Taylor & Francis
Taylor & Francis Group

Expert Review of Vaccines

ISSN: 1476-0584 (Print) 1744-8395 (Online) Journal homepage: www.tandfonline.com/journals/ierv20

Readiness assessment for cervical cancer elimination and prevention of human papillomavirus (HPV)-related cancers in Europe – are we winning the RACE?

Eugenia Karamousouli, Ugne Sabale, Stefano Valente, Fanut Morosan, Maria Heuser, Olivia Dodd, Danielle Riley, Louise Heron, Giovanna Elisa Calabrò, Theodoros Agorastos, Paul Sevelda, Zoárd Tibor Krasznai, Shay Nahum & Rune Horby

To cite this article: Eugenia Karamousouli, Ugne Sabale, Stefano Valente, Fanut Morosan, Maria Heuser, Olivia Dodd, Danielle Riley, Louise Heron, Giovanna Elisa Calabrò, Theodoros Agorastos, Paul Sevelda, Zoárd Tibor Krasznai, Shay Nahum & Rune Horby (2025) Readiness assessment for cervical cancer elimination and prevention of human papillomavirus (HPV)-related cancers in Europe – are we winning the RACE?, Expert Review of Vaccines, 24:1, 11-26, DOI: 10.1080/14760584.2024.2438759

To link to this article: https://doi.org/10.1080/14760584.2024.2438759

EXPERT REVIEW OF VACCINES
2025, VOL. 24, NO. 1, 11–26
https://doi.org/10.1080/14760584.2024.2438759

Taylor & Francis
Taylor & Francis Group

PERSPECTIVE

Readiness assessment for cervical cancer elimination and prevention of human papillomavirus (HPV)-related cancers in Europe – are we winning the RACE?

Eugenia Karamousouli[a], Ugne Sabale[b], Stefano Valente[c], Fanut Morosan[d], Maria Heuser[e], Olivia Dodd[e], Danielle Riley[e], Louise Heron[e], Giovanna Elisa Calabrò[f], Theodoros Agorastos[g], Paul Sevelda[h], Zoárd Tibor Krasznai[i], Shay Nahum[j] and Rune Horby[k]

[a]Regional Market Access, MSD, Athens, Greece; [b]Value & Implementation Outcomes Research, MSD, Vilnius, Lithuania; [c]Value & Implementation Global Medical and Scientific Affairs, MSD, Rome, Italy; [d]Regional Market Access, Regional Market Access, MSD, Bucharest, Romania; [e]Adelphi Values PROVE, Macclesfield, Cheshire, UK; [f]Department of Human, Social and Health Sciences, University of Cassino and Southern Lazio, Cassino, Italy; [g]School of Health Sciences, Department of Medicine, Third Clinic of Obstetrics and Gyneacology, Aristotle University of Thessaloniki, Thessaloniki, Greece; [h]Karl Landsteiner Institute for gynecologic Oncology and Senology, Austrian Cancer Aid, Vienna, Austria; [i]Department of Obstetrics and Gynecology, University of Debrecen Faculty of Medicine, Debrecen, Hungary; [j]Regional Market Access, MSD, Aviel, Israel; [k]Public Policy Mid-European Region, MSD, Copenhagen, Denmark

ABSTRACT

Introduction: To address the cervical cancer burden globally, the World Health Organization and European Union released strategies to facilitate HPV-related cancers prevention, including cervical cancer elimination. This research assessed European country level readiness to achieve cervical cancer elimination by adhering to such strategies.

Areas covered: Readiness for cervical cancer elimination was assessed across a range of guiding questions relevant to three defined key domains: vaccination, screening, and treatment, each with two sub-domains focusing on decision making and implementation efforts. Publicly available data sources were used to inform the scoring across domains, to tier countries into either high, moderate-high, moderate-low, and low readiness archetypes.

Key parameters identified associated with the high readiness archetype were high vaccination coverage rates (>70%), availability of gender neutral and catch-up vaccination, school-based vaccination availability, organized screening programs, use of HPV DNA primary screening tests, and data surveillance.

Expert opinion: Our analysis highlights significant variability in decision making and implementation of vaccination, screening, and treatment programmes across Europe. Country scores expose the need for a multifaceted approach to achieve cervical cancer elimination in Europe, encompassing solid decision making commitments, implementation of these commitments, and the ability to collect, surveil, and apply the data use accurately.

ARTICLE HISTORY
Received 9 September 2024
Accepted 3 December 2024

KEYWORDS
Cervical cancer; policy; readiness assessment; cancer prevention; cancer management; vaccination; healthcare data; HPV

1. Introduction

1.1. Background

Human papillomavirus (HPV) is one of the most common sexually transmissible infection in the world and has a high negative impact on individuals' lives [1]. In their lifetime, the vast majority of sexually active males and females (84.6% and 91.3%, respectively) will be infected with HPV at least once [2]. HPV is a well-established cause of cervical cancer, a range of other anogenital (anus, penis, vagina, and vulvar), head and neck cancers. It is also the primary cause of other diseases such as recurrent respiratory papillomatosis (RRP) and genital warts [3]. There are multiple HPV genotypes, with high-risk types 16 and 18 being responsible for ~ 70% of all cervical cancer cases worldwide. Low-risk types (i.e. those unlikely to develop into cancer), 6 and 11, are responsible for ~ 90% of genital warts and are major cause of RRP [3,4].

Globally, cervical cancer is the second most common cancer in women aged 15–44 years [5]. Across the European Union (EU)-27, it was estimated that in 2020, cervical cancer accounted for 2.5% of all new cancer cases diagnosed in females, and 2.4% of all cancer-related deaths in females [6]. Though, notably, both males and females have a substantial burden associated with HPV-related disease(s) and cancer(s) [1,5,7]. More than four out of every ten cases of cancer caused by HPV occur among males and, globally, HPV-related oropharyngeal cancer is four times more common in males than in females, and in some high-income countries like the US, Denmark, and the United Kingdom (UK), rates of oropharyngeal cancer have surpassed that of cervical cancer [5,8–10].

Direct protection through vaccination is the primary prevention strategy for cervical cancer and other HPV-related cancers and diseases [11–14]. The three types of approved HPV vaccines in Europe, including bivalent, tetravalent, and nonavalent vaccines, are effective in protecting against HPV

CONTACT Eugenia Karamousouli eugenia.karamousouli@merck.com Regional Market Access, MSD, Agiou Dimitriou 63, Alimos, Athens 17456, Greece
Supplemental data for this article can be accessed online at https://doi.org/10.1080/14760584.2024.2438759

Article highlights

- Across Europe, there is a political willingness to comply with the objective of cervical cancer elimination, as stated by the World Health Organization (WHO) and European Commission.
- Findings showed that higher-income and western European countries such as Sweden, the United Kingdom (UK), and Ireland achieved the highest overall readiness scores, while Eastern and Southern European countries such as Bulgaria, Romania, Cyprus, and Greece, some of which are considered lower-income countries, achieved the lowest.
- Differences in country performance, which were mainly driven by differences in vaccination-and screening-related implementation efforts, may be due to countries' income status, which could reflect vaccine inequity.
- High readiness countries typically have mature HPV vaccination programmes for primary cohorts, incorporating gender-neutral vaccinations, while offering catch-up cohort vaccination for late adolescent and adult populations.
- Data gaps were identified across vaccination, screening, and treatment domains, which prevents accurate estimates of cervical cancer and limits the tracking of efforts toward cervical cancer elimination. Improvements in data systems and surveillance are a pertinent factor in steps toward cervical cancer elimination.

infection and HPV-related disease incidence. Nonavalent vaccine provides the broadest direct protection against potential HPV cases caused by genotypes not included in other formulations [1,15,16]. Besides female vaccination, literature shows that gender-neutral vaccination provides much greater herd protection and resilience of the HPV immunization system [11,17–23]. Moreover, vaccinating males against HPV allows this population to build up their own immunity to HPV infection and provide direct protection against HPV-related cancers and diseases, regardless of the vaccination coverage for females, while promoting vaccine equity [11,19–25]. Despite the proven efficacies and advances in the field of HPV vaccination, vaccination uptake in target populations remains low or is decreasing in a substantial number of European countries and subsequently, the burden of HPV-associated cancers and diseases remains high [26–29].

Early detection of abnormal cells via screening can prevent advancement of disease and is therefore considered an important secondary prevention strategy [30]. While primary screening via cytology tests can help detect abnormal cells in the cervix, including HPV-negative lesions, HPV DNA tests are more effective and determine whether a woman has an HPV infection, including the strain risk status, before it may lead to lesions and cervical cancer [31–33]. As such, the WHO recommends using HPV DNA detection as primary screening test rather than cytology [34]. In terms of cervical cancer treatment, surgery, chemotherapy, radiotherapy and targeted medicine and immunotherapy may be provided, depending on circumstances [35].

In 2018, the WHO identified cervical cancer as a public health problem and issued a global call for action to eliminate cervical cancer, urging all global stakeholders to join forces in pursuit of a common goal and demonstrating a strong political commitment. In 2020, the WHO released a global strategy with the aim of eliminating cervical cancer [36]. The WHO strategy proposes the vision of a world where cervical cancer is eliminated as a public health problem. According to this strategy, the following 90–70–90 targets that must be met by 2030, for countries to be on the path toward cervical cancer elimination: 90% of girls fully vaccinated with an HPV vaccine by age 15 years, 70% of women are screened with a high-performance test (e.g. HPV DNA test) by 35 years of age and again by 45 years of age, and 90% of women identified with cervical disease receive treatment (90% of women with pre-cancer treated, and 90% of women with invasive cancer managed) [36]. Further, in addition to the elimination strategy, the WHO proposed a framework to evaluate country progress to achieve elimination, specifying that robust surveillance and monitoring systems at national or subnational level are fundamental to evaluate the impact of actions implemented as a part of the elimination strategy [37].

Within the EU, there are ongoing initiatives including Europe's Beating Cancer Plan by the European Commission, which aims to prevent, detect, diagnose and treat, and improve quality of life of patients with cancer, as well as support innovations [14]. Cancer prevention is of particular importance within the EU, echoed by the ambition to improve prevention strategies to eliminate cervical cancer and reduce the burden of other HPV-related diseases. More specifically, Europe's Beating Cancer Plan supports Members States' effort to eliminate cervical cancer and prevent other HPV-related cancers by aiming to vaccinate at least 90% of the EU target population of girls and to significantly increase the vaccination of boys by 2030. Additionally, the plan includes putting forward a new EU-supported cancer screening scheme to help member states ensure that 90% of the EU population who qualify for cervical cancer screening are offered screening by 2025. Further, the plan supports member states in establishing at least one national comprehensive cancer center by 2025, ensuring that 90% of eligible patients have access to such centers by 2030 [14].

