Original Article

Impact of Per Capita Income on the Effectiveness of School-Based Health Education Programs to Promote Cervical Cancer Screening Uptake in Southern Mozambique

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Abstract

Context: In the face of rising mortality rates from cervical cancer (CC) among women of reproductive age, a nationwide screening program based on visual inspection with acetic acid was introduced in Mozambique in 2009. **Objective:** The objective of the study is to examine the impact of per capita income on the effectiveness of school-based health education programs to promote the utilization of CC screening services. **Materials and Methods:** We conducted a cross-sectional study in 2013 involving 105 women randomly selected from households of different economic backgrounds. Marginal effect estimates derived from a logit model were used to explore the patterns in the effectiveness of school-based health education to promote CC screening uptake according to household per capita income, based on purchasing power parity. **Results:** We found a CC screening uptake of 16.1% (95% confidence interval [CI], 9.7%–24.6%) even though 64.6% (95% CI, 54.2%–74.1%) of women had heard of it. There are important economic differentials in the effectiveness of school-based health education to influence women's decision to receive CC screening. Among women with primary school or less, the probability of accessing CC screening services increases with increasing income ($P < 0.05$). However, income significantly reduces the effect that school-based health education has on the probability of screening uptake among those women with more than 7 years of educational attainment ($P = 0.02$). **Conclusion:** These results show that CC screening programs in resource-constrained settings need approaches tailored to different segments of women with respect to education and income to achieve equitable improvement in the levels of screening uptake.

Keywords: Cancer screening, cervical cancer, economic inequalities, health education, human papillomavirus, Mozambique, Sub-Saharan Africa

Introduction

Recent estimates indicate that if effective and sustainable measures are not implemented, cervical cancer (CC) may become the next great epidemic of Southern Africa, where the disease represents the most common cancer, and the most common cause of cancer mortality among women of reproductive age.[1-2] CC contributes each year to the loss of 2.7 million years of life among women aged 25–64 years, with 89% of this loss occurring in low-income countries (LIC), compared to only 11% occurring in high-income countries (HIC).[3] Well-organized CC screening programs are indicated as having contributed to the reduction in mortality rates in HIC.[4,5] In many LIC, however, especially in Southern Africa, these programs are still suboptimal or nonexistent.[3,6]

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In Mozambique, before 2009, CC screening was limited to a few urban hospitals with either routine gynecological services or through research projects that had access to pathology services that allowed for the provision of CC screening through Pap smear.[7-9] In December 2009, the Ministry of Health (MoH) introduced a national program of cervical (and breast) cancer screening based on visual inspection with acetic acid (VIA).[7] National guidelines first recommended that

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all women between 30 and 55 years of age were eligible for CC screening, however, due to existing perceptions that CC in Mozambique may be occurring among younger women, possibly in the context of a high HIV prevalence,[9-11] the MoH expanded screening eligibility to all sexually active women.[12] Despite this, the burden of CC in the country remains high, with 65 new cases and 49 deaths/100,000 women reported in 2012, compared to 32 new cases and 21 deaths per 100,000 women in 2008.[7]

The previous studies conducted in Mozambique have indicated that (1) the late arrival of women in their disease course to the health facility for screening, (2) limited coverage of public health services, (3) unawareness of CC screening, and (4) irregular or no use at all of health facilities by women who feel healthy, remain barriers to a well-functioning CC screening program.[7,12] Despite the growing body of evidence on factors impacting the use of CC screening services and on the effectiveness of school-based health education programs to improve the utilization of CC screening services,[6,13-16] studies assessing the impact of per capita income on the effectiveness of these programs to influence women's decision to do CC screening, while accounting for the effect of other equally important socioecological factors on the relationship between education and screening, remain scarce, particularly in LIC. Our paper explores the impact of per capita income on the effectiveness of school-based health education programs to promote CC screening uptake. We use educational attainment as a proxy of women's exposure to school-based health education programs. Following the approach proposed by Gakidou *et al*., we define effective coverage of CC screening as the proportion of women reporting having done the screening in the 3 years preceding the survey and crude coverage of CC screening as the proportion of those reporting having ever done irrespective of the period when the screening occurred.[6] Understanding the contribution of women's income on the impact of school-based health education on women's probabilities to get CC screening is important as this could help enable the development of effective, sustainable, and tailored interventions aimed at improving uptake of CC screening in women from economically disadvantaged backgrounds, a group who represent the most vulnerable population at risk of CC in Mozambique.[1,7]

Materials and Methods

This study was performed in KaMubukwana, a suburban district of Maputo city, the capital of Mozambique, with women from different socioeconomic backgrounds. The study consisted of 105 women and was powered to detect a 10% difference in CC screening uptake based on assumptions from similar studies.[7,17] Participants were selected through simple probabilistic sampling. Households equaling the sample size were randomly selected by a computer program using the list of all households in the study site derived from local authorities, and from each of these households, the first eligible woman was included in the study. The inclusion criteria were (1) being female, aged ≥15 years; (2) accepting to participate in the study by signing written consent; and (3) being a resident of the KaMubukwana district. Ethical clearance was obtained from the Institutional Committee for Bioethics in Health of the Faculty of Medicine (Eduardo Mondlane University) and Maputo Central Hospital, where the protocol is registered under the number CIBS/FMHCM/20/2013. Written informed consent was sought from the study participants prior to data collection, and confidentiality was maintained throughout the study. For participants <18 years old, we obtained written assent from the participant and written consent from their legal guardian.

