BMC Medicine

RESEARCH

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Global cervical cancer elimination: quantifying the status, progress, and gaps

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Abstract

Background To address the public health concern of cervical cancer (CC), 194 countries committed to eliminate it at the initiative of the World Health Organization (WHO). We summarised quantitative results concerning CC elimination across these countries, including the progress in implementing three prevention levels (human papillomavirus [HPV] vaccination, CC screening, and treatment for patients with CC) and achievement of interim Global Strategy for Cervical Cancer Elimination targets.

Methods Data were obtained from the International Agency for Research on Cancer, WHO, United Nations International Children's Emergency Fund, and country responses to the WHO National Capacity Survey on Non-Communicable Diseases. This retrospective analysis examined data from 194 countries and regions, stratified by national income (high-income countries (HICs) vs low- and middle-income countries (LMICs)) and geographic location (continents such as Europe, Asia, and North America). A quantitative assessment evaluated global progress in primary, secondary, and tertiary CC prevention.

Results By 2020, four countries had achieved Target 1 (90% of girls fully vaccinated against HPV by age 15). A total of 115 countries (51 (44.35%) HICs and 64 (55.65%) LMICs)) included HPV vaccination in their national immunisation programs. As of 2021, 133 countries (50 (37.59%) HICs and 83 (62.41%) LMICs)) implemented CC screening programs. Most of these were in Europe (41, 30.83%), Asia (32, 24.06%), and North America (20, 15.04%). Additionally, 126 countries (44 (34.92%) HICs and 82 (65.08%) LMICs)) had published national guidelines on CC management. These countries were primarily in Asia (32, 25.40%) and Europe (32, 25.40%). Furthermore, 69 countries provided palliative care under both scenarios. The 10 countries with the highest annual opioid consumption (excluding methadone) for CC, in oral morphine equivalence per capita (2017), were all HICs.

Conclusions Major inequalities persist in CC vaccination and screening across 194 countries, and access to these services is limited in most LMICs. Focusing on vulnerable populations with lower incomes and regions with stunted economic growth may help alleviate inequity and accelerate CC elimination. We also found that tertiary prevention was achieved in most LMICs, but the indicator-reported annual opioid consumption in oral morphine equivalents indirectly illustrates the under-utilisation of cancer treatment services.

Keywords Cervical cancer elimination, Immunization, Screening, Treatment

Background

As a prevalent malignancy that poses a significant threat to women's health, cervical cancer represents a prominent global public health concern. In 2022, there were 661,021 new cases and 348,189 deaths associated with cervical cancer worldwide [1]. Cervical cancer is most often caused by high-risk human papillomavirus

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(HPV) infection [2]. HPV vaccination is considered an effective means of preventing cervical cancer [3]. In 2020, the World Health Organization (WHO) launched the Global Strategy for Accelerated Elimination of Cervical Cancer, which has since been positively responded to by 194 countries around the world. The threshold for eliminating cervical cancer in each country is < 4 new cases of cervical cancer per 100,000 women per year [4].

Between 2018 and 2019, the WHO assessed epidemiological cervical cancer data and incidence rates across various countries, calling for a global initiative to eliminate this malignancy as a public health issue. The organisation proposed a comprehensive strategy combining HPV vaccination, screening, treatment of precancerous lesions, and high-coverage management of cervical cancer. The goal is to achieve and sustain the 90–70–90 targets by 2030: 90% of girls fully vaccinated with HPV vaccine by age 15, 70% of women screened for cervical cancer using high-performance tests by 35 years of age and again by 45 years of age, and 90% of women identified as having cervical disease receiving treatment (i.e., 90% of women with precancerous lesions and 90% of women with invasive cancer appropriately managed) [4]. The expected impacts of this goal are a 42% reduction in the median cervical cancer incidence by 2045 and a 97% reduction by 2120 globally, with > 74 million new cases of cervical cancer averted; and a median of 300,000 cervical cancer-related deaths averted by 2030—subsequently growing to > 14 million by 2070 and > 62 million by 2120 [5]. For the first time, 194 countries have pledged to eliminate a cancer type under a resolution adopted by the World Health Assembly.

Several scholars have focused on the progress, strategies, and shortcomings of the global strategy to eliminate cervical cancer. Alfaro et al. qualitatively discussed the current obstacles faced by the strategy and proposed strategies based on policy practices [6]. D S et al. examined the global burden of cervical cancer disease and the implementation of a global strategy to eliminate it and assessed the disparity in worldwide cervical cancer incidence and mortality rates in 2020 [5]. A study conducted in Australia predicted the impact of a strategy to eliminate cervical cancer through modelling [7]. Subsequent research further modelled and predicted the differences in cervical cancer mortality rates among countries with different economic development levels under various intervention measures, emphasising the importance of tertiary prevention [8]. While previous studies have discussed the global progress in eliminating cervical cancer from different perspectives, quantitative analyses using real-world data encompassing all stages of tertiary prevention at a global level are lacking.