Moreover, The EU4 Health program, stated by the Council of the EU, aims to address the burden associated with cancer by improving and fostering health, protecting people, improving access to medical products and medical devices, and strengthening health systems [38]. Further, the EU's Council recommendation on vaccine-preventable cancers reiterates the importance for availability of data to monitor progress of program implementation, particularly with regards to HPV vaccination coverage [39]. The recommendation includes 19 measures to increase uptake in females and males by a series of strategies, including but not limited to: removing structural barriers, expanding access in- and outside of regular immunization programs, improving program performance by using data for decision making, improving targeted outreach and communication efforts, and developing or upgrading screening and cancer registries or equivalents [39].

Published literature and policy papers have also highlighted the need for a comprehensive approach to help countries overcome barriers to prevention and management of HPV infection and outcomes, particularly cervical cancer [40–42]. Individualized evaluation efforts of countries and vaccination programmes have previously been published. However, there is a need for a systematic assessment of country readiness to eliminate cervical cancer by considering vaccination, screening

and treatment aspects, while focusing on decision making and implementation efforts [43,44]. Leveraging insights from the WHO and EU Commission, this assessment is intended to provide European countries with clear and more unified benchmarks that allows countries to identify key areas for strengthening and improvement, while enabling cross-country comparisons and learnings to create and tailor actionable recommendations.

In line with these initiatives and strategies, our aims was to assess and describe the readiness of European countries to eliminate cervical cancer by developing a scoring framework, informed by both the WHO cervical cancer framework and EU cervical cancer elimination and HPVrelated cancer prevention strategies and recommendations, while including policy elements such as existence of targets. The scoring framework was intended to assess the current status of vaccination, screening, and treatment programmes, alongside the status of the required data systems and infrastructure to ensure surveillance and monitoring for the elimination initiative at a country level.

2. Methods

2.1. Assessing country readiness to eliminate cancer

The development of the scoring framework comprises a review of published literature, initial framework concepts, and existing frameworks [37,41,45]. Following the initial development of the scoring framework, the general structure, questions, and corresponding scoring were validated by experts, while existing data gaps were highlighted and recommendations at a policy, implementation, and data system level were provided. Experts were chosen professionals with significant experience in the field of HPV-related cancer (s) and disease(s) and/or public health from Austria, Greece, Hungary, and Italy ($N = 4$), representing varying Health Technology Assessment (HTA) archetypes as similarly used by Laigle *et al* 2021 [42].

2.1.1. Overview of available sources and existing frameworks

Publicly available data sources were reviewed manually to identify and summarize most relevant and up-to-date country-specific information regarding vaccination, screening, and treatment programmes, and existing data systems for cervical cancer across European countries. Online translations were utilized where necessary. Additionally, the experts were consulted to validate the data and findings. Where country-specific data were scarce or unreliable, other data sources, including but not limited to the WHO Cervical Cancer Country Profiles, the WHO's database of HPV vaccine coverage, Economic Co-

Table 1. Outputs from the evidence overview used to inform the structure of the scoring framework.

Data parameters identified from the evidence review		Definition
Key indicators to monitor progress of cervical cancer elimination across countries of interest	Vaccination coverage rates (VCRs)	The proportion of target population, females or males up to the age of 15 years, that received the complete dosing schedule.
	Screening participation	The proportion of individuals that were screened for HPV within the past 5 years based on the countries screening setting (programme or opportunistic)
	Disease outcomes (cervical cancer incidence)	Cervical cancer incidence rate per 100,000 people-year
Insights relating to policy and infrastructure/ implementation across countries of interest	National cervical cancer elimination plans	Country specific cervical cancer elimination plans as part of a wider cancer prevention plan or specific cervical cancer plans.
	National guidelines of cervical cancer management	National or regional guidelines for the early detection of first symptoms at primary care.
	The inclusion of HPV in NIP	Programme implemented at a national level, assumed to be generally free of charge. Including variance in how NIPs are defined across countries.
	The presence of a female-only vaccination versus a gender neutral vaccination	Gender-neutral vaccination includes the vaccination of all genders (e.g. girls and boys).
	National VCR targets	A predefined vaccination target that has been agreed upon at a national level.
	Vaccine delivery system (e.g. in school versus healthcare setting roll out)	Vaccine delivery reduced to a healthcare setting or in addition offered through schools.
	Screening systems (e.g. self-sampling, screening at healthcare centers)	Screening at healthcare centers conducted by a HCP or via self-sampling with upfront instruction by a HCP.
	National screening programs and targets	National screening programs are assumed to be organized, population based and free of charge.
	The implementation of HPV DNA screening and cytology screening	Differentiating between HPV DNA or cytology as the primary test of HPV DNA test with cytology as triage test.
	Referral systems from primary care to secondary and/or tertiary care	Clearly defined systems
	Availability of specific cancer centers and cancer hospital departments at a tertiary level	Availability of tertiary level cancer departments for cervical cancer.
	Palliative care of patients with non-communicable diseases	Primary healthcare facilities and/or community and/or home-based care
Insights relating to the use of data systems and their capability across countries of interest	The use of periodic and granular VCR reporting and publication	VCRs are published annually or more often (with granularity on gender, cohorts, municipalities)
	Screening and vaccination registries	National registries or equivalent (e.g. local reporting used to estimate national rate).
	The use of periodic and granular screening rate reporting and publication	Screening rates are published annually or more often (based on robust source stating publication frequency).
	Cancer registries	Subnational or population-based cancer registry or equivalent.

HCP: Healthcare professional; HPV: Human papillomavirus; NIP: National immunization programme; VCR: Vaccination coverage rate.

operation and Development (OECD) report 'Beating Cancer Inequalities in the EU' based on European Cancer Inequalities Registry, were used [46–48].

Publicly reported international sources were used for key indicators for consistency and comparability. For vaccine coverage rates (VCR), the last dose for 15-year-old girls as reported in the WHO's database of HPV vaccine coverage was used across all countries for consistency. Moreover, VCR ranges used for scoring were based on WHO's recommendation and publications such as Bonanni *et al* 2020 and Nguyen-Huu *et al* 2020 [36,37,49,50]. For screening participation rates, OECD screening data were used and include only programme coverage data. Data from surveys were not considered as reliable and hence were not used within the assessment. European Cancer Information Statistics 2022 data for cervical cancer incidence (age standardized rate [ASR]), were leveraged.

Additionally, existing frameworks and availability of country-specific information informed key outcomes of interest, which formulated the initial structure of the scoring framework (Table 1). This helped us identify key elements to be considered when assessing country readiness to eliminate cervical cancer and to ensure a comprehensive overview and assessment of country readiness.

2.1.2. Scoring framework and validation

The scoring framework was devised based on guiding questions related to the three key domains, vaccination, screening, and treatment [14,36]. Moreover, each domain was split into two sub-domains: decision making and implementation, as per Pham *et al* 2023 framework structure [41]. Scoring ranges were limited between 0–2 or 0–3 points based on existing country nuances and question complexity, where, generally, 0 indicates no availability/existence/alignment, 1 or 1–2 indicates some availability/alignment, and 2 or 3 indicates full availability/alignment [41]. Within the framework the three key domains do not carry the same weight when it comes to the scoring, as they do not consists of the same number of guiding questions. Overall, the vaccination as primary prevention strategy carries the biggest weight with 15 guiding questions, followed by the screening with 10 and the treatment with 8 guiding questions.

Each subdomain consists of parameters relevant to actions toward cervical cancer elimination informed by publicly available country data as well as international reports and previously published frameworks. The decision-making subdomain encompasses the process of generating recommendations to ensure vaccine availability and accessibility. Hence, the readiness of countries to eliminate cervical cancer with regards to decision making was assessed by the availability of relevant programmes and policies to ensure broad access to HPV vaccination, including gender neutral vaccination, screening and treatment at a national level and the involvement of key stakeholders in setting targets aligned with the WHO cervical cancer elimination strategy and Europe's Beating Cancer plan [14,36]. The implementation was assessed by indicating how countries ensure prevention programme implementation and access to early detection and treatment of cervical cancer. For example, the vaccination implementation subdomain included vaccination setting, opt-in/opt-out initiatives, and centralized invites/reminders and vaccine coverage.

It should be noted that the framework was developed with the aim to assess countries' current cervical cancer elimination status, rather than assessing progress over time or providing future perspectives.

The scoring framework is presented in Table 2.

2.1.3. Archetypes

Countries were archetyped as a reflection of the current status of readiness to eliminate cervical cancer across European countries (Figure 1).

Countries were tiered based on four archetypes: high readiness, moderate-high readiness, moderate-low readiness, and low readiness to eliminate cervical cancer (Table 3). Data used to inform the scores can be found in the Supplementary material.

3. Framework scoring and findings - prevention

3.1. Vaccination – primary prevention

3.1.1. Decision making

When assessing HPV vaccination decision making, all countries were found to have the HPV vaccination included within the National Immunisation Programme (NIP) (assumed to be generally free of charge) [42] and the majority of countries (90%) had higher-valent HPV vaccines available ensuring broadest protection against different HPV serotypes, except countries such as Norway, Finland, and the Netherlands where a bivalent HPV vaccine is still being used in the public programmes. Additionally, all countries, other than Bulgaria, had gender neutral vaccination programmes. With regards to breadth of HPV vaccination programmes, 84% of countries recommended and funded HPV vaccination for both primary (9–14 y/o) and catch-up cohorts (>15 y/o), with Bulgaria, Cyprus, Czechia, Hungary, and Slovakia only having primary cohorts covered by the NIP.

Only five countries (Italy, Ireland, Sweden, Slovenia, and the UK) had a publicly available national cervical cancer elimination plan, and the majority of countries ($n = 17$, 55%) stated cervical cancer elimination strategies as part of a broader cancer prevention plan or expressed alignment with WHO or EU elimination strategies. Notably, with regards to the UK, the elimination ambition was released by the National Health Service (NHS) England specifically, rather than the UK as a whole.

For vaccination decision making, all countries ranked within the moderatehigh or high readiness tiers, encompassing the availability of broad vaccination programs, the presence of specific cervical cancer elimination plans, accepting WHO vaccination uptake targets and vaccination coverage targets.

