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Key points

Question: What is the lifetime prevalence of cervical cancer screening in low- and middle-income countries?

Findings: In this cross-sectional study based on self-reported data collected in 55 countries between 2005 and 2018, the country-level median lifetime prevalence of cervical cancer screening was 44%, with a range of 0.3% to 97.4%.

Meaning: Although there was a wide range of variation in self-reported cervical cancer screening prevalence among these countries, the findings support the need to increase the rate of screening.

Importance: The World Health Organization is developing a global strategy to eliminate cervical cancer, with goals for screening prevalence among women aged 30 to 49 years. However, evidence on prevalence levels of cervical cancer screening in low- and middle-income countries (LMICs) is sparse.

Objective: To determine lifetime cervical cancer screening prevalence in LMICs, and its variation across and within world regions and countries.

Design, Setting, and Participants: Cross-sectional, population-based analysis of nationally representative household surveys carried out in 55 LMICs between 2005 and 2018. The median response rate across surveys was 93.8% (range, 64.0%-99.3%). The population-based sample consisted of 1,136,289 women aged 15 years or older of whom 0.6% had missing information for the survey question on cervical cancer screening.

Exposures: World region, country, countries' economic, social, and health system characteristics, and individuals' sociodemographic characteristics.

Main Outcomes and Measures: Self-report of having ever had a screening test for cervical cancer.

Results: 1,129,404 women were included in the analysis of whom 542,475 were aged 30 to 49 years. A country-level median of 43.6% (interquartile-range [IQR], 13.9%-77.3%; range, 0.3%-97.4%) of women aged 30 to 49 self-reported to have ever been screened, with countries in Latin America and the Caribbean having the highest prevalence (country-level median, 84.6%; IQR, 65.7%-91.1%; range, 11.7%-97.4%) and those in sub-Saharan Africa the lowest prevalence (country-level median, 16.9%; IQR, 3.7%-31.0%; range, 0.9%-50.8%). There was large variation in the self-reported lifetime prevalence of cervical cancer screening among countries within regions, and among countries with similar levels of per capita gross domestic product and total health expenditure. Within countries, women who lived in rural areas, had low education, or had low household wealth were generally least likely to self-report to have ever been screened.

Conclusion and Relevance: In this cross-sectional study of data collected in 55 LMICs between 2005 and 2018, there was wide variation between countries in the self-reported lifetime prevalence of cervical cancer screening. However, the median prevalence was 44%, supporting the need to increase the rate of screening.

Introduction

Cervical cancer was estimated to be the fourth most common cause of cancer incidence and mortality among women globally in 2018.[1] Deaths due to cervical cancer are largely preventable through regular screening combined with early-stage treatment and, more recently, through vaccination against the human papillomavirus (HPV).[2,3] While scaling up HPV vaccination could prevent many cases of cervical cancer in the future,[4,5] HPV vaccination coverage is currently still very low in LMICs.[6,7] Increasing effective screening for cervical cancer in LMICs is, thus, indispensable to achieve a rapid reduction in cervical cancer incidence and mortality.

The World Health Organization (WHO) Director-General's call for action on cervical cancer in 2018 emphasized the importance of increasing cervical cancer screening in LMICs as being key to eliminating cervical cancer as a public health problem globally.[8] Implementing and maintaining effective screening programs requires an in-depth understanding of current screening rates, how they are changing over time, and which population groups within countries are not reached. However, despite its importance for policy makers in LMICs and recommended use as an indicator for measuring progress towards achieving both universal health coverage and global non-communicable disease (NCD) goals,[9–11] the only available international comparison of cervical cancer screening rates with nationally representative data is based on the World Health Surveys.[12,13] These surveys were conducted in 2002-2003 and are, thus, at least 17 years old.

In an effort to inform the design and monitoring of interventions to improve coverage with cervical cancer screening, this study aimed to determine the proportion of women aged 30 to 49 years in LMICs who self-reported to have ever been screened for cervical cancer, and how these estimates vary across regions, countries, and population groups within countries.

Methods

Ethics

This analysis of pseudonymized data (i.e., data that could not be linked to individuals without additional information that was not available to the analysts) was considered exempt for non-human subjects research by the institutional review board of the Heidelberg University Medical Faculty.

Data sources

We requested access to the most recent nationally representative WHO STEPwise approach to Surveillance (STEPS) survey conducted since 2005 for all countries that the World Bank categorized as low-income, lower middle-income, or upper middle-income at any time since 2005.[14] To be included in this study, a country must have been an LMIC (as per the World Bank categorization) at the time of the survey's data collection. We preferred STEPS surveys because they use the same standardized questionnaire, ask about all commonly applied cervical cancer screening techniques, sample a wide age range of women, and are the official approach developed by the WHO for monitoring NCD risk factors at the population level.