The surveys were conducted between October and December 2013 by trained interviewers in either Portuguese or a national language in which the respondent was most at ease using. The questionnaire included questions on socioeconomic characteristics, CC screening uptake, reasons for not having done the screening, perception of risk, main sources of information on CC, CC knowledge, and reproductive history. The CC knowledge score was assessed based on twelve questions including awareness about CC, knowledge about CC screening, and knowledge on CC risk factors, adopted from previous studies.[17,18] CC knowledge score and household per capita income were measured on a ratio scale while all other measures were dichotomized. Using 2013 purchasing power parity conversion factor from the World Bank, household per capita income in local currency (Mozambican Metical) was converted to the International dollar (international $).[19]

We used logistic regression to model the effect of variables chosen using a stepwise selection procedure with a *P* value for the omission of 0.2. Based on the previous studies, we considered as control variables in our predictive model those which may be correlated with screening uptake but have also been associated with education and per capita income.[10,15,17] These included age group, knowledge score, knowing someone ever screened for CC, number of sexual partners, and age at sexual debut. Likewise, to account for any differential effect on screening uptake due to education among women from economically disadvantaged backgrounds, we included an interaction term between education and income. The interaction term between knowing someone who had participated in CC screening and CC knowledge score was introduced to reflect the potential for variation in the effect of knowing someone who had undergone CC screening on the utilization of CC screening services across CC knowledge scores, reported in the previous studies.[17,18] We fit two models, with model-2 including education, income, as well as CC knowledge score, whether the woman knows someone ever screened for CC, reproductive history, and the interactions. In model-1, we kept education, income, age and the interaction between education and income. The final model was selected on the basis of the area under the Receiver Operating Characteristics curve (AUC), Akaike's Information Criterion (AIC), Bayesian Information Criterion (BIC), and Pearson's goodness-of-fit statistic. To examine the patterns of the impact of household per capita income on the probability of CC screening for women with defined levels of attained education, we derived marginal effects at representative values. We used a significance level of 5% in our hypothesis testing and R version 3.4.2 along with Stata/MP 14.2 for statistical analysis.[20,21]

Results

Table 1 presents the characteristic of the study participants. The mean age was 30.3 ± 10.8 years and median per capita income was $66.96 (interquartile range: $50.00 to $138.39)/month. Approximately 87% of female participants worked outside the home and half of them had only 7 years of attained education or less. On the 12 question CC knowledge assessment, participants responded correctly on average to only 4.3 ± 2.3 questions despite 64.6% (95% confidence interval [CI], 54.2%–74.1%) of participants having heard of CC screening previously. Both effective and crude coverage levels of CC screening were low among the study population as only 16.1% (95% CI 9.7-24.6%) and 20.9% (95% CI 13.6-29.9%) had undergone screening for CC in the three years preceding the survey, or at least in some point in their lives, respectively. Fully 90.4% of participants indicated a lack of information about CC screening services as their main reason for not pursuing CC screening.

Despite having comparable AUC and AIC between our two models, model-2 was outperformed by model-1 in terms of both Pearson's goodness-of-fit statistic and BIC, enabling us to acknowledge that model-1 fits better our data than model-2, as illustrated in Table 2. We, therefore, adopted model-1 to estimate the odds of CC screening uptake by educational attainment, per capita income, and the interaction between them, as well as the marginal effects of these factors on screening uptake, while accounting for age. Further, we made use of a mosaic plot with residual-based shading to visually assess our model-1 overall hypothesis of CC screening being independent of exposure to school-based health education and per capita income, given age group [Figure 1]. This showed that overall there is a strong relationship between these variables ($P < 0.01$).

In our predictive logit model, the characteristic most significantly associated with CC screening uptake was education beyond primary school, which we found to improve remarkably the odds of CC screening among women from deprived households (odds ratio [OR] 71.63; 95% CI 2.60–1976.93; $P = 0.01$). For those women reporting only primary school level or less, we examined their odds of receiving CC screening based on one-dollar incremental increases in per capita income and found a weak association (OR 1.04; 95% CI: 1.01–1.08; $P = 0.02$) [Table 2]. For these women, a sizeable increase in per capita income is needed before income notably influences their odds of using CC screening services. A reflection of this pattern can be seen in Figure 2 where the relationship between income and the probability that a woman gets screened for CC is S-shaped for those with

Table 1: Selected demographic characteristics of the study participants[a]