To achieve this goal and reduce the global burden of cervical cancer, it is necessary to report on the current status and progress towards the goal of global cervical cancer elimination, thereby providing a clear picture of the process of eliminating cervical cancer and the areas that remain to be addressed.

Methods

Data from the International Agency for Research on Cancer, WHO, United Nations International Children's Emergency Fund, and country-level responses to the WHO National Capacity Survey on Non-Communicable Diseases (NCDs) [9–18] provide opportunities to estimate the global process of elimination. In this study, we retrospectively analysed a sample of 194 countries and regions in the report data, stratified by national income level (i.e., high-income countries (HICs), and lower- to middle-income countries (LMICs)) and geographical location (continents such as Europe, Asia, North America). In accordance with the strategic actions outlined to achieve the 2030 targets, we aimed to summarise the global epidemiology of cervical cancer and current status of access to primary, secondary, and tertiary prevention interventions as well as explore the possible gaps currently present in the elimination of cervical cancer. Primary prevention included five indicators: a national immunisation program with or without HPV vaccination, coverage of the first and last doses in the vaccination program for all girls, and coverage of the first and last doses in the vaccination program for girls under 15 years of age. Secondary prevention was mainly based on three indicators: the implementation of a national cervical cancer screening program, cervical cancer screening rate for women aged 30–49 years (ever-screened), and cervical cancer screening rate over the preceding 5 years (and whether the screening rates exceeded 10% and 70%). Tertiary prevention included seven indicators: release of national guidelines for cervical cancer management; establishment of tertiary cancer centres or oncology departments; establishment of pathology laboratories; provision of cancer surgery, chemotherapy, and radiotherapy; and provision of palliative care for patients with NCDs in the public health system.

Results

The current status of cervical cancer elimination

Iraq had the lowest incidence of cervical cancer (1.4/100,000), and Eswatini had the highest incidence (57.8/100,000) among the 194 countries. The incidence rates in 164 of these countries were above the threshold for eliminating cervical cancer, and those in 12 of them were below (incidence rates were not available for 18 countries). The age-standardised cervical

cancer incidence rates in Eswatini (84.6/100,000), Malawi (67.9/100,000), and Zambia (67.9/100,000) were the top three among the 194 countries. Eswatini had the highest cumulative risk of cervical cancer in those aged 0–74 years (8.6%), followed by Zambia (7.4%) and the United Republic of Tanzania (7.4%). Population-based cancer registries (as of 2021) existed in 137 countries (71%). Table 1 details the situation in HICs, with the data for the other countries presented in the Additional file 1: Table S1. Portugal represented the only country among the 194 that met all of the targets. A total of 75 countries (38 HICs) simultaneously implemented national immunisation programs (NIPs) and national screening programs for cervical cancer and issued national guidelines on cervical cancer management. Most of these were in Europe (25, 33.33%), Asia (15, 20.00%), and North America (14, 18.67%).

Progress related to eliminating cervical cancer

The process of eliminating cervical cancer was described using primary prevention (e.g., NIP coverage), secondary prevention (e.g., national screening programs for cervical cancer and rate of cervical cancer screening among women aged 30–49 years), and tertiary prevention (e.g., national guidelines on cervical cancer management, cancer diagnosis and treatment services, and palliative care for patients with NCDs in the public health system).

Progress related to primary prevention

Progress regarding primary prevention for cervical cancer elimination was evaluated using five indicators: the presence of a NIP and the coverage rates of first and final vaccination doses for all girls and women under and over the age of 15 years (Fig. 1). As of 2020, 115 countries (51 (44.35%) HICs and 64 (55.65%) LMICs)) had implemented NIPs for HPV vaccination. In terms of geographic region, 21 (18.26%) were in North America, 11 (9.57%) were in South America, and 33 (28.70%) were in Europe. The overall coverage rate was higher for all females than for those aged < 15 years. First dose coverage was higher than final dose coverage. First dose coverage ranged from 3.00% (Bulgaria, Saint Vincent and the Grenadines, South Africa) to 99.00% (Federated States of Micronesia, Myanmar, Turkmenistan, Uzbekistan), with a median of 63.50%. Final dose coverage ranged from 0.80% (Japan) to 99.00% (Turkmenistan, Uzbekistan), with a median of 49.00%. First dose coverage for females < 15 years of age ranged from 1.00% (Singapore) to 99.00% (Bhutan, Cook Islands, Ecuador, Mexico, Seychelles, Zambia), with a median of 75.50%. Final dose coverage for females < 15 years ranged between 0.30% (Japan, Singapore) to 99.00% (Cook Islands, Mexico, Seychelles), with a median of 62.00%. Primary cervical cancer prevention data were unavailable for 13 countries (Additional file 1: Table S2).