If an eligible STEPS dataset was not available for a country that was an LMIC at any time since 2005, or we could not gain access to it, we conducted a systematic search in September 2019 using the Google search engine, the International Household Survey Network (IHSN) central data catalogue, and the Global Health Data Exchange (GHDx) to identify the most recent nationally representative household survey with data on cervical cancer screening prevalence for that country (see eMethods 1 in the Supplement for details). Surveys were eligible if they were conducted in 2005 or later, collected data on at least three ten-year-age groups older than 15 years, and asked female respondents about whether they had ever been screened for cervical cancer. We excluded surveys with a response rate below 50%. The sampling strategy and response rate calculation for each survey is detailed in eMethods 2 and 3 in the Supplement. Response rate calculations were categorized according to the American Association for Public Opinion Research definitions RR1, RR2, RR5, and COOP1.[15]

Outcome definition

The outcome for the present analysis was defined as self-reporting to have ever undergone a screening test for cervical cancer or cervical precancerous lesions. The survey questions are detailed in eMethods 4 in the Supplement.

Statistical analysis

This analysis proceeded in four steps. First, we estimated self-reported lifetime prevalence of cervical cancer screening by country and calculated the country-level median prevalence (as well as the range and interquartile range) globally and by World Bank region. We restricted the sample for analysis to women aged 30 to 49 years in our primary analysis for this step because the WHO recommends prioritizing cervical cancer screening in this age group.[16]

Second, to ascertain health system performance for cervical cancer screening relative to a country's wealth and expenditure on health, we plotted the self-reported lifetime prevalence of cervical cancer screening for women aged 30 to 49 years against the country's gross domestic product (GDP) per capita and total health expenditure per capita (both in constant 2011 international dollars[17]) in the year of survey data collection. We show an ordinary least squares regression line through these point estimates, weighting each country equally, for visual orientation only (as opposed to statistical inference).

Third, to explore reasons for differences in screening prevalence between countries, we plotted the self-reported lifetime prevalence of cervical cancer screening for women aged 30 to 49 years separately against each of eight country-level indicators. We used all country-level indicators as independent variables that we hypothesized may be causally related to a country's cervical cancer screening prevalence and were available in the public domain for the majority of the study countries. These indicators were measures of economic development (GDP per capita), human development (the Human Development Index [HDI] and the Gender-related Development Index [GDI]), investments into the health system (total health expenditure per capita), health worker density (number of nurses and midwives per 1,000 people and combined number of physicians, nurses, and midwives per 1,000 people), and gender discrimination (the Gender Inequality Index [GII] and the 2014 Social Institutions and Gender Index [SIGI]).

Fourth, to ascertain which population groups were most likely to self-report to have ever been screened, we regressed, separately for each country, self-reporting to have ever had a cervical cancer screening test on ten-year age group, educational attainment, household wealth quintile, rural versus urban residence, and a binary indicator for current self-reported tobacco smoking. The computation of the household wealth quintiles is detailed in the Supplement (eMethods 5). We fitted covariate-unadjusted and covariate-adjusted Poisson regression models with cluster-robust standard errors (using the sandwich estimator of variance) that were adjusted for clustering at the level of the primary sampling unit. We adhere to the term "risk" when interpreting the resulting risk ratios (RRs) even though risk in this analysis depicts a desirable (reporting to have undergone screening) rather than an undesirable outcome.

All analyses were complete-case analyses. All primary analyses accounted for the multi-stage random sampling of the surveys by use of sampling weights and adjusted standard errors for clustering at the level of the primary sampling unit. As a robustness check for the fourth step of this analysis and given ongoing debate as to when regression in survey data should account for sampling weights,[18] we also fitted Poisson regression models without using sampling weights. We provide further details on the statistical analysis in the Supplement (eMethods 6). Analyses were conducted in R version 3.6.1 and Stata 15.

Results

Sample characteristics

Out of a total of 142 countries that were classified as an LMIC at any point since 2005, we obtained individual-level STEPS survey data from 20 LMICs and included, from the systematic search, survey datasets from an additional 35 LMICs (eFigure 1 and eFigure 2 in the Supplement). Of the 55 included surveys, 20 surveys asked women whether they had ever undergone at least one of the three commonly used screening modalities (Pap smear test, visual inspection of the cervix with acetic acid [VIA], or HPV test), 28 surveys asked only about Pap smear tests, and seven surveys asked about cervical cancer screening without specifying a screening modality. The survey-level median response rate was 93.8% (IQR, 86.2%-96.8%; range, 64.0%-99.3%; **Table 1**). The country-level median percent of women aged 30 to 49 years with missing information on whether they had ever received a cervical cancer screening was 0.5% (IQR, 0.1%-3.4%; range, 0.0%-12.6%). 1,129,404 women with outcome data, of whom

542,475 were aged 30 to 49 years, were included in the analyses (eTable 1 in the Supplement). Detailed sample characteristics are shown in eTable 2-4 in the Supplement.

Lifetime prevalence of cervical cancer screening by region and country

A country-level median of 43.6% (IQR, 13.9%-77.3%) of women aged 30 to 49 years self-reported to have ever had a cervical cancer screening test, ranging from 0.3% in Egypt (95% CI, 0.1%-0.6%) to 97.4% in Colombia (95% CI, 97.0%-97.8%). With a country-level median of 84.6% (IQR, 65.7%-91.1%; range, 11.7%-97.4%), countries in Latin America and the Caribbean had the highest self-reported lifetime prevalence of cervical cancer screening, whereas countries in sub-Saharan Africa had the lowest (country-level median, 16.9%; IQR, 3.7%-31.0%; range, 0.9%-50.8%) (**Figure 1**; eFigure 3-5 and eTable 5 in the Supplement). There was substantial variation across countries within regions.

