

Quantification of the HPV-Attributable Cancer Mortality in Greece: Years of Life Lost and Productivity Costs

Background and objectives

• HPV-related cancers are estimated to account for approximately 5% of cancers worldwide. It is the primary etiological agent of cervical cancer and contributes significantly to anal, vaginal, vulvar, penile, and oropharyngeal cancers¹.

• In Greece, 63,176 new cancer cases and 34,730 cancer-related deaths were reported in 2022². While the incidence rate was slightly below the EU average (604 vs. 614 cases per 100,000; -1.6%), the mortality rate was higher (308 vs. 289 deaths per 100,000;+6.5%)². **Despite HPV-attributable cancers contributing significantly to this burden, the HPV-attributable cancer burden and its impact have not been yet quantified in Greece.**

• **Quantifying the burden of HPV-attributable cancer mortality and the associated productivity losses is essential to inform evidence-based cancer prevention strategies, including HPV vaccination.**

• **This study aims to estimate the epidemiological burden and societal economic impact of premature mortality from HPV-related cancers in Greece.**

Methods

Description of the tool

• A previously published model³ was adapted to estimate the epidemiological and economic burden of premature mortality from HPV-related cancers in Greece. The model included individuals with cancer who died from 9 cancers related to HPV in 2022, as indicated by International Classification of Diseases (ICD)-10 codes: oral cavity (C02-06), oropharynx (C01, 09,10), cervical (C53), vulva (C51), vaginal (C52), anal (C21), penile (C60), nasopharynx (C11) and Larynx (C14).

• The number of HPV-attributable deaths, YLL, years of productive life lost (YPLL), and the present value of future lost productivity (PVFLP) were estimated, using a published HPV-attributable fraction (AF). AF were derived from Hartwig et al., who provided site-specific estimates for the proportion of cancer deaths attributable to HPV infection⁴.

• For each HPV-related cancer type, the model applied the corresponding attributable fraction to the total number of deaths to estimate the number of HPV-attributable deaths.

• Using age and sex-specific mortality data, the YLL was calculated by subtracting the midpoint age of death in each age group (15-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70+ years old) from the standard life expectancy.

• YPLL were calculated from the midpoint age to retirement age, adjusted using labor force participation rates. It was assumed that individuals remained economically active until retirement, and that economic activity ceased.

Model calculations

• For the calculation of YLL, YPLL, and PVFLP, the model estimated the projected remaining years of life, had the person not died from cancer, and anticipated remaining productive years as outlined below:

$$Expected\ life\ years\ remaining_i = (life\ expectancy) - (mid\ point\ of\ age\ category)_i$$
$$Expected\ productive\ life\ years\ remaining_i = (retirement\ age) - (mid\ point\ of\ age\ category)_i$$

Where $i = 1,2,3 \dots n$ represent the population age groups utilized in the model, with n denoting the total number of age categories.

$$YLL = \sum_{i=1}^I (number\ of\ cancer\ deaths)_i * (expected\ life\ years\ remaining)_i * (cancer\ specific\ attributable\ fractions)$$
$$YPLL = YLL * \frac{(expected\ productive\ life\ years\ remaining)_i}{(expected\ life\ years\ remaining)_i} * labor\ force\ participation_i$$

Where $i = 1,2,3 \dots n$ were population age groups used in the model.

Model calculations (cont')

$$PVFLP/person = \sum_{i=1}^T (Discounted\ expected\ productive\ life\ years\ remaining_i) * (annual\ earning)_i * (labor\ force\ participation)_i$$
$$PVFLP\ per\ country = \sum_{i=1}^I (PVFLP\ per\ person)_i * (number\ of\ deaths)_i * (cancer\ specific\ attributable\ fractions)$$

Data Sources

• Cancer mortality data by age group and cancer site were obtained from GLOBOCAN for the year 2022⁵. Life expectancy and retirement age information were sourced from World Bank dataset⁶. Labor force participation rates were extracted from World Bank datasets⁷, while annual average earnings, disaggregated by age, sex, and country, were also obtained from Eurostat⁸. These inputs were combined to reflect the demographic and economic context of Greece for the model calculations.