Progress related to secondary prevention

Secondary prevention of cervical cancer was reported through three indicators: a national screening program for cervical cancer and screening for cervical cancer among women aged 30–49 years—both in terms of ever-screened and screened within the preceding 5 years (Fig. 2). As of 2021, the national screening programs for cervical cancer had been implemented in 133 of the participating countries: 50 (37.59%) HICs and 83 (62.41%) LMICs. Most of these were in Europe (41, 30.83%), Asia (32, 24.06%), and North America (20, 15.04%).

As of 2019, 149 countries reported that in the past five years, more than 10% of women aged 30–49 had undergone cervical cancer screening, with 53 (35.57%) being high-income countries and 89 (59.73%) being low- and middle-income countries. Most of these were in Europe (43,28.86%), Asia (33,22.15%), Africa (26,17.45%), North America (23,15.44%), Oceania (11,7.38%), and South America (12,8.05%). (Additional file 2: Fig. S1).

The cervical cancer screening rate for women aged 30–49 in the past five years ranged from less than 10% (in 45 countries, including Egypt, Ethiopia, Papua New Guinea, Pakistan, and Benin) to 90% (in Austria, Finland, Croatia, Sweden, and Greece), with a median of 50%. In 58 countries, more than 70% of women aged 30–49 had undergone screening in the past five years, with 62.07% (36) being high-income countries and 29.31% (17) being low- and middle-income countries.Most of these were in Europe (32,55.17%), North America (16,27.59%), South America (6,10.34%), Oceania (3, 5.17%), and Asia (1,1.72%) (Additional file 2: Fig. S2).

Progress related to tertiary prevention

Tertiary prevention of cervical cancer was described in terms of national guidelines concerning cervical cancer management, cancer diagnosis and treatment services, and palliative care for patients with NCDs in the public health system (Fig. 3). As of 2021, 45 of the participating countries had implemented all of these measures, most of which were in Europe (24, 60.00%), Asia (10, 25.00%), and North America (6, 15.00%). More details are available in Additional file 1: Table S3. As of 2021, 126 of the countries (44 HICs (34.92%) and 82 LMICs (65.08%)) had offered national guidelines concerning cervical cancer management. These countries were mostly located in Asia (32, 25.40%) and Europe (32, 25.40%).

Cancer diagnosis and treatment services were described by five indicators: access to cancer centres or specialized cancer departments at the tertiary healthcare level, pathology services (i.e., laboratories), cancer

Table 1 Status of cervical cancer elimination in 194 countries (data from WHO[5], IARC[6], WHO 2021 NCD Country Capacity Survey[8])

Country	Crude cervical cancer incidence per 100 000 women (2020)	Age-standardized cervical cancer incidence per 100,000 women (2020)	Cumulative risk of cervical cancer, ages 0–74 (2020) %	Cervical cancer mortality-to-incidence ratio (2020)	Population-based cancer registry exists (2021)
Andorra	NA	NA	NA	NA	No
Antigua and Barbuda	NA	NA	NA	NA	No
Australia	7·20	5·60	0·50	0·36	Yes
Austria	8·40	5·30	0·50	0·44	Yes
Bahamas	19·30	14·90	1·70	0·72	Yes
Bahrain	3·50	3·90	0·50	0·57	Yes
Barbados	26·30	15·20	1·40	0·67	Yes
Belgium	10·90	7·70	0·80	0·37	Yes
Brunei Darussalam	25·70	20·80	2·10	0·26	Yes
Canada	7·50	5·50	0·50	0·45	Yes
Chile	15·50	11·10	1·1	0·53	Yes
Cook Islands	NA	NA	NA	NA	No
Croatia	15·80	10·10	1·00	0·45	Yes
Cyprus	7·60	5·60	0·50	0·72	Yes
Czech Republic	14·20	9·30	0·90	0·52	Yes
Denmark	13·20	10·20	0·90	0·36	Yes
Estonia	28·10	18·50	1·90	0·32	Yes
Finland	6·60	5·20	0·50	0·36	Yes
France	10·00	7·00	0·70	0·43	Yes
Germany	11·00	7·60	0·70	0·44	Yes
Greece	13·10	8·10	0·80	0·40	No
Hungary	24·70	17·20	1·60	0·39	Yes
Iceland	9·40	8·30	0·70	0·31	Yes
Ireland	13·80	10·70	1·00	0·31	Yes
Israel	5·60	4·90	0·50	0·49	Yes
Italy	10·20	6·90	0·70	0·32	Yes
Japan	19·80	15·20	1·40	0·33	Yes
Kuwait	3·20	2·80	0·30	0·53	Yes
Latvia	26·30	18·40	1·80	0·51	Yes
Lithuania	28·20	18·70	1·80	0·47	Yes
Luxembourg	7·80	5·20	0·50	0·42	Yes
Malta	5·90	3.70	0·40	0·38	Yes
Monaco	NA	NA	NA	NA	No
Netherlands	9·00	6·90	0·60	0·33	Yes
New Zealand	7·10	5·60	0·50	0·47	Yes
Norway	14·80	12·00	1·10	0·24	Yes
Oman	5·10	6·50	0·70	0·57	Yes
Palau	NA	NA	NA	NA	No
Poland	19·80	12·30	1·30	0·55	Yes
Portugal	16·10	10·80	1·00	0·44	Yes
Qatar	3·20	4·10	0·50	0·48	Yes
Republic of Korea	12·60	8·10	0·80	0·32	Yes
Romanian	34·20	22·60	2·30	0·53	Yes
Saint Kitts and Nevis	NA	NA	NA	NA	No
San Marino	NA	NA	NA	NA	Yes
Saudi Arabia	2·40	2·80	0·30	0·50	Yes
Seychelles	NA	NA	NA	NA	Yes