Characteristic	Value
Age, years[b]	27 (22;36)
Educational attainment	
Primary school or less	52 (49.7)
Beyond primary school	53 (50.5)
Per capita income per month in international $[b]	67.0 (50.0;138.4)
Marital status	
Married	46 (43.8)
Single, widows, or divorced	59 (56.2)
Occupation	
Housewife (including family subsistence work such as farming)	14 (13.3)
Works outside the home (including students)	91 (86.7)
Primary source of information on CC	
Health facility	40 (38.5)
Outside source (mass media, social network, and school)	64 (61.5)
Knows someone with CC	19 (18.1)
Reproductive history and sexual behavior	
Age of sexual debut	16.9±2.7
Parity	2.3±2.2
Number of sexual partners	1.5±1.0
Consistent use of condom	34 (32.4)
Perceptions about CC and screening	
Perception of personal risk of cancer	34 (32.4)
Belief that CC screening procedure is very painful	59 (56.2)
Knowledge score on CC[c]	4.3±2.3
Awareness about CC	
Have you ever heard of CC?	95 (90.5)
Is HPV the cause of CC?	10 (9.5)
Can CC be prevented?	45 (42.9)
Have you ever heard of HPV vaccine before today?	5 (4.8)
Have you ever heard of CC screening?	62 (64.6)
Knowledge about CC screening	
Screening tests can help prevent CC?	31 (29.5)
Should healthy women do CC screening?	53 (50.9)
Do you know a health facility that offers CC screening?	9 (8.6)
Do you know of any method of screening for CC?	51 (48.6)
Knowledge about risk factors for CC	
Is having multiple partners a risk factor for CC?	63 (60.0)
Is early sexual debut a risk factor for CC?	2 (1.9)
Is sexual intercourse without condom a risk factor for CC?	71 (67.6)
Knows someone ever screened for CC	29 (27.9)
Crude coverage of CC screening[d]	
Women aged ≥15 years	20.9 (13.6;29.9)
Women aged 30−49 years	23.5 (9.3;37.8)
Effective coverage of CC screening[d]	
Women aged ≥15 years	16.1 (9.7;24.6)
Women aged 30−49 years	14.7 (2.8;26.6)

Contd...

Table 1: Contd...

Characteristic	Value
Reasons for nonattendance in CC screening	
Poor quality of and access to healthcare	8 (9.6)
Low knowledge about CC screening service	75 (90.4)

[a]Values given as mean±SD or *n* (%), unless otherwise stated, [b]Values given as median (IQR), [c]Number of correct responses out of 12, [d]Coverage levels given as percentage (95%CI). CC: Cervical cancer, HPV: Human papillomavirus, International $: International dollar, SD: Standard deviation, IQR: Interquartile range

Table 2: Odds ratios of cervical cancer screening uptake with 95% confidence intervals

Logistic regression	Model 1	Model 2
Predictors		
Age (≤30 years)	1.37 (0.36-5.22)	4.27 (0.64-28.43)
Education (beyond primary school)	71.63 (2.60-1976.93)[a]	266.22 (2.74-25,906.53)[b]
Per capita income (international $)	1.04 (1.01-1.08)[b]	1.06 (1.01-1.11)[b]
Knowledge score on CC		0.69 (0.40-1.20)
Knows someone ever screened for CC		0.13 (0.00-23.41)
Age at sexual debut (≥18 years)		0.29 (0.04-2.38)
Sexual partners in 12 months (>3)		7.28 (0.12-460.22)
Education x income	0.95 (0.92-0.99)[b]	0.93 (0.89-0.99)[b]
Knows someone x knowledge score		2.28 (0.82-6.39)
Model performance		
AUC[c]	0.76 (0.63-0.90)	0.86 (0.73-0.99)
AIC	65.40	64.84
BIC	76.31	86.58
Pearson's goodness of fit test (*P* value)	0.81	<0.01

[a]*P*≤0.01, [b]*P*≤0.05, [c]Test of equality of AUC suggests that the two models have a similar predictive ability (*P*=0.10). CC: Cervical cancer, International $: International dollar; AUC: Area under the ROC (Receiver Operating Characteristics) curve, AIC: Akaike's information criterion, BIC: Bayesian information criterion

only "primary school or less". This indicates that increasing income has little effect on the probability of CC screening uptake among women with <8 years of schooling for extremely low, as well as extremely high, values of income. There is a midrange of per capita income ($70 to $150/month) where the effect of increasing income is notable, as can be seen by the slope of the curve across the income spectrum in Figure 2. We estimate that among women with <8 years of schooling and income within the $70–$150/month range, an increase of $10 in per capita income per month improves their probability of getting a CC screening test by at least 5%. Among those with the same educational attainment, but a per capita income per month below $70 or above $150,

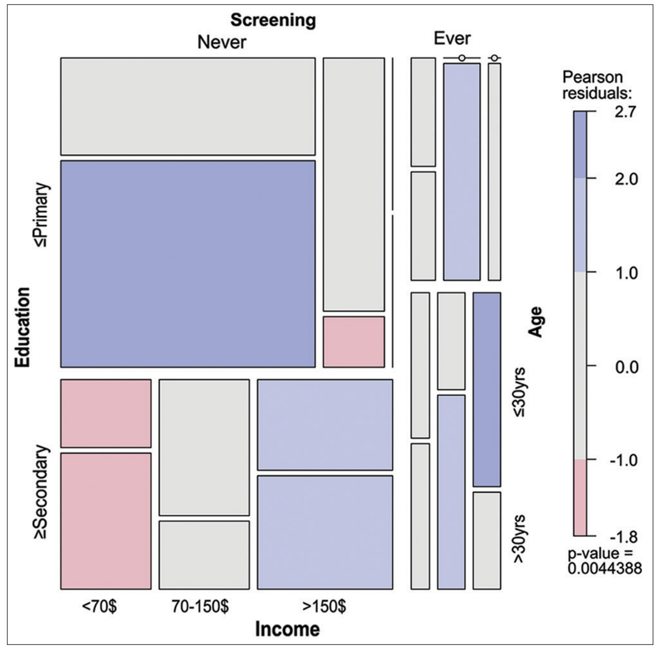

Figure 1: Mosaic plot showing the distribution of cervical cancer screening uptake given per capita income, educational attainment, and age group. The *P* value is based on a Pearson test and indicates the overall significance of the deviations of observed from expected frequencies. Residuals >2 are individually significant at the 5% level. Details of the underlying log-linear model can be found in Table S3. Abbreviations: $: international dollar, Yrs: years