3.1.2. Implementation

With regards to the implementation of HPV vaccine-related facilities, the majority of countries have targets for vaccination (61%); though, only two countries (Norway and Portugal) aligned with or exceeded WHO targets for 15 year-old female based on vaccine coverage reported by the WHO [48]. Furthermore, countries typically scored lower on the implementation subdomain compared to the decision making domain (Figure 2), with the majority of countries (68%)

Table 2. Scoring framework.

Vaccination	Parameter	Question	Readiness score
	Decision making		
	National Programmes and Policies		
	HPV vaccination in National Immunisation Programmes (NIP)	Is HPV vaccination included in the NIP? Please note that it was assumed that all countries that do have HPV vaccination included in their NIP generally offer the vaccine free of charge.	0 = No HPV vaccine is included in the NIP 1 = HPV vaccine is introduced in selected regions 2 = HPV vaccine is included in NIP/equivalent availability and funding
		For how long has HPV vaccination been included in the NIP?	0 = No HPV vaccine is included in the NIP 1 = 0–10 years 2 = >10 years
		What is the target primary age cohort for the HPV vaccination programme?	0 = No HPV vaccine is included in the NIP 1 = The target age cohort covers only one year of age (e.g. 10 years) or one school year or birth cohort (e.g. 10–11 years) 2 = The target age cohort covers more than one year of age or birth cohort (e.g. 9–11)
		Is HPV vaccination available for both genders?	0 = No HPV vaccine is included in the NIP 1 = Only girls are vaccinated 2 = Gender neutral vaccination is available
		Does the NIP cover the primary cohort as well as catch-up cohort?	0 = No HPV vaccine is included in the NIP 1 = Primary cohort only 2 = Primary and catch-up cohorts (± adults and other populations)
		Does HPV vaccine provide highest protection against oncogenic HPV types?	0 = No HPV vaccine is included in the NIP 1 = Vaccine protects against 2 or less oncogenic HPV types 2 = Vaccine protects against more than 2 oncogenic HPV types
	National immunization strategy	Do national vaccination targets for HPV vaccine uptake (VCR) exist?	0 = No vaccination targets exist 2= Vaccination targets exist
	National cervical cancer management and elimination strategy	Does a country-specific cervical cancer elimination plan exist?	0 = No national cervical cancer elimination plan exists 1 = Cervical cancer elimination is included in a broader cancer prevention plan or expressed alignment with the WHO or European Beating cancer plan 2 = National cervical cancer elimination plan exists, and actions are being taken to execute this plan
		Are HPV vaccination coverage rates (VCR) published?	0 = No VCRs are publicly available 1 = VCRs are published sporadically (assumed based on availability of VCR data, limited cohort, and granularity) 2 = VCRs are published annually or more often (with granularity on gender, cohorts, municipalities)
	Surveillance systems		
	Immunisation registries	Does a national immunization (population level) registry exist?	0 = No national immunization registry exists 1 = Geographically restricted/unstructured surveillance system exist 2 = National immunization registry or an equivalent exists
	Implementation		
	Vaccine delivery systems	In what setting are HPV vaccines administered?	0 = No programme/no clearly defined vaccine delivery pathways 1 = HCP within primary healthcare setting and local health prevention departments 2 = HCP and other alternative sites (e.g. schools, pharmacies)
	Vaccination acceptance and compliance	How is parental consent for vaccination implemented?	0 = No programme/no clearly defined vaccine delivery pathways exists 1 = Opt-in 2 = Opt-out
		Do the VCRs for females 15 years old (complete dose) align with the WHO target of 90%?*	0 = VCR rates are ≤ 50% 1 = VCRs are 51–70% 2 = VCRs are 71–89% 3 = VCRs are ≥ 90% (aligned or exceeded with WHO targets)
		How high are the VCRs for males 15 years old (complete dose)?**	0 = VCR rates are between ≤ 30% 1 = VCRs are 31–50% 2 = VCRs are 51–69% 3 = VCRs are ≥ 70%
	Invited and reminders	Are centralized vaccine invites/reminders/recalls for HPV vaccination being sent?	0 = No invites/reminders/recalls are sent 1 = Limited/geographically restricted 2 = Reminders/invitations are received nationally

(*Continued*)

Table 2. (Continued).

Screening	Decision making		
	National Programs and Policies		
	National screening programmes	Is cervical cancer screening available? Please note that it was assumed that all countries that have national screening programs offer screening free of charge.	0 = No screening program exists 1 = Screening is available in geographically restricted areas, is sporadic 2 = Screening is available at a national level
		How is the screening being conducted?	0 = No screening available 1 = Opportunistic or in development/transition 2 = Organised population-based
		What type of tests are being used?	0 = No screening available 1 = Cytology (PAP) test as primary test 2 = HPV DNA primary test with Cytology (PAP) used for triage testing 3 = HPV DNA test as primary test
	National screening strategy	Do national screening targets exist?	0 = No screening targets exist 2= Screening targets exist
	Surveillance systems		
	Screening registries	Does a national screening registry exist?	0 = No national screening registry exists 2 = Screening registry exists (or equivalents)
		Are screening rates published?	0 = No screening rates are publicly available 1 = Screening rates are published sporadically (assumed based on availability of European screening data) 2 = Screening rates are published annually or more often (based on robust source stating publication frequency)
	Implementation		
	Screening delivery systems	What is the screening setting?	0 = No clearly defined screening pathways/no screening program exist 1 = Community healthcare center only and piloting self-sampling 2 = Self-sampling and community healthcare center
		Does a clearly defined referral system from primary care to secondary and tertiary care exist?	0 = No or no clearly defined referral system exists 2 = Clearly defined system exists
	Screening acceptance and compliance	Are centralized screening invite/reminder/recall being sent?	0 = No invites/reminders/recalls are sent 1 = Limited/geographically restricted 2 = Reminders are received nationally
		Does the screening participation, within the past 5 years, align with the EU Commission target of 90%?	0 = Screening rates are between ≤ 50% 1 = Screening participation rates are between 51–70% 2 = Screening participation rates are at ≥ 71–89% 3 = Screening participation rates are ≥ 90% (aligned or exceeded with EU Commission targets)
Treatment	Decision making		
	National Programmes and Policies		
	National guidelines	Do governmental guidelines on cervical cancer management exist?	0 = No guidelines exist 1 = Guidelines available in selected regions 2 = Guidelines available at a national level
		Do governmental programmes/guidelines to strengthen early detection of first symptoms at primary care level exist?	0 = No guidelines exist 1 = Guidelines available in selected regions 2 = Guidelines available at a national level
	National treatment strategy	Do national treatment targets exist?	0 = No treatment targets exist 2= Treatment targets exist
	Surveillance systems		
	Outcomes registries	Do population-based cancer registries exist?	0 = No population level cancer registries are available 1 = Subnational cancer registry, limited data included, sporadic 2 = Population-based cancer registry or equivalent available
		Are cervical cancer disease outcomes published (e.g. epidemiological or mortality data)?	0 = No disease outcomes are publicly available 1 = Disease outcomes are published with delays, sporadically or with restricted access 2 = Disease outcomes are published publicly, annually, or more often
		Are cervical cancer treatment rates being published?	0 = No treatment rates are publicly available 1 = Treatment rates are published with delays, sporadically or with restricted access 2 = Treatment rates are published publicly, annually, or more often

(*Continued*)

Table 2. (Continued).

Implementation		
Cancer treatment delivery systems	Are cancer centers or cancer departments at tertiary level available?	0 = Not available 2 = Available
	Is palliative care for cancer patients available?	0 = Not available in primary healthcare facilities or community/home-based care 2 = Available in either primary healthcare facilities or community and/or home-based care
Effects on epidemiology	How high is the current cervical cancer incidence rate compared to the WHO framework (4 per 100,000 people-year)?	0 = ≥10 per 100,000 people-year 1 = 5–9 per 100,000 people-year 2 = ≤4 per 100,000 people-year

EU: European Union; HPV: Human papillomavirus; NIP: National Immunization Programme; VCR: Vaccine coverage rate; WHO: World Health Organization.
*Based on data from the WHO Cervical Cancer Country Profiles rather than local, country-level data.
**There are currently no official targets for male vaccination, VCR ranges were based on published literature.

ranking within moderate-low or low readiness tiers. This signifies sub-optimal VCRs, geographically limited or no reminders sent, and/or the vaccination setting being limited to healthcare professionals (HCP) within primary health care settings and local health prevention departments. Findings reveal a substantial gap between countries' political willingness and practical commitment within the country's infrastructure to action these commitments.

3.2. Screening – secondary prevention

3.2.1. Decision making

With regards to decision making for cervical cancer screening, all countries other than Croatia have national cervical cancer screening available, and 74% used organized screening programs (assumed to be free of charge) [50]. A total of 61% had HPV DNA tests as primary screening test or HPV DNA with cytology (PAP) for triage testing available; though, 55% of countries did not have screening targets. A total of 30 countries (98%) had national cervical cancer screening available; though, only 14 countries (45%) had screening targets or noted they adhered to the overall WHO strategy.

A total of 21 countries ranked within the moderate-high or high readiness tiers, indicating availability of a national screening program, availability of HPV DNA as primary screening test, existence of screening targets, and publication of screening rates.

3.2.2. Implementation

As for the implementation of screening programs, no countries had screening rates which aligned with or exceeded EU Commission targets of 90%; however, a total of eight countries (26%) had screening participation rates ≥ 70%, all of which used organized screening programmes and HPV DNA as primary or HPV DNA test with cytology (PAP) for triage testing.

Overall, countries typically scored lower within the implementation subdomain compared to the decision making subdomain (Figure 3), with 65% of countries ranking within the moderate-low or low readiness tiers. These archetypes were generally characterized by low screening participation rates within the public programme, an absence of selfsampling, a lack of nationally sent reminders, and absence of a clearly defined referral system from primary to secondary and tertiary care.

Findings show that there is a gap between countries' political willingness to adhere to elimination strategies, and the effort to implement such strategies.

4. Framework scoring and findings – treatment

4.1. Treatment

4.1.1. Decision making

When assessing decision making for cervical cancer treatment, the majority of countries have government guidelines on cervical cancer management, or governmental programmes/guidelines to strengthen early detection of first symptoms at primary care level available at a national level (90% and 97%), respectively. Though 90% of countries had population-based cancer registries, only seven countries published up-to-date treatment rates annually.