Table 1 (continued)

Country	Crude cervical cancer incidence per 100 000 women (2020)	Age-standardized cervical cancer incidence per 100,000 women (2020)	Cumulative risk of cervical cancer, ages 0–74 (2020) %	Cervical cancer mortality-to-incidence ratio (2020)	Population-based cancer registry exists (2021)
Singapore	11·10	6·90	0·70	0·56	Yes
Slovakia	24·90	16·60	1·70	0·41	Yes
Slovenia	10·00	6·70	0·70	0·52	Yes
Spain	8·20	5·40	0·50	0·42	Yes
Sweden	13·00	10·40	0·90	0·30	Yes
Switzerland	5·40	3·40	0·30	0·42	Yes
Trinidad and Tobago	28·50	19·80	2·00	0·63	Yes
United Arab Emirates	4·00	6·20	0·70	0·48	Yes
United Kingdom	11·00	9·90	0·80	0·30	Yes
United States of America	8·10	6·20	0·60	0·42	Yes
Uruguay	15·20	11·70	1·10	0·58	Yes

NA Not available

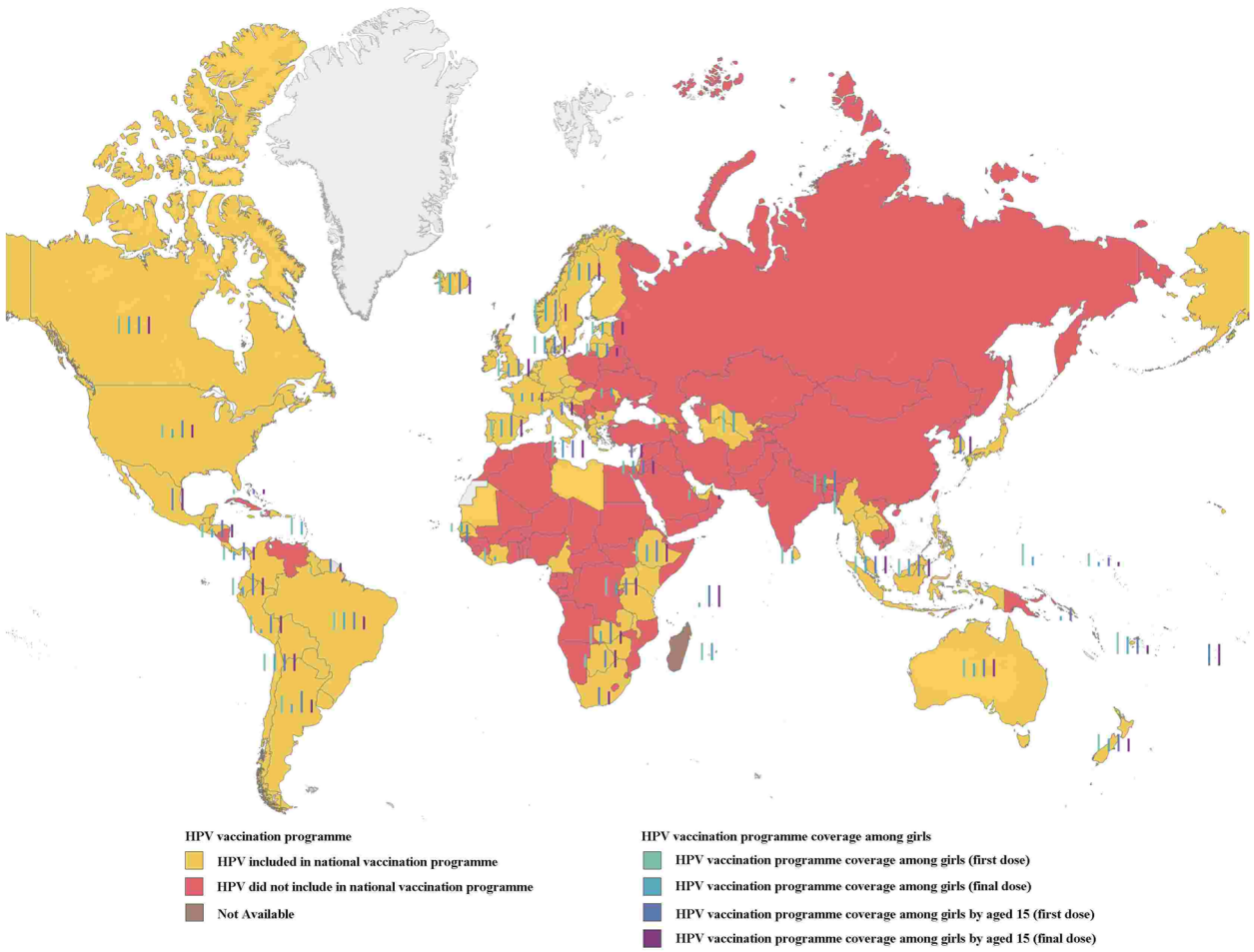

Fig. 1 Status of primary prevention measures for eliminating cervical cancer across 194 participating countries (source: WHO/UNICEF Joint Reporting Form on Immunization [21])