Benchmarking to countries' gross domestic product and total health expenditure

Both GDP per capita and total health expenditure per capita appeared to be positively associated with the self-reported lifetime prevalence of cervical cancer screening in a country (**Figure 2**). Countries that performed well relative to their GDP per capita in the year of the survey included Belarus, Belize, Bhutan, Bolivia, Brazil, Chile, Colombia, the Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Jamaica, Moldova, Nicaragua, Peru, and St. Vincent and the Grenadines.

Country-level variables associated with lifetime prevalence of cervical cancer screening

In addition to GDP per capita and total health expenditure per capita, a higher HDI and more gender equality as indicated by the GDI, GII, and SIGI appeared to be positively associated with a country's lifetime prevalence of cervical cancer screening (**Figure 3**). A higher density of nurses and midwives, as well as of all health workers, statistically accounted for less of the variability in the self-reported lifetime prevalence of cervical cancer screening between countries (R^2 = 0.05 and R^2 = 0.09, respectively) than the other country-level variables. The apparent associations shown in Figure 3 were similar when using weighting to adjust for differences in individual-level characteristics between countries (eFigure 8-11 in the Supplement).

Individual-level variables associated with cervical cancer screening

While there was some heterogeneity among countries, living in an urban area (compared to a rural area), having had secondary or tertiary education (compared to only having completed primary education or less), being in the two highest household wealth quintiles (compared to the bottom two household wealth quintiles), and being aged 30 to 49 years (compared to 20 to 29 years) all appeared to be associated with a higher probability of self-reporting to have ever had a cervical cancer screening test in most countries (**Figure 4;** eFigure 12-13; eTable 6-11 in the Supplement). The relationship between age and self-reported lifetime prevalence of cervical cancer screening had an inverted "U" shape in all regions, with middle-aged women having the highest self-reported prevalence (eFigure 14 in the Supplement). There was no apparent association between currently smoking (compared to having never smoked or smoked in the past) and self-reporting of ever having had a cervical cancer screening test in 32 out of 46 countries that collected smoking data (eFigure 15; eTable 12 in the Supplement). Currently being married appeared to be associated with a higher probability of self-reporting to have ever had a cervical cancer screening test in 41 out of 55 countries (eFigure 16; eTable 13 in the Supplement). Risk ratios with 95% confidence intervals from covariate-unadjusted and covariate-adjusted regressions are shown in eTable 14-24 in the Supplement. The regression results were similar when not using sampling weights (eFigure 17-24; eTable 6-13; eTable 25-35 in the Supplement).

Countries with a lower GDP per capita at the time of the survey tended to have larger relative differences in lifetime cervical cancer screening prevalence by education, household wealth, and urban versus rural residency than countries with a higher GDP per capita (eFigure 25-30 in the Supplement). This was not the case when examining absolute rather than relative differences (eFigure 25-30 in the Supplement).

Discussion

Overall, the country-level median lifetime prevalence of self-reported cervical cancer screening was 44% in this sample of 55 LMICs, which represent 72% of the world's population in LMICs.[19] Screening prevalence was generally highest among countries in Latin America and the Caribbean, and lowest among countries in sub-Saharan Africa. In addition, the highly populous countries of Indonesia (survey in 2014-15), India (survey in 2015-16), and China (survey in 2008-10) had a comparatively low self-reported lifetime screening prevalence among women aged 30 to 49 years. Within countries, women in rural areas and those who were less educated or lived in a less wealthy household tended to be least likely to self-report having ever been screened for cervical cancer.

The low prevalence of self-reported cervical cancer screening identified in this study is especially concerning given that this analysis examined lifetime prevalence of screening as opposed to the prevalence of being screened in the past three to five years as recommended by the WHO,[16] the limited sensitivity of available screening tests,[20,21] often poorly functioning referral systems for positive cervical cancer screening tests in LMICs,[22,23] and low quality of care for cervical cancer diagnosis and treatment in many of these settings.[22,24,25] Nonetheless, while the majority of countries (37 of 55) included in this study missed the target of 70% cervical cancer screening prevalence proposed by the WHO,[26] the analyses identified large differences in self-reported lifetime prevalence among regions and among countries within regions. Relative to their GDP per capita and total health expenditure per capita, many countries in Latin America and the Caribbean, as well as some countries in other regions (e.g., Belarus, Bhutan, or Moldova) achieved high self-reported lifetime prevalence levels of cervical cancer screening. Reasons for these countries' high performance may include having national cervical cancer control programs in place that provide cervical cancer screening to women free of charge in primary healthcare system structures at the local level,[27,28] integration of screening services into comprehensive cervical cancer control activities,[28,29] as well as trialing and implementation of programs to reach underserved sociodemographic groups.[30,31]