A total of 28 countries (90%) ranked within the moderate-high or high readiness tiers, indicating availability of cervical cancer management-specific guidance and national surveillance of cervical cancer cases. Only two countries, Cyprus and Malta, ranked within the moderate-low tier, and Greece ranked the low readiness tier. All three countries had a lack of guidelines for cervical cancer management and an absence of publicly available cervical cancer disease outcomes and treatment rates.

4.1.2. Implementation

With regards to cervical cancer treatment implementation, all countries had cancer centers or cancer departments at a tertiary level available, and 90% had palliative care for cancer patients available in either primary health care facilities of community and/or home-based care. Further, the majority of countries (52%) had a cervical cancer incidence (ASR) of 5–9 per 100,000 people-year. However, countries such as Luxembourg, Malta, and Switzerland had a cervical cancer incidence rate of ≤ 4 per 100,000 people, which is below the global target for the achievement of cervical cancer elimination as public health problem [37].

In accordance with vaccination and screening domains, countries typically scored lower on the implementation domain (Figure 4); however, Greece attained a score of 20% for decision making and 50% for implementation.

5. Discussion

To the authors' knowledge, this is the first scoring framework dedicated to assessing European countries' readiness for cervical cancer elimination across prevention, screening and cervical cancer treatment, leveraging a framework based on the

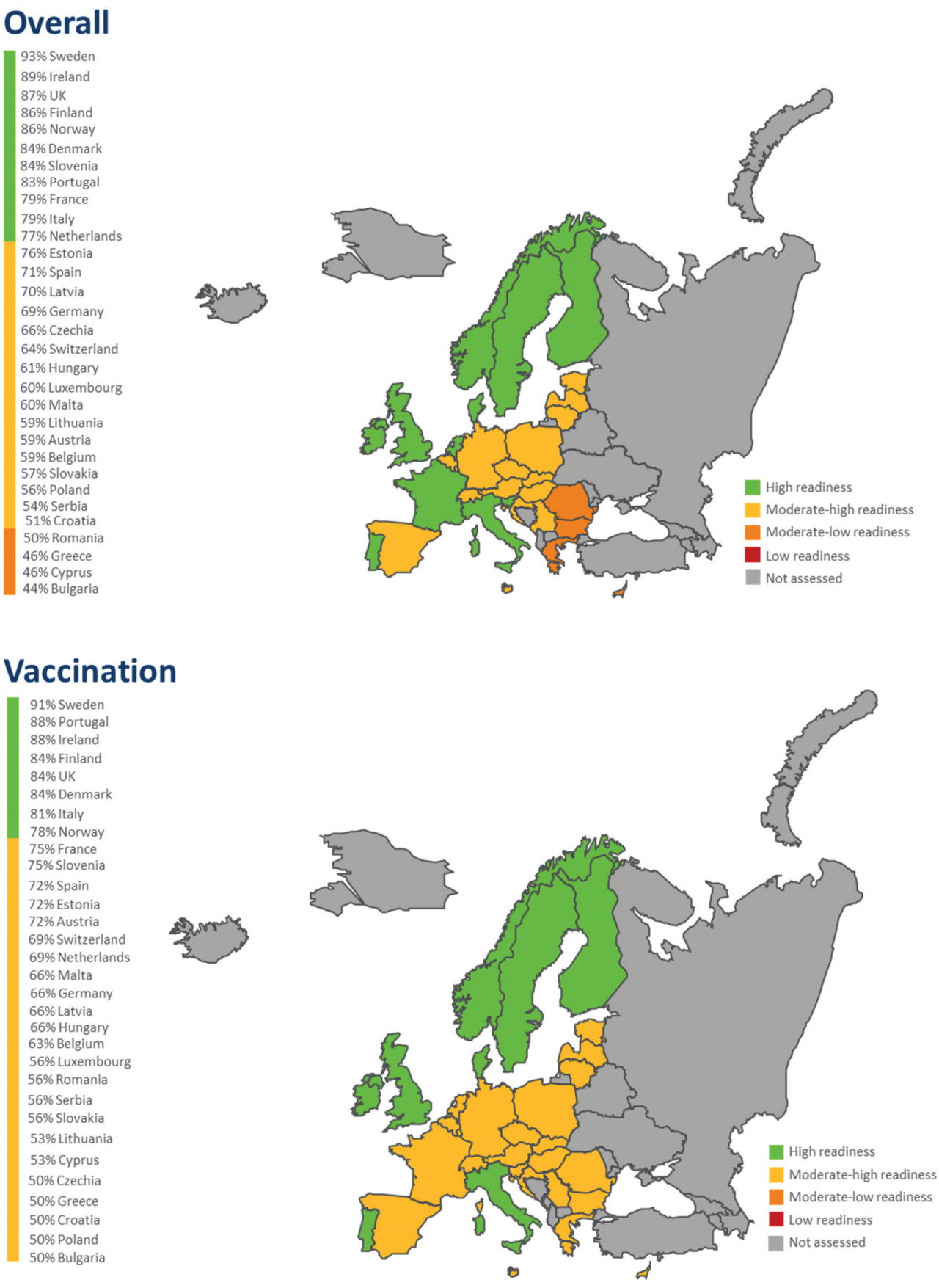
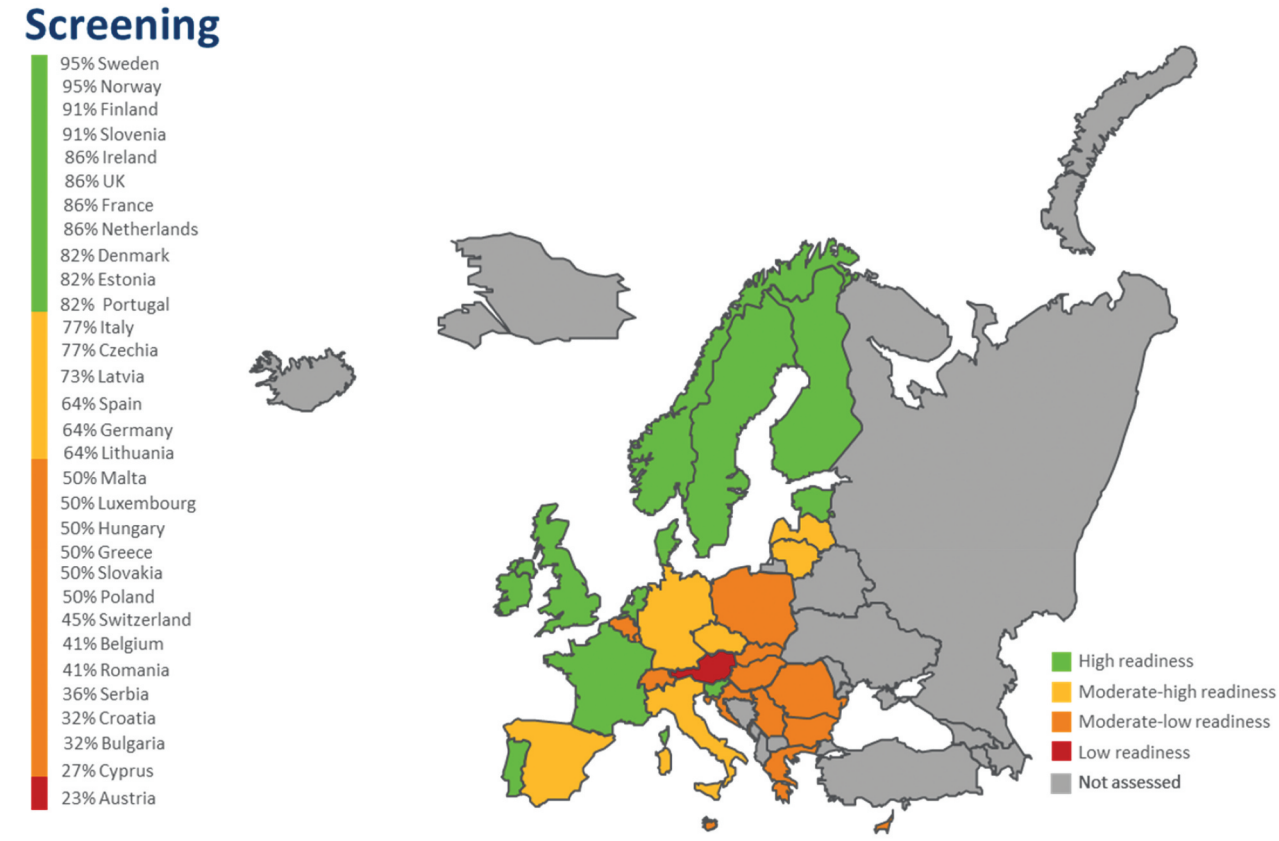


Figure 1. Overall scores by domain.
UK: United Kingdom.
Percentages refer to the score attained for each domain and overall. No countries were in the low readiness category overall, or for the vaccination domain.