the increase in the probability of CC screening due to an additional $10 in monthly income is <5.0% [Table S1]. It is important to emphasize that the combined effect of education plus income is nevertheless less than the combination of their separate effects, as illustrated by the interaction parameter in Table 2. This shows that inclusion of the interaction term in our modeling framework was warranted and that the interaction between education and income explains significant variation in the uptake of CC screening. This parameter further reveals that the odds of CC screening uptake, per every one-dollar increase in income, for those participants with education beyond primary school, is 5% less than the odds for participants with primary school or less and a similar one-dollar incremental increase in income. Thus, while among women with only primary school or less and living with $2.30 to $5.00/day the odds of accessing CC screening services increases notably with increasing per capita income, among those with >7 years of education income significantly reduces the effect of education on the odds of CC screening uptake (OR 0.95; 95% CI 0.92–0.99; *P* = 0.02) [Figure 3 and Table S2].

Discussion

Here, for the first time, we use marginal effects estimates to illustrate important patterns in the utilization of CC screening services in Mozambique. Despite its ability to provide powerful insights for policy-making, marginal analysis has not been

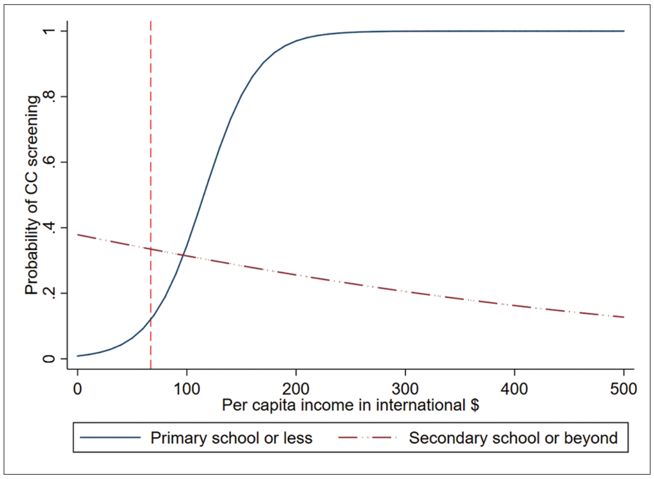

Figure 2: Predictive margins of cervical cancer screening uptake at representative values of educational attainment and per capita income. The dashed vertical line represents median household per capita income per month based on purchasing power parity. Individual predicted probabilities are available in Table S1. Abbreviations: CC: cervical cancer, International $: international dollar

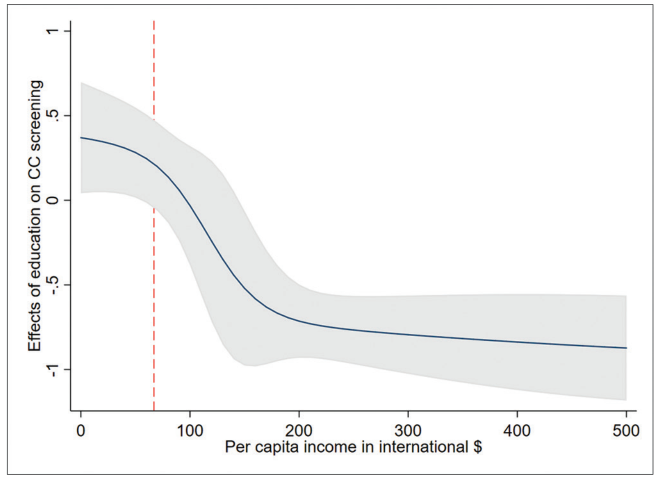

Figure 3: Effect of educational attainment on the probability of cervical cancer screening uptake among women from different economic backgrounds with 95% confidence intervals. The dashed vertical line represents median household per capita income per month based on purchasing power parity. Details about change in predictive margins at representative values of income from the baseline education level are available in Table S2. Abbreviations: CC: cervical cancer, International $: international dollar

widely used in health services research.[22] This method enables us to both quantify income and educational gradients in CC screening and explore the patterns of these inequalities in women with selected profiles, which subsequently gives us unique insights about the location and trends on the effect of health education on CC screening uptake across the income spectrum.

