# Analysis of Disease Burden of Common Malignant Tumors of the Female Reproductive System in China, 1990-2019

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## Abstract

Objective To analyze the disease burden and changes in risk factors of common malignant tumors of the female reproductive system in China from 1990 to 2019. Methods Using data from the 2019 Global Burden of Disease database, we described changes in incidence, mortality, and indicators such as disability-adjusted life years (DALY), years of life lost due to premature death (YLL), and years lived with disability (YLD) for cervical cancer, uterine cancer, and ovarian cancer in China from 1990 to 2019. Population attributable risk percentage was used to estimate the levels of different risk factors. Results From 1990 to 2019, the incidence and mortality rates of cervical cancer, uterine cancer, and ovarian cancer in China showed an upward trend, with ovarian cancer having the highest increase in incidence rate at 0.78%. In 2019, the peak age groups for cervical cancer and uterine cancer were both 55-59 years, while for ovarian cancer it was 70-74 years. DALY, YLL, and YLD across all age groups for cervical cancer, uterine cancer, and ovarian cancer increased to varying degrees. Among the risk factors contributing to DALY and DALY rates, for cervical cancer they were smoking (145,300 person-years/20.83%) and unsafe sexual behavior (1,622,200 person-years/232.57%); for uterine cancer, high body mass index (BMI) (90,800 person-years/13.02%); and for ovarian cancer, high BMI (16,700 person-years/2.39%), high blood glucose (44,600 person-years/6.40%), and occupational asbestos exposure (7,900 person-years/1.13%). Compared with 1990, the largest increases in DALY rates in China in 2019 were for ovarian cancer attributable to high BMI, high blood glucose, and occupational asbestos exposure, which increased by 482.93%, 253.59%, and 162.79%, respectively—growth rates far exceeding global levels. Conclusion From 1990 to 2019, the overall disease burden of common malignant tumors of the female reproductive system in China showed an upward trend. Postmenopausal and late postmenopausal women should be targeted as key populations for prevention and control. Efforts should be made to increase public education on the three types of cancers,

promote healthy lifestyles, actively conduct cancer screening, and improve vaccination willingness, thereby reducing the disease burden of cervical cancer, uterine cancer, and ovarian cancer among Chinese women.

## Full Text

# Disease Burden of Common Malignant Tumors of the Female Reproductive System in Chinese Women, 1990-2019

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### Abstract

**Objective:** To analyze the disease burden and changes in risk factors for common malignant tumors of the female reproductive system in China from 1990 to 2019.
**Methods:** Using data from the 2019 Global Burden of Disease (GBD) database, we described temporal changes in incidence, mortality, disability-adjusted life years (DALYs), years of life lost due to premature mortality (YLLs), and years lived with disability (YLDs) for cervical, uterine, and ovarian cancers in China. Population attributable risk percentages were used to estimate the contribution of different risk factors.
**Results:** From 1990 to 2019, the incidence and mortality rates of cervical, uterine, and ovarian cancers in China showed upward trends, with ovarian cancer exhibiting the highest increase at 0.78%. In 2019, the peak incidence age was 55-59 years for both cervical and uterine cancers, while ovarian cancer peaked at 70-74 years. DALYs, YLLs, and YLDs increased across all age groups for the three cancers to varying degrees. The leading risk factors contributing to DALYs and DALY rates were smoking (145,300 person-years/20.83%) and risky sexual behavior (1,622,200 person-years/232.57%) for cervical cancer; high body mass index (BMI) (90,800 person-years/13.02%) for uterine cancer; and high BMI (16,700 person-years/2.39%), high blood glucose (44,600 person-years/6.40%), and occupational asbestos exposure (7,900 person-years/1.13%) for ovarian cancer. Compared with 1990, the largest increases in China's DALY rates in 2019 were observed for ovarian cancer attributable to high BMI (482.93%), high blood glucose (253.59%), and occupational asbestos exposure (162.79%), with growth rates far exceeding global levels.
**Conclusion:** From 1990 to 2019, the disease burden of common malignant tu-

mors of the female reproductive system in Chinese women showed an overall upward trend. Menopausal and postmenopausal women should be prioritized for prevention and control efforts. Increasing public education on these three cancers, promoting healthy lifestyles, actively conducting cancer screening, and improving vaccination willingness are essential to reduce the disease burden of cervical, uterine, and ovarian cancers among Chinese women.

