Vaccine 70 (2026) 128026

Contents lists available at ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

HPV vaccination coverage among children and adolescents in Greece using national prescription data

Kalliopi Doulou [a], Flora Bacopoulou [b], Athanasios Michos [c], Anastasios Tsolakidis [d,e], Kostas Mathioudakis [d], Dimitris Zografopoulos [f], Georgia Kourlaba [g,*]

[a] Msc in General Pediatrics and Pediatric Subspecialties: Clinical Practice and Research, Department of Medicine, National and Kapodistrian University of Athens, Athens 115 27, Greece
[b] Center for Adolescent Medicine and UNESCO Chair in Adolescence Health Care, First Department of Pediatrics, School of Medicine, National and Kapodistrian University of Athens, Aghia Sophia Children's Hospital, 11527 Athens, Greece.
[c] First Department of Pediatrics, School of Medicine, National and Kapodistrian University of Athens, Agia Sofia Children's Hospital, 11527 Athens, Greece.
[d] IDIKA SA - e-Government Center for Social Security Services, Athens 10551, Greece
[e] Department of Archival, Library and Information Studies, University of West Attica, Egaleo 12243, Greece
[f] Ministry of Health, Athens, Greece
[g] Department of Nursing, National and Kapodistrian University of Athens, 11527 Athens, Greece.

ARTICLE INFO

Keywords:
Human papillomavirus
Cervical cancer
HPV
Vaccination coverage
Adolescents
Children

ABSTRACT

Background: To eradicate cervical cancer, the World Health Organization (WHO) targets 90 % human papillomavirus (HPV) vaccination coverage in girls by the age of 15 until 2030. In Greece, data regarding how close the country is to meeting this target, is completely lacking.
Objectives: To assess annual HPV vaccination coverage among individuals aged 9–15 years in Greece (2022–2024).
Methods: This is a retrospective, population-based cohort study using the Greek National Electronic Prescription Database to record all HPV vaccine doses dispensed from 1/1/2019 to 31/12/2024. The annual vaccination coverage was estimated as the proportion of eligible population receiving at least one dose or the full vaccination scheme from January 1st, 2019, through December 31st of the respective reference year. Full vaccination scheme by age 15 was defined – according to national recommendations - as two doses at a minimum interval of 6 months.
Results: From 2022 to 2024, the proportion of individuals 9–15 years old, who appropriately initiated vaccination increased from 34.7 % (2022) to 41.4 % (2024) in girls and from 10.8 % (2022) to 31.4 % (2024) in boys. The proportion of children who initiate HPV vaccination at the age of 9, increased from 3.5 % and 3.4 % in 2022 to 8.0 % and 7.4 % in 2024 in girls and boys respectively. Among girls turning 15, appropriate vaccine initiation rate marginally exceeded 63.0 % throughout the study period while full vaccination coverage increased from 47.7 % in 2022 to almost 52.5 % in 2024.
Conclusion: Despite notable improvements in HPV vaccination uptake among adolescents in Greece between 2022 and 2024, coverage levels remain suboptimal relative to the WHO's 90 % target. Limited early initiation despite national recommendations starting at age 9, highlight the need for targeted strategies to promote timely HPV vaccination and accelerate progress toward elimination goals.

1. Introduction

The human papillomavirus (HPV) is the most common sexually transmitted infection of the reproductive tract. The 70–90 % of the HPV infections remain asymptomatic and resolve spontaneously within 1–2 years. However, persistent infection with high-risk HPV strains is responsible for the development of precancerous lesions in both men and women, which if not detected and managed in time, may progress to

* Corresponding Author at: Public Health Nursing-Prevention, Department of Nursing, National and Kapodistrian University of Athens, Papadiamantopoulou 123 Str, 115 27 Athens, Greece.
E-mail address: kurlaba@nurs.uoa.gr (G. Kourlaba).

https://doi.org/10.1016/j.vaccine.2025.128026
Received 8 September 2025; Received in revised form 21 November 2025; Accepted 21 November 2025
Available online 26 November 2025

invasive malignancies in the affected areas. In women, 91 % of HPV-related cancers concern cervical cancer, which according to the World Health Organization (WHO), ranks as the fourth most common cancer in terms of incidence and mortality and as such it is considered a significant public health issue [1]. In fact, in 2022, it was estimated that there were 662.301 new cases of cervical cancer and 348.874 related deaths (9th cause of cancer deaths in both sexes), worldwide [2]. According to WHO department of data and analytics of June 2024, in Greece in 2021 there was a crude death rate of 2.5 deaths per 100.000 population by cervical cancer [3]. Moreover, in a nationwide observational cross-sectional study conducted in Greece, the Grecoself study, data by self-sample examination of HPV-DNA of 12.787 women showed that hrHPV prevalence was 8.3 % and high-grade cervical/vaginal disease or cancer prevalence was 0.6 % [4]. Beyond cervical cancer, HPV is also implicated in the development of anal, vulvar, penile, head and neck cancers—particularly oropharyngeal cancer—in both women and men. Additionally, the virus causes benign lesions of the skin and mucous membranes of the anogenital region, commonly known as genital warts [1].

HPV vaccination has been in use since 2006, and all HPV vaccines (HPV4/9/2) have been proven safe and highly effective in reducing the incidence of HPV-related diseases [1]. It has significantly decreased the incidence of cervical cancer and genital warts. The most substantial benefits have been observed among girls vaccinated prior to exposure to the virus [5,6]. As part of its global initiative to eradicate cervical cancer as a public health threat, the WHO targets 90 % HPV vaccination coverage in girls by the age of 15 until 2030 [7]. Vaccination could be administered with all currently licensed bivalent, quadrivalent, and nonavalent HPV vaccines. It is estimated that this strategy, if implemented, will prevent 60,000 new cases of cervical cancer and 45,000 related deaths over the next 100 years.

In recent years, many countries have integrated HPV vaccination into their National Immunization Programs (NIPs), targeting primarily adolescent girls and, increasingly, boys. In Greece, HPV vaccination was introduced in 2008, initially targeting girls aged 11–15 with a two-dose schedule. Girls aged 15–26 were eligible for catch-up vaccination with three doses. In 2019, the recommended vaccination age was adjusted to 11–12 years, while the upper age limit for catch-up- vaccination was revised to 18 years. From March of 2022, boys were also added to the eligible population, and the recommended vaccination age was adjusted to 9–11 years, while catch-up eligibility remained up to 18 years of age. The standard vaccination schedule consists of two doses administered six months apart. The bivalent, quadrivalent, and nonavalent vaccines have been used, with the nonavalent vaccine (HPV9) becoming predominant since March 2022 [8].

Monitoring the vaccination coverage of a population is of major importance for informing public health strategies aiming at improving vaccine uptake. Despite the free of charge availability of the vaccine for eligible age groups, concerns have been raised regarding suboptimal uptake since a recently published systematic review revealed that the global HPV vaccination coverage remains significantly below the target of 90 % [9]. Factors such as vaccine hesitancy, limited awareness, socioeconomic barriers, and gaps in primary care engagement may all contribute to the observed trends [10–13].

To the best of our knowledge, there is a lack of published data in Greece regarding HPV vaccination coverage and how close the country is to meeting the 2030 WHO's target. Most existing studies focus on public and healthcare professionals' knowledge and attitudes toward the vaccine [10–15]. Therefore, a comprehensive and systematic recording of HPV vaccination coverage is deemed necessary and as such the objective of this study is to assess the annual HPV vaccination coverage among children and adolescents aged 9–15 years in Greece during the period 2022–2024, and to assess differences by age and sex, based on cumulative vaccine uptake from January 1st, 2019 through the end of each reference year. The findings of the study are intended to support evidence-based policy decisions and contribute to the broader effort toward prevention of cervical cancer.