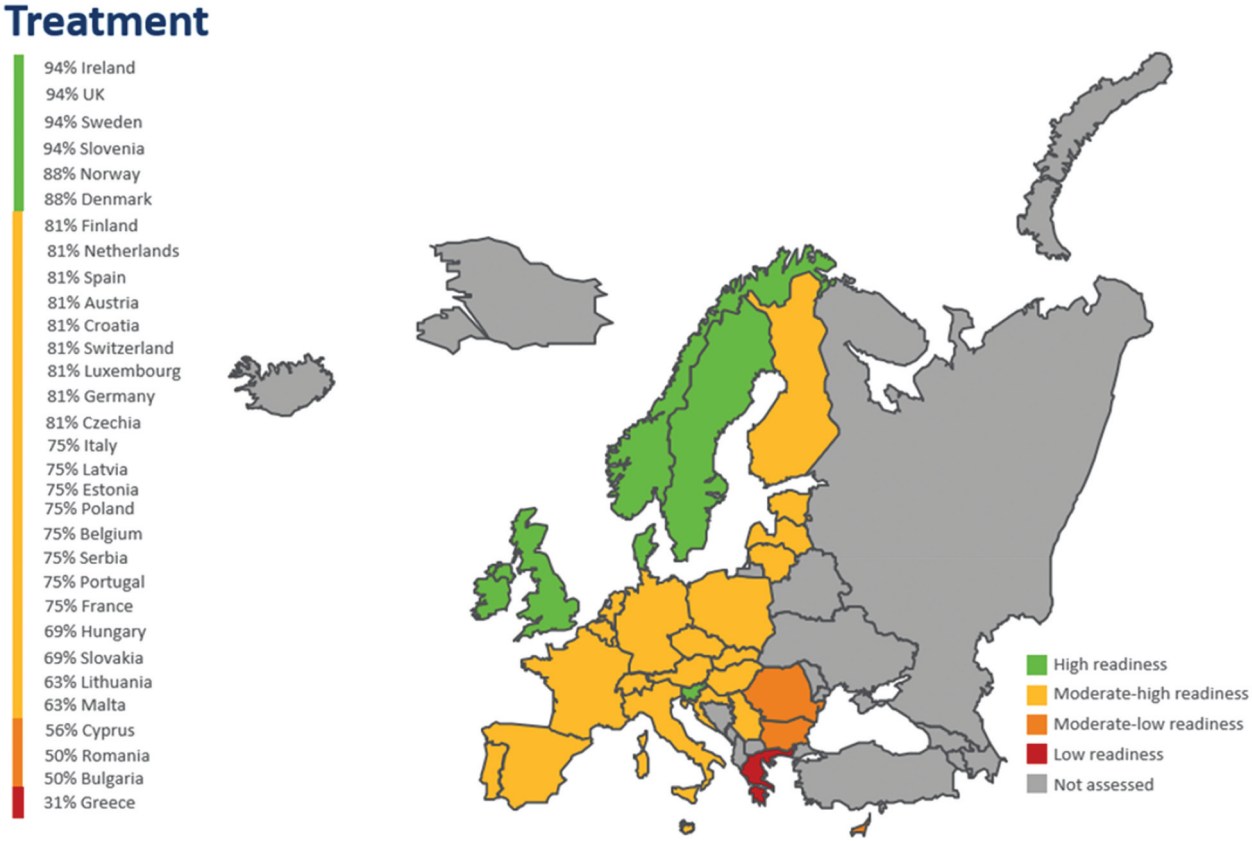


Figure 1. (*continued*)

Table 3. Description of archetypes.

Archetype label	Description	Areas for improvement
High readiness	Countries with a strong readiness to eliminate cervical cancer and prevent HPV-related cancers. These countries have comprehensive gender-neutral vaccination programs with high vaccine coverage rates, well-established, effective, and accessible screening programs as well as robust and broadly available cancer management facilities. They have strategic plans specifically targeting cervical cancer elimination in place and show exceptional progress across all three domains.	To continue to focus on all three domains, vaccination, screening and treatment, to ensure to stay on track toward cervical cancer elimination and HPV-related cancer prevention.
Moderate-high readiness	Countries with a good level of readiness to eliminate cervical cancer and prevent HPV-related cancers but have certain areas that require further improvement. These countries have implemented vaccination programs with reasonable coverage rates, effective screening initiatives, and accessible treatment facilities. There may be some gaps observed across domains that should be addressed in order to achieve the highest level of readiness.	To progress to high readiness, countries should seek to improve VCRs for both genders, employ accessible and effective screening programs, and ensure treatment facilities are robust. Countries should seek to improve data surveillance to ensure progress is documented and detailed.
Moderate-low readiness	Countries that show d some progress toward cervical cancer elimination and HPV-related cancers, but still have areas which require significant improvement. These countries may have vaccination programs that are restricted to certain populations or/ and have low coverage rates. Screening may exist but lack broad accessibility and good quality Treatment facilities may exist but with limited access.	To progress to moderate-high and high readiness, countries should vastly improve VCRs for both genders, improve accessibility to/ quality of screening programs, and ensure to improve treatment facilities. Countries should ensure data accessible and up-to-date by implementing vaccination, screening, and treatment registries.
Low readiness	Countries at a relatively low level of readiness to eliminate cervical cancer and prevent HPV-related cancers. These countries may be in the early stages of implementing vaccination programs, establishing screening initiatives, and improving treatment facilities. Comprehensive cervical cancer elimination or cancer prevention plans and key elements may still be under development, and their progress toward cervical cancer elimination is limited.	To progress to moderate-low, moderate-high and high readiness, countries should continue to develop vaccination programs, screening programs, and treatment facilities. Countries should strive to improve decision making and implementation of vaccination, screening, and treatment programs. Countries should begin to monitor data to track progress to elimination.

NA: Not applicable; VCR: Vaccination coverage rate.

EU and WHO strategies and recommendations. The framework differs from that of the WHO as additional elements, such as policy-focused elements, are included. The framework provides a comprehensive assessment of the differences and discrepancies between countries' readiness status and how the countries have approached implementation strategies. Overall findings demonstrated a strong overall political willingness to comply with the objective of cervical cancer elimination across Europe. Though, there is substantial variation between countries in terms of developing sufficient guidelines and targets for elimination parameters and making the subsequent implementations to achieve the targets within a reasonable timeline. It should be noted, however, that international public sources such as the WHO and OECD were used to inform key indicators and to ensure consistency and comparability.

Findings showed that higher-income and western European countries such as Sweden, UK, and Ireland achieved the highest overall readiness scores, while Eastern and Southern European countries such as Bulgaria, Romania, Cyprus, and Greece, some of which are considered lower-income countries, achieved the lowest. Findings show that differences in country performance, mainly driven by differences in vaccination and screening related implementation efforts, may be due to countries' income status to some extent, which could reflect vaccine inequity. Sweden attained the highest overall score, highlighting their readiness to achieve cervical cancer elimination. These results concur with findings from the white paper 'A global blueprint for cervical cancer elimination: learnings from Sweden' published in 2023, stating that Sweden may become the first European country to come close to eliminating cervical cancer before 2030 [51]. One study by Basak et al., 2022 found that the wealthier the country (measured at the GDP per capita) the higher were vaccination rates.

5.1. Key considerations

When comparing higher and lower tiered countries, key parameters associated with high readiness were high VCRs (>70%), availability of gender neutral vaccines, availability of catch-up cohort vaccinations, vaccination setting not limited to healthcare facilities (e.g. also school- or pharmacy-based vaccination), organized screening programmes, self-sampling screening, and use of HPV DNA primary screening tests. Findings generally aligned with recommendations made by the WHO and EU Commission [14,36]. Moreover, our assessment showed that high readiness countries typically have mature HPV vaccination programmes for primary cohorts, incorporating gender neutral vaccinations, while offering catch-up cohort vaccination for late adolescent and adult populations. This also aligns with the EU Council recommendation on vaccine-preventable cancers which highlight the need for all member states to strengthen national efforts to fully vaccinating at least 90% of the EU target population of females, and significantly increasing the vaccination of males [39]. Countries scoring within the low or moderate-low readiness archetypes may seek to implement these key parameters to improve progress to achieve cervical cancer elimination. For example, approximately half of the countries assessed did not have school-based vaccinations available which was

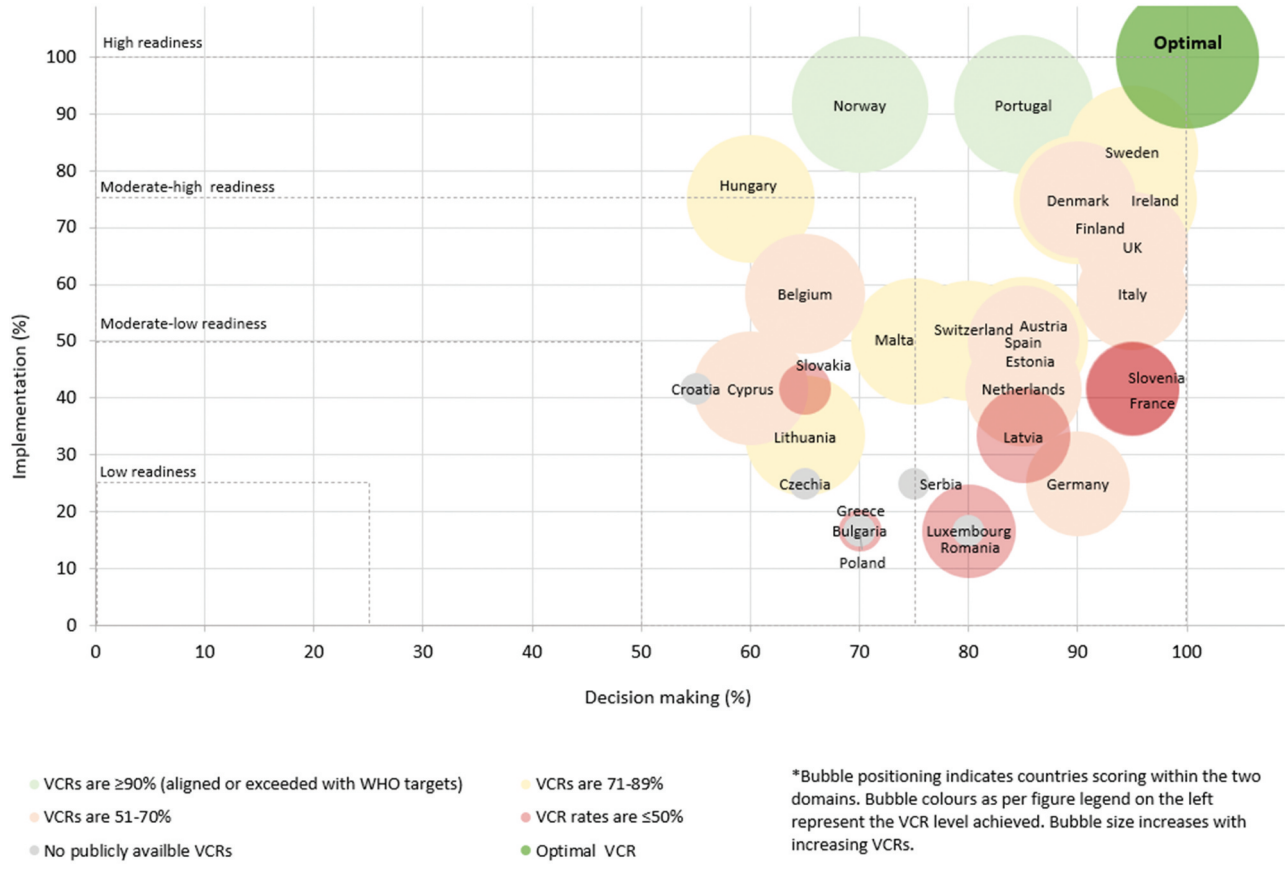


Figure 2. Decision making versus implementation scores for vaccination (female).
UK: United Kingdom; VCR: Vaccination coverage rate; WHO: World Health Organization.
Bubble positioning indicates countries scoring within the two domains. Bubble colors as per figure legend on the left represent the VCR level achieved. Bubble size increases with increasing VCRs.

identified as one of the key drivers of high HPV vaccine uptake by both the WHO and the EU [14,36]. Further, the EU's Council Recommendations on vaccine-preventable cancers reiterate the importance of improving VCRs for both females and males, as well as continuously monitoring coverage rates for both genders, by offering vaccination to adolescent and preadolescent girls and boys in schools and educational settings or by implementing or strengthening invitation and reminder systems for vaccination in accordance with the national context [39].