GDP per capita, total health expenditure per capita, HDI, GDI, GII, and SIGI all statistically accounted for a substantial degree of the variation in self-reported lifetime prevalence of cervical cancer screening between countries. The comparatively strong apparent association between indices of gender equality and self-reported lifetime prevalence of cervical cancer screening suggests that cultural and societal values influence women's demand for and/or access to cervical cancer screening.[32] The density of nurses and midwives, as well as the density of healthcare workers in general, statistically accounted for only relatively little (less than ten percent) of the variation between countries, suggesting that other factors may be more important determinants of screening rates, such as the distribution of healthcare workers within countries, if healthcare workers have been trained and equipped to conduct cervical cancer screens, and whether women seek out or consent to screenings.[33]

Limitations

This study has several limitations. First, 28 of the 55 included surveys asked women only whether they had undergone a Pap smear test rather than cervical cancer screening more generally. However, available documentation on cervical cancer screening practices in these countries suggests that it is unlikely that a substantial degree of cervical cancer screening was conducted through modalities other than Pap smear testing in all but three (Guatemala, Mexico, and Nepal) of these 28 countries prior to the data collection period of the included survey (see eMethods 7 and eTable 36 in the Supplement). Nevertheless, this study's estimates of self-reported lifetime prevalence of cervical cancer screening in these three countries may be underestimates of the true prevalence. Second, this study's estimates relied entirely on self-report. This probably led to an overestimation of the true lifetime cervical cancer screening prevalence because it is likely that most women who had a cervical cancer screening remember the event (given that these screenings are generally perceived as being uncomfortable[34,35]), while some women who did not have a screening in the past probably reported having had one due to social desirability bias.[36] However, because the awareness of the recommendation to have a regular screening, and thus the expected degree of bias from social desirability bias, is fairly low in LMICs,[37,38] it is unlikely that social desirability bias led to a substantial overestimation of self-reported cervical cancer screening prevalence in this study. Third, the surveys were conducted in different years ranging from 2005 to 2018. Each country's performance should thus be interpreted as the performance in the given year rather than as the country's current performance. Under the assumption that cervical cancer screening prevalence has been increasing in LMICs over time, this study likely underestimates the current prevalence of cervical cancer screening in the study countries. To avoid confounding by time in the analyses with country-level independent variables, this analysis used values for country-level variables for the year of the survey's data collection. This, however, was not possible for the SIGI, for which values were only available for 2014 and 2019. Fourth, the 55 LMICs in this analysis are unlikely to be representative of all LMICs globally.

Conclusions

In this cross-sectional study of data collected in 55 LMICs between 2005 and 2018, there was wide variation between countries in the self-reported lifetime prevalence of cervical cancer screening. However, the median prevalence was 44%, supporting the need to increase the rate of screening.

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References

1. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin*. 2018;68(6):394-424. doi:10.3322/caac.21492
2. Peirson L, Fitzpatrick-Lewis D, Ciliska D, Warren R. Screening for cervical cancer: a systematic review and meta-analysis. *Syst Rev*. 2013;2(1):35. doi:10.1186/2046-4053-2-35
3. Campos NG, Sharma M, Clark A, et al. The health and economic impact of scaling cervical cancer prevention in 50 low- and lower-middle-income countries. *Int J Gynecol Obstet*. 2017;138:47-56. doi:10.1002/ijgo.12184
4. Huh WK, Joura EA, Giuliano AR, et al. Final efficacy, immunogenicity, and safety analyses of a nine-valent human papillomavirus vaccine in women aged 16–26 years: a randomised, double-blind trial. *Lancet*. 2017;390(10108):2143-2159. doi:10.1016/S0140-6736(17)31821-4
5. Brisson M, Kim JJ, Canfell K, et al. Impact of HPV vaccination and cervical screening on cervical cancer elimination: a comparative modelling analysis in 78 low-income and lower-middle-income countries. *Lancet*. 2020;395(10224):575-590. doi:10.1016/S0140-6736(20)30068-4

6. Bruni L, Diaz M, Barrionuevo-Rosas L, et al. Global estimates of human papillomavirus vaccination coverage by region and income level: A pooled analysis. *Lancet Glob Heal*. 2016;4(7):e453-e463. doi:10.1016/S2214-109X(16)30099-7

7. Oberlin AM, Rahangdale L, Chinula L, Fuseini NM, Chibwesha CJ. Making HPV vaccination available to girls everywhere. *Int J Gynecol Obstet*. 2018;143(3):267-276. doi:10.1002/ijgo.12656

8. Adhanom Ghebreyesus T. Cervical Cancer: An NCD We Can Overcome. https://www.who.int/reproductivehealth/DG_Call-to-Action.pdf. Published 2018. Accessed October 23, 2019.

9. Wagstaff A, Neelsen S. A comprehensive assessment of universal health coverage in 111 countries: a retrospective observational study. *Lancet Glob Heal*. 2020;8(1):e39-e49. doi:10.1016/S2214-109X(19)30463-2

10. Hogan DR, Stevens GA, Hosseinpoor AR, Boerma T. Monitoring universal health coverage within the Sustainable Development Goals: development and baseline data for an index of essential health services. *Lancet Glob Heal*. 2018;6(2):e152-e168. doi:10.1016/S2214-109X(17)30472-2

11. World Health Organization. *Noncommunicable Diseases Global Monitoring Framework: Indicator Definitions and Specifications*.; 2013. https://www.who.int/nmh/ncd-tools/indicators/GMF_Indicator_Definitions_Version_NOV2014.pdf.