2. Material and methods

2.1. Study design and setting

This is a retrospective, population-based cohort study using the Greek National Electronic Prescription Database, which runs under surveillance of IDIKA S.A., on behalf of the Greek Ministry of Health. All drugs prescribed through IDIKA's system are reimbursed by the National Organization for the Provision of Health Services (EOPYY), the largest national health-care provider, reimbursing health expenses for almost the entire Greek population. In Greece, an individual needs the Social Security Number (AMKA), which is essential for identification and access to electronic prescribing services, to receive an electronic prescription.

To serve the objective of the present study, all electronic prescriptions classified under the Anatomical Therapeutic Chemical (ATC) codes: J07BM03 Gardasil® 9 (HPV types 6, 11, 16, 18, 31, 33, 45, 52, 58), J07BM01 Gardasil® (HPV types 6, 11, 16, 18), and J07BM02 Cervarix® (HPV types 16, 18), during the period 1/1/2019 to 31/12/2024 (data capturing period), were initially extracted from IDIKA's system.

Moreover, to estimate the total eligible population for HPV vaccination, data was obtained from the national AMKA registry, which includes all individuals with active health coverage in the country.

Permission to use anonymized data was obtained by the Ministry of Health, in accordance with the national legislation on the Protection of Individuals with regards to the Processing of Personal. The protocol of the study was approved by the Ethics Committee of the Medical School of National and Kapodistrian University of Athens (registration number 1057/30.06.2025) and the research was conducted according to the 1964 Declaration of Helsinki and its later amendments.

2.2. Study population

Although vaccination data was available for the period 1/1/2019–31/12/2024, analyses focused on the population of males and females aged 9–15 years as of December 31 of each calendar year from 2022 to 2024, registered in the AMKA national registry before the age of 9. During this period, the revised NIP was fully in effect and data can be considered complete. For annual cross-sectional analyses, children and adolescents were grouped into seven dynamic age-defined cohorts, consisting of individuals born in the seven consecutive years corresponding to ages 9 through 15 (birth cohorts), for each reference year (2022, 2023, 2024). For example, the study population of 2022 included individuals born between 2007 and 2013, while the corresponding population of 2023 included those born between 2008 and 2014, respectively.

Each annual distinct age-defined cohort was assessed longitudinally, and vaccination status at each reference year was determined cumulatively based on all HPV vaccine doses received from 1st January of 2019 up to and including December 31st of the respective reference year. Since the IDIKA database does not contain information on the actual administration of the vaccine, the prescription execution date was used as a proxy.

2.3. Data collection

The following data were extracted for each prescription: month and year of children's birth, sex, ATC code, prescription issuance and execution date. The following variables were analyzed from the National AMKA Registry: place of birth and residence: municipality, region, country, and AMKA issuance date.

2.4. Definitions and outcomes

Individuals aged 9–15 years, during the period 2022–2024, were considered to have appropriately initiated HPV vaccination if they had received at least one dose of the HPV vaccine from January 1st, 2019, through December 31st of the respective reference year. However, for the reference year in which an individual turned 15, vaccination initiation was considered appropriate only if the first dose was received before the month of their 15th birthday, according to the WHO target for full HPV vaccination by age 15 [7]. This criterion also aligns with the NIP, which recommends a two-dose schedule only when the series is initiated prior to age 15.

According to the Greek NIP, an individual was considered fully vaccinated by age 15 in a given reference year if they had received two HPV vaccine doses at least 6 months apart (operationalized as a minimum of 5 months between the execution dates of the first- and second-dose prescriptions), with the first dose administered before the month of their 15th birthday and the second dose administered on or before December 31 of the reference year, regardless of the year of initiation [8].

2.5. Statistical analysis

Absolute (n) and relative frequencies (%) were used to summarize coverage rates. At each reference year, the HPV vaccination coverage was calculated, by sex and age, separately for: a) appropriate initiation of vaccination, and b) full vaccination. Coverage was expressed as the proportion of individuals in the corresponding age-defined cohort who met the criteria for each vaccination status, as described above. Subgroup analyses were conducted for individuals born in Greece and those born in other countries. For the assessment of possible trends for vaccination across the years, the Jonckheere–Terpstra test [16] was used, while possible differences in the percentage of vaccination between residence regions were assessed using the Pearson's Chi-squared test. Moreover, maps were generated using R v.4.2.0 and packages "sf", "ggplot2" and "dplyr". And other analyses were conducted using STATA v.17.

3. Results

3.1. Total eligible population for HPV vaccination

During the study period (2022–2024), the eligible population for HPV vaccination fulfilling the inclusion/exclusion criteria, as mentioned above, was children born between 2007 and 2015 and ranged between 115,095 in 2007 and 105,739 in 2015. Most of the study population was born in Greece with this figure showing slight decrease over time (from 95.7 % in birth cohort of 2007 to 86.9 % in birth cohort of 2015) (Table 1). The ~10 % decline in the eligible adolescent population across successive birth cohorts reflects the well-documented contraction in annual live births in Greece after 2008, resulting in smaller cohorts entering adolescence during our study window [17].

3.2. HPV appropriate initiation of vaccination by year, sex and age

From 2022 to 2024, the proportion of individuals who appropriately initiated vaccination (i.e. at the age of 9 to <15) progressively increases for both sexes, with girls consistently exhibited higher vaccination coverage than boys across all study years (p for trend < 0.001, Fig. 1, Table S1). To be more specific, appropriate vaccination initiation (coverage with at least one dose) increases from 34.7 % (2022) to 41.4 % (2024) in girls and from 10.8 % (2022) to 31.4 % (2024) in boys (Fig. 1, Table S1). Focusing on the sub-population of children aged 9–11 years – the recommended age for HPV vaccination based on the revised NIP- it seems that vaccination initiation rates are consistently low throughout the study period, ranging from 8.1 % in 2022 to 18.6 % in 2024 (p for trend < 0.001) in girls and from 6.6 % (2022) to 16.6 % (2024) in boys (p for trend < 0.001).

Table 1
The eligible population for HPV vaccination fulfilling the inclusion/exclusion criteria of our study during the period 2022–2024.