Results

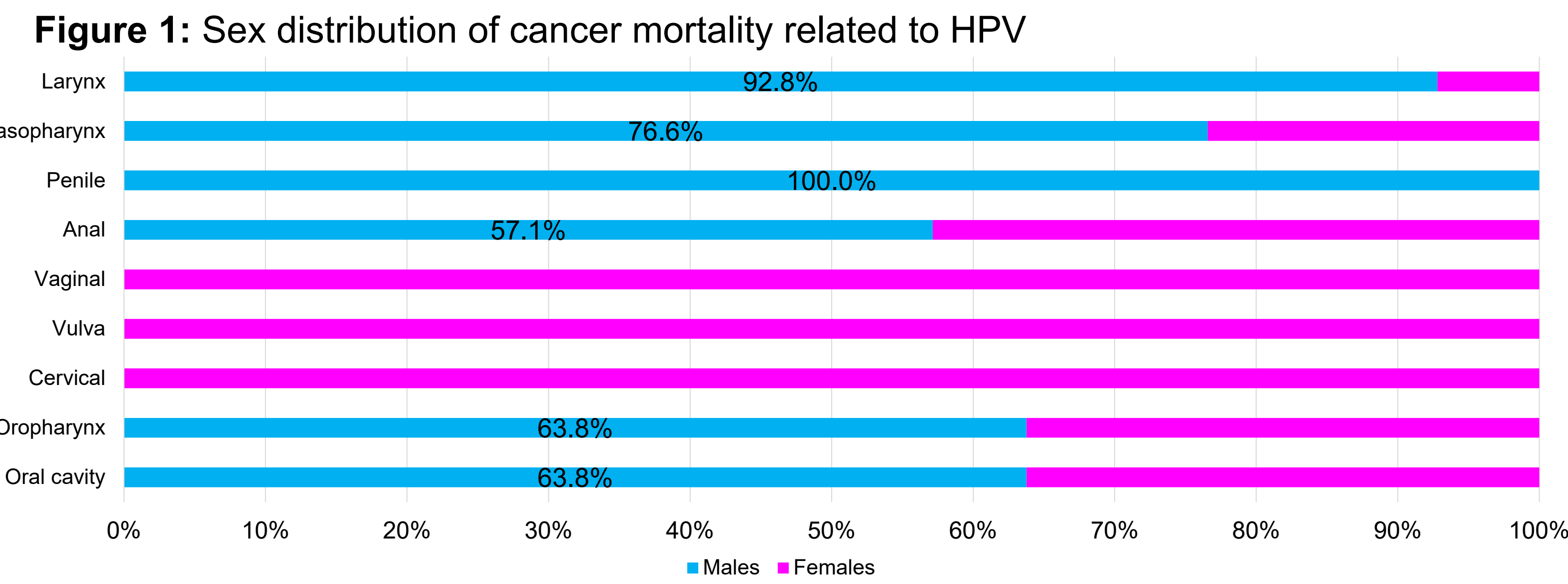
• In 2022, a total of 1,313 deaths were recorded in Greece from the 9 cancer types associated with HPV. After applying site-specific HPV-attributable fractions, **an estimated 443 of these deaths were attributable to HPV infection (Table 1). This corresponds to more than 1.2 HPV-related cancer deaths per day.**

• Although cervical cancer accounted for the majority of HPV-attributable cancer deaths, with 268 deaths (60.5% of the total HPV-related cancer mortality), virginal and anal cancer are also contributed significantly, accounting for 13.1% and 9.7% of HPV-related cancer deaths, respectively (Table 1).

Table 1: Quantification of cancer related mortality in Greece

Cancer subtype	Number of deaths ⁵	Attributable fractions (HPV) ⁴	Deaths attributed to HPV cancer mortality	Percentages of total HPV related deaths
Cervical	268	100.0%	268	60.5%
Vulva	92	15.9%	15	3.4%
Oral cavity	172	3.7%	6	1.4%
Oropharynx	89	19.9%	18	4.1%
Nasopharynx	111	10.8%	12	2.7%
Larynx	403	2.4%	10	2.3%
Vaginal	83	70.2%	58	13.1%
Anal	49	87.1%	43	9.7%
Penile	46	29.0%	13	2.9%
Total	1,313		443	

• **It is important that for certain cancers, such as anal, larynx, nasopharynx or oropharyngeal cancers, the mortality burden among males was higher than among females (Figure 1).**



Years of Life Lost, Years of Productive Life Lost and Economic impact

• The YLL in 2022 in Greece due to premature mortality from HPV cancer related deaths was estimated **at 6,388 YLL, with 5,5659 to affect females (Table 2)**. The YLL per death was estimated at 16.0 years, with cervical cancer to cause the loss of 18.3 years

• **In terms of productivity, the total number of YPLL was estimated at 1,813, with 1,576 affecting females (Table 2)**. The average YPLL per death was estimated at 5.5 years, with cervical cancer responsible for 6.7 productive years lost per case.

Gountas Ilias¹, Skroumpelos Anastasios¹, Trimis Georgios¹, Sabale Ugne², Karokis Antonis¹

- MSD Greece,
- Value & Implementation Outcomes Research, MSD, Stockholm, Sweden

Table 2: YLL and YPLL related to HPV, by cancer type and by sex

	YLL			YPLL		
Cancer subtype	Male	Female	Total	Male	Female	Total
Cervical	0	4536	4536	0	1373	1373
Vulva	0	116	116	0	4	4
Oral cavity	43	34	77	15	9	24
Oropharynx	123	92	214	42	24	66
Nasopharynx	101	40	141	32	10	41
Larynx	82	9	91	21	2	23
Vaginal	0	580	580	0	84	84
Anal	266	252	519	95	71	168
Penile	114	0	114	30	0	30
Total	729	5,659	6,388	236	1,576	1,813

• **The PVFLP due to premature HPV-related cancer deaths was estimated at €24.6 M in 2022.** Of this, €21.5M was attributed to females and €3.1M to males.

• The PVFLP/deaths was estimated at €55,674.

Limitations

• The HPV-attributable fractions used in the model were drawn from international literature potentially limiting national precision and potentially outdated data..

• The analysis focused solely on productivity losses and did not account for direct medical cost to treat cancers.

•The model assumed full labor force participation until a fixed retirement age, without accounting for early retirement, part-time work, or informal employment

• The study offers a cross-sectional snapshot based on 2022 data and does not model future trends or vaccination impact over time.

Discussion

• **This study provides the first national estimate of the epidemiological and societal economic burden of HPV-related cancer mortality in Greece.**

• In 2022, an estimated 443 cancer deaths were attributable to HPV infection, corresponding to more than 1 HPV-related cancer deaths per day. Due to the long latency between HPV infection and cancer development, current mortality patterns reflect exposure occurring many years earlier.

• Despite the substantial mortality burden, in Greece, the impact of HPV-related cancers has been overlooked in public health discussions.

• These findings highlight the urgent need to support and expand HPV vaccination, scale up screening programs, and adopt targeted public health policies to reduce HPV transmission and associated cancer outcomes.

References

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Disclosures

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Contact Information

Dr. Ilias Gountas (ilias.gountas@merck.com)