12. Gakidou E, Nordhagen S, Obermeyer Z. Coverage of cervical cancer screening in 57 countries: Low average levels and large inequalities. *PLoS Med*. 2008;5(6):0863-0868. doi:10.1371/journal.pmed.0050132

13. Akinyemiju TF. Socio-Economic and Health Access Determinants of Breast and Cervical Cancer Screening in Low-Income Countries: Analysis of the World Health Survey. Noor

AM, ed. *PLoS One*. 2012;7(11):e48834. doi:10.1371/journal.pone.0048834

14. The World Bank. Historical classification by income. World Bank Country and Lending Groups. http://databank.worldbank.org/data/download/site-content/OGHIST.xls. Published 2020. Accessed May 23, 2020.
15. The American Association for Public Opinion Research. Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys. 9th edition. AAPOR. https://www.aapor.org/AAPOR_Main/media/publications/Standard-Definitions20169theditionfinal.pdf. Published 2016. Accessed April 14, 2020.
16. World Health Organization. WHO guidelines for screening and treatment of precancerous lesions for cervical cancer prevention. https://apps.who.int/iris/bitstream/handle/10665/94830/9789241548694_eng.pdf. Published 2013. Accessed October 23, 2019.
17. The World Bank. GDP per capita, PPP (constant 2011 international $). https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.KD. Published 2019. Accessed October 23, 2019.
18. Deaton A. Econometric issues for survey data. In: *The Analysis of Household Surveys (Reissue Edition with a New Preface): A Microeconometric Approach to Development Policy*. The World Bank; 2019:63-132. doi:10.1596/978-1-4648-1331-3_ch2
19. UN Department of Economic and Social Affairs. World Population Prospects 2019. https://population.un.org/wpp/Download/Standard/Population/. Published 2019. Accessed October 23, 2019.
20. Fokom-Domgue J, Combescure C, Fokom-Defo V, et al. Performance of alternative strategies for primary cervical cancer screening in sub-Saharan Africa: systematic review and meta-analysis of diagnostic test accuracy studies. *BMJ*. July 2015:h3084.

doi:10.1136/bmj.h3084
21. Chen C, Yang Z, Li Z, Li L. Accuracy of Several Cervical Screening Strategies for Early Detection of Cervical Cancer: A Meta-Analysis. *Int J Gynecol Cancer*. 2012;22(6):908-921. doi:10.1097/IGC.0b013e318256e5e4
22. Maza M, Schocken CM, Bergman KL, Randall TC, Cremer ML. Cervical Precancer Treatment in Low- and Middle-Income Countries: A Technology Overview. *J Glob Oncol*. 2017;3(4):400-408. doi:10.1200/JGO.2016.003731
23. Maza M, Matesanz S, Alfaro K, et al. Adherence to recommended follow-up care after high-grade cytology in El Salvador. *Int J Healthc*. 2016;2(2). doi:10.5430/ijh.v2n2p31
24. Drummond JL, Were MC, Arrossi S, Wools-Kaloustian K. Cervical cancer data and data systems in limited-resource settings: Challenges and opportunities. *Int J Gynecol Obstet*. 2017;138:33-40. doi:10.1002/ijgo.12192
25. Catarino R, Petignat P, Dongui G, Vassilakos P. Cervical cancer screening in developing countries at a crossroad: Emerging technologies and policy choices. *World J Clin Oncol*. 2015;6(6):281-290. doi:10.5306/wjco.v6.i6.281
26. World Health Organization. *Draft Global Strategy towards the Elimination of Cervical Cancer as a Public Health Problem*.; 2019. https://www.who.int/docs/default-source/cervical-cancer/cerv-cancer-elimn-strategy-16dec-12pm.pdf. Accessed January 15, 2020.
27. Dhendup T, Tshering P. Cervical cancer knowledge and screening behaviors among female university graduates of year 2012 attending national graduate orientation program, Bhutan. *BMC Womens Health*. 2014;14(1):44. doi:10.1186/1472-6874-14-44
28. International Agency for Research on Cancer. Current Status and Future Directions of Breast and Cervical Cancer Prevention and Early Detection in Belarus. IARC Working

Group Report Volume 6. https://publications.iarc.fr/_publications/media/download/4048/987fae663fb0fde0b9f31245163bba6e7f2051cb.pdf. Published 2012. Accessed October 30, 2019.

29. United Nations Population Fund (UNFPA). Cervical Cancer Prevention Project in the Republic of Moldova. https://moldova.unfpa.org/en/publications/cervical-cancer-prevention-project-republic-moldova. Published 2017. Accessed October 30, 2019.