Fig. 2 National screening programs and screening for cervical cancer among 194 participating countries (source: WHO 2021 NCD Country Capacity Survey [13] and Bruni et al. [20])

surgery, chemotherapy, and radiotherapy. Of 151 countries with cancer centres or cancer departments at the tertiary level, 54 (35.76%) were HICs, whereas 97 (64.24%) were LMICs. Of 164 countries that offered cervical cancer-specific pathology services, 108 (65.85%) were LMICs, and 56 (34.15%) were HICs. Of 156 countries that offered cervical cancer surgery, 56 (35.90%) were HICs, and 100 (64.10%) were LMICs. Of 150 countries that offered chemotherapy as a treatment option for cervical cancer, 55 (36.67%) were HICs, and 95 (63.33%)

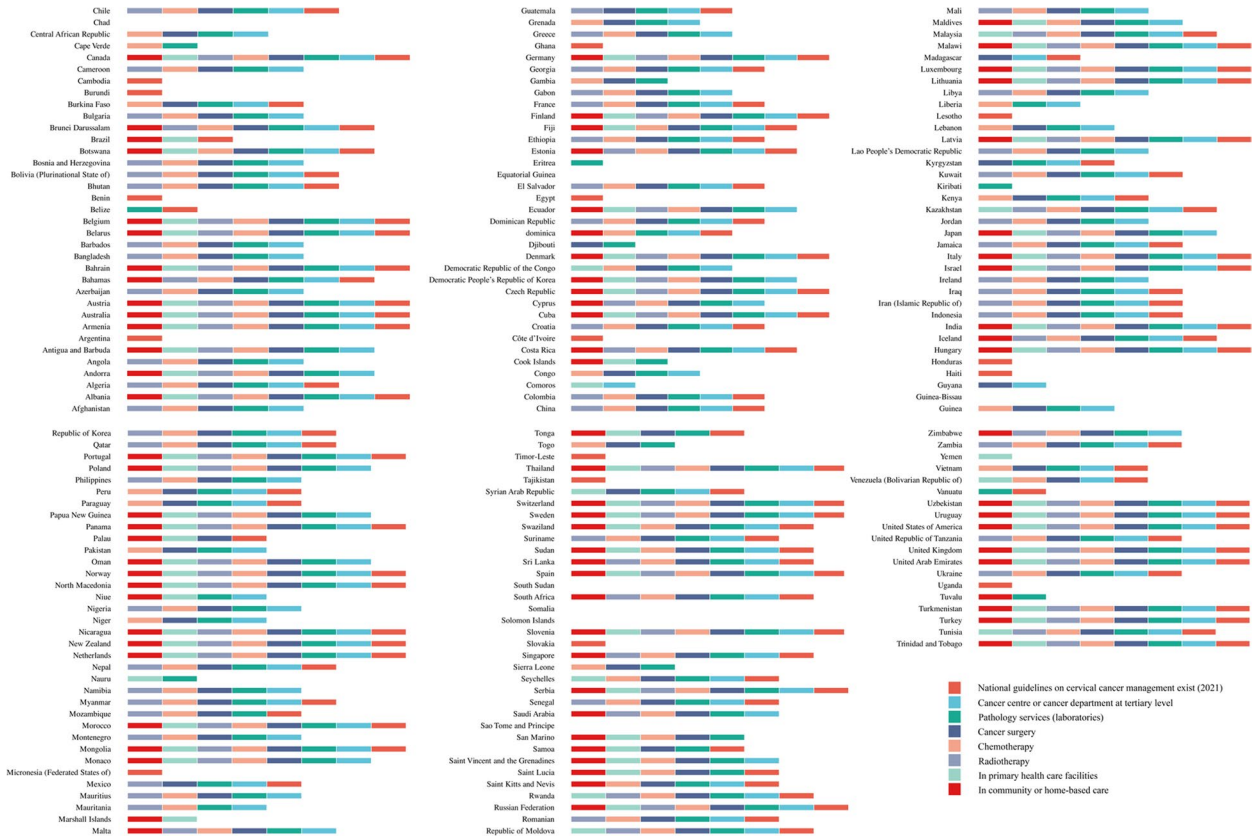

Fig. 3 Treatment and supportive care for patients with cervical cancer across 194 countries (source: WHO 2021 NCD Country Capacity Survey [8])

were LMICs. Of 122 countries that offered radiotherapy, 52 (42.62%) were HICs, and 70 (57.38%) were LMICs.

