 26:275-280, 2003
43. Hoang TTH, Bengtsson C, Phung DC, et al: Seroprevalence of Helicobacter pylori infection in urban and rural Vietnam. Clin Diag Lab Immunol 12:81-85, 2005
44. Vietnam Administration of HIV/AIDS Control: Vietnam HIV/AIDS estimates and projections 2007-2012. http://www.ilo.org/wcmsp5/groups/public/—ed_protect/—protrav/—ilo_aids/documents/legaldocument/wcms_174609.pdf
45. Brauer M, Freedman G, Frostad J, et al: Ambient air pollution exposure estimation for the global burden of disease 2013. Environ Sci Technol 50:79-88, 2016
46. Committee for Population Family and Children: Vietnam Demographic and Health Survey 2002. https://dhsprogram.com/pubs/pdf/fr139/00frontmatter00.pdf
| Infectious Carcinogens | Year of Data Collection |
|------------------------|-------------------------|
|                        | 1997 | 1998 | 1998-2001 | 2002 | 2003 | 2004-2006 | 2006 | 2007 | 2008 | 2009 | 2010 | 2012 | 2013 | 2015 |
| HBV                    | 19%  | 10%  | 8.3%       | 9.4% | 11.4% | 15.3%       | 10%  | 10%  | 11.4% | 15.3% | 15.3% | 15.3% | 15.3% |      |
|                        |      |      |            |      |      |            |      |      |      |      |      |      |      |      |
| HCV                    | 2%   | 1%   | 0.17%      | 0.9% | 3.3%  | 3.3%        |      |      |      |      |      |      |      |      |
|                        |      |      |            |      |      |            |      |      |      |      |      |      |      |      |
| HPV                    | 1%–1% to 9.6% | 5.1% | 2%         | 65.6% | 29.3–61% | 2%         |      |      |      |      |      |      |      |      |
|                        |      |      |            |      |      |            |      |      |      |      |      |      |      |      |
| EBV                    | 0.05% | 0.1% | 0.14% | 0.2% | 0.26% | 0.29% | 0.29% | 0.29% | 0.29% |      |      |      |      |      |
|                        |      |      |            |      |      |            |      |      |      |      |      |      |      |      |
| HIV                    | 0.05% | 0.1% | 0.14% | 0.05% | 0.2% | 0.26% | 0.29% | 0.2% | 0.28% | 0.28% | 0.29% | 0.29% | 0.29% | 0.29% |

Abbreviations: DUV, data unavailable for Vietnam; EBV, Epstein-Barr virus; HBV, hepatitis B virus; HCV, hepatitis C virus; HPV, human papillomavirus.

1Nguyen VT, McLaws ML, Dore GJ: Highly endemic hepatitis B infection in rural Vietnam. J Gastroenterol Hepatol 22:2093-2100, 2007.
2Goto A, Nguyen QV, Pham NM, et al: Prevalence of and factors associated with reproductive tract infections among pregnant women in ten communes in Nghe An Province, Vietnam. J Epidemiol 15:163-172, 2005.
3Pham TH: Sexually transmitted infections and other reproductive tract infections in rural Vietnam. Current situation, management and implications for control. https://openarchive.ki.se/xmlui/bitstream/handle/10616/39145/thesis.pdf;sequence=1.
4Pham TH, Nguyen TH, Herrero R, et al: Human papillomavirus infection among women in South and North Vietnam. Int J Cancer 104:13-20, 2003.
5Nguyen TL, Uchida T, Tsukamoto Y, et al: Helicobacter pylori/factor and gastrointestinal diseases in Vietnam: A cross-sectional, hospital-based study. BMC Gastroenterol 10:114, 2010.
6Binh TT, Tran VH: Study on the types of HPV (human papilloma virus) infection detected by PCR among women in Hanoi city. Ho Chi Minh City J Med 13(5), 2009.