**Keywords:** cervical cancer; uterine cancer; ovarian cancer; disease burden

## Introduction

Malignant tumors of the female reproductive system primarily include ovarian, cervical, and uterine cancers (encompassing endometrial carcinoma and uterine sarcoma), as well as vulvar, vaginal, and fallopian tube cancers. Among these, ovarian, cervical, and uterine cancers represent the three most common malignancies of the reproductive system, imposing substantial disease and economic burdens on individuals, families, and society. According to data from the *World Cancer Report* [1], in 2018, global cervical cancer accounted for 570,000 new cases and 311,000 deaths; uterine cancer for 382,000 new cases and 90,000 deaths; and ovarian cancer for 295,000 new cases and 210,000 deaths.

To mitigate the impact of these three malignant tumors on China's socioeconomic development, we must thoroughly investigate their epidemiological status and changing trends to inform the formulation of chronic disease prevention and control strategies. Based on data from the Global Burden of Diseases (GBD) 2019 study, this research examines the incidence and mortality of cervical, uterine, and ovarian cancers among Chinese women, estimates their disease burden and trends across different age groups, and analyzes changes in risk factors. The findings aim to provide evidence for developing effective prevention and control strategies for female reproductive system malignancies and reducing the disease burden among Chinese women.

## Materials and Methods

**Data Sources** This study utilized data from the GBD 2019 database for China and globally from 1990-2019. The GBD database, maintained by the Institute for Health Metrics and Evaluation (IHME), assesses the disease burden attributable to 359 diseases or injuries and 84 risk factors across 195 countries using various health indicators including disease statistics, mortality statistics, and risk factor metrics. Detailed data extraction and analysis methods are described in references [2, 3].

**Disease Classification** Following the *International Statistical Classification of Diseases and Related Health Problems (10th Revision)* (ICD-10), disease codes

were C53 for cervical cancer, C54 for uterine cancer, and C56 for ovarian cancer.

**Analysis Indicators** We extracted incidence numbers, incidence rates, mortality numbers, and mortality rates for cervical, uterine, and ovarian cancers from GBD 2019 for China and globally. The study analyzed incidence and mortality by year and age group, and measured disease burden using years of life lost due to premature mortality (YLL), years lived with disability (YLD), disability-adjusted life years (DALY), and their corresponding rates.

GBD 2019 employs counterfactual analysis using population attributable fractions to estimate the proportion of disease burden that could be reduced if a risk factor were lowered to a counterfactual level (typically the theoretical minimum risk exposure level), assuming other risk factor exposures remain unchanged [4, 5]. This approach was used to estimate the attributable disease burden for cervical, uterine, and ovarian cancers. Age-standardized rates were calculated based on the GBD world standard population age structure and the upper and lower limits of raw data.

**Statistical Analysis Methods** Using R 4.3.0 and Excel software, we conducted descriptive analyses of the disease burden of uterine, cervical, and ovarian cancers among Chinese women across different years and age groups, examining indicators including incidence numbers, incidence rates, prevalence numbers, prevalence rates, mortality rates, DALY rates, YLL rates, and YLD rates. Age standardization of incidence, mortality, DALY, YLL, and YLD rates was performed according to the GBD 2019 global standard population.