Regarding palliative care, palliative care to patients with NCDs provided by a country's public healthcare system was categorised according to whether it was offered in primary healthcare facilities or in community- or home-based care. Sixty- countries provided palliative care to patients with cervical cancer in both settings, and 81 provided it in primary healthcare facilities within their public healthcare systems. Of these, 70 countries (86.42%) offered national guidelines on cervical cancer management—most of which were in Europe (29, 35.80%) and Asia (18, 22.22%). A total of 84 countries provided palliative care to patients with cervical cancer in community- or home-based healthcare settings. Of these, 64 (76.19%) offered national guidelines on cervical cancer management—most of which were in Europe (32, 38.10%) and Asia (18, 21.43%) (Additional file 1: Table S4).

Gaps related to eliminating cervical cancer

According to the WHO's target of "90% of girls fully vaccinated against HPV by the age of 15 years", Cook Islands (99.00%), Mexico (99.00%), Portugal (95.00%), and Seychelles (99.00%) achieved the goal.; Australia (83·00%) and Canada (84·00%). Botswana (87.00%), Brunei Darussalam (89.00%), Canada (87.00%), Ethiopia (84.00%), Iceland (88.00%), Malaysia (83.00%), Malta (84.00%), Norway (88.00%), Rwanda (84.00%), Spain (80.00%), Sweden (80.00%), and the United Kingdom (81.00%) were in the 80.00–89.00% range. Ten of the HICs in Europe (Estonia, France, Germany, Italy, Latvia, Lithuania, Luxembourg, Netherlands, San Marino, and Slovenia), four of those in Asia (Israel, Japan, Singapore, and the United Arab Emirates), three in North America (The Bahamas, Barbados, and Trinidad and Tobago) in North America, and one in South America (Uruguay) fell below the median rate (none of the HICs in Africa or Oceania were below this value). Of the LMICs, four in North America (Honduras, Jamaica, Marshall Islands, and Panama), three in South America (Colombia, Guyana, and Suriname), two in Africa (South Africa and the United Republic of Tanzania), one in Asia (Armenia), and one in Oceania (Fiji) were below the median (Fig. 4).

The WHO goal of "70% of women are screened using a high-performance test by 35 years of age, and again by 45 years of age" was evaluated via two indicators: screening for cervical cancer in women aged 30–49 years, in terms of ever-screened and screened