	Birth year								
	2007	2008	2009	2010	2011	2012	2013	2014	2015
Sex	**N = 115,095**	***N* = 121,817**	**N = 122,451**	***N* = 119,347**	***N* = 113,017**	***N* = 110,792**	***N* = 105,665**	**N = 105,287**	**N = 105,739**
Male	59,407 (51.6 %)	62,464 (51.3 %)	62,934 (51.4 %)	61,232 (51.3 %)	58,079 (51.4 %)	56,961 (51.4 %)	54,553 (51.6 %)	54,229 (51.5%)	54,536 (51.6 %)
Female	55,688 (48.4 %)	59,353 (48.7 %)	59,517 (48.6 %)	58,115 (48.7 %)	54,938 (48.6 %)	53,831 (48.6 %)	51,112 (48.4 %)	51,058 (48.5 %)	51,203 (48.4 %)
Birth Country*	***N* = 115,090**	**N = 121,813**	**N = 122,448**	**N = 119,345**	**N = 113,015**	**N = 110,791**	**N = 105,663**	**N = 105,287**	**N = 105,737**
Greece	110,092 (95.7 %)	116,444 (95.6 %)	116,470 (95.1 %)	112,789 (94.5 %)	104,677 (92.6 %)	100,116 (90.4 %)	94,015 (89.0 %)	92,092 (87.5 %)	91,844 (86.9 %)
Other	4998 (4.3 %)	5369 (4.4 %)	5978 (4.9 %)	6556 (5.5 %)	8338 (7.4 %)	10,675 (9.6 %)	11,648 (11.0 %)	13,195 (12.5 %)	13,893 (13.1 %)
Residence Region*	***N* = 114,871**	**N = 121,592**	***N* = 122,183**	**N = 119,076**	***N* = 112,815**	**N = 110,566**	**N = 105,422**	**N = 105,024**	**N = 105,459**
Attica	40,820 (35.5 %)	43,577 (35.8 %)	43,442 (35.6 %)	42,558 (35.7 %)	40,586 (36.0 %)	40,629 (36.7 %)	38,711 (36.7 %)	39,133 (37.3 %)	39,101 (37.1 %)
Central Greece	5062 (4.4 %)	5394 (4.4 %)	5475 (4.5 %)	5260 (4.4 %)	4901 (4.3 %)	4786 (4.3 %)	4580 (4.3 %)	4491 (4.3 %)	4412 (4.2 %)
Central Macedonia	20,442 (17.8 %)	21,362 (17.6 %)	21,501 (17.6 %)	20,821 (17.5 %)	19,698 (17.5 %)	18,871 (17.1 %)	18,161 (17.2 %)	17,500 (16.7 %)	17,582 (16.7 %)
Crete	7732 (6.7 %)	8227 (6.8 %)	8138 (6.7 %)	7904 (6.6 %)	7359 (6.5 %)	7465 (6.8 %)	6939 (6.6 %)	7043 (6.7 %)	7081 (6.7 %)
Eastern Macedonia and Thrace	6208 (5.4 %)	6488 (5.3 %)	6640 (5.4 %)	6421 (5.4 %)	5955 (5.3 %)	5645 (5.1 %)	5489 (5.2 %)	5308 (5.1 %)	5495 (5.2 %)
Epirus	3107 (2.7 %)	3228 (2.7 %)	3440 (2.8 %)	3397 (2.9 %)	3121 (2.8 %)	2974 (2.7 %)	2969 (2.8 %)	2815 (2.7 %)	2859 (2.7 %)
Ionian Islands	2285 (2.0 %)	2525 (2.1 %)	2386 (2.0 %)	2297 (1.9 %)	2242 (2.0 %)	2184 (2.0 %)	2132 (2.0 %)	2122 (2.0 %)	2088 (2.0 %)
North Aegean	2376 (2.1 %)	2492 (2.0 %)	2781 (2.3 %)	2811 (2.4 %)	2891 (2.6 %)	2966 (2.7 %)	2861 (2.7 %)	3172 (3.0 %)	3467 (3.3 %)
Peloponnese	5703 (5.0 %)	5862 (4.8 %)	5883 (4.8 %)	5825 (4.9 %)	5374 (4.8 %)	5301 (4.8 %)	4900 (4.6 %)	4868 (4.6 %)	4727 (4.5 %)
South Aegean	4241 (3.7 %)	4451 (3.7 %)	4577 (3.7 %)	4361 (3.7 %)	4160 (3.7 %)	4251 (3.8 %)	4028 (3.8 %)	4170 (4.0 %)	4138 (3.9 %)
Thessaly	7479 (6.5 %)	7988 (6.6 %)	7884 (6.5 %)	7664 (6.4 %)	7204 (6.4 %)	6700 (6.1 %)	6398 (6.1 %)	6262 (6.0 %)	6353 (6.0 %)
Western Greece	6738 (5.9 %)	7217 (5.9 %)	7244 (5.9 %)	7036 (5.9 %)	6848 (6.1 %)	6341 (5.7 %)	5943 (5.6 %)	5864 (5.6 %)	5953 (5.6 %)
Western Macedonia	2678 (2.3 %)	2781 (2.3 %)	2792 (2.3 %)	2721 (2.3 %)	2476 (2.2 %)	2453 (2.2 %)	2311 (2.2 %)	2276 (2.2 %)	2203 (2.1 %)

* N is different than that of the corresponding N for sex, due to missing data for residence region and birth country.

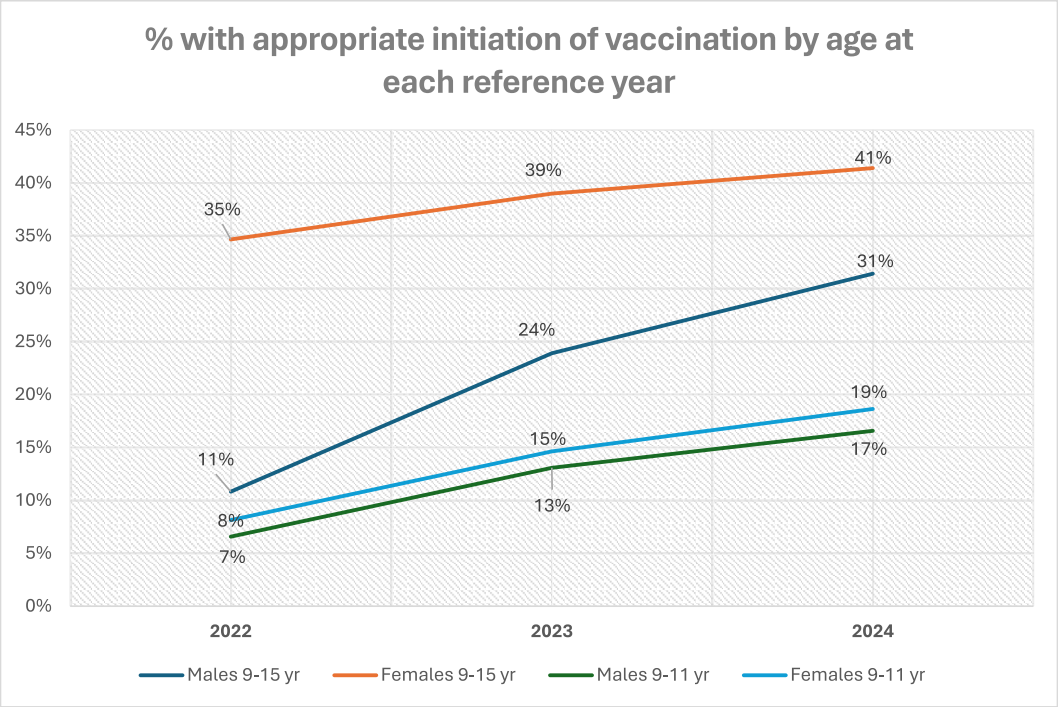

Fig. 1. Percentage of individuals with appropriate initiation of vaccination* each reference year by sex *first dose administered between the age of 9 and the month prior to their 15th birthday P for trend < 0.001 for both males and females, 9–15 yrs. & 9–11 yrs.

Examination of each age-defined cohorts within each reference year revealed that the proportion of children found to initiate HPV vaccination at the age of 9, seems to increase in both sexes moving from 2022 to 2024. To be specific, coverage with at least one dose rose from 3.5 % and 3.4 % in 2022 to 8.0 % and 7.4 % in 2024, in girls and boys, respectively (Fig. 2a & b, Table S1, p for trend < 0.001). Among girls turning 15, the cumulative vaccination rate with at least one dose prior to their 15th birthday (appropriate vaccination initiation) marginally exceed 63.0 % throughout the study period (Fig. 2a, Table S1, p for trend = 0.398). In contrast, among boys, the corresponding figure showed a remarkable increase over time, ranging from 7.6 % (2022) to 38.2 % (2024) (Fig. 2b, Table S1).

Stratified analysis by birthplace (Greece versus other than Greece country) revealed that appropriate vaccination initiation was significantly higher in individuals born in Greece compared to those born in other countries for both males and females aged 9–15 years old across all reference years. For example, appropriate vaccination initiation ranged from 36.3 % (2022) to 44.2 % (2024) in girls aged 9–15 years born in Greece and from 11.0 % (2022) to 11.9 % (2024) in those born in other than Greece countries (Figs. S1 and S2).