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## Results

**Incidence, Prevalence, and Mortality of Cervical, Uterine, and Ovarian Cancers** In 2019, incidence numbers for cervical, uterine, and ovarian cancers in Chinese women were 109,800, 66,700, and 45,300 cases, respectively; prevalence numbers were 575,200, 516,300, and 195,000 cases; and mortality numbers were 53,400, 12,200, and 29,100 deaths. Compared with 1990, incidence numbers, prevalence rates, and mortality numbers for all three cancers increased, with ovarian cancer showing the highest increase at 2.64%. In 2019, age-standardized incidence, prevalence, and mortality rates were 15.68/100,000, 84.69/100,000, and 7.37/100,000 for cervical cancer; 10.12/100,000, 78.19/100,000, and 1.85/100,000 for uterine cancer; and 6.27/100,000, 28.06/100,000, and 3.86/100,000 for ovarian cancer. Compared with 1990, age-standardized incidence rates increased by 0.33%, 0.25%, and 0.78% for the three cancers, respectively. Age-standardized mortality rates decreased by 0.10% and 0.51% for cervical and uterine cancers but increased by 0.58% for ovarian cancer. Compared with global levels, China's age-standardized incidence and mortality rates for these three common reproductive system malignancies were lower, but their age-standardized incidence

rates have risen rapidly in recent years, with increases far exceeding global levels (Table 1, Figure 1).

**Table 1** Incidence, prevalence, and mortality of cervical cancer, uterine cancer, and ovarian cancer globally and in China in 1990 and 2019, and change trends from 1990 to 2019

**Figure 1** [Figure 1: see original paper] Changes in incidence, prevalence, and mortality of cervical cancer, uterine cancer, and ovarian cancer in China from 1990 to 2019. A. Incidence; B. Prevalence; C. Mortality

**Age-Specific Incidence, Prevalence, and Mortality** Compared with 1990, the peak incidence age for cervical cancer in China shifted from 70-74 years (27.61/100,000) to 55-59 years (29.83/100,000), while the mortality peak shifted from 85-89 years (31.99/100,000) to 95+ years (32.43/100,000). For uterine cancer, the peak incidence age remained at 55-59 years, but the rate increased from 19.57/100,000 to 23.90/100,000, while the mortality peak shifted from 80-84 years (13.84/100,000) to 95+ years (9.63/100,000). For ovarian cancer, the peak incidence age shifted from 85-89 years (7.85/100,000) to 70-74 years (16.59/100,000), and the mortality peak shifted from 85-94 years (10.37/100,000) to 90-94 years (15.90/100,000).

**Table 2** Changes in incidence and mortality of cervical cancer, uterine cancer, and ovarian cancer among different age groups in China in 1990 and 2019

**Disease Burden Changes for Cervical, Uterine, and Ovarian Cancers in China and Globally** In 2019, DALYs for cervical, uterine, and ovarian cancers among Chinese women were 1.6222 million, 364,300, and 832,600 person-years, respectively, representing increases of 89.66%, 9.71%, and 208.14% compared with 1990. The increases for cervical and ovarian cancers exceeded global growth levels, while uterine cancer's increase was lower than global levels (Table 3 ). China's DALYs for cervical and ovarian cancers showed annual increases from 1990-2019, while uterine cancer DALYs increased annually from 1990-2009, began declining after 2009, and rose again from 2016 to present (Figure 2 [Figure 2: see original paper]).

**Table 3** Changes in the burden of cervical cancer, uterine cancer, and ovarian cancer globally and in China from 1990 to 2019

**Figure 2** [Figure 2: see original paper] Changes in the disease burden of cervical cancer, uterine cancer, and ovarian cancer in China from 1990 to 2019. A. DALY: Disability-adjusted life years; B. YLL: Years of life lost due to premature mortality; C. YLD: Years lived with disability

**Age Distribution of Disease Burden** From 1990-2019, DALYs, YLLs, and YLDs for cervical, uterine, and ovarian cancers increased across all age groups to varying degrees. In 2019, DALY rates peaked at 506.33/100,000 for cervi-

cal cancer at ages 55-59, 133.12/100,000 for uterine cancer at ages 60-64, and 310.47/100,000 for ovarian cancer at ages 65-69.