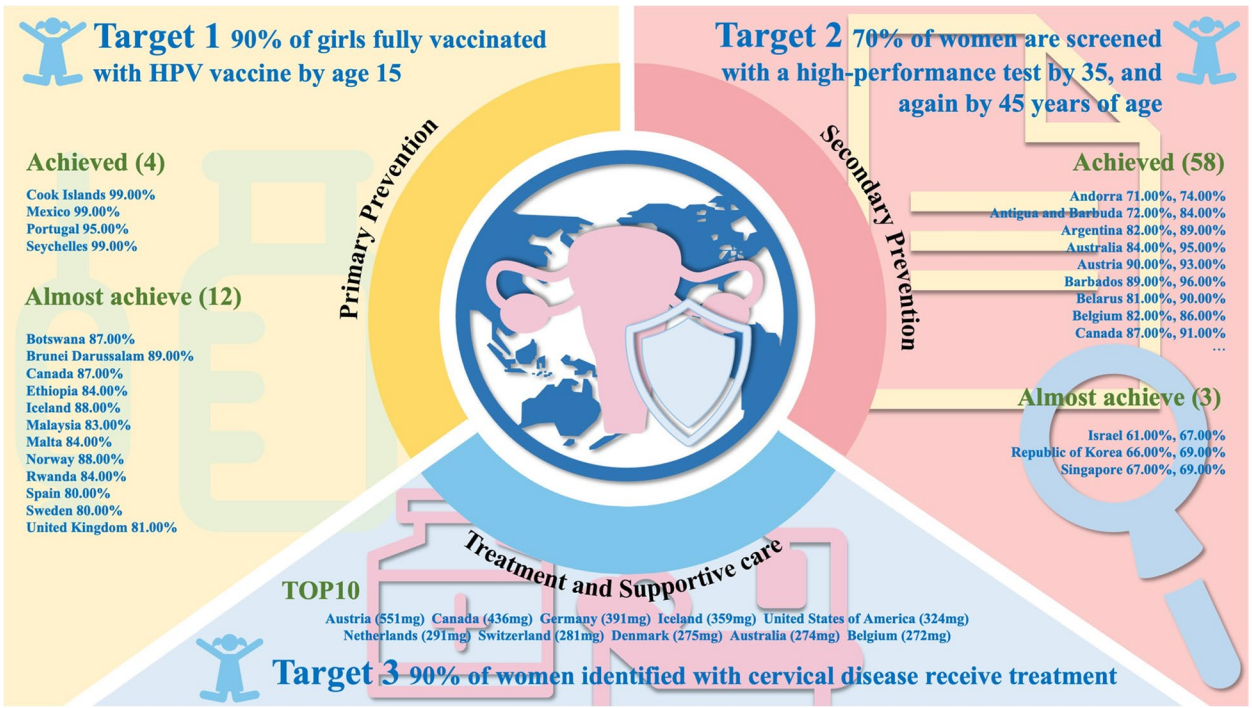

Fig. 4 Current status of interim targets on the path towards cervical cancer elimination. Note: Fifty-eight of the participating countries achieved Target 2: Andorra, Antigua Barbuda, Argentina, Australia, Austria, Barbados, Belarus, Belgium, Canada, Chile, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, El Salvador, Finland, France, Germany, Greece, Grenada, Hungary, Iceland, Ireland, Italy, Jamaica, Lithuania, Luxembourg, Malta, Mexico, Monaco, The Netherlands, New Zealand, Nicaragua, Norway, Palau, Panama, Paraguay, Peru, Poland, Portugal, Republic of Moldova, Poland, Portugal, Russian Federation, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom of Great Britain and Northern Ireland, the United States of America, and Uruguay

within the preceding 5 years. As of 2019, the ever-screened rate for cervical cancer was higher than that of screening within the preceding 5 years. The former ranged from 0.00% (Benin) to 100.00% (Sweden), with a median of 43.00%, and the latter ranged from 0.00% (Benin) to 93.00% (Sweden), with a median of 37.00%. The countries that were above the median ever-screened rate for cervical cancer (94 total) were mainly in Europe (41, 43.62%) and North America (23, 24.47%). Albania (67.00%), Belize (64.00%), Bhutan (62.00%), Plurinational State of Bolivia (63.00%), Guatemala (69.00%), Israel (67.00%), Kazakhstan (66.00%), Mongolia (62.00%), Qatar (61.00%), Republic of Korea (69.00%), Singapore (69.00%), Trinidad and Tobago (66.00%), Turkmenistan (62.00%), and Ukraine (62.00%) fell within the 60.00–69.00% range. Nine of these were LMICs, and five were HICs. The countries that were above the median cervical cancer screening rate over the preceding 5 years (97 in total) were mainly in Europe (42, 43.00%) and North America (23, 23.71%). Armenia (34.00%), Brunei Darussalam (32.00%), the Democratic People's Republic of Korea (36.00%), Kyrgyzstan (33.00%), Suriname (32.00%), and the United Arab Emirates (34.00%)—two HICs and four LMICs—fell within the 30.00–36.00% range.

Palliative care is one of the important parts of tertiary prevention, and it is most likely to be selected in the face of more severe advanced cervical cancer or patients who cannot afford medical expenses [19]. The WHO goal of "90% of women identified with cervical disease receive treatment" was indirectly reflected by the reported annual opioid consumption (excluding methadone) in oral morphine equivalence per capita (2017). With the exception of Monaco and San Marino (for which data were not available), and 42 countries that reported a result of "< 1 mg", the top ten countries for this indicator were Austria (551 mg), Canada (436 mg), Germany (391 mg), Iceland (359 mg), the United States of America (324 mg), The Netherlands (291 mg), Switzerland (281 mg), Denmark (275 mg), Australia (274 mg), and Belgium (272 mg).

Discussion

The elimination of cervical cancer represents an urgent and complex health challenge that requires collaborative efforts from the global health system to address, as well as multidisciplinary and multilevel interventions.

Inequality in global healthcare services represents a major challenge for cancer prevention and control. Our results show that most countries without NIPs for HPV vaccination and those with relatively low coverage rates were LMICs. Nearly all HICs reported their rates of cervical cancer vaccination coverage. Among the countries where the cervical cancer screening rate for women aged 30–49 exceeded 70% over the preceding 5 years, HICs accounted for 62.07%. Furthermore, HICs made up 62.2% of those that reported providing cervical cancer management, cancer diagnosis and treatment services, and palliative care to patients with NCDs. These findings indicated disparities in the implementation of primary, secondary, and tertiary prevention measures across countries with different income levels. Specifically, HICs performed better in the tertiary prevention of cervical cancer than LMICs, which may be attributable to their levels of economic development (Additional file 1: Table S5).

