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Life-Course Socio-Economic Status and Breast and Cervical Cancer Screening; Analysis of the WHO study on Global Ageing and Adult Health (SAGE)

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ABSTRACT

Objectives: Routine breast and cervical cancer screening remains the most effective strategy for early detection of cancer among women. Socio-economic differences in screening have been well documented in developed but not developing countries. The aim of this analysis is to examine SES differences in age-appropriate breast and cervical cancer screening among women in Middle income Countries (MICs).

Setting: A cross sectional analysis of the WHO Study on Global Ageing and Adult Health (SAGE) 2007-2008 data was carried out**.** We conducted survey weighted multivariable regression analysis, and examined the association between individual and life-course SES in relation to breast and cervical cancer screening using education and employment based measures of SES.

Participants: A total of 22,283 women ages 18-65 years, recruited from China, Mexico, India, Russia and South Africa.

Results: After adjusting for age, health status, rural/urban residence and marital status, having a college degree (OR: 4.10, 95% CI: 2.52-6.71), or secondary school education (OR: 1.89, 95% CI: 1.35-2.64) increased breast cancer screening compared with those with no formal education. Stable higher life-course SES (OR: 3.07, 95% CI: 1.96 – 4.79) increased breast cancer screening by 3-fold, and increased cervical cancer screening by more than 4-fold (OR: 4.35, 95% CI: 2.94 – 6.45). However, those with declining life-course SES were less likely to receive breast cancer screening (OR: 0.26, 95% CI: 0.08-0.79) compared with those of low life-course SES.

Conclusion: Higher individual and life course SES were positively associated with breast and cervical cancer screening, although education based SES measures were stronger predictors of screening compared with employment based measures. Addressing social inequality and improving knowledge and access to cancer screening services at all levels of the SES are actionable strategies that may significantly improve screening rates in developing countries

STRENGTH and LIMITATIONS

- The strengths of this study include the use of data from the multi-country, nationally representative and standardized SAGE study. SAGE was designed to elicit response on a wide-range of health related questions and had very high response rates, which permitted robust assessment of comprehensive measures of life-course SES and cancer screening in multiple countries.

- One potential limitation of this study includes the use of self-reported screening data, however since SAGE is a standardized survey of multiple health items, any recall bias of self-reported screening is unlikely to be differential with respect to country or SES.

- Another potential limitation involves SES and potential country-level differences in the ability of education or employment measures to capture the full range of SES. We used both measures of education and employment to better capture variability in SES, as these are less vulnerable to recall bias or social desirability bias, and have been used in past studies as robust measures of SES.

INTRODUCTION

Breast and cervical cancers remain the most common malignancies in women worldwide.[1] In low- and middle- income countries (LMICs), incidence and mortality due to these cancers have increased in recent decades, while the reverse has been observed in upper income countries (UIC) [2-5]. According to the International Agency for Research on Cancer (IARC), 84% and 53% of new cervical and breast cancer cases respectively, as well as 88% and 58% of cervical and breast cancer deaths respectively, occur in LMICs [5-8]. Concurrently, mortality due to breast and cervical cancers has declined significantly in UICs of the US and Europe in the past few decades, a trend that has been attributed to widespread use of routine cancer screening and improved cancer treatment[1 4 9]. Routine screening and timely diagnostic follow-up is key to early diagnosis of cancer at stages where treatment is cheaper, less toxic and more effective [10]. Whereas IARC recommends mammograms for women ages 50 – 74 years and pap smears for women from 25 years triennially[11 12], low financial resources may account for non-compliance with screening guidelines, in addition to poor implementation of comprehensive cancer control plans (in countries that have them), poor healthcare infrastructure to implement cancer screening programs, and high prevalence of competing health issues[13]. Prior studies in the US have reported that socioeconomic status (SES) at both the individual level, including parental SES and over the entire life-course, and the neighborhood level, strongly influences multiple health factors [14-18], and is associated with screening utilization [19-22]. The life-course approach to understanding cancer screening recognizes the complex interplay of early life factors including parental and individual SES in shaping health behavior, either directly through financial resources and healthcare access or indirectly through awareness of cancer screening recommendations [23].

Although multiple studies in LMICs have shown that low SES is a major predictor of the lack of cancer screening [24-27], none to our knowledge have examined SES over the life-course in relation to breast cancer screening and cervical cancer screening. It remains unclear whether parental SES plays a role in adherence to cancer screening guidelines above and beyond individual SES, or whether this association depends on the measure of SES, i.e. education or income measures, or based on maternal or paternal SES measures. The present analysis fills this gap by examining life-course SES and adherence to breast and cervical cancer screening guidelines among adult women in India, China, Mexico, Russia and South Africa.