Finally, stratified analysis by residence region indicated a great variability on the vaccination initiation with lower percentages detected on North and South Aegean and the higher percentages on Crete ($p <$ 0.001 for both males and females). For example, the appropriate vaccination initiation rate in girls turning 15 ranged from 51.9 % in North Aegean to 72.0 % in Crete in 2024 (Fig. 3, p < 0.001). Similar findings were detected in 2022 and 2023 in girls (p < 0.001 in both years, Fig. 3) and in boys (Fig. S3).

3.3. Full vaccination by year, sex, and age

As for full vaccination rate, the age-specific cohort analysis showed that among girls turning 15, full vaccination coverage increased from 47.7 % in 2022 to 53.1 % in 2023 and 52.5 % in 2024 (p for trend < 0.001), (Table 2). On the other hand, among boys in the same age group a marked increase was observed from 1.0 % in 2022 to 27.7 % in 2024 (p for trend < 0.001) (Table 2).

Focusing on children born in Greece, the full vaccination coverage increased from 48.9 % (2022) to 54.2 % (2024) and from 1.0 % (2022) to 28.7 % (2024) in girls and boys turning 15, respectively. The corresponding figures for children born in countries other than Greece were significantly lower.

Similarly to vaccination initiation, analysis revealed that the percentage of fully vaccinated children and adolescents presents a great variability across the country with lower percentages detected on North and South Aegean and the higher percentages on Crete ($p <$ 0.001 for both males and females). For instance, in 2024, the proportion of fully vaccinated girls by age of 15 ranged between 40.7 % in North Aegean and 61.9 % in Crete (Fig. 4) and in boys from 20.0 % to 32.7 %, respectively (Fig. S4).

4. Discussion

This population-based study is the first one that provides robust estimates of HPV vaccination coverage in Greece, offering critical insights into progress and gaps in vaccine uptake among adolescents aged 9–15 years in Greece, leveraging nationwide prescription data spanning from 2019 to 2024. Our results demonstrate a steady and encouraging increase in both vaccination initiation and full coverage by age 15 between 2022 and 2024, for both sexes, with females consistently exhibited higher vaccination rates than males. However, boys showed a steeper increase, reducing the gender gap over time. Specifically, initiation rate rose from 34.7 % (2022) to 41.4 % (2024) in girls aged 9–15 years, and from 10.8 % to 31.4 % in boys aged 9–15 years. The lower vaccination coverage among boys in Greece is most likely explained by their late inclusion in the NIP, which only began in March 2022. Nonetheless, existing evidence [18] emphasizes the critical importance of vaccinating boys, given their role as a reservoir of HPV genital infection. This underlines the necessity of including males in HPV prevention strategies to reduce HPV-related morbidity and mortality and to achieve the goal of eliminating cervical cancer and other HPV-related diseases.

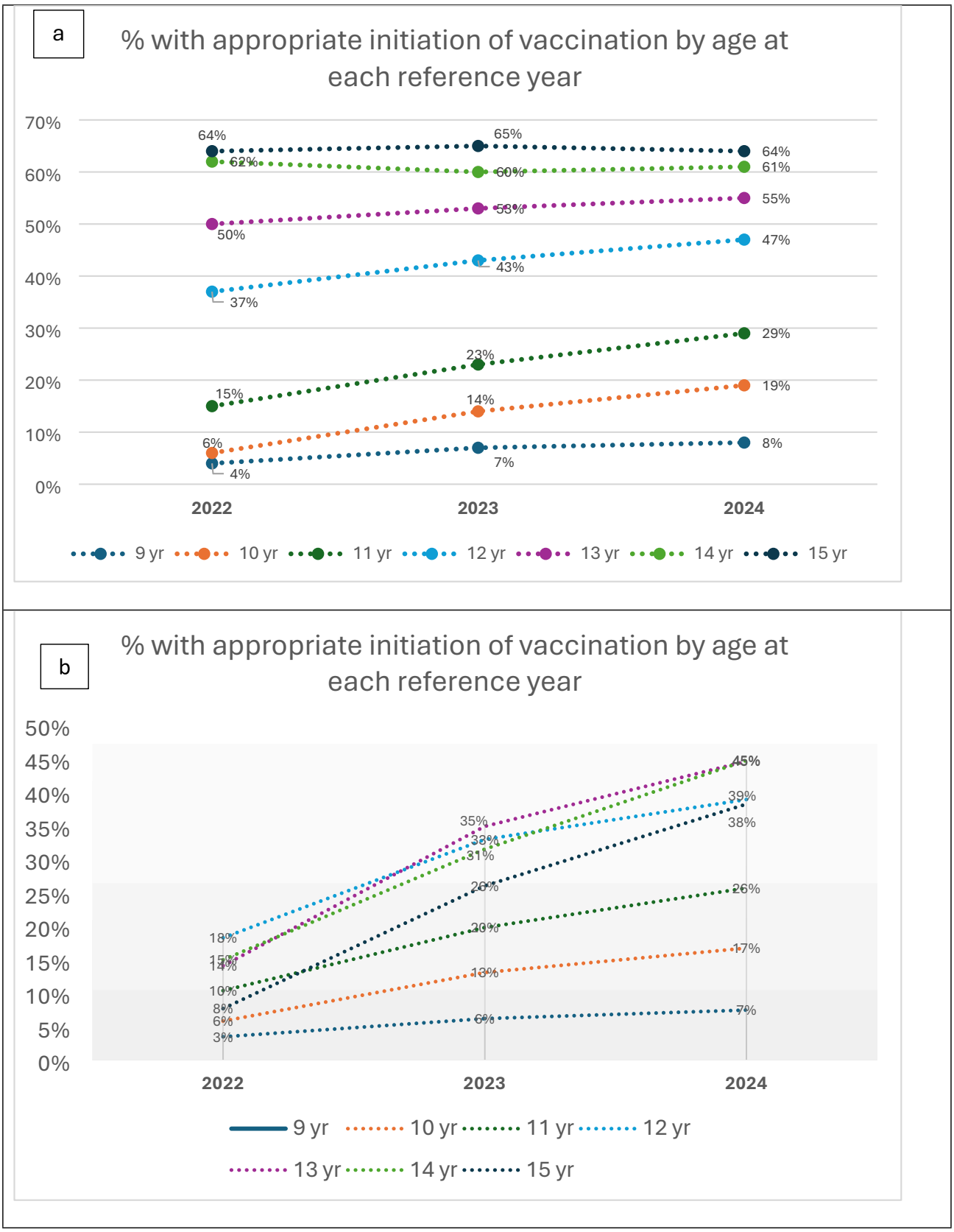

Fig. 2. Percentage of female (a) and male (b) individuals with appropriate initiation of vaccination* each reference year by age. *first dose administered between the age of 9 and the month prior to their 15th birthday P for trend < 0.001 for all age-defined cohorts for both males and females except for females turning 15. Note: Percentages in this figure represent age-specific vaccination initiation rates. These values are not additive across ages and therefore cannot be directly compared or summed to approximate the cumulative coverage for the 9–11 age group shown in Fig. 1, as each age-specific rate is calculated using a different denominator (i.e., the total number of individuals of that specific age in the reference year).