In their study on reducing disparities related to cervical cancer management among women in LMICs compared with those in HICs, Denny et al. emphasised that government departments, public healthcare professionals, and community health workers all play essential roles in the prevention and control of cervical cancer [20]. Bajaj et al. [21], when addressing the issue of the widening gap in the global equity of vaccination, mentioned that eradicating a disease globally should focus on sustainable collaboration with LMICs. In reality, these countries often offer incomplete or poor-quality healthcare services and are unable to provide adequate screening and vaccination. This renders timely detection and intervention difficult in such regions. Focusing on vulnerable populations with lower incomes and regions or countries with stunted economic growth, such as imposing subsidies for vaccination of the population, allocating central finances or transfers to support vaccination in underdeveloped areas, and administrating healthcare-specific aid by international non-governmental organisations to such countries or regions [22–24], may be conducive to improving inequity and accelerating the pace of vaccination.

Healthcare services inaccessibility represents another major challenge. This is reflected in four areas: economic, geographical, informational, and cultural inaccessibility. First, in countries that have not implemented NIPs for HPV vaccines, women may not be able to afford screening and vaccination. This has a direct impact on the accessibility of healthcare service usage. Solutions to this may include governments providing free or low-cost screening and vaccination services, and vaccine manufacturers producing vaccines with fewer dosing schedules. Several teams have demonstrated the efficacy of a single-dose HPV vaccine [25–28]. Geographical inaccessibility represents a second issue. HPV vaccines are administered via intramuscular injections, which are temperature-sensitive, [29] and thus, require controlled temperature chain management (which differs from the traditional cold chain) [30]. In some regions with complex geographic conditions and harsh climates, the safety and efficacy of vaccines can be directly affected by temperature fluctuations [31]. Vaccine microarray patches provide one alternative solution to this problem [32]. Third, cervical cancer-related information may be inaccessible. The prevention and control of cervical cancer requires the participation and understanding of society as a whole. To address this problem, it is necessary to strengthen public health education through popular education in schools, communities, media, and other means to improve women's knowledge of cancer prevention and control [33–36]. Finally, certain cultures may limit accessibility. Cultural and religious beliefs, such as conservative views regarding interventions involving reproductive health of women, may affect their attitude towards cervical cancer screening and vaccination [37]. To address this issue, prevention and control policies for cervical cancer should be tailored to local cultures and values based on respect for and understanding the cultural characteristics of each country [38].

It is encouraging to note that in 2020, the World Health Assembly adopted the Global Strategy to Accelerate the Elimination of Cervical Cancer, marking a historic milestone as this is the first time that 194 countries have committed to eliminating a single cancer. Global implementation of this strategy is expected to significantly reduce the number of cervical cancer cases worldwide.

This study has some limitations. The indicator "reported annual opioid consumption (excluding methadone) in oral morphine equivalence per capita (2017)" was compared only quantitatively, and there has been no standardised measure of the strengths and weaknesses of this indicator with regard to measuring the WHO target of "90% of women identified with cervical disease receive treatment". However, this is currently the most representative quantitative indicator of the extent to which the target has been met across the 194 participating countries. Another limitation is related to the nature of descriptive studies, which are unable to explore causal relationships. This requires more comprehensive data and the use of causal inference methods to analyze causation. Finally, this study's data exhibited partial missingness, potentially introducing bias into the results. Future research should focus on how to collect more comprehensive and reliable data or utilize modeling techniques for result estimation.

Conclusion

The elimination of cervical cancer is a complex and urgent global health challenge that demands collaborative, multidisciplinary, and multilevel interventions. Our study reveals that LMICs lag behind in the implementation of primary, secondary, and tertiary prevention measures compared to HICs, which may be due to their lower levels of economic development. To address these disparities, it is essential to focus on vulnerable populations and regions with economic constraints, providing subsidies for vaccination and allocating resources to support vaccination in underdeveloped areas. Additionally, overcoming healthcare services inaccessibility in terms of economic, geographical, informational, and cultural aspects is crucial. Solutions include government provision of affordable screening and vaccination services, development of alternative vaccine delivery methods, strengthening public health education, and tailoring prevention policies to local cultures.

Abbreviations

WHO	World Health Organization
HPV	Human papillomavirus
HICs	High Income Countries
LMICs	Low- and Middle-Income Countries
NCDs	Communicable Diseases
NIP	National Immunisation Programme

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12916-025-03897-3.

Supplementary Material 1.

Supplementary Material 2.

Acknowledgements

We thank the Fundamental Research Funds for Central Universities. The funder had no role in data collection, analysis, interpretation, or the drafting of the manuscript.

Authors' contributions

LZ and RL designed and conceptualized this study. RQ and ZH collected and verified the data. YL analyzed the data and reported the results. LZ and HW verified the results. LZ drafted the manuscript. YL and RL commented on and revised the manuscript. LZ obtained the funding. All authors had provided feedback on the manuscript, and had final responsibility for the decision to submit for publication.

Funding

This project was supported by Fundamental Research Funds for the Central Universities (2024-JYB-XJSJJ-019) from China.

Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 3 April 2024 Accepted: 23 January 2025
Published online: 04 February 2025

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