Our estimates highlight that women with economic hardship and low education face remarkable difficulties to use CC screening services in Mozambique, and most importantly that among those with higher income, exposure to school-based health education tends to negatively affect their uptake of CC screening. Thus, as their income increases, the most educated women become less likely to get a CC screening test, which may be a reflection of poor performance not only of school-based health education efforts in the country but also of the health system which impacts negatively its responsiveness to patients' needs.[23,24] While economically disadvantaged women may be willing to accept services with poor responsiveness, as their income and education improve, their demands on nonhealth enhancing aspects of care increases as well and these demands increasingly become influential for their decision to use CC screening services.[25,26] Moreover, the finding that a relatively small increase in income among low-income women from a selected range of per capita income is associated with a material improvement in CC screening uptake among those with low education suggests that interventions linking cash transfers to service use could help improve the levels of CC screening uptake in LIC. Despite the growing body of evidence suggesting that conditional cash transfer programs can improve the utilization of health services such as maternity care, HIV/AIDS prevention, and tuberculosis treatment, the use of these approaches to improve CC screening uptake has not been reported to date.[27]

The low levels of CC screening among our study population are consistent with the findings of previous studies in LIC. An analysis of population-based surveys conducted in 2008 to examine the coverage of CC screening in 57 countries found that the average effective coverage of CC screening was 19% in LIC, compared to 63% in HIC.[6] In addition, this report revealed large between-country and within-country inequalities in CC screening coverage across SSA, with levels of effective coverage ranging from < 1% in Ethiopia to < 20% in Mauritius. Mozambique was not included in this analysis as the national CC screening program based on VIA was introduced a year later. Our analysis is, therefore, the first study in Mozambique, since the introduction of the program, to examine the effective coverage of CC screening. Because women living in Maputo have more access to health facilities relative to those living in other regions of the country,[23,28] we expect the levels of effective coverage of CC screening to be notably <16% in other, more impoverished, districts in the country.

Our analysis allows detailed estimation of the interaction between the effects of health education and per capita income on CC screening and helps identify inequalities of different segments of society with regard to screening uptake. The finding suggesting that education and income influence each other negatively on CC screening uptake is new and could guide the design and implementation of health education programs and future research in the field. This pattern in the effectiveness of health education on CC screening has never been reported so far as most studies assessing this relationship assume that health education efforts are equally effective across all income subgroups, and thus compute the averaged effect of education on the screening uptake for all income subgroups,[14,18] or do not take account of income at all.[10,15,16,26,29,30] The interaction term in our modeling framework enabled us to examine the variation of the effectiveness of education to influence a women's decision to participate in screening due to the influence of income. While the pattern of this relationship among the most deprived women is in-line with previous evidence showing that women exposed to health education programs are on average more likely to undergo CC screening procedures,[10,18,30] our estimates reveal that the contribution of income on the impact of health education on CC screening uptake is an essential determinant of inequalities on CC screening. Therefore, unless there is empirical evidence of homogeneity in the effect estimates across the income spectrum, the effectiveness of health education programs aimed at promoting CC screening should be assessed for each relevant segment of women's income. It is nevertheless important to acknowledge limitations. First, our estimates are subject to recall bias. Second, the per capita income data may be subject to social desirability bias. Third, the precision of our estimates is notably affected by our dataset size. Increased precision in the future studies may be accomplished using nationally representative health surveys which however currently do not include measures about CC screening and HPV vaccine as well as household per capita income.

Conclusion

We have shown that educational curriculum enhancements are a remarkable avenue for interventions aimed at increasing utilization of CC screening services among the most deprived women, but not among those from less deprived or relatively affluent households to whom health system responsiveness seems to be the most important driver of their decision to use CC screening services. Further, our results suggest that for women with a low exposure to school-based health education, a sizeable increase in their per capita income is needed to see an impactful change in their accessing of CC screening services. This finding is of considerable practical value in the identification of the most-at-risk-populations for CC, which is a cornerstone for priority-setting and resource allocation, particularly in resource-constrained settings such as Mozambique.

Supplementary material

Further details about predictive margins of CC screening uptake at representative values of educational attainment and per capita income as well as differences in adjusted probabilities of CC screening uptake from the baseline educational level are provided in Tables S1 and S2, respectively. Table S3 provides details regarding the log-linear model underlying the mosaic plot statistics.

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Conflicts of interest

There are no conflicts of interest.

Author contributions

FA conceived of and designed the research, led data collection, conducted statistical analysis, drafted the manuscript, drafted the supplementary material of the manuscript, discussed the results and contributed to the revision of the final manuscript. TM, AM, JS reviewed the manuscript, supported interpretation and policy contextualization, discussed the results and contributed to the revision of the final manuscript. All authors read and approved the final manuscript.