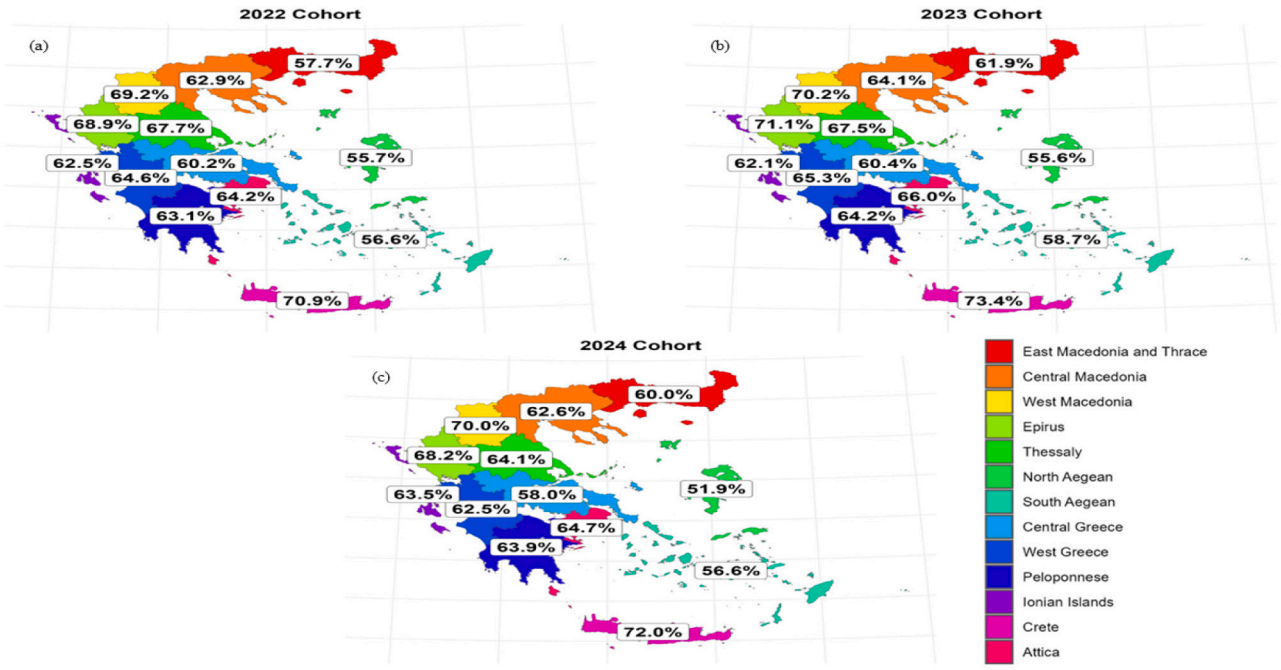

Fig. 3. Percentage of female individuals turning 15* in 2022 (a), 2023 (b) and 2024 (c) with appropriate initiation of vaccination[§], by residence region. * Birth year: 2007 for the 2022 cohort. Birth year:2008 for the 2023 cohort. Birth year: 2009 for the 2024 cohort. [§] first dose administered between 1/1/2019 and the month prior to their 15th birthday.

Stratified analysis by age revealed a clear age-related pattern of HPV vaccine uptake and suggest delayed initiation of vaccination, despite national recommendations promoting initiation from the age of 9. More specifically, in 2024 only 18.6 % of girls and 16.6 % of boys in the recommended initiation age of 9–11 years had received at least one dose. This might be linked to the previous eligibility criteria of the NIP, which had set the recommended age at 11–12 years until March 2022. Moreover, this mirrors patterns observed in other high-income countries, where provider hesitancy and parental concerns drive delays in early vaccination [9,19,20].

The highest coverage consistently observed among older adolescents, reflecting the cumulative nature of the vaccination process. For instance, HPV vaccination initiation by age 15 in girls consistently slightly exceeded 63 %, whereas boys showed a dramatic increase from 7.6 % (2022) to 38.2 % (2024). Full vaccination reached at 52.5 % in 2024 among girls turning 15, while among boys, the corresponding figure was 27.7 %.

When comparing the findings of the present study with those of other WHO member countries, we revealed that HPV vaccination landscape in Greece remains markedly behind. In 2023, in the USA by age 15, 77.0 % of girls and 78.3 % of boys had received at least one dose of HPV vaccination [21]. In Canada, the results from the childhood national immunization coverage survey in 2019 revealed that the coverage with at least one dose was 87.1 % and 73.0 % in 14-year-old girls and boys, respectively [22]. In Australia, in 2021, a total of 80.3 % of girls and 77.2 % of boys had completed HPV vaccination schedule by 15 years of age [23]. Compared to other European countries, data for the estimated HPV vaccination coverage by age 15 for females in 2023, as documented in a recent systematic review [9], indicate that coverage in Greece is, for instance, significantly lower than Scandinavian countries where the target of 90 % has been met, and other Mediterranean countries like Cyprus & Italy (73 %), and Spain (90 %), but similar to Germany (66 %) and higher to France (55 %). These findings indicate that despite the provision of the vaccine free of charge, there is an urgency for designing targeted intervention to enhance adherence with national and international recommendations for HPV vaccination, achieving the 90 % target of the WHO among girls under the age of 15 by the year 2030 [1]. While this study did not directly assess the association between vaccination coverage and HPV-related disease burden, previous research has demonstrated that high vaccination uptake leads to substantial declines in HPV infection, genital warts, and cervical precancer incidence, underscoring the public health impact of achieving high coverage levels [5,24].

In Greece, HPV vaccination is publicly funded but neither school-delivered nor required for school entry, which may contribute to lower coverage. International evidence suggests that school-entry requirements can raise uptake in some U.S. jurisdictions [25,26], while an international comparative review across high-income settings highlights four effective policy families-mandates, provider/system incentives, logistical enablers (including school delivery), and communication-with the caveat that awareness-only approaches show limited, heterogeneous impact and school delivery, though promising, requires careful organization [27]. Given legal constraints on DTC advertising of prescription vaccines in the EU/Greek context, public communication should rely on government-led disease-awareness, while a pilot school-based programme (opt-out) paired with reminder/recall and provider prompts could be a feasible pathway to accelerate initiation and completion in Greece [28–31].

Stratified analysis by residence region and birthplace pronounce geographic and sociodemographic inequalities, with the North and South Aegean islands displaying the lowest coverage rates. This likely reflects the inherent challenges associated with delivering preventive health services to remote and insular populations. Previous studies in Greece have documented significant regional inequalities in access to primary care services, particularly in island or sparsely populated areas, due to limited healthcare infrastructure, difficulty reaching specialized care, and understaffed facilities [32–34]. This finding is aligned with rural-urban gaps in vaccine coverage observed in high-income countries such as the United States [35,36] and with the results of other childhood immunization studies in Greece revealing that children in remote or rural areas are consistently less likely to be fully vaccinated than their urban peers [37]. This finding underscores the urgent need for targeted and equity-oriented interventions, such as mobile health units, and school-based interventions, to ensure that all children/adolescents are

Table 2
Fully and partially vaccinated by reference year, birth year and sex.