30. Maza M, Alfaro K, Garai J, et al. Cervical cancer prevention in El Salvador (CAPE)—An HPV testing-based demonstration project: Changing the secondary prevention paradigm in a lower middle-income country. *Gynecol Oncol Reports*. 2017;20:58-61. doi:10.1016/j.gore.2017.02.011

31. Baussano I, Tshering S, Choden T, et al. Cervical cancer screening in rural Bhutan with the care HPV test on self-collected samples: an ongoing cross-sectional, population-based study (REACH-Bhutan). *BMJ Open*. 2017;7(7):e016309. doi:10.1136/bmjopen-2017-016309

32. Williams-Brennan L, Gastaldo D, Cole DC, Paszat L. Social determinants of health associated with cervical cancer screening among women living in developing countries: A scoping review. *Arch Gynecol Obstet*. 2012;286(6):1487-1505. doi:10.1007/s00404-012-2575-0

33. Maseko FC, Chirwa ML, Muula AS. Health systems challenges in cervical cancer prevention program in Malawi. *Glob Health Action*. 2015;8(1):26282. doi:10.3402/gha.v8.26282

34. Chorley AJ, Marlow LA V., Forster AS, Haddrell JB, Waller J. Experiences of cervical screening and barriers to participation in the context of an organised programme: a systematic review and thematic synthesis. *Psychooncology*. 2017;26(2):161-172.

doi:10.1002/pon.4126

35. Armstrong N, James V, Dixon-Woods M. The role of primary care professionals in women's experiences of cervical cancer screening: a qualitative study. *Fam Pract*. 2012;29(4):462-466. doi:10.1093/fampra/cmr105

36. Lavrakas P, ed. Social Desirability. In: *Encyclopedia of Survey Research Methods*. 2455 Teller Road, Thousand Oaks California 91320 United States of America: Sage Publications, Inc. doi:10.4135/9781412963947.n537

37. Chidyaonga-Maseko F, Chirwa ML, Muula AS. Underutilization of cervical cancer prevention services in low and middle income countries: a review of contributing factors. *Pan Afr Med J*. 2015;21. doi:10.11604/pamj.2015.21.231.6350

38. Devarapalli P, Labani S, Nagarjuna N, Panchal P, Asthana S. Barriers affecting uptake of cervical cancer screening in low and middle income countries: A systematic review. *Indian J Cancer*. 2018;55(4):318. doi:10.4103/ijc.IJC_253_18

39. ICF. Demographic and Health Surveys (various) [Bolivia, Colombia, Cote d'Ivoire, Dominican Republic, Egypt, Guatemala, Haiti, Honduras, India, Lesotho, Namibia, Peru, Philippines, South Africa, Sri Lanka, Zimbabwe]. Funded by USAID. https://dhsprogram.com/.

40. UNHCR. Syria Regional Refugee Response. Operational Portal Refugees Situations. https://data2.unhcr.org/en/situations/syria/location/71. Published 2019. Accessed October 23, 2020.

Figure 1. Self-reported lifetime prevalence of cervical cancer screening among women aged 30 to 49 years, by country

Abbreviations: LMIC, low- or middle-income country at the time of the survey year

The numbers show the percent of women aged 30 to 49 years in each country who reported to have ever had a cervical cancer screening test. Solid grey coloring indicates that there was no eligible survey or we could not obtain access to the dataset. Prevalence estimates are shown for the countries and survey years listed in Table 1. A map with aged-standardized estimates based on the WHO World Standard Population is shown in eFigure 3 in the Supplement.

Figure 2. Self-reported lifetime prevalence of cervical cancer screening among women aged 30 to 49 years by GDP per capita and total health expenditure per capita

Abbreviations: S. Asia, E. Asia, & Pacific, South Asia, East Asia, and Pacific.

Countries are indicated by their ISO 3 code. GDP per capita and total health expenditure per capita is in constant 2011 international dollars for the year in which each survey was conducted. Health expenditure per capita was not available for Iraq. The vertical bars depict the 95% confidence interval for each point estimate. The grey line depicts an Ordinary Least Squares regression (with each country having the same weight) of lifetime cervical cancer screening prevalence in a country onto GDP per capita or total health expenditure per capita. The standardized regression coefficient for this Ordinary Least Squares regression was 0.47 (95% CI, 0.23-0.71) and 0.49 (95% CI, 0.25-0.73), respectively. The sample was restricted to women aged 30 to 49 years. Estimates among all women and estimates adjusted for differences in individual-level characteristics between countries are shown in eFigure 6, 8 and 10 in the Supplement.

Figure 3. Self-reported lifetime prevalence of cervical cancer screening among women aged 30 to 49 years by human development index, gender equality indices, and health worker density

Abbreviations: S. Asia, E. Asia, & Pacific, South Asia, East Asia, and Pacific.

Countries are indicated by their ISO 3 code. A GDI value was not available for St. Vincent & the Grenadines. A GII value was not available for Ghana, St. Vincent & the Grenadines, and Timor-Leste. The vertical bars depict the 95% confidence interval for each point estimate. Each grey line depicts an Ordinary Least Squares regression (with each country having the same weight) of lifetime cervical cancer screening prevalence in a country onto the country-level variables HDI, GDI, GII, SIGI, density of medical nurses and midwives, and health worker density. The standardized regression coefficient for this Ordinary Least Squares regression was 0.53 (95% CI, 0.30-0.76), 0.62 (95% CI, 0.41-0.83), -0.40 (95% CI, -0.66- -0.15), -0.72 (95% CI, -0.92- -0.52), 0.24 (95% CI, -0.02-0.50), 0.22 (95% CI, -0.04-0.48), and 0.30 (95% CI, 0.04-0.56), respectively. The sample was restricted to women aged 30 to 49 years. Estimates among all women and estimates adjusted for differences in individual-level characteristics between countries are shown in eFigure 7, 9 and 11 in the Supplement.