References

1. Bruni L, Barrionuevo-RosasL, Albero G, Serrano B, Mena M, Gómez D, *et al*. Human Papillomavirus and Related Diseases in the World Summary Report. Barcelona, Spain: Institut Català d'Oncologia, Information Centre on HPV and Cancer (HPV Information Centre); 30 June, 2017.
2. Bray F, Jemal A, Grey N, Ferlay J, Forman D. Global cancer transitions according to the human development index (2008-2030): A population-based study. Lancet Oncol 2012;13:790-801.
3. Lingwood RJ, Boyle P, Milburn A, Ngoma T, Arbuthnott J, McCaffrey R, *et al.* The challenge of cancer control in Africa. Nat Rev Cancer 2008;8:398-403.
4. Jemal A, Center MM, DeSantis C, Ward EM. Global patterns of cancer incidence and mortality rates and trends. Cancer Epidemiol Biomarkers Prev 2010;19:1893-907.
5. Elovainio L, Nieminen P, Miller AB. Impact of cancer screening on women's health. Int J Gynaecol Obstet 1997;58:137-47.
6. Gakidou E, Nordhagen S, Obermeyer Z. Coverage of cervical cancer screening in 57 countries: Low average levels and large inequalities. PLoS Med 2008;5:e132.
7. Audet CM, Silva Matos C, Blevins M, Cardoso A, Moon TD, Sidat M, *et al.* Acceptability of cervical cancer screening in rural Mozambique. Health Educ Res 2012;27:544-51.
8. Castellsagué X, Klaustermeier J, Carrilho C, Albero G, Sacarlal J, Quint W, *et al.* Vaccine-related HPV genotypes in women with and without cervical cancer in Mozambique: Burden and potential for prevention. Int J Cancer 2008;122:1901-4.
9. Naucler P, Mabota da Costa F, da Costa JL, Ljungberg O, Bugalho A, Dillner J, *et al.* Human papillomavirus type-specific risk of cervical cancer in a population with high human immunodeficiency virus prevalence: Case-control study. J Gen Virol 2011;92:2784-91.
10. Gichangi P, Estambale B, Bwayo J, Rogo K, Ojwang S, Opiyo A, *et al.* Knowledge and practice about cervical cancer and pap smear testing among patients at Kenyatta National Hospital, Nairobi, Kenya. Int J Gynecol Cancer 2003;13:827-33.
11. Thorsteinsson K, Ladelund S, Jensen-Fangel S, Katzenstein TL, Johansen IS, Pedersen G, *et al.* Incidence of cervical dysplasia and cervical cancer in women living with HIV in denmark: Comparison with the general population. HIV Med 2016;17:7-17.
12. Moon TD, Silva-Matos C, Cordoso A, Baptista AJ, Sidat M, Vermund SH, *et al.* Implementation of cervical cancer screening using visual inspection with acetic acid in rural Mozambique: Successes and challenges using HIV care and treatment programme investments in Zambézia province. J Int AIDS Soc 2012;15:17406.
13. Di Cesare M, Khang YH, Asaria P, Blakely T, Cowan MJ, Farzadfar F, *et al.* Inequalities in non-communicable diseases and effective responses. Lancet 2013;381:585-97.
14. Viens LJ, Clouston S, Messina CR. Women's autonomy and cervical cancer screening in the lesotho demographic and health survey 2009. Soc Sci Med 2016;150:23-30.
15. Wellensiek N, Moodley M, Moodley J, Nkwanyana N. Knowledge of cervical cancer screening and use of cervical screening facilities among women from various socioeconomic backgrounds in Durban, Kwazulu Natal, South Africa. Int J Gynecol Cancer 2002;12:376-82.

16. Dreyer G, van der Merwe FH, Botha MH, Snyman LC, Constant D, Visser C, *et al.* School-based human papillomavirus vaccination: An opportunity to increase knowledge about cervical cancer and improve uptake of screening. S Afr Med J 2015;105:912-6.
17. Rosser JI, Njoroge B, Huchko MJ. Cervical cancer screening knowledge and behavior among women attending an urban HIV clinic in Western Kenya. J Cancer Educ 2015;30:567-72.
18. Perng P, Perng W, Ngoma T, Kahesa C, Mwaiselage J, Merajver SD, *et al.* Promoters of and barriers to cervical cancer screening in a rural setting in Tanzania. Int J Gynaecol Obstet 2013;123:221-5.
19. Republic of Mozambique. PPP conversion factor, private consumption (LCU per international $): World Bank, International Comparison Program database; 2011.
20. R Development Core Team. R: A language and environment for statistical computing. R Foundation for Statistical Computing. In. Vienna, Austria; 2008.
21. StataCorp. Stata Statistical Software: Release 14.2. College Station, TX: StataCorp LP.; 2015.
22. Onukwugha E, Bergtold J, Jain R. A primer on marginal effects – part I: Theory and formulae. Pharmacoeconomics 2015;33:25-30.
23. Fernandes QF, Wagenaar BH, Anselmi L, Pfeiffer J, Gloyd S, Sherr K, *et al.* Effects of health-system strengthening on under-5, infant, and neonatal mortality: 11-year provincial-level time-series analyses in Mozambique. Lancet Glob Health 2014;2:e468-77.
24. Murray CJ, Frenk J. A framework for assessing the performance of health systems. Bull World Health Organ 2000;78:717-31.
25. Robone S, Rice N, Smith PC. Health systems' responsiveness and its characteristics: A cross-country comparative analysis. Health Serv Res 2011;46:2079-100.
26. Abiodun OA, Olu-Abiodun OO, Sotunsa JO, Oluwole FA. Impact of health education intervention on knowledge and perception of cervical cancer and cervical screening uptake among adult women in rural communities in Nigeria. BMC Public Health 2014;14:814.
27. Pantoja T, Opiyo N, Lewin S, Paulsen E, Ciapponi A, Wiysonge CS, *et al.* Implementation strategies for health systems in low-income countries: An overview of systematic reviews. Cochrane Database Syst Rev 2017;9:CD011086.
28. Dos Anjos Luis A, Cabral P. Geographic accessibility to primary healthcare centers in Mozambique. Int J Equity Health 2016;15:173.
29. Mbachu C, Dim C, Ezeoke U. Effects of peer health education on perception and practice of screening for cervical cancer among urban residential women in South-East Nigeria: A before and after study. BMC Womens Health 2017;17:41.
30. Réka V, Annamária KP, Zsuzsanna É, Mónika SG, Péter T, Ákos DV, *et al*. Analysis of the knowledge on cervical cancer and attendance indicators of cervical screening. Lege Artis Med 2014;2014;24:118-25.