METHODS

Data Source and Sample Population: Data for this cross-sectional analysis included women ages 18 years and older from the WHO Study on Global Ageing and Adult Health (SAGE) conducted in China, Mexico, India, South Africa and Russia in 2007-2008 (http://www.who.int/healthinfo/sage/cohorts/en/). SAGE, a longitudinal study of adults from nationally representative samples in these five countries, aimed to evaluate disease risk factors, access to healthcare, health status and wellbeing.

Main Study Variables: Key self-reported outcomes were: 1) receipt of screening mammography in the past 5 years among women ages 40 years and older, 2) receipt of a pelvic examination and pap smear in the past 3 years among women ages 21 years and older. Individual and parental SES (maternal and paternal) were assessed based on education and occupation. Educational attainment was based on highest level of education completed, and categorized as no formal education, primary school only, high school graduate, and college or higher degree, while employment status was categorized as unemployed, public sector employment, private sector employment, and self-employed/informal employment. Life-course SES was defined as a change in SES status, i.e. social mobility, from parent to individual based on the education and employment measures. Education based life-course SES was categorized as: stable low i.e. < primary parental education and < primary daughter's education, if neither the parent nor the daughter completed primary school education; declining i.e. >= primary and < primary if the parent completed primary school education but the daughter did not; increasing i.e. < primary and >= primary if the parent did not complete primary school education but the daughter did; and stable high i.e. >= primary and >= primary if both the parent and the daughter completed primary school education. Life-course SES based on employment

was categorized similarly, based on whether the parent or the daughter were employed or unemployed: stable low, i.e. both the parent and the daughter were unemployed; declining, i.e. employed and unemployed, if the parent was employed and the daughter was unemployed; increasing, i.e. unemployed and employed, if the parent was unemployed but the daughter was employed; and stable high, i.e. employed and employed, if both were employed. Other covariates examined in the analysis included age, marital status, rural/urban residence, and current health status.

Statistical Analysis: Descriptive analysis was conducted to assess the distribution of SES and life-course SES variables by screening status in the SAGE countries. Multivariable logistic regression models were created to determine the relationship between each SES and life-course SES variable in relation to breast and cervical cancer screening. Regression models were adjusted for age, marital status, rural/urban residence, health status and country to obtain adjusted estimates of odds of breast and cervical cancer screening. For all analyses, p values ≤ 0.05 were considered statistically significant. All statistical analyses were performed with SAS 9.4 (SAS Institute, Cary NC).

RESULTS

Characteristics of the Study Population: Of a total of 22,283 women residing in five countries, cancer screening was assessed among 15,367 women between ages 21 and 65 years; 5,346 from China, 914 from Mexico, 6,064 from India, 1,596 from South Africa and 1,447 from Russia (Table 1). Although almost a half of women had at least a secondary school education (43%), about a third of women had no formal education (34%), ranging from 58% in India, 28% in Mexico, 25% in China, 23% in South Africa through to 1.3% in Russia. Across all countries, 55% of women were self-employed, ranging from 80% in India to 4.6% in Russia. Other than Russia, where most women had parents with at least a secondary school education and employed in the public sector, the majority of women in other countries had mothers (58% - 80%) and fathers (53% - 71%) with no formal education, and most were either unemployed or self-employed. While 44% of women ages ≥21 years received a pelvic examination in the past 3 years, out of this number, 56% had also received a pap smear, and only 28% of women ages ≥40 years had received a mammogram in the past 5 years.