High readiness countries scored consistently higher within the vaccination domain, indicating that efforts for decision making and implementation of HPV primary prevention positively impacted overall readiness to eliminate cervical cancer. This additionally aligns with the outputs from a 2023 report on HPV vaccination and cervical cancer screening in Asian National Cancer Centers Alliance (ANCCA) member countries, which reported that countries with a national vaccination program and surveillance data achieve a reduction in HPV prevalence and high-grade cervical cancer precancers, compared to countries without such programs.

It should be noted that although there are differences between countries guiding question scoring, the assessment of countries is complex and domains and sub-domains were built on a series of guiding questions which correlate with each other, making the comparison between domain and subdomain scoring most important. This ensures the framework is comprehensive, rather than limiting the assessment to VCRs, screening participation rates, and incidence data. As an example, it is important for countries to have multiple vaccination cohorts which has been explored in one guiding question (primary and catch-up); however, this may not be sufficient to reach cervical cancer elimination, if high vaccination coverage is not achieved across all cohorts (VCR explored in separate guiding questions).

Moreover, guiding questions explore what the optimal strategies across the three domains may be, to provide a visual presentation of areas for improvement that could be considered for future decision making. However, not all parameters are equally important and not all would have to be improved to move closer toward cervical cancer elimination. For example, Sweden which scored the highest compared to other countries is still using an opt-in vaccine approach, which does not appear to limit the countries efforts due to other important implementations. Nevertheless, for other countries switching from an opt-in to an opt-out vaccination strategy may be favorable. Since parameters are complex and countries situations are unique, experts were asked to help guide countries in their future decision making and ultimately help improve their current status, by providing key considerations to focus their efforts on, which are reported in the Section 5.4.

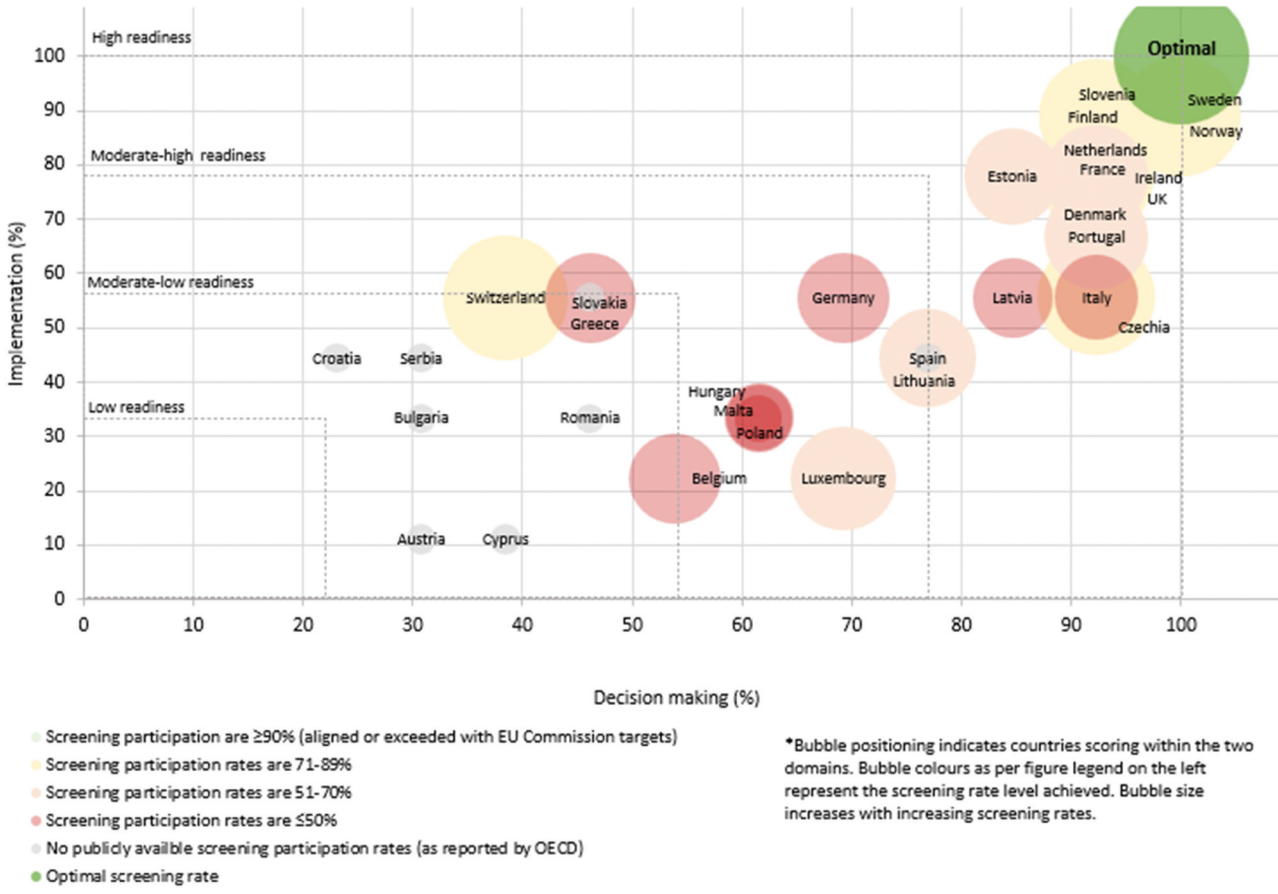


Figure 3. Decision making versus implementation scores for screening.
EU: European Union; OECD: Organisation for Economic Co-operation and Development; UK: United Kingdom.
Bubble positioning indicates countries scoring within the two domains. Bubble colors as per figure legend on the left represent the screening rate level achieved. Bubble size increases with increasing screening rates.

5.2. Data systems and surveillance

In addition to political willingness and implementation of elimination strategies, the ability to collect, monitor, and use data accurately is a pertinent factor in steps toward cervical cancer elimination. The effectiveness of implementing digital technologies to support vaccination programs has been demonstrated across ten European countries, demonstrating the positive impact institutional websites, educational videos, and electronic immunization records have on vaccination uptake [52].

Within this assessment, some country-specific data gaps were identified across vaccination, screening, and treatment domains, which prevents accurate estimates of cervical cancer and limit the tracking of efforts toward cervical cancer elimination. Furthermore, elimination strategies can only be successfully implemented following informed decision making, based on transparency of up-to-date, precise data at a country level as well as subnational level. This was lacking across several countries for parameters such as VCRs (male and female), screening participation rates, and publication of treatment rates. Improvement in country surveillance programs is additionally recommended as an initiative within the EU's Beating Cancer Plan, and should be employed by countries to improve readiness status [53]. Moreover, implementation of registries which produce up-to-date, annual reports is warranted to provide a clear indication of a country's progress. This is similarly echoed by the Council of the EU recommendations on vaccine preventable cancers, which state the necessity for improving the monitoring of VCRs by building or upgrading population-based electronic vaccination registries or equivalents to enable the analysis of data at a national and subnational level. Further, data recorded by different vaccine and vaccination providers can be seamlessly transferred, to inform efficient, data-driven public health action [39].

It should be noted that since the framework data collection was finalized in July 2024, some countries such as Hungary are already putting different initiatives in place that will improve their scoring in future updates.

5.3. Limitations

Due to limited publicly available data or accurate and reliable country-specific data, some data gaps were identified across countries within this assessment. As reliable and accurate data are one of the cornerstones for informed decision making [54], countries should strive to improve data collection and surveillance to ensure reflective and accurate tracking of progress toward cervical cancer elimination. Moreover, since this work provides a static representation of the current country status,

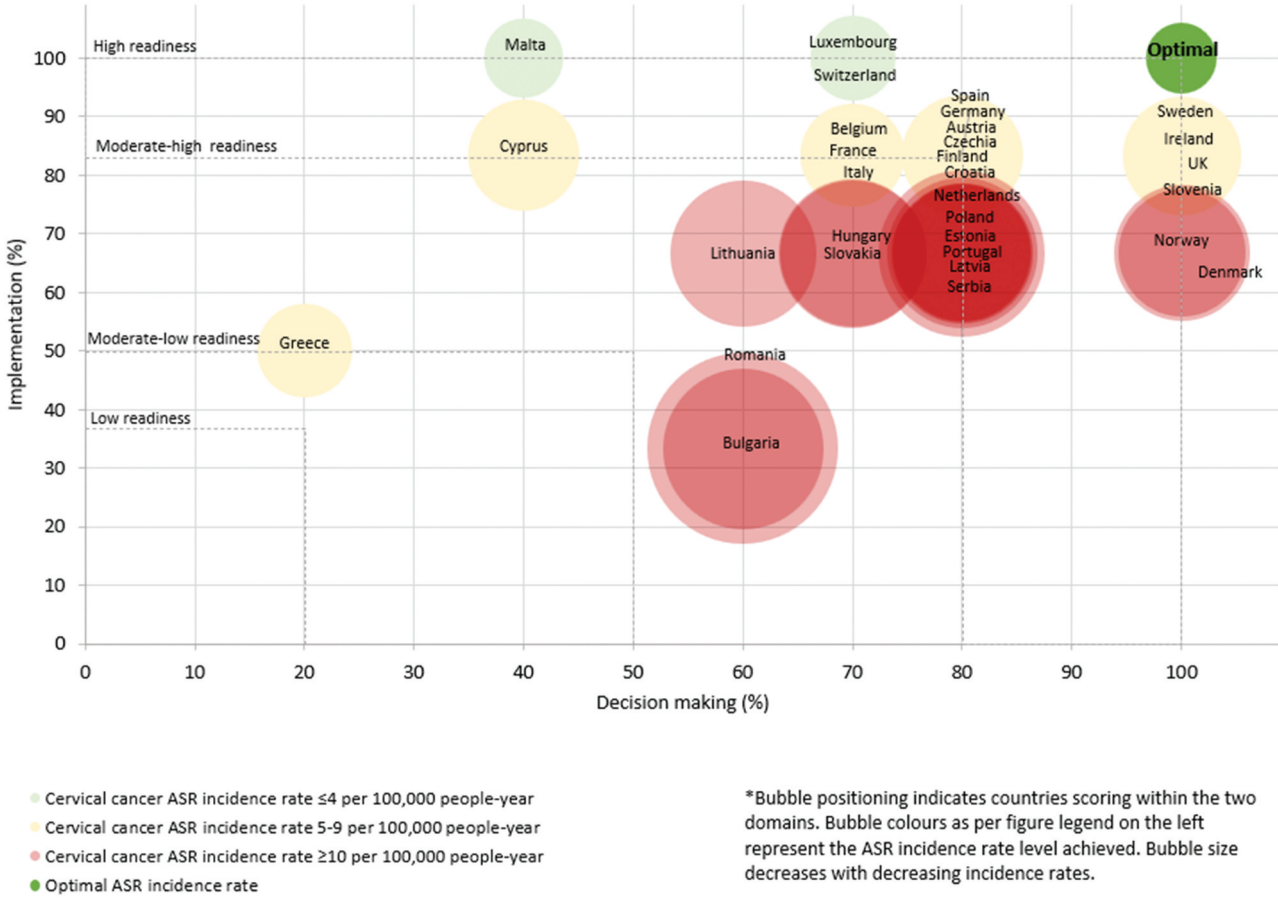


Figure 4. Decision making versus implementation scores for treatment.
ASR: Age standardized rate; UK: United Kingdom.
Bubble positioning indicates countries scoring within the two domains. Bubble colors as per figure legend on the left represent the ASR incidence rate level achieved. Bubble size decreases with decreasing incidence rates.

rather than an assessing changes over time, it is recognized that data are evolving and therefore this assessment may require updates as countries improve their decision making, implementation, and data surveillance of vaccination, screening, and treatment programs.