Table S1: Predictive margins of cervical cancer screening uptake at representative values of educational attainment and per capita income

Variables		MER	
Per capita income, international $	**Highest educational level**	**Estimate**	**95% CI**
0	Primary school or less	0.009	−0.017-0.034
0	Beyond primary school	0.379[a]	0.052-0.706
10	Primary school or less	0.013	−0.021-0.047
10	Beyond primary school	0.372[a]	0.061-0.683
20	Primary school or less	0.019	−0.026-0.064
20	Beyond primary school	0.365[a]	0.070-0.660
30	Primary school or less	0.029	−0.029-0.086
30	Beyond primary school	0.359	0.079-0.638
40	Primary school or less	0.042	−0.030-0.116
40	Beyond primary school	0.352[b]	0.087-0.617
50	Primary school or less	0.063	−0.027-0.153
50	Beyond primary school	0.346 [b]	0.095-0.596
60	Primary school or less	0.092	−0.016-0.201
60	Beyond primary school	0.339[b]	0.0102-0.577
70	Primary school or less	0.133[a]	0.001-0.265
70	Beyond primary school	0.333[b]	0.0108-0.558
80	Primary school or less	0.188[a]	0.022-0.355
80	Beyond primary school	0.327[b]	0.113-0.540
90	Primary school or less	0.259[a]	0.040-0.479
90	Beyond primary school	0.320[b]	0.117-0.524
100	Primary school or less	0.345[a]	0.053-0.639
100	Beyond primary school	0.314[c]	0.120-0.508
110	Primary school or less	0.443[a]	0.070-0.816
110	Beyond primary school	0.307[c]	0.112-0.494
120	Primary school or less	0.545[a]	0.105-0.985
120	Beyond primary school	0.302[c]	0.112-0.481
130	Primary school or less	0.644[b]	0.171-1.117
130	Beyond primary school	0.296[c]	0.112-0.470
140	Primary school or less	0.731[b]	0.266-1.197
140	Beyond primary school	0.290[c]	0.120-0.460
150	Primary school or less	0.804[c]	0.381-1.227
150	Beyond primary school	0.284[c]	0.116-0.452
160	Primary school or less	0.861[c]	0.500-1.222
160	Beyond primary school	0.278[c]	0.112-0.445
170	Primary school or less	0.903[c]	0.611-1.195
170	Beyond primary school	0.273[c]	0.106-0.440
180	Primary school or less	0.934[c]	0.706-1.161
180	Beyond primary school	0.267[b]	0.099-0.435
190	Primary school or less	0.955[c]	0.783-1.127
190	Beyond primary school	0.261[b]	0.091-0.432
200	Primary school or less	0.970[c]	0.842-1.097
200	Beyond primary school	0.256[b]	0.082-0.430
210	Primary school or less	0.980[c]	0.887-1.073
210	Beyond primary school	0.251[b]	0.072-0.429
220	Primary school or less	0.987[c]	0.920-1.053
220	Beyond primary school	0.245[b]	0.062-0.428
230	Primary school or less	0.991[c]	0.943-1.039
230	Beyond primary school	0.240[b]	0.052-0.428
240	Primary school or less	0.994[c]	0.960-1.028
240	Beyond primary school	0.235[a]	0.041-0.429

Contd...

Table S1: Contd...