Figure 4. Relative and absolute differences in the probability of having ever been screened for cervical cancer by individuals' sociodemographic characteristics

Abbreviations: ref., reference category

Risk ratios are shown on a logarithmic scale. Countries are indicated by their ISO 3 code. Except for panel D, regressions were adjusted for age as a continuous variable with restricted cubic splines with five knots placed at the fifth, 27.5th, 50th, 72.5th and 95th percentiles. All regressions were run separately for each country, used sampling weights, and adjusted standard errors for clustering at the level of the primary sampling unit. The horizontal bars depict the 95% confidence interval for each point estimate. In panel C, the upper limit of the confidence interval was truncated for the risk ratio in Cote d'Ivoire. An alternative panel C that compares top 20% versus bottom 20% wealth (instead of top 40% versus bottom 40%) is shown in eFigure 11 in the Supplement. Risk ratios from Poisson regressions without using sampling weights are shown eFigure 15-22 in the Supplement. Exact estimates are provided in eTable 6-12 in the Supplement.

Table 1. Survey characteristics by region and country[a,b]

Country	ISO code	Survey	Year[c]	Response rate[d] (%)	Missing outcome[e] (%)	Sample size (all ages)	Age range (y)	Sample size (30-49 y)	Median age (30-49 y)	GDP per capita (int. $)[f]	Female population in 2019[g] (thousands)
Latin America and the Caribbean											
Belize	BLZ	CAMDI	2005-6	92.7	0.8	1,425	19-94	562	40	7,924	196
Costa Rica	CRI	ENSA	2006	95.0	12.1	2,474	18-101	772	40	11,558	2,525
Bolivia	BOL	DHS	2008	95.9	0.6	16,699	15-49	7,782	38	5,525	5,733
El Salvador	SLV	FESAL	2008	90.0	0.2	11,983	15-49	6,094	37	6,309	3,430
Jamaica	JAM	RHS	2008	96.7	0.5	8,217	15-49	4,532	39	8,593	1,485
Paraguay	PRY	ENDSSR	2008	95.1	0.1	6,536	15-44	2,666	36	9,028	3,464
Chile	CHL	ENS	2009-10	85.0	7.2	2,916	15-100	1,036	40	18,924	9,610
Nicaragua	NIC	ENDESA	2011	93.8	0.1	15,257	15-49	7,183	37	4,163	3,320
Honduras	HND	DHS	2011-12	93.2	0.0	22,019	15-49	9,677	38	4,028	4,877
Argentina	ARG	ENFR	2013	70.7	0.5	17,951	18-98	6,891	38	19,638	22,939
Brazil	BRA	PNS	2013	77.0	0.0	34,282	18-101	14,546	38	15,062	107,316
Dominican Republic	DOM	DHS	2013	94.1	0.4	8,990	15-49	4,347	39	12,183	5,373
Ecuador	ECU	ENSANUT	2012	NA	0.2	17,808	15-50	10,121	38	10,286	8,683
Peru	PER	DHS	2013	97.3	7.0	20,808	15-49	11,398	39	11,734	16,362
St. Vincent & the Grenadines	VCT	STEPS	2013	67.8	0.2	1,937	18-69	902	39	10,259	54
Mexico	MEX	SAGE	2014	81.0	0.0	2,799	18-98	368	40	17,150	65,172
Guatemala	GTM	DHS	2014-15	96.8	0.1	25,557	15-49	11,224	38	7,220	8,922
Colombia	COL	DHS	2015	86.6	0.0	26,670	21-49	17,235	38	13,115	25,626
Guyana	GUY	STEPS	2016	66.7	0.1	1,588	18-69	690	39	7,285	390
Haiti	HTI	DHS	2016-17	99.3	0.0	2,495	35-64	1,368	41	1,654	5,705
Europe and Central Asia											
Russia	RUS	SAGE	2007-10	87.7	1.0	2,777	19-99	215	41	23,063	78,269
Kyrgyzstan	KGZ	STEPS	2013	NA	0.7	1,665	25-64	840	40	3,117	3,242
Moldova	MDA	STEPS	2013	83.5	11.5	2,637	18-69	939	39	5,638	2,105
Bulgaria	BGR	EHS	2014	72.5	13.4	2,897	15-85	802	40	16,324	3,600
Romania	ROU	EHS	2014	NA	0.0	8,728	15-85	2,616	40	19,802	9,946
Georgia	GEO	STEPS	2016	75.7	1.3	2,903	17-70	1,000	40	9,256	2,091
Belarus	BLR	STEPS	2016-17	87.1	7.8	2,692	18-69	1,095	41	16,978	5,052
Azerbaijan	AZE	STEPS	2017	97.3	5.1	1,580	18-69	632	40	15,929	5,032
Tajikistan	TJK	STEPS	2016-17	94.4	4.9	1,539	18-70	773	39	2,854	4,623
Mongolia	MNG	SISS	2018	92.0	0.3	10,765	15-49	6,764	39	12,209	1,635