Scoring across guiding questions is currently limited to a maximum of 2–3 points, although for some guiding questions additional scoring levels may be appropriate to capture additional country specific nuances. The main reason for this was to keep achievable points across guiding questions more or less the same. Future updates of the framework may explore adding more weight on specific guiding questions by introducing more achievable points, although this may add complexity and should generally reflect the weight of questions compared to others.

Besides the assumptions that HPV vaccination included in the NIP [42] and screening programmes (organized population-based) [50] are generally free of charge, funding and cost related aspects are not currently considered in this framework. As this would add an additional complexity to the framework, it may be explored in future updates. In addition, this framework may be adapted in the future to not only assess the elimination of cervical cancer, but also other HPV-related cancers and diseases.

6. Expert opinion

There is a strong political willingness across European countries to adhere to cervical cancer elimination strategies, such as those stated by the WHO and EU [14,36]. Although, it should be recognized that without the implementation of facilities to activate cervical cancer strategies and targets, countries cannot progress and achieve high readiness for elimination. In addition to maintaining well-established vaccination and screening prevention programmes as well as treatment programmes, accurate data collection and surveillance is necessary to track and improve country progress. To achieve cervical cancer elimination, country decision makers should consider implementing key parameters that will broaden access and improve adherence to vaccination and screening programmes. Such parameters include mobilizing healthcare professionals to proactively address the importance of vaccination and screening, improving vaccination settings within schools, pharmacies or other easily accessible facilities to increase VCRs, gender-neutral access to vaccines, availability of catch-up cohort vaccinations, organized screening programmes, self-sampling screening and use of HPV DNA as primary screening tests. Furthermore, it is pivotal that countries have population-based registries for data surveillance in

place, as well as willingness to ensure data are publicly accessible and up to date. In particular, countries should focus on improving vaccination as primary prevention strategy and screening as secondary prevention and detection strategy, through well-established programmes, to substantially decrease the prevalence of HPV infection, eliminate cervical cancer, and subsequently prevention of other HPV-related cancers. Overall, it was reiterated that vaccination, screening and treatment do not carry the same weight when it comes to cervical cancer elimination and that vaccination for primary prevention followed by screening should be the main focus, as reflected in the framework structure and weighting across domains.

Global health systems face challenges ensuring access to high-quality healthcare for all populations. Evidence-based tools to support a value-based decision-making process in the context of disease prevention are needed, taking into account cost and health outcomes in addition to societal value, to ensure social wellbeing is maximized [55,56].

Funding

This paper was funded by Merck Sharp & Dohme LLC, a subsidiary of Merck & Co., Inc., Rahway, NJ, USA.

Declaration of interest

U Sabale is an employee of MSD Lithuania who may own stock and/or hold stock options in Merck & Co., Inc., Rahway, NJ, U.S.A., E Karamousouli is an employee of MSD Greece who may own stock and/or hold stock options in Merck & Co., Inc., Rahway, NJ, U.S.A., S Valente is an employee of MSD Italy who may own stock and/or hold stock options in Merck & Co., Inc., Rahway, NJ, U.S.A., R Hornby is an employee of MSD Denmark who may own stock and/or hold stock options in Merck & Co., Inc., Rahway, NJ, U.S.A., F Morosan is an employee of MSD Romania and who may own stock and/or hold stock options in Merck & Co., Inc., Rahway, NJ, U.S.A. Research execution was delivered by L Heron, D Riley, M Heuser and O Dodd, who are employed by Adelphi Values PROVE; the research was commissioned by MSD and funding was provided to Adelphi Values PROVE. GE Calabrò, T Agorastos and Z Krasznai were reimbursed for serving as steering committee members. The authors have no other relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript apart from those disclosed.

Reviewer disclosures

Peer reviewers on this manuscript have no relevant financial or other relationships to disclose.

Author contributions

All authors attest they meet the ICMJE criteria for authorship. U Sabale, E Karamousouli, S Valente, R Hornby, F Morosan, M Heuser, O Dodd, D Riley and L Heron contributed to study design, data analysis, data interpretation, and preparing and editing the manuscript. GE Calabrò, T Agorastos, P Sevelda, and Z Krasznai contributed to data validation and provided expert opinion. All authors have approved the final manuscript and agree to be accountable for all aspects of the work.

Data availability statement

The full datasets generated and analyzed to inform the conclusions drawn within the manuscript during the current study are available from the corresponding author on reasonable request.

References

Papers of special note have been highlighted as either of interest (•) or of considerable interest (••) to readers.

1. Kombe Kombe AJ, Li B, Zahid A, et al. Epidemiology and burden of human papillomavirus and related diseases, molecular pathogenesis, and vaccine evaluation. Front Public Health. 2021;8:8. doi: 10.3389/fpubh.2020.552028
2. Chesson HW, Dunne EF, Hariri S, et al. The estimated lifetime probability of acquiring human papillomavirus in the United States. Sex Transm Dis. 2014;41(11):660. doi: 10.1097/OLQ.0000000000000193
3. Catalan Institute of Oncology (ICO), International Agency for Research on Cancer (IARC). Human Papillomavirus and Related Diseases Report. 2019 [cited 2023 Mar 15]. p. 82.
4. CDC. Human Papillomavirus (HPV). 2023) [cited 2023 Mar 15]. Available from: https://cdc.gov/vaccines/pubs/pinkbook/hpv.html#:~:text=Infection%20with%20low-risk%20or,HPV%20types%206%20or%2011
5. Bruni L, Albero G, Serrano B, et al. Human papillomavirus and related diseases report (2023). [cited 2024 Jul]. https://hpvcentre.net/statistics/reports/XWX.pdf
6. European Commission. Cervical cancer burden EU-27. 2021 [cited 2024 May]. Available from: https://ecis.jrc.ec.europa.eu/sites/default/files/2023–12/cervical_cancer_en-Nov_2021.pdf
7. de Martel C, Georges D, Bray F, et al. Global burden of cancer attributable to infections in 2018: a worldwide incidence analysis. Lancet Glob Health. 2020;8(2). pe180–e190. doi: 10.1016/S2214-109X(19)30488-7
8. Van Dyne EA, Henley SJ, Saraiya M. Trends in human papillomavirus–associated cancers—United States, 1999–2015. MMWR Morb Mortal Wkly Rep. 2018;67(33):918–924. doi: 10.15585/mmwr.mm6733a2
9. Lechner M, Liu J, Masterson L, et al. Hpv-associated oropharyngeal cancer: epidemiology, molecular biology and clinical management. Nat Rev Clin Oncol. 2022;19(5):306–327. doi: 10.1038/s41571-022-00603-7
10. Carlander A-L, Larsen CG, Jensen DH, et al. Continuing rise in oropharyngeal cancer in a high HPV prevalence area: a Danish population-based study from 2011 to 2014. Eur J Cancer. 2017;70(75–82):75–82. doi: 10.1016/j.ejca.2016.10.015
11. European Cancer Organisation. ACTION AREA 1: HPV prevention via gender neutral vaccination programmes. 2024 [cited 2024 Sep 30th]. https://www.europeancancer.org/content/hpv-action-area-1-hpv-prevention-via-gender-neutral-vaccination-programmes
12. World Health Organization. European Immunization Agenda 2030. 2021 [cited 2023 Mar 15].Available from: https://iris.who.int/bitstream/handle/10665/348002/9789289056052-eng.pdf?sequence=1

•• Of considerable interest to inform the structure of the framework and outline the European Commission's guidance for cervical cancer elimination.