Reference Year	Birth Year (age)	Total population	Fully vaccinated according to guidelines	Partially vaccinated according to guidelines
Males			**N (%)**	**N (%)**
2022	2007–2013	415,630	3870 (0.93 %)	41,113 (9.89 %)
	2007 (15 yrs)	59,407	572 (0.96 %)	3963 (6.67 %)
	2008 (14 yrs)	62,464	959 (1.54 %)	8361 (13.39 %)
	2009 (13 yrs)	62,934	763 (1.21 %)	8073 (12.83 %)
	2010 (12 yrs)	61,232	794 (1.30 %)	10,355 (16.91 %)
	2011 (11 yrs)	58,079	489 (0.84 %)	5502 (9.47 %)
	2012 (10 yrs)	56,961	238 (0.42 %)	3047 (5.35 %)
	2013 (9 yrs)	54,553	55 (0.10 %)	1812 (3.32 %)
2023	2008–2014	410,452	44,277 (10.79 %)	53,862 (13.12 %)
	2008 (15 yrs)	62,934	9606 (15.26 %)	6614 (10.51 %)
	2009 (14 yrs)	62,934	9824 (15.61 %)	9966 (15.84 %)
	2010 (13 yrs)	61,232	10,616 (17.34 %)	10,724 (17.51 %)
	2011 (12 yrs)	58,079	7490 (12.90 %)	11,619 (20.01 %)
	2012 (11 yrs)	56,961	4076 (7.16 %)	7169 (12.59 %)
	2013 (10 yrs)	54,553	2385 (4.37 %)	4722 (8.66 %)
	2014 (9 yrs)	54,229	280 (0.52 %)	3048 (5.62 %)
2024	2009–2015	402,524	74,682 (18.55 %)	51,802 (12.87 %)
	2009 (15 yrs)	62,934	17,455 (27.74 %)	6569 (10.44 %)
	2010 (14 yrs)	61,232	18,241 (29.79 %)	9128 (14.91 %)
	2011 (13 yrs)	58,079	16,441 (28.31 %)	9447 (16.27 %)
	2012 (12 yrs)	56,961	11,560 (20.29 %)	10,577 (18.57 %)
	2013 (11 yrs)	54,553	6984 (12.80 %)	7000 (12.83 %)
	2014 (10 yrs)	54,229	3623 (6.68 %)	5416 (9.99 %)
	2015 (9 yrs)	54,536	378 (0.69 %)	3665 (6.72 %)
Females			**N (%)**	**N (%)**
2022	2007–2013	392,554	80,814 (20.59 %)	55,248 (14.07 %)
	2007 (15 yrs)	55,688	26,569 (47.71 %)	8908 (16.00 %)
	2008 (14 yrs)	59,353	27,001 (45.49 %)	9554 (16.10 %)
	2009 (13 yrs)	59,517	18,596 (31.24 %)	11,204 (18.82 %)
	2010 (12 yrs)	58,115	7425 (12.78 %)	13,796 (23.74 %)
	2011 (11 yrs)	54,938	965 (1.76 %)	7070 (12.87 %)
	2012 (10 yrs)	53,831	205 (0.38 %)	2973 (5.52 %)
	2013 (9 yrs)	51,112	53 (0.10 %)	1743 (3.41 %)
2023	2008–2014	387,924	95,053 (24.50 %)	56,221 (14.49 %)
	2008 (15 yrs)	59,517	31,593 (53.08 %)	7137 (11.99 %)
	2009 (14 yrs)	59,517	26,480 (44.49 %)	9250 (15.54 %)
	2010 (13 yrs)	58,115	19,577 (33.69 %)	11,036 (18.99 %)
	2011 (12 yrs)	54,938	10,360 (18.86 %)	13,024 (23.71 %)
	2012 (11 yrs)	53,831	4433 (8.24 %)	8123 (15.09 %)
	2013 (10 yrs)	51,112	2336 (4.57 %)	4588 (8.98 %)
	2014 (9 yrs)	51,058	274 (0.54 %)	3063 (6.00 %)
2024	2009–2015	379,774	103,975 (27.38 %)	53,265 (14.03 %)
	2009 (15 yrs)	59,517	31,252 (52.51 %)	6555 (11.01 %)
	2010 (14 yrs)	58,115	26,626 (45.82 %)	8725 (15.01 %)
	2011 (13 yrs)	54,938	20,961 (38.15 %)	9352 (17.02 %)
	2012 (12 yrs)	53,831	13,576 (25.22 %)	11,607 (21.56 %)
	2013 (11 yrs)	51,112	7387 (14.45 %)	7621 (14.91 %)
	2014 (10 yrs)	51,058	3804 (7.45 %)	5661 (11.09 %)
	2015 (9 yrs)	51,203	369 (0.72 %)	3744 (7.31 %)

adequately protected by vaccination programs.

In addition to regional disparities, vaccination coverage was markedly lower among adolescents born outside Greece compared to their Greek-born peers. Across all reference years and both sexes, children born abroad demonstrated significantly lower HPV vaccination initiation and completion rates. This finding likely reflects structural barriers documented in EU/EEA settings-limited or disrupted access to primary care, language and cultural obstacles, administrative/insurance hurdles, and reduced outreach capacity-rather than intrinsic ethnic or religious effects [38–41]. EU/EEA guidance explicitly recommends targeted vaccination offers for newly arrived migrants, removal of access frictions, language mediation, and delivery through schools/mobile services, approaches shown to improve uptake in migrant populations [40].

The major strength of this study is that it is the first to provide population-based estimates of HPV vaccination coverage in Greece, using comprehensive nationwide prescription and registry data. To date, no official or peer-reviewed national estimates have been available. This gap is underscored by the findings of a recently published systematic review, which did not report HPV vaccine coverage data for Greece, highlighting the absence of publicly accessible or reliable national data [9]. By addressing this evidence gap, our study offers an essential baseline for evaluating progress in HPV vaccination uptake and informing future public health strategies in Greece to achieve the global target of WHO's 2030 agenda.

Despite the uniqueness of this study, some limitations should be acknowledged. First, the study relies on prescription data, and the execution of prescription was used as a proxy of vaccine administration. Given that some vaccines may be dispensed but not injected to children/adolescents, this limitation might lead to overestimation of coverage. Second, e-prescription database covers only vaccines reimbursed by Greek sickness fund (EOPYY) and not those dispensed for free (i.e. uninsured population) or those paid out of pocket, resulting in a potential underestimation of coverage. Although Greek legislation provides access to public vaccination for uninsured minors, the absence of a reliable population denominator for uninsured adolescents precludes precise quantification of this potential bias [42]. Third, we did not have access to the exact date of birth and as such, individuals were classified as being appropriately initiated vaccination before turning 15 if they had executed at least their first prescription for HPV vaccination the month of their 15th birthday. This might have resulted in a slight overestimation of this figure. Moreover, the availability of vaccination data from January 1st, 2019, might have led to a slight underestimation

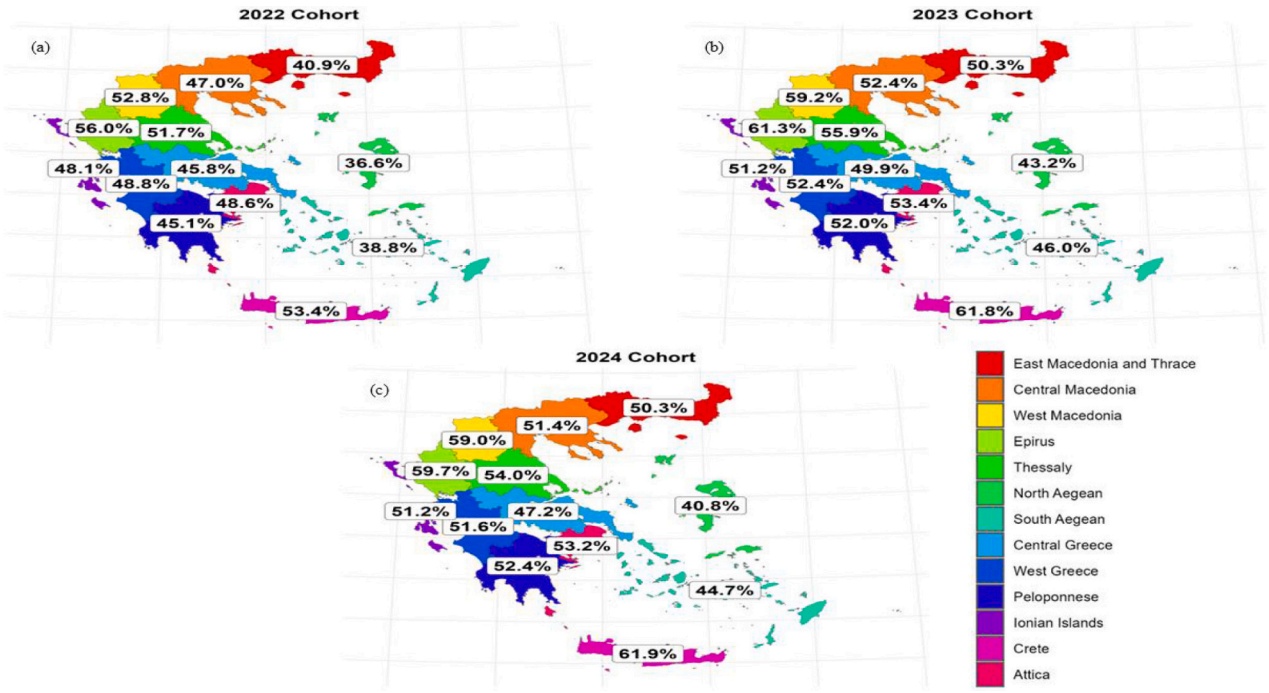

Fig. 4. Percentage of fully vaccinated female individuals turning 15* in 2022 (a), 2023 (b) and 2024 (c). * Birth year: 2007 for the 2022 cohort. Birth year: 2008 for the 2023 cohort. Birth year: 2009 for the 2024 cohort. Full vaccination: two doses with a minimum interval of 6 months.