Compared with 1990, DALY and YLL rates for cervical and uterine cancers decreased among women aged 20-59 in 2019. In contrast, ovarian cancer DALY and YLL rates in 2019 were higher than 1990 levels across ages 35-95, particularly doubling at ages 65-69. Except for the 85-89 age group for cervical cancer and 90-95 age group for uterine cancer, YLD rates for all three cancers were higher in 2019 than in 1990 across other age groups (Table 4, Figure 3).

**Table 4** Disease burden of cervical cancer, uterine cancer, and ovarian cancer in different age groups in China in 1990 and 2019

**Figure 3** [Figure 3: see original paper] DALY changes in cervical cancer, uterine cancer, and ovarian cancer globally and in China from 1990 to 2019. A. China; B. Global

**Risk Factor Changes for Cervical, Uterine, and Ovarian Cancers in Chinese and Global Women** According to GBD database statistics, risk factors for cervical cancer include smoking and risky sexual behavior; for uterine cancer, high body mass index (BMI); and for ovarian cancer, high BMI, high blood glucose, and occupational asbestos exposure.

Compared with 1990, global DALY rates attributable to smoking and risky sexual behavior for cervical cancer decreased by 28.73% and 0.14%, respectively, while China's rates increased by 45.36% and 55.93%. Global DALY rates for uterine cancer attributable to high BMI increased by 45.07%, while China's increased by 94.62%. For ovarian cancer, global DALY rates attributable to high BMI, high blood glucose, and occupational asbestos exposure increased by 62.92%, 93.46%, and 1.38%, respectively, while China's rates increased by 482.93%, 253.59%, and 162.79%. The increases in attributable DALY rates for all three cancers in China far exceeded global growth levels (Table 5).

**Table 5** Attributed DALY changes in risk factors for cervical cancer, uterine cancer, and ovarian cancer globally and in China in 1990 and 2019

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## Discussion

The GLOBOCAN 2020 global cancer epidemiology database assessment showed [6] that new cases of cervical, uterine, and ovarian cancers reached 604,100, 417,400, and 314,000, respectively—trends similar to the global statistics in this study. According to 2023 data from China's National Cancer Center [7], in 2016, new cases of cervical and uterine cancers among urban and rural Chinese women were 119,300 and 71,100, respectively, with age-standardized incidence rates of 11.34/100,000 and 6.64/100,000, ranking 6th and 8th among female malignant tumors in urban and rural China. Cervical and ovarian cancer deaths numbered 37,200 and 27,200, respectively, with age-standardized mortality rates

of 3.36/100,000 and 2.45/100,000, ranking 8th and 9th among female malignant tumor deaths. In recent years, the age-standardized incidence rates of all three cancers have risen rapidly, with increases far exceeding global levels.

This study found that cervical, uterine, and ovarian cancers have different peak incidence ages and risk factors. The high-incidence age for cervical cancer shifted from 70-74 years (27.61/100,000) in 1990 to 55-59 years (29.83/100,000) in China. Uterine cancer's high-incidence age remained at 55-59 years, with both cancers occurring predominantly during menopause. Ovarian cancer's peak incidence shifted from 85-89 years (7.85/100,000) in 1990 to 70-74 years (16.59/100,000), also occurring mainly post-menopause.

Risk factor analysis revealed that cervical cancer stems primarily from behavioral risk factors, including smoking and risky sexual behavior. Risky sexual behavior leading to HPV infection is the cause of nearly all cervical cancers, with only 5-10% of cervical adenocarcinomas being unrelated to HPV infection [1]. Vaccarella et al. [8] suggested that the younger trend in cervical cancer incidence may result from persistent HPV infection due to high-risk sexual behavior, with studies showing [9] that high-risk HPV strains 16, 18, 31, and 33 have potential carcinogenicity. Tobacco's harmful substances can impair female immune function and increase HPV infection risk [10-12], making both active and passive smoking risk factors for cervical cancer.