Table 1: Baseline characteristics of female SAGE participants*

	Total N=22,283	China N=8,002	Mexico N=1,689	India N=7,489	South Africa N=2,427	Russia N=2,676
Age group						
<21	512 (4.6)	13 (1.2)	5 (0.3)	483 (9.5)	9 (1.9)	2 (0.4)
21-40	3234 (37.1)	400 (29.9)	159 (51.2)	2424 (45.3)	124 (42.0)	127 (31.2)
40-65	11451 (47.0)	4730 (58.3)	704 (38.0)	3357 (36.6)	1390 (46.8)	1270 (46.2)
>65	7086 (11.3)	2859 (10.6)	821 (10.5)	1225 (10.6)	904 (9.2)	1277 (22.2)
Marital status						
Married	14621 (77.3)	6315 (89.4)	869 (64.9)	5375 (77.8)	874 (37.9)	1188 (53.6)
Never married	1341 (7.6)	101 (3.7)	186 (19.9)	483 (8.3)	453 (34.0)	118 (8.1)
Widow/divorced	6321 (15.1)	1586 (6.9)	634 (15.2)	1631 (13.9)	1100 (28.1)	1370 (38.3)
Highest Education						
No formal education	10341 (34.5)	3911 (24.5)	879 (27.8)	4402 (57.9)	1053 (22.8)	96 (1.3)
Primary school	3311 (14.1)	1301 (16.2)	356 (30.8)	954 (16.0)	492 (15.6)	208 (2.6)
Secondary school	6311 (42.9)	2493 (50.5)	218 (31.0)	1265 (22.0)	473 (52.1)	1862 (76.8)
College/university	1321 (8.4)	297 (8.8)	169 (10.4)	260 (4.1)	86 (9.4)	509 (19.2)
Employment status						
Unemployed	8686 (24.1)	3746 (27.9)	368 (15.9)	1382 (14.9)	1438 (38.3)	1752 (37.0)
Private sector	962 (6.9)	268 (9.3)	70 (7.8)	273 (3.5)	221 (11.0)	130 (1.5)
Public sector	1438 (14.3)	489 (16.0)	41 (3.3)	116 (1.5)	103 (11.3)	689 (49.4)
Self-employed	11197 (54.7)	3499 (46.8)	1210 (73.0)	5718 (80.1)	665 (36.4)	105 (4.6)
Health Status						
Good	7152 (45.1)	1636 (12.3)	626 (49.4)	1076 (11.4)	908 (54.8)	340 (36.0)
Moderate	11075 (42.8)	2614 (49.5)	856 (40.6)	3749 (45.7)	1140 (33.0)	1578 (50.5)
Bad	4056 (12.1)	3752 (38.2)	207 (10.0)	1076 (11.4)	379 (12.2)	758 (13.5)
Mother's education						
No formal	17341 (73.3)	7040 (80.0)	1442 (81.2)	6145 (87.2)	1719 (58.0)	995 (19.1)
Primary school	1546 (9.4)	342 (10.7)	107 (10.3)	382 (6.5)	162 (22.9)	553 (10.3)
Secondary school	1809 (14.9)	325 (10.4)	38 (6.0)	323 (5.8)	142 (13.5)	981 (59.4)
College/university	289 (2.4)	42 (0.9)	35 (2.5)	31 (0.6)	43 (5.6)	138 (11.2)
Father's education						
No formal	14815 (58.4)	6095 (65.2)	1407 (71.1)	4886 (67.0)	1575 (52.8)	852 (16.4)
Primary school	2437 (13.1)	772 (14.7)	138 (19.3)	777 (12.5)	217 (12.7)	533 (10.3)
Secondary school	3106 (23.9)	766 (17.2)	48 (7.5)	1012 (17.3)	190 (27.8)	1090 (60.4)
College/university	592 (4.6)	130 (2.80	29 (2.2)	204 (3.2)	42 (6.6)	187 (12.9)
Mother's employment						
Unemployed	10064 (37.7)	3382 (30.6)	1021 (48.9)	4194 (54.2)	1107 (38.9)	360 (6.8)
Private sector	993 (3.4)	162 (2.3)	72 (5.8)	266 (3.3)	466 (18.3)	27 (1.9)
Public sector	3272 (20.0)	895 (17.5)	38 (3.9)	67 (1.0)	87 (9.4)	2185 (89.3)
Self-employed	79549 (38.9)	3563 (49.6)	558 (41.3)	2962 (41.5)	767 (33.4)	104 (2.1)
Father's employment						
Unemployed	3128 (8.9)	2230 (19.3)	357 (12.7)	134 (1.3)	314 (9.9)	93 (2.0)
Private sector	2049 (7.2)	261 (4.30	207 (20.9)	640 (7.9)	897 (41.2)	44 (2.5)
Public sector	5223 (28.0)	1761 (27.8)	133 (8.1)	705 (9.3)	244 (9.5)	2380 (92.0)
Self-employed	11883 (55.9)	3750 (48.6)	992 (58.3)	6010 (81.4)	972 (39.4)	159 (3.5)
Pelvic exam						
< 3 years	7831 (44.1)	3165 (61.4)	1108 (70.1)	878 (14.9)	587 (34.7)	2093 (86.7)
>=3 years	14452 (55.9)	4837 (38.6)	581 (29.9)	6611 (85.1)	1840 (65.3)	583 (13.3)
Pap smear+						
Yes	5769 (55.8)	1776 (43.1)	1134 (93.6)	129 (17.8)	549 (77.6)	2181 (91.3)
No	3238 (43.1)	2252 (56.9)	64 (6.4)	503 (81.5)	176(3.6)	243 (6.1)

Mammogram**						
<5 years	4908 (27.7)	2138 (38.4)	716 (32.1)	660 (10.8)	396 (15.6)	998 (44.1)
>= 5 years	17375 (73.5)	5864 (61.6)	973 (67.9)	6829 (89.2)	2031 (84.4)	1678 (55.9)