of vaccination coverage for children born in 2007, who turned 12 in 2019, since prior to 2022, the NIP recommended HPV vaccination primarily at ages 11–12, with 9 years being the minimum eligible age. Finally, while the findings of this study may not be generalizable to countries with different healthcare systems or vaccination strategies, they offer critical insights for settings with similar public health structures and challenges.

To sum up, the findings highlight a steady increase in both initiation and completion rates over time, particularly among males, yet reveal persistent delays in early initiation and overall suboptimal coverage -especially when benchmarked against international standards and the WHO's 90 % target for girls under 15 years by 2030. The observed geographic and sociodemographic disparities further underscore the need for targeted, culturally sensitive interventions, with emphasis on timely vaccination beginning at age 9. Despite limitations inherent in the use of prescription data, this study addresses a significant evidence gap and provides a vital reference point for national vaccination policy and programmatic planning toward HPV-related disease elimination.

Authors contribution

GK conceived and designed the study. GK and KD conducted the statistical analyses and wrote the first draft of the manuscript. All authors contributed to data interpretation, manuscript revisions and approved the final version of the manuscript.

CRediT authorship contribution statement

Kalliopi Doulou: Writing – review & editing, Writing – original draft, Resources, Data curation. **Flora Bacopoulou:** Writing – review & editing, Data curation. **Athanasios Michos:** Writing – review & editing, Data curation. **Anastasios Tsolakidis:** Writing – review & editing, Data curation. **Kostas Mathioudakis:** Writing – review & editing, Data curation. **Dimitris Zografopoulos:** Writing – review & editing, Data curation. **Georgia Kourlaba:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Data curation, Conceptualization.

Funding

No funding.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2025.128026.

Data availability

The data that has been used is confidential.

References

[1] World Health Organization. Human papillomavirus vaccines: WHO position paper (2022 update). Wkly Epidemiol Rec 2022;97(50):645–672. Available from: https://iris.who.int/bitstream/handle/10665/365350/WER9750-eng-fre.pdf?sequence=1.
[2] International Agency for Research on Cancer. GLOBOCAN 2022: World fact sheet. Lyon: IARC; 2022 [cited 2025 Jul 5]. Statistics at a glance. (n.d.) Available from: https://gco.iarc.who.int/media/globocan/factsheets/populations/900-world-fact-sheet.pdf.
[3] World Health Organization. Leading causes of death. Global Health Estimates [Internet]. [cited 2025 Oct 4]. Available from: https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/ghe-leading-causes-of-death.
[4] Agorastos T, Chatzistamatiou K, Tsertanidou A, et al. Implementation of HPV-based cervical cancer screening combined with self-sampling using a midwifery network across rural Greece: the GRECOSELF study. Cancer Prev Res (Phila) 2019 12(10):701–710. doi:https://doi.org/10.1158/1940-6207.CAPR-19-0192. Available from: https://pubmed.ncbi.nlm.nih.gov/31427275/.
[5] Drolet M, Bénard É, Pérez N, et al. HPV vaccination impact study group. Population-level impact and herd effects following the introduction of human papillomavirus vaccination programmes: updated systematic review and meta-analysis. Lancet 2019;394(10197):497–509. https://doi.org/10.1016/S0140-6736(19)30298-3. Available from: https://pubmed.ncbi.nlm.nih.gov/31255301/.

[6] Lei J, Ploner A, Elfström KM, et al. HPV vaccination and the risk of invasive cervical cancer. N Engl J Med 2020;383(14):1340–8. https://doi.org/10.1056/NEJMoa1917338.

[7] World Health Organization. Global strategy to accelerate the elimination of cervical cancer as a public health problem. Geneva: World Health Organization; 2020. Licence: CC BY-NC-SA 3.0 IGO. Available from: https://iris.who.int/bitstream/handle/10665/336583/9789240014107-eng.pdf?sequence=1.

[8] Hellenic Ministry of Health. National Immunization Program for Children and Adolescents (NIP) [Internet]. Athens: Ministry of Health; [cited 2025 Jul 5]. Available from: https://www.moh.gov.gr/articles/health/dieythynsh-dhmosias-ygieinhs/emboliasmoi/ethniko-programma-emboliasmwn-epe-paidiwn-kai-efhbwn.

[9] Bruni L, Saura-Lázaro A, Montoliu A, et al. Global HPV vaccination programs and coverage rates: a systematic review. EClinicalMedicine 2025;49:101523. doi:https://doi.org/10.1016/j.eclinm.2025.101523. Available from: https://www.thelancet.com/journals/eclinm/article/PIIS2589-5370%2825%2900222-6/fulltext.

[10] Vaidakis D, Moustaki I, Zervas I, et al. Knowledge of Greek adolescents on human papilloma virus (HPV) and vaccination: a national epidemiologic study. Medicine (Baltimore) 2017;96(1):e5287. https://doi.org/10.1097/MD.0000000000005287. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5228643/.

[11] Pergialiotis V, Papageorgiou D, Douligeris A, et al. Awareness, knowledge and attitudes of human papillomavirus infection, screening and vaccination: a survey study in Greece. Arch Gynecol Obstet 2024;309:2031–40. https://doi.org/10.1007/s00404-024-07398-1.

[12] Papazoglou A, Giamaiou K, Poulopoulou S, et al. The National Vaccination Programme in Greece: factors affecting parents' knowledge. Glob J Med Res Interdiscip 2013;13(3). Available from: https://medicalresearchjournal.org/index.php/GJMR/article/view/100152/.

[13] Bernstein TA, Broome M, Millman J, et al. Promoting strategies to increase HPV vaccination in the pediatric primary care setting. J Pediatr Health Care 2022;36(2):e36–41. https://doi.org/10.1016/j.pedhc.2021.10.009. Available from: https://pubmed.ncbi.nlm.nih.gov/35120779/.

[14] Maltezou HC, Rahiotis C, Tseroni M, et al. Attitudes toward vaccinations and vaccination coverage rates among dental students in Greece. Int J Environ Res Public Health 2022;19(5):2879. Available from: https://doi.org/10.3390/ijerph19052879.

[15] Dinas K, Nasioutziki M, Arvanitidou O, et al. Awareness of human papillomavirus infection, testing and vaccination in midwives and midwifery students in Greece. J Obstet Gynaecol 2009;29(6):542–6. Available from: https://doi.org/10.1080/01443610902977684.

[16] Daniel Wayne W. Jonckheere–Terpstra test for ordered alternatives. In: Applied nonparametric statistics. 2nd ed. Boston: PWS-Kent; 1990. p. 234–40. ISBN 0-534-91976-6.