Variables		MER	
Per capita income, international $	**Highest educational level**	**Estimate**	**95% CI**
250	Primary school or less	0.996[c]	0.972-1.020
250	Beyond primary school	0.230[a]	0.030-0.430
260	Primary school or less	0.997[c]	0.981-1.014
260	Beyond primary school	0.225[a]	0.018-0.431
270	Primary school or less	0.998[c]	0.987-1.009
270	Beyond primary school	0.220[a]	0.007-0.432
280	Primary school or less	0.999[c]	0.991-1.007
280	Beyond primary school	0.215[a]	−0.004-0.434
290	Primary school or less	0.999[c]	0.994-1.005
290	Beyond primary school	0.210	−0.015-0.435
300	Primary school or less	0.999[c]	0.996-1.003
300	Beyond primary school	0.205	−0.026-0.437
310	Primary school or less	0.999[c]	0.997-1.002
310	Beyond primary school	0.201	−0.037-0.438
320	Primary school or less	0.999[c]	0.998-1.001
320	Beyond primary school	0.196	−0.047-0.440
330	Primary school or less	0.999[c]	0.999-1.001
330	Beyond primary school	0.191	−0.060-0.441
340	Primary school or less	0.999[c]	0.999-1.000
340	Beyond primary school	0.187	−0.068-0.442
350	Primary school or less	0.999[c]	0.999-1.000
350	Beyond primary school	0.183	−0.077-0.443
360	Primary school or less	0.999[c]	0.999-1.000
360	Beyond primary school	0.179	−0.087-0.444
370	Primary school or less	0.999[c]	0.999-1.000
370	Beyond primary school	0.175	−0.096-0.445
380	Primary school or less	0.999[c]	0.999-1.000
380	Beyond primary school	0.170	−0.104-0.445
390	Primary school or less	0.999[c]	0.999-1000
390	Beyond primary school	0.166	−0.113-0.446
400	Primary school or less	0.999[c]	0.999-1.000
400	Beyond primary school	0.162	−0.121-0.446
410	Primary school or less	0.999[c]	0.999-1.000
410	Beyond primary school	0.159	−0.129-0.446
420	Primary school or less	0.999[c]	0.999-1.000
420	Beyond primary school	0.155	−0.136-0.446
430	Primary school or less	0.999[c]	0.999-1.000
430	Beyond primary school	0.151	−0.143-0.445
440	Primary school or less	0.999[c]	0.999-1.000
440	Beyond primary school	0.147	−0.149-0.445
450	Primary school or less	0.999[c]	0.999-1.000
450	Beyond primary school	0.144	−0.156-0.444
460	Primary school or less	0.999[c]	0.999-1.000
460	Beyond primary school	0.140	−0.162-0.443
470	Primary school or less	0.999[c]	0.999-1.000
470	Beyond primary school	0.137	−0.168-0.442
480	Primary school or less	0.999[c]	0.999-1.000
480	Beyond primary school	0.134	−0.173-0.441
490	Primary school or less	0.999[c]	0.999-1.000
490	Beyond primary school	0.130	−0.178-0.440
500	Primary school or less	0.999[c]	0.999-1.000
500	Beyond primary school	0.127	−0.183-0.438

[a]$P \leq 0.05$, [b]$P \leq 0.01$, [c]$P \leq 0.001$. MER: Marginal effects at representative values, International $: International dollar, CI: Confidence interval

Table S2: Differences in adjusted probabilities of cervical cancer screening uptake from the baseline educational level

Variable	Differences in adjusted probabilities	
Per capita income, international $	Estimate	95% CI
0	0.370[a]	0.042-0.698
10	0.360[a]	0.047-0.672
20	0.346[a]	0.048-0.644
30	0.330[a]	0.045-0.615
40	0.301[a]	0.018-0.569
50	0.282[a]	0.016-0.548
60	0.247	−0.014-0.508
70	0.200	−0.061-0.460
80	0.138	−0.133-0.409
90	0.061	−0.239-0.361
100	−0.031	−0.383-0.321
110	−0.135	−0.553-0.283
120	−0.243	−0.720-0.233
130	−0.348	−0.853-0.158
140	−0.441	−0.939-−0.056
150	−0.520[a]	−0.976-−0.063
160	−0.583[a]	−0.981-−0.184
170	−0.631[c]	−0.968-−0.291
180	−0.667[c]	−0.950-−0.383
190	−0.694[c]	−0.937-−0.450
200	−0.714[c]	−0.930-−0.500
210	−0.729[c]	−0.931-−0.528
220	−0.741[c]	−0.937-−0.546
230	−0.751[c]	−0.946-−0.557
240	−0.760[c]	−0.957-−0.562
250	−0.766[c]	−0.968-−0.565
260	−0.773[c]	−0.980-−0.566
270	−0.779[c]	−0.991-−0.566
280	−0.784[c]	−1.003-−0.565
290	−0.789[c]	−1.014-−0.564
300	−0.794[c]	−1.026-−0.563
310	−0.800[c]	−1.036-−0.562
320	−0.804[c]	−1.047-−0.560
330	−0.808[c]	−1.057-−0.559
340	−0.813[c]	−1.067-−0.558
350	−0.817[c]	−1.077-−0.557
360	−0.821[c]	−1.087-−0.556
370	−0.825[c]	−1.096-−0.555
380	−0.830[c]	−1.104-−0.555
390	−0.834[c]	−1.112-−0.554
400	−0.837[c]	−1.121-−0.554
410	−0.841[c]	−1.128-−0.554
420	−0.845[c]	−1.136-−0.554
430	−0.849[c]	−1.143-−0.555
440	−0.853[c]	−1.150-−0.555
450	−0.856[c]	−1.156-−0.556
460	−0.860[c]	−1.162-−0.557
470	−0.863[c]	−1.168-−0.558

Contd...

Table S2: Contd...

Variable	Differences in adjusted probabilities	
Per capita income, international $	Estimate	95% CI
480	−0.866[c]	−1.173-−0.559
490	−0.870[c]	−1.178-−0.561
500	−0.873[c]	−1.183-−0.562

[a]$P \leq 0.05$, [b]$P \leq 0.01$, [c]$P \leq 0.001$. International $: International dollar, CI: Confidence interval

Table S3: Statistics derived from the log-linear model (screening, income, education, age) underlying the test of independence between cervical cancer screening uptake, per capita income, educational attainment, and age group

Statistics	χ^2	Degrees of freedom	*P*
LRS	41.83498	18	0.001166105
Pearson	37.55121	18	0.004438751

The *P* value provided in the mosaic plot is based on Pearson.
LRS: Likelihood ratio statistic, Screening: CC screening