*Un-weighted n (Weighted %)
**Defined as women ages 40-65 years who reported receiving a mammogram in the past 5 years
+Defined as women ages 21 -65 years who reported receiving a pelvic examination and Pap smear in the past 3 years

SES and Breast Cancer Screening: Breast cancer screening rates were higher among women with secondary school education (64.9%), and lowest among women with primary school education (9.8%). In India and Mexico, screening was highest among women with no formal education (79.8% and 34.7% respectively), while in China, South Africa and Russia, screening was higher among women with at least secondary school education. Screening was also higher among public sector employees (34.4%) or the self-employed (32.3%), and lowest among private sector employees (8.7%). Screening was higher among women whose mothers had no formal education (59.8%) and those who had a secondary school education (24.5%), but lower among women whose mothers had primary school (13.2%) or college education (2.5%). Similar trends were observed in relation to maternal and paternal education across countries, except in Russia where screening was higher among women whose mothers (65.3%) or fathers (71.1%) had secondary education. Although women whose mothers were employed in the public sector (40.0%) or were self-employed (37.9%) had higher rates of breast cancer screening overall, this was driven by trends in Russia (91.8% of women screened if maternal employment was in the public sector). In other countries, breast cancer screening was highest in women whose mothers were self-employed or unemployed. Breast cancer screening was lowest in women whose mothers were employed in the private sector across all countries (2.3%, 1.3%, 9.7%, 14.3% and 0.7% for China, Mexico, India, South Africa and Russia respectively). Similar results were observed for paternal employment (Table 2).

Table 2: Guideline-Adherent screening for breast and cervical cancer by country and SES

Socio-Economic Status (%)	Breast Cancer Screening*						Cervical Cancer Screening+					
	China (n=4946)	India (n=3640)	Mexico (n=755)	South Africa (n=1472)	Russia (n=1320)	Total (n=12133)	China (n=53466)	India (n=6064)	Mexico (n=9144)	South Africa (n=1596)	Russia (n=1447)	Total (n=15 367)
Own Education												
No formal education	17.7	79.8	34.7	9.6	0.0	13.4	11.4	38.6	23.8	7.9	0.0	6.6
Primary school	12.8	12.9	27.1	18.8	0.1	9.8	11.8	24.9	36.1	16.7	0.2	6.9
Secondary/High School	59.7	9.5	22.2	68.1	80.7	64.9	61.2	30.7	28.9	60.1	78.5	68.8
College/university/Post-graduate	9.7	0.7	16.0	3.4	19.2	11.9	15.6	5.7	11.1	15.1	21.3	17.8
Mother's Education												
No formal education	76.2	93.2	84.0	64.6	13.3	59.8	72.6	85.4	80.1	47.6	8.3	42.7
Primary school	13.5	1.1	10.1	14.0	12.9	13.2	14.0	8.5	11.3	26.6	8.1	11.7
Secondary/High School	9.9	5.7	4.2	20.5	65.3	24.5	11.6	6.1	5.3	20.0	71.4	39.0
College/university/post-graduate	0.4	0.0	1.7	0.9	8.5	2.5	1.7	0.0	3.3	5.8	12.2	6.6
Father's Education												
No formal education	59.5	66.0	79.0	64.9	10.3	47.0	51.5	71.2	66.8	36.3	7.4	31.3
Primary school	16.4	24.8	16.0	11.7	9.5	14.6	19.3	8.4	25.9	26.6	7.9	14.2
Secondary/High school	21.7	9.1	3.3	22.5	71.0	34.3	25.8	15.1	3.9	27.1	70.3	45.9
College/University/post-graduate	2.3	0.0	1.8	0.9	9.3	4.1	3.4	5.2	3.4	10.0	14.3	8.6
Own Employment												
Public sector	28.7	0.0	2.7	3.8	66.5	34.4	28.8	2.6	3.3	33.9	65.9	45.1
Private sector	9.0	0.7	2.3	10.4	10.8	8.7	15.2	10.0	7.7	20.2	10.9	13.5
Self-employed	34.1	97.5	83.1	34.1	3.4	32.3	29.0	63.1	76.0	15.9	2.4	17.1
Unemployed	28.1	1.8	11.9	51.7	19.2	24.5	27.0	24.3	13.1	30.0	20.8	24.4
Mother's Employment												
Public sector	28.1	0.0	0.8	3.2	91.8	40.0	26.6	1.3	4.8	16.8	92.8	55.2
Private sector	2.3	1.3	9.7	14.3	0.7	2.2	5.0	9.2	5.7	16.3	2.4	4.6
Self-employed	44.2	93.2	35.6	25.2	2.0	37.9	34.1	34.1	44.3	38.5	1.1	19.6
Unemployed	25.4	5.7	53.9	57.2	5.6	20.0	34.2	55.4	45.1	28.4	3.6	20.6
Father's Employment												
Public sector	39.4	0.8	9.3	17.3	92.7	48.0	39.0	5.9	8.2	13.2	93.1	61.1
Private sector	3.1	2.0	19.7	42.1	0.4	3.5	8.3	26.6	26.9	39.1	2.7	7.8
Self-employed	43.1	97.0	58.3	35.4	5.2	38.5	31.9	67.5	52.1	40.6	2.9	20.1
Unemployed	14.4	0.2	12.7	5.2	1.7	9.9	20.7	0.0	12.7	7.2	1.3	10.9