Middle East and Northern Africa											
Egypt	EGY	DHS	2015	98.9	0.0	8,687	15-59	3,653	38	10,243	49,665
Iraq	IRQ	STEPS	2015	98.8	4.0	2,355	18-102	1,148	39	14,964	19,418
Algeria	DZA	STEPS	2016-17	93.2	2.1	3,823	18-69	1,928	39	13,908	21,303
Iran	IRN	STEPS	2016	98.4	4.5	15,260	18-100	6,712	38	18,664	41,024
Lebanon	LBN	STEPS	2017	69.9	8.2	2,167	16-70	1,022	39	11,647	3,911 [h]
Morocco	MAR	STEPS	2017	89.0	4.0	3,398	18-100	1,535	39	7,509	18,379
South Asia, East Asia, and Pacific											
China	CHN	SAGE	2008-10	98.9	5.2	7,601	18-93	785	42	8,683	698,159
Philippines	PHL	DHS	2013	98.3	0.0	24,832	15-49	12,269	39	6,282	53,801
Bhutan	BTN	STEPS	2014	96.9	1.9	1,712	18-69	887	38	7,954	358
Nepal	NPL	SOSAS	2014	97.0	2.0	1,007	15-100	394	38	2,385	15,562
Timor-Leste	TLS	STEPS	2014	96.3	7.8	1,407	18-69	668	39	6,467	640
Indonesia	IDN	IFLS	2014-15	90.5	0.0	16,518	15-101	7,151	37	10,181	134,356
India	IND	DHS	2015-16	96.7	0.0	677,463	15-49	331,512	38	5,944	656,288
Sri Lanka	LKA	DHS	2016	98.9	0.1	18,288	15-49	13,968	39	11,447	11,090
Sub-Saharan Africa											
Ghana	GHA	SAGE	2008-09	92.1	12.4	2,407	18-114	294	40	2,729	15,002
Cote d'Ivoire	CIV	DHS	2011-12	93.0	0.3	9,802	15-49	4,130	37	5,192	12,742
Namibia	NAM	DHS	2013	93.8	0.9	9,641	15-64	3,969	38	9,600	1,286
Botswana	BWA	STEPS	2014	64.0	2.3	2,687	15-69	1125	38	16,175	1,190
Eswatini	SWZ	STEPS	2014	81.8	7.3	2,135	15-70	821	38	9,309	585
Lesotho	LSO	DHS	2014	97.1	0.0	6,211	15-49	2,596	37	2,811	1,077
Benin	BEN	STEPS	2015	98.6	3.5	2,702	18-69	1,273	36	1,987	5,910
Kenya	KEN	STEPS	2015	95.0	0.3	2,681	18-69	1,197	37	2,798	26,452
Zimbabwe	ZWE	DHS	2015	96.2	0.0	9,481	15-49	4,211	37	2,509	7,662
South Africa	ZAF	DHS	2016	83.1	0.4	5,939	15-95	2,014	38	12,246	29,699
Sudan	SDN	STEPS	2016	95.0	8.2	4,606	18-69	2,143	37	4,357	21,425
Total	NA	NA	NA	93.8 (86.2 – 96.8)[i]	0.6 (0.1 – 4.7)[i]	1,129,404[j]	15 – 114	542,475	39 (38 – 39.5)[9]	9,256 (5,582 – 12,681)[i]	2,259,850[j]

Abbreviations: y, years; GDP, Gross Domestic Product; int. $, constant 2011 international dollars; NA, not available. CAMDI, Central America Diabetes Initiative; DHS, Demographic Health and Surveillance Survey[39]; EHS, European Health Survey; ENFR, Encuesta Nacional de Factores de Riesgo; ENS, Encuesta Nacional de Salud; ENSA, Encuesta Nacional de Salud; FESAL, Encuesta Nacional de Salud Familiar; ENSANUT, Encuesta Nacional de Salud y Nutrición; ENDSSR, Encuesta Nacional de Demografía y Salud Sexual y Reproductiva; ENDESA, Encuesta Nicargaüense de Demografía y Salud; IFLS-5, Indonesia Family Life Survey Wave 5; PNS, Pesquisa Nacional de Saúde; RHS, Reproductive Health Survey; SAGE, Study on global AGEing and adult health; SISS, Social Indicator Sample Survey; SOSAS, Surgeons OverSeas Assessment of Surgical need; STEPS, STEPwise approach to Surveillance.

[a] Values are unweighted (i.e., do not account for the multi-stage cluster sampling used by the included surveys).

[b] Sample size, median age, and age range are shown for those with a non-missing outcome variable.

[c] Year(s) in which the data collection for the survey was carried out.
[d] This is the women's response rate.
[e] This is the percent of female participants who had a missing response for the survey question assessing whether she had ever undergone a screening test for cervical cancer.
[f] This is GDP per capita in constant 2011 international dollars (as estimated by the World Bank[17]) for the year of the survey's data collection. In case of a multi-year data collection period, we calculated the mean GDP per capita in constant 2011 international dollars across years.
[g] Population in 2019 as estimated by United Nations, Population Division, Department of Economic and Social Affairs (2019).[19]
[h] This is the combined number of Lebanese citizens and Syrian refugees living in Lebanon in 2017 as estimated by the UN Refugee Agency (UNHCR).[40]
[i] This is the median value and interquartile range with each country having the same weight.
[j] This is the sum across all countries.