Many high-income countries currently have widespread HPV vaccination, which effectively prevents HPV infection-related cervical cancer [13]. China is actively promoting HPV vaccination while employing cervical cytology for screening, and the combination of screening and vaccination can effectively reduce cervical cancer incidence and mortality.

This study identified metabolic risk factors, primarily high BMI, as the main risk factor for uterine cancer. American Cancer Society research indicates [14] that obesity or overweight is an important risk factor for uterine cancer, with each 5 $kg/m^2$ increase in BMI raising uterine cancer risk by approximately 50%. However, the relationship is not linear—higher BMI increases risk more rapidly, with BMI of 30, 35, and 40 $kg/m^2$ carrying approximately 2, 4, and 13 times the risk of BMI 20 $kg/m^2$ [15]. Evidence shows [16] that physical activity can effectively reduce uterine cancer risk, suggesting that appropriate exercise and reasonable diet to maintain healthy BMI may lower risk. Wilson et al. [17] demonstrated that if the proportion of overweight/obese women in Australia decreased by 10% annually over 10 years, uterine cancer incidence would be reduced by 11-18% within 25 years.

Although uterine cancer incidence rates in 2019 exceeded 1990 levels across ages 20-74 in China, mortality rates decreased significantly in all age groups. This may be because uterine cancer has obvious early clinical symptoms, and enhanced health awareness enables earlier medical consultation, leading to earlier diagnosis and reduced mortality. The 2019 YLD rates increased across age groups, while YLL rates decreased compared with 1990, ultimately resulting in

lower DALY rates, which supports this interpretation.

Compared with cervical and uterine cancers, ovarian cancer has lower incidence but higher mortality, representing the eighth most common cause of cancer death among women globally [1]. This may be due to ovarian cancer's subtle early clinical symptoms, leading to late diagnosis and delayed effective treatment. China Cancer Registry Annual Report data [18] show that in 2017, ovarian cancer ranked 11th in female cancer incidence spectrum, accounting for 2.89% of new female cancer cases, but 9th in female cancer death spectrum, accounting for 2.78% of female cancer deaths, with a continuing upward trend [19]. Therefore, effective measures for early detection and prevention are essential.

This study's results show that ovarian cancer risk factors are primarily metabolic and occupational, including high BMI, high blood glucose, and occupational asbestos exposure. Asbestos is a Group 1 carcinogen, and occupational asbestos exposure increases risk for multiple cancers; applying talc containing asbestos to the genital area significantly increases ovarian cancer risk [20]. Cabasag et al.'s birth cohort study [21] identified obesity as a risk factor for ovarian cancer, as it raises estrogen levels, causing ovarian overstimulation and increasing risk. However, the Ovarian Cancer Association Consortium study [22] suggested that while obesity may increase risk for less common histological subtypes, it does not increase risk for common types. In this study, incidence rates across ages 30-84 in 2019 increased substantially compared with 1990, doubling in the 60-79 age group. This may be related to rising BMI due to socioeconomic development, dietary changes, psychological stress, and reduced physical activity, particularly evident among middle-aged and elderly women [23]. Additionally, because ovarian cancer onset is insidious, YLL rates increased significantly while YLD rates increased modestly across age groups, resulting in markedly elevated DALY rates.

In summary, cervical, uterine, and ovarian cancers pose serious threats to Chinese women's health. Prevention and control strategies should be tailored according to their distinct risk factors and age patterns. The government should strengthen workplace environment supervision in asbestos-processing industries, reduce environmental asbestos fiber concentrations, enhance operational protection, minimize occupational exposure, increase public education on all three cancers, improve screening and vaccination willingness, avoid high-risk sexual behavior, enhance public health awareness, advocate smoking cessation, and maintain healthy body weight.

This study utilized GBD database data, conducting statistical analysis only for China as a whole. Due to China's unbalanced and insufficient development, significant regional differences exist across provinces, representing a limitation of this study. Future research will employ China Cancer Registry data for further investigation.

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*Note: Figure translations are in progress. See original paper for figures.*