Proportion of women screened among all eligible women based on age
+ Pelvic exam and pap smear in the past 3 years among women ages 21 years and older
*Mammograms in the past 5 years among women ages 40 years and older

SES and Cervical Cancer Screening: Cervical cancer screening was higher among women with secondary school education (68.8%), and lowest among women with no formal education (6.6%). This trend were observed in China, Russia and South Africa, but not in India (30.7%) and Mexico (28.9%) where cervical screening was higher among women with no formal education and those with primary education respectively (Table 2). Cervical cancer screening was also higher among women who were employed in the public sector (45.1%) overall and in South Africa (33.9%) and Russia (65.9%), but higher among women who were self-employed in India (63.1%) and Mexico (76.0%). Screening was highest among women whose mother had no formal education (42.7%) and lowest among women whose mothers had a college degree (6.6%) overall and across countries except in Russia where screening was highest among women whose mothers had a secondary school education (71.4%). A similar pattern was observed for paternal education, with screening highest among women whose father had no formal education in China (51.5%), India (71.2%), Mexico (66.8%) and South Africa (36.3%), but higher screening among those whose fathers had a secondary school education in Russia (70.3%). Screening was highest among women whose mothers were employed in the public sector (55.2%) and lowest among those whose mothers were employed in the private sector (4.6%). However, in China, India, Mexico and South Africa, cervical cancer screening was higher among women whose mothers were unemployed (34.2%, 55.4%, and 45.1%, respectively), while in Russia screening was higher among women whose mothers were employed in public sector (92.8%). Screening was higher among women whose fathers were employed in the public sector (61.1%) and lower among women whose fathers were unemployed (10.9%).

Life-course SES and Cancer Screening: Significant differences in breast and cervical cancer screening were observed based on SES over the life-course (Table 3). Breast cancer screening was higher among women with either stable or increasing life-course SES based on maternal or paternal education, i.e. when mother's education and own education were both greater than primary school (36.3%), or maternal education was less than primary school and own education was greater than primary school (43.3%), or paternal education and own education was greater than primary school (46.5%), or father's education was less than primary and own education was greater than primary (33.1%) school (all p-values < 0.001). In contrast, breast cancer screening was higher among women with stable low life-course SES (43.1%), and stable high life-course SES (28.4%) based on maternal employment, with similar trends based on paternal employment. Similarly, cervical cancer screening was higher with stable (Maternal: 56.1%, Paternal: 65.5%) or increasing (Maternal: 35.8%, Paternal:

26.4%) life-course SES based on maternal and paternal education, respectively, and higher among stable high (44.4%, 47.8%) life-course SES based on maternal and paternal employment.

Table 3: Guideline Adherent Screening for Breast and Cervical Cancer by Life-Course SES

Life-Course Socio-Economic Status N (%)		Breast cancer Screening**	P-value*	Cervical cancer Screening+	P-value*
Mother's education	**Own education**				
Greater than primary	Greater than primary	819 (36.3)	<.0001	1274 (56.1)	<.0001
Less than primary	Greater than primary	1206 (43.3)		1341 (35.8)	
Greater than primary	Less than primary	11 (0.1)		14 (0.2)	
Less than primary	Less than primary	979 (20.3)		643 (7.9)	
Father's Education	**Own Education**				
Greater than primary	Greater than primary	1074 (46.5)	<.0001	1513 (65.5)	<.0001
Less than primary	Greater than primary	951 (33.1)		1102 (26.4)	
Greater than primary	Less than primary	43 (1.5)		57 (1.8)	
Less than primary	Less than primary	947 (19.0)		600 (6.3)	
Mother's Employment	**Own Employment**				
Employed	Employed	467 (28.4)	<.0001	749 (44.4)	<.0001
Employed	Unemployed	551 (13.7)		757 (15.3)	
Unemployed	Employed	267 (14.8)		321 (14.1)	
Unemployed	Unemployed	1730 (43.1)		1445 (26.1)	
Father's Employment	**Own Employment**				
Employed	Employed	563 (32.6)	<.0001	854 (47.8)	<.0001
Employed	Unemployed	825 (18.9)		1044 (21.2)	
Unemployed	Employed	171 (10.6)		216 (10.8)	
Unemployed	Unemployed	1456 (37.9)		1158 (20.3)	

*Estimated using chi-squared test

** Defined as women ages 40-65 years who reported receiving a mammogram in the past 5 years

+ Defined as women ages 21-65 years who reported receiving a pelvic examination and Pap smear in the past 3 years

Multivariable Adjusted Model of SES and Cancer Screening: After adjusting for age, health status, rural/urban residence and marital status, having a college degree (OR: 4.18, 95% CI: 2.36-7.4), or secondary school education (OR: 1.86, 95% CI: 1.27-2.78) was associated with higher odds of breast cancer screening compared with those with no formal education (Table 4). Having a parent with a secondary school education (mother OR: 2.50, 95% CI: 1.60 – 3.92; father OR: 2.48, 95% CI: 1.73 – 3.55) or higher increased the likelihood of breast cancer screening. In addition, women who themselves (OR: 2.38, 95% CI: 1.60-3.53), had mothers (OR: 2.39, 95% CI: 1.60 - 3.59) or fathers (OR 1.83, 95% CI: 1.21 – 2.78) employed in the public sector were significantly more likely to receive screening. Similarly, having a secondary school (OR: 2.24, 95% CI: 1.52 – 3.30) or a college education (OR: 4.18, 95% CI: 2.44 – 7.15), or having a mother (OR: 2.34, 95% CI: 1.60 – 3.42) or a father (OR: 2.13, 95% CI: 1.55 – 2.94) with a secondary education significantly increased cervical

cancer screening after adjustment for potential confounders. Being employed in the public sector (OR: 1.92, 95% CI: 1.31-2.81), or having a mother (OR: 1.48 95% CI: 1.04-2.12) employed in the public sector significantly increased the likelihood of cervical cancer screening.

Table 4: Multivariable Regression Analysis of Breast and Cervical Cancer Screening by SES, SAGE 2008

Socio-Economic Status[b]	Breast cancer Screening OR (95% CI)[a]	P-value	Cervical cancer Screening OR (95% CI)[a]	P-value
Own Education				
College/University/post-graduate	4.18 (2.36-7.40)	<.00	4.18 (2.44-7.15)	<.00
Secondary/high school	1.86 (1.27-2.78)	0.53	2.24 (1.52-3.30)	0.09
Primary school	1.17 (0.73-1.89)	0.01	1.34 (0.84-2.14)	0.02
No formal education	Ref	Ref	Ref	Ref
Mother's education				
College/University/post-graduate	2.81 (1.13-6.97)	0.27	1.77 (0.65-4.85)	0.73
Secondary/high school	2.50 (1.60-3.92)	0.18	2.34 (1.60-3.42)	0.03
Primary school	1.97 (1.26-3.09)	0.91	1.38 (0.92-2.07)	0.55
No formal education	Ref	Ref	Ref	Ref
Father's Education				
College/University/post-graduate	1.94 (0.91-4.14)	0.59	1.66 (0.80-3.43)	0.84
Secondary/high school	2.48 (1.73-3.55)	0.01	2.13 (1.55-2.94)	0.034
Primary school	1.59 (1.07-2.36)	0.79	1.71 (1.20-2.44)	0.56
No formal education	Ref	Ref	Ref	Ref
Own Employment				
Public sector	2.38 (1.60-3.53)	<.00	1.92 (1.31-2.81)	<.00
Private sector	1.10 (0.66-1.84)	0.86	1.36 (0.88-2.09)	0.03
Self-employed	0.64 (0.48-0.86)	<.00	0.38 (0.28-0.53)	<.00
Unemployed	Ref	Ref	Ref	Ref
Mother's Employment				
Public sector	2.39 (1.60-3.59)	0.00	1.48 (1.04-2.12)	0.04
Private sector	1.64 (0.86-3.14)	0.81	1.99 (1.13-3.50)	0.01
Self-employed	1.47 (1.11-1.96)	0.66	0.54 (0.39-0.75)	<.00
Unemployed	Ref	Ref	Ref	Ref
Father's Employment				
Public sector	1.83 (1.21-2.78)	0.01	1.21 (0.85-1.74)	0.09
Private sector	1.26 (0.68-2.34)	0.83	1.58 (0.89-2.80)	0.02
Self-employed	1.30 (0.88-1.93)	0.92	0.51 (0.36-0.74)	<.00
Unemployed	Ref	Ref	Ref	Ref

[a]Adjusted for smoking, alcohol, physical activity, rural/urban residence, marital status, country, age , health status
Bold indicates significant p-value <0.05
[b]Each model includes own SES variable and parental SES variable adjusted for covariates

Multivariable Adjusted Model of Life-course SES and Cancer Screening: In adjusted models, women with stable higher life-course SES based on maternal education i.e. high maternal education and high own education, (OR: 2.53, 95% CI: 1.69 – 3.80), or increasing life-course SES based on maternal education i.e. low maternal education and high own education (OR: 1.23, 95% CI: 0.90 –

1.66) were more likely to receive breast cancer screening. However, those with declining life-course SES were significantly less likely to receive breast cancer screening (OR: 0.26, 95% CI: 0.08 – 0.79). Likewise, stable higher life-course SES based on father's education was associated with increased likelihood of breast cancer screening (OR: 2.01, 95% CI: 1.43 – 2.82). Similar associations were observed for cervical cancer screening among women with stable high life-course SES based on maternal education (OR: 2.47, 95% CI: 1.47 – 4.16) and paternal education (OR: 2.74, 95% CI: 1.66 – 4.54), and for increasing life-course SES based on education. Stable higher life-course SES based on maternal employment (OR: 3.07, 95% CI: 1.96 – 4.79) and paternal employment (OR: 2.62, 95% CI: 1.77 – 3.89) increased breast cancer screening by 2 to 3-fold, and increased cervical cancer screening by more than 4-fold (OR mothers: 4.35, 95% CI: 2.94 – 6.45; OR fathers: 4.24, 95% CI: 2.95 – 6.11). Compared with stable low life-course SES, women with declining life-course SES still had a 2 to 3-fold higher odds of cervical cancer screening and breast cancer screening based on employment but not education measures of SES (Table 5).

Table 5: Multivariable Regression Analysis of Breast and Cervical Cancer Screening by Life-Course SES, SAGE 2008

Life-Course Socioeconomic Status[b]		Breast cancer Screening OR (95% CI)[a]	P-value	Cervical cancer Screening OR (95% CI)[a]	P-value
Mother's Education	**Own Education**				
Greater than primary	Greater than primary	2.53 (1.69-3.80)	<.00	2.47 (1.47-4.16)	0.08
Less than primary	Greater than primary	1.23 (0.90-1.66)	0.12	1.67 (1.10-2.52)	0.99
Greater than primary	Less than primary	0.26 (0.08-0.79)	0.00	1.89 (0.43-8.24)	0.82
Less than primary	Less than primary	Ref		Ref	
Father's Education	**Own Education**				
Greater than primary	Greater than primary	2.01 (1.43-2.82)	<.00	2.7 (1.66-4.54)	0.01
Less than primary	Greater than primary	1.08 (0.78-1.49)	0.96	1.72 (1.08-2.72)	0.59
Greater than primary	Less than primary	0.64 (0.27-1.56)	0.1	2.45 (1.12-5.39)	0.29
Less than primary	Less than primary	Ref		Ref	
Mother's employment	**Own employment**				
Employed	Employed	3.07 (1.96-4.79)	0.00	4.35 (2.94-6.45)	<.00
Employed	Unemployed	1.68 (1.12-2.52)	0.40	1.83 (1.21-2.75)	0.24
Unemployed	Employed	2.53 (1.68-3.82)	0.07	2.90 (2.00-4.24)	0.06
Unemployed	Unemployed	Ref		Ref	
Father's employment	**Own employment**				
Employed	Employed	2.62 (1.77-3.89)	0.00	4.24 (2.95-6.11)	<.00
Employed	Unemployed	1.27 (0.92-1.76)	0.01	1.90 (1.36-2.66)	0.15
Unemployed	Employed	2.66 (1.63-4.34)	0.02	3.32 (2.12-5.21)	0.02
Unemployed	Unemployed	Ref		Ref	

[a]Adjusted for smoking, alcohol, physical activity, rural/urban residence, marital status, country, age, health status
[b]Each model includes own SES variable and parental SES variable adjusted for covariates.
Bold indicates significant p-value <0.05

DISCUSSION

This study provides a comprehensive assessment of the association between socio-economic status, at both the individual level and over the life-course, in relation to breast and cervical cancer screening among women in China, India, Mexico, South Africa and Russia. In 2008, only 27% of women ages ≥40 years old had received a mammogram in the past five years, and only 23% of women ages ≥21 years old had received a pelvic examination with Pap smear in the past three years. There were clear gradients in screening rates by SES, and between country differences in the association of SES and screening. For instance, although Russia had the highest proportion of women with a secondary school or college education (95%), only 44% had received age-appropriate breast cancer screening. In contrast, only 41% of Mexican women had a secondary school or college education, yet over 30% of Mexican women had received age-appropriate breast cancer screening. Women with stable high or increasing life-course SES were more likely to receive breast and cervical cancer screening, while those with declining or stable low life-course SES were least likely to receive screening when SES was defined based on education. However, when defined based on employment, women with stable low life course SES also had high screening rates. In the fully adjusted model, women with stable high life course SES based on education were more than twice as likely to receive breast and cervical cancer screening, and 3-4 times as likely to receive screening using life-course SES based on employment compared with women with stable low life-course SES.

Other studies have reported low coverage of cancer screening in resource-poor settings, particularly in LMICs [28 29], and higher cancer screening rates in higher SES groups [30-33]. This may be the result of measurable factors such as SES and financial barriers to screening. Although increasing SES by all measures assessed in the present analysis were strongly associated with screening, having a college degree of higher was by far the strongest predictor, increasing the likelihood of screening by more than 4-fold. In terms of parental SES, maternal SES variables were also stronger predictors of screening compared with paternal SES, although both measures increased the likelihood of screening. This is in line with other studies showing that a stronger influence of maternal education on daughter's adult health, likely due to the fact that women may be more strongly socialized and view their mothers as role models compared with their fathers[34 35], potentially shaping daughter's own SES and health-related behavior, including cancer screening. We also observed that maternal employment was a major predictor for breast and cervical cancer screening, this is possibly as a

result of employment outside the home increasing exposure to health information and extra household income to increase knowledge of, and access to cancer screening services.

Further, education based SES measures have emerged as stronger predictors of screening compared with employment based measures, which suggests that factors related to literacy, awareness and self-efficacy may be more important for screening compared with income and financial factors per se[36]. Other studies have shown that low literacy, lack of awareness of the benefits of screening and low self-efficacy regarding cancer prevention and early detection options may reduce the likelihood of cancer screening[24 27]. Healthcare access barriers may also be critical to utilization of age-appropriate cancer screening, as routine screening programs and screening infrastructure may not be widely available or easily accessible[24 37]. Higher SES individuals may be able to overcome these barriers through increased knowledge of the importance of screening and more financial resources to overcome accessibility barriers [38]. However, in the current study, the high proportion of women who had received a pelvic examination in the past 3 years but did not also receive a Pap smear suggests that even when access to healthcare barriers are eliminated or reduced, appropriate screening still may not occur. Improvements in healthcare infrastructure and personnel continue to be major barriers to screening in LMICs. While recent recommendations for cervical cancer screening involves HPV DNA testing at ages 35 and/or 40, and HPV vaccination may contribute to significantly reducing the global burden of cervical cancer[39], these approaches still require significant initial investments in the healthcare infrastructure, and community outreach programs to improve knowledge and acceptance by women at risk, especially those with lower SES who are unlikely to have access to routine and timely health-related information. Simply providing cancer screening programs is insufficient to ensure successful utilization by women at risk of cancer[40].

We observed strong associations between SES over the life-course and cancer screening, adding to the growing body of literature on the importance of early life and adult factors in human health, and cancer prevention, in particular. Specifically, we observed a clear gradient of increased screening with higher SES, although this appeared to vary by country. The lack of SES gradient in some countries such as Russia is likely due to differences in national policies regarding screening such as insurance subsidies, free screening programs, or employment based programs, which may mitigate some of the effects of low SES on screening. In Russia, 66% of women employed in the public sector received breast and cervical cancer screening, and over 90% of women with maternal and

paternal employment in the public sector had been screened for both cancers. This is in contrast with other countries like India and Mexico where comparable screening rates were 2.6% and 3.3% respectively for public sector employment. These between-country differences warrant further study, specifically country-level differences in healthcare infrastructure, health insurance coverage and screening costs, availability of medical personnel, and population knowledge about cancer screening. This is a highly understudied area of research, particularly in LMICs where little attention has been paid to examining factors that promote health or reduce disease rates over the life-course, and to our knowledge, this is the first study to assess life-course SES trajectory in relation to cancer screening across diverse geographic regions.

Our results suggest that for cervical cancer screening, women who had higher SES over their life-course were more successful in overcoming existing infrastructural barriers to screening and were far more likely to obtain screening than those who had lower early life SES but higher adult SES using measures of maternal education (56% vs. 36%), paternal education (65% vs. 26%), maternal employment (44% vs. 15%) and paternal employment (48% vs. 21%). In addition, declining life-course SES was also associated with lower likelihood of screening compared with stable low life-course SES using measures of maternal education (0.2% vs. 8%), paternal education (1.8% vs. 6.2%), maternal employment (19% vs. 26%) and paternal employment (11% vs. 20%). These results are consistent with a recent publication by Schmeisser et al showing a higher risk of cancer in men with a downward social trajectory over the life-course compared with those at high social trajectory over the life-course[41