13. Council of the European Union. Council recommendation on vaccine-preventable cancers (2024).
[cited 2024 Sep 24th]. Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CONSIL%3AST_10128_2024_INIT&qid=1719224079627

•• of considerable interest to inform the structure of the framework and outline the European Commission's guidance for cervical cancer elimination

14. European Commission. Europe's beating cancer plan: communication from the commission to the european parliament and the council. 2022 [cited 2023 Dec 5th]. https://health.ec.europa.eu/system/files/2022–02/eu_cancer-plan_en_0.pdf
15. de Sanjosé S, Serrano B, Tous S, et al. Burden of human papillomavirus (hpv)-related cancers attributable to HPVs 6/11/16/18/31/33/45/52 and 58. JNCI Cancer Spectr. 2018;2(4):ky045. doi: 10.1093/jncics/pky045
16. Palmer C, Dolk C, Sabale U, et al. Cost-effectiveness of nonavalent HPV vaccination in the Netherlands. Expert Rev Vaccines. 2024;23(1):312–323. doi:10.1080/14760584.2024.2322543

17. Man I, Georges D, Sankaranarayanan R, et al. Building resilient cervical cancer prevention through gender-neutral HPV vaccination. Elife. 2023;12(e85735). doi: 10.7554/eLife.85735
18. Elfström KM, Lazzarato F, Franceschi S, et al. Human papillomavirus vaccination of boys and extended catch-up vaccination: effects on the resilience of programs. J Infect Dis. 2016;213(2):199–205. doi:10.1093/infdis/jiv368
19. Marty R, Roze S, Bresse X, et al. Estimating the clinical benefits of vaccinating boys and girls against hpv-related diseases in Europe. BMC Cancer. 2013;13(1). doi: 10.1186/1471-2407-13-10
20. Lehtinen M, Luostarinen T, Vänskä S, et al. Gender-neutral vaccination provides improved control of human papillomavirus types 18/31/33/35 through herd immunity: results of a community randomized trial (III). Int J Cancer. 2018;143(9):2299–2310. doi: 10.1002/ijc.31618
21. Hintze JM, O'Neill JP. Strengthening the case for gender-neutral and the nonavalent HPV vaccine. Eur Arch Otorhinolaryngol. 2018;275(4):857–865. doi:10.1007/s00405-018-4866-y
22. Takes RP, Wierzbicka M, D'Souza G, et al. HPV vaccination to prevent oropharyngeal carcinoma: what can be learned from anogenital vaccination programs? Oral Oncol. 2015;51(12):1057–1060. doi: 10.1016/j.oraloncology.2015.10.011
23. Markowitz LE, Schiller JT. Human papillomavirus vaccines. J Infect Dis. 2021;224(12 Suppl 2):S367–S378. doi: 10.1093/infdis/jiaa621
24. Vänskä S, Luostarinen T, Baussano I, et al. Vaccination with moderate coverage eradicates oncogenic human papillomaviruses if a gender-neutral strategy is applied. J Infect Dis. 2020;222(6):948–956. doi: 10.1093/infdis/jiaa099
25. Joura EA, Kyrgiou M, Bosch FX, et al. Human papillomavirus vaccination: the ESGO–EFC position paper of the European society of gynaecologic oncology and the European federation for colposcopy. Euro J Cancer. 2019;116(21–26):21–26. doi: 10.1016/j.ejca.2019.04.032
26. Mavundza EJ, Iwu-Jaja CJ, Wiyeh AB, et al. A systematic review of interventions to improve HPV vaccination coverage. Vaccines (Basel). 2021;9(7):687. doi: 10.3390/vaccines9070687
27. Bogani G, Ghelardi A, Sopracordevole F, et al. Human papillomavirus (HPV) vaccination: a call for action in Italy. Int J Gynecol Cancer. 2023;33(7):1132–1139. doi: 10.1136/ijgc-2023-004275
28. Gabutti G, Ogliastro M. History of human papilloma virus vaccination with a focus on Italy. Women. 2024;4(1):42–52. doi:10.3390/women4010004
29. Bogani G, Scambia G, Raspagliesi F, et al. Human papillomavirus vaccination coverage in Italy. Eur J Cancer Prev. 2024;34(1):81–82.
30. Hartwig S, St Guily JL, Dominiak-Felden G, et al. Estimation of the overall burden of cancers, precancerous lesions, and genital warts attributable to 9-valent HPV vaccine types in women and men in Europe. Infect Agent Cancer. 2017;12(1). doi: 10.1186/s13027-017-0129-6
31. Ramírez AT, Valls J, Baena A, et al. Performance of cervical cytology and HPV testing for primary cervical cancer screening in Latin America: an analysis within the ESTAMPA study. Lancet Reg Health - Americas. 2023;26:100593. doi: 10.1016/j.lana.2023.100593
32. Feldstein O, Gali-Zamir H, Schejter E, et al. High-risk HPV testing vs liquid-based cytology for cervical cancer screening among 25- to 30-year-old women: a historical cohort study. Acta Obstet Gynecol Scand. 2023;102(2):226–233. doi: 10.1111/aogs.14482
33. Koliopoulos G, Nyaga VN, Santesso N, et al. Cytology versus HPV testing for cervical cancer screening in the general population. Cochrane Database Systematic Reviews. 2017;8(7):Cd008587. doi: 10.1002/14651858.CD008587.pub2
34. World Health Organisation. Table 1, Screening and treatment recommendations and good practice statements for the general population of women and women living with HIV. In: WHO guideline for screening and treatment of cervical pre-cancer lesions for cervical cancer prevention. 2nd ed. National Library of Medicine: National Center of Biotechnology Information; 2021.
35. National Health Service. Treatment for cervical cancer. 2024 [cited 2024 Sep 30th]. https://www.nhs.uk/conditions/cervical-cancer/treatment/
36. World Health Organisation. Global strategy to accelerate the elimination of cervical cancer as a public health problem. 2020 [cited 2023 Mar 15th]. https://www.who.int/publications/i/item/9789240014107

•• **Of considerable interest to inform the structure of the framework and outline the WHO's guidance for cervical cancer elimination**

37. World Health Organisation. Framework for monitoring the implementation of the WHO global strategy to accelerate the elimination of cervical cancer as a public health problem. 2023 [cited 2024 May]. Available from: https://cdn.who.int/media/docs/default-source/ncds/ncd-surveillance/cxca/220121-bls21466-who-cp-accompany-doc_v01-web_.pdf?sfvrsn=2d2c811c_5&download=true

•• **Of considerable interest to inform the structure of the framework and outline the WHO's guidance for cervical cancer elimination**

38. EU4 health framework. General objectives of the EU4 health framework. 2022 [cited 2023 Dec 6th]. https://health.ec.europa.eu/system/files/2022–05/eu4health-2021-2027_2022-work-prog_en.pdf
39. Council of the European Union. Council recommendation on vaccine-preventable cancers. 2024 [cited 2024 Jun]. Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CONSIL%3AST_10128_2024_INIT&qid=1719224079627
40. Ong SK, Abe SK, Thilagaratnam S, et al. Towards elimination of cervical cancer–human papillomavirus (HPV) vaccination and cervical cancer screening in asian national cancer centers alliance (ANCCA) member countries. The Lancet Reg Health–West Pac. 2023;39:100860. doi: 10.1016/j.lanwpc.2023.100860
41. Pham TH, Beck E, Postma MJ, et al. Country score tool to assess readiness and guide evidence generation of immunization programs in aging adults in Europe. Front Public Health. 2023;10. doi: 10.3389/fpubh.2022.1080678

• **Of interest to inform the structure of the framework**

42. Laigle V, Postma MJ, Pavlovic M, et al. Vaccine market access pathways in the EU27 and the United Kingdom– analysis and recommendations for improvements. Vaccine. 2021;39(39):5706–5718. doi: 10.1016/j.vaccine.2021.07.040

• **Of interest to inform the structure of the framework.**

43. European Parliamentary Forum. HPV Prevention Policy Atlas 2023. 2023 [cited 2024 Apr 4]. Available from: https://www.epfweb.org/sites/default/files/2024–01/HPV%20Atlas_EN%202024-JAN25.pdf
44. Cooperation A-P. Status report: cervical cancer elimination in the APEC region. 2023 [cited 2024 May]. Available from: https://www.apec.org/docs/default-source/publications/2023/3/status-report-on-cervical-cancer-elimination-in-the-apec-region/223_hwg_apec-cervical-cancer-status-report-2023_v3.pdf?sfvrsn=3b3d289a_2
45. Goldin S, Moen A, Moss WJ, et al. The 2020 immunization programme landscape: piloting an assessment metric to evaluate the maturity of national immunization programmes across the life course. Vaccine. 2024;42:125541. doi: 10.1016/j.vaccine.2023.12.051
46. OECD. Health policy studies: beating cancer inequalities in the EU - Spotlight on cancer prevention and early detection. 2024 [Accessed on 5th March 2024]. Available from https://www.oecd-ilibrary.org/docserver/14fdc89a-en.pdf?expires=1707226063&id=id&accname=guest&checksum=ED696E4E190391E7CC2FD049AD1A5B6C

• **Of interest to inform the data included within the readiness assessment**

47. European Cancer Information System. Incidence and mortality 2022. 2022 [cited 2024 May]. Available from: https://ecis.jrc.ec.europa.eu/explorer.php?$0–0$1-All$4–2$3–30$6–0,85$5–2022,2022$7–7$2-All$CEstByCountry$X0_8–3$X0_19-AE27$X0_20-No$CEstBySexByCountry$X1_8–3$X1_19-AE27$X1_-1–1$CEstByIndiByCountry$X2_8–3$X2_19-AE27$X2_20-No$CEstRelative$X3_8–3$X3_9-AE27$X3_19-AE27$CEstByCountryTable$X4_19-AE27.

• **Of interest to inform the data included within the readiness assessment**

48. World Health Organization (WHO). Human papillomavirus (HPV) vaccination coverage (2022). [cited 2023 Nov 29th]. https://immunizationdata.who.int/global/wiise-detail-page/human-papillomavirus-(hpv)-vaccination-coverage
    - **Of interest to inform the data included within the readiness assessment**
49. Nguyen-Huu NH, Thilly N, Derrough T, et al. Human papillomavirus vaccination coverage, policies, and practical implementation across Europe. Vaccine. 2020;38(6):1315–1331. doi: 10.1016/j.vaccine.2019.11.081
50. Bonanni P, Faivre P, Lopalco PL, et al. The status of human papillomavirus vaccination recommendation, funding, and coverage in WHO Europe countries (2018–2019). Expert Rev Vaccines. 2020;19(11):1073–1083. doi: 10.1080/14760584.2020.1858057
51. MSD. A global blueprint for cervical cancer elimination: learnings from Sweden. 2023) [Accessed on March 25th 2024]. Available from https://impact.economist.com/perspectives/sites/default/files/download/msd_ccp_exsum_final.pdf
52. Odone A, Gianfredi V, Sorbello S, et al. The use of digital technologies to support vaccination programmes in Europe: state of the art and best practices from experts' interviews. Vaccines (Basel). 2021;9(10):1126. doi: 10.3390/vaccines9101126
53. European Commission. PERCH. 2022 [cited 2024 May]. Available from https://health.ec.europa.eu/document/download/06515c08–0122-428b-8676-d7e433eafc40_en?filename=fs_cancer_perch.pdf
54. Bernardi FA, Alves D, Crepaldi N, et al. Data quality in health research: integrative literature review. J Med Internet Res. 2023;25(e41446):e41446. doi: 10.2196/41446
55. Calabrò GE, Riccardi MT, D'Ambrosio F, et al. Cervical cancer elimination in Italy: current scenario and future endeavors for a value based prevention. Front Public Health. 2022;10(1010237). doi: 10.3389/fpubh.2022.1010237
56. De Waure C, Calabrò GE, Ricciardi W. Recommendations to drive a value-based decision-making on vaccination. Expert Rev Vaccines. 2022;21(3):289–296. doi:10.1080/14760584.2022.2021880