[17] Vlachadis N, Siori M, Petrakos G, et al. Tracing time trends of births in Greece. Cureus 2023;15(1):e34040. https://doi.org/10.7759/cureus.34040. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC9940775/.

[18] Bruni L, Albero G, Rowley J, et al. Global and regional estimates of genital human papillomavirus prevalence among men: a systematic review and meta-analysis. Lancet Glob Health 2023;11(9):e1345–e1362. doi: https://doi.org/10.1016/S2214-109X(23)00305-4. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10447222/PubMed.

[19] Cangelosi G, Sacchini F, Mancin S, et al. Papillomavirus vaccination programs and knowledge gaps as barriers to implementation: a systematic review. Vaccines 2025;13(5):460. https://doi.org/10.3390/vaccines13050460.

[20] Kumar S, Khanduri A, Sidibe A, et al. Acting on the call: a framework for action for rapid acceleration of access to the HPV vaccination in low- and lower-middle-income countries. Int J Gynaecol Obstet 2021;152(1):32–39. doi:https://doi.org/10.1002/ijgo.13482. Available from: https://pubmed.ncbi.nlm.nih.gov/33185283/.

[21] Pingali C, Yankey D, Chen M, et al. National vaccination coverage among adolescents aged 13–17 years — National Immunization Survey-Teen, United States, 2023. MMWR Morb Mortal Wkly Rep 2024;73(33):708–714. doi:10.15585/mmwr.mm7333a1. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC11349384/pdf/mm7333a1.pdf.

[22] Sathiyamoorthy A, Guay M, Chen R. Estimates and determinants of HPV non-vaccination in 14-year-old Canadians: results from the childhood National Immunization Coverage Survey, 2019. Hum Vaccin Immunother 2024;20(1):2379090. doi:https://doi.org/10.1080/21645515.2024.2379090. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC11275521/pdf/KHVI_20_2379090.pdf.

[23] Hull B, Hendry A, Dey A, et al. Annual immunisation coverage report 2021. Commun Dis Intell (2018) 2023;47. https://doi.org/10.33321/cdi.2023.47.47. Available from: https://pubmed.ncbi.nlm.nih.gov/37817316/.

[24] Falcaro M, Castañón A, Ndlela B, et al. The effects of the national HPV vaccination programme in England, UK, on cervical cancer and grade 3 cervical intraepithelial neoplasia incidence: a register-based observational study. Lancet 2021;398(10316):2084–2092. doi:https://doi.org/10.1016/S0140-6736(21)02178-4. Available from: https://pubmed.ncbi.nlm.nih.gov/34741819/.

[25] Thompson EL, Livingston MD, Daley EM, et al. Rhode Island human papillomavirus vaccine school entry requirement and uptake: a natural experiment. Am J Prev Med 2020;59(2):274–281. doi:https://doi.org/10.1016/j.amepre.2020.04.023. Available from: https://pubmed.ncbi.nlm.nih.gov/32600966/.

[26] Pingali C, Yankey D, Williams CL, et al. Policy approaches for increasing adolescent HPV vaccination coverage in the United States. Pediatrics 2024;153(5):e2023064692. doi:https://doi.org/10.1542/peds.2023-064692. Available from: https://pubmed.ncbi.nlm.nih.gov/38632354/.

[27] Kroneman M, Fermin A, Rechel B, et al. Initiatives to increase childhood vaccination coverage: an international comparison. Health Policy 2025;158:105351. doi:https://doi.org/10.1016/j.healthpol.2025.105351. Available from: https://pubmed.ncbi.nlm.nih.gov/40449380/.

[28] European Parliament and Council of the European Union. Directive 2001/83/EC of the European Parliament and of the council on the community code relating to medicinal products for human use—article 88 (ban on advertising prescription medicines to the public). Off J Eur Communities 2001 28;L311:67–128. Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32001L0083.

[29] EUPATI. European legislation—Directive 2001/83/EC (advertising to the general public) [Internet]. EUPATI Open Classroom; [cited 2025 Oct 12]. Available from: https://eupati.eu/.

[30] Velo G, Minuz P. Direct-to-consumer information in Europe: the blurred border with advertising. Br J Clin Pharmacol 2008;66(2):212–218. doi:https://doi.org/10.1111/j.1365-2125.2008.03193.x. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC2503661/.

[31] Rand CM, Brill H, Albertin C, et al. Effectiveness of centralized text message reminders on HPV vaccination. J Adolesc Health 2015;56(5 Suppl):S17–S23. doi: https://doi.org/10.1016/j.jadohealth.2015.03.017. Available from: https://pubmed.ncbi.nlm.nih.gov/25900824/.

[32] Economou C, Kaitelidou D, Karanikolos M, et al. Greece: health system review. Health Syst Transit 2017 Sep;19(5):1–166. Available from: https://pubmed.ncbi.nlm.nih.gov/29972131/.

[33] Gogos C, Papadopoulou E, Doukas ID, et al. Regional distribution disparities of healthcare resources in Greece. Eur Mod Stud J 2022;6(4):745. Available from: https://lorojournals.com/index.php/emsj/article/view/745.

[34] Kassas P, Gogou E, Varsamas C, et al. The Alonissos study: cross-sectional study of the healthcare access and user satisfaction in the Community of a non-Profit-Line Greek Island. Healthcare (Basel) 2023;11(13):1931. doi: https://doi.org/10.3390/healthcare11131931. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC10340698/.

[35] Walker TY, Elam-Evans LD, Yankey D, et al. National, regional, state, and selected local area vaccination coverage among adolescents aged 13–17 years — United States, 2018. MMWR Morb Mortal Wkly Rep 2019;68(33):718–723. doi: 10.15585/mmwr.mm6833a2. Available from: https://www.cdc.gov/mmwr/volumes/68/wr/mm6833a2.htm.

[36] Hirth J. Disparities in HPV vaccination rates and HPV prevalence in the United States: a review of the literature. Hum Vaccin Immunother 2019;15(1):146–155. doi: https://doi.org/10.1080/21645515.2018.1512453. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC6363146/.

[37] Danis K, Georgakopoulou T, Stavrou T, et al. Socioeconomic factors play a more important role in childhood vaccination coverage than parental perceptions: a cross-sectional study in Greece. Vaccine 2010;28(7):1861–9. doi: https://doi.org/10.1016/j.vaccine.2009.11.078. Available from: https://pubmed.ncbi.nlm.nih.gov/20006570/.

[38] World Health Organization. Ensuring the integration of refugees and migrants in immunization policies, planning and service delivery globally. Geneva: World Health Organization; 2022 (Global Evidence Review on Health and Migration series). Available from: https://www.ncbi.nlm.nih.gov/books/NBK583123/.

[39] Farmakioti E, Pylli M, Giannakou K. Access to healthcare services and essential medicines in Greek migrant camps: an online cross-sectional study. J Immigr Minor Health 2023;25(3):580–588. doi: https://doi.org/10.1007/s10903-022-01425-6. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC9676798/.

[40] European Centre for Disease Prevention and Control. Public health guidance on screening and vaccination for infectious diseases in newly arrived migrants within the EU/EEA. Stockholm: ECDC; 2018. Available from: https://www.ecdc.europa.eu/en/publications-data/public-health-guidance-screening-and-vaccination-infectious-diseases.

[41] Grabenstein JD. What the world's religions teach, applied to vaccines and immune globulins. Vaccine 2013;31(16):2011–23.doi:https://doi.org/10.1016/j.vaccine.2013.02.026.Available from: https://pubmed.ncbi.nlm.nih.gov/23499565/.

[42] Myloneros T, Sakellariou D. The effectiveness of primary health care reforms in Greece towards achieving universal health coverage: a scoping review. BMC Health Serv Res 2021;21:628. https://doi.org/10.1186/s12913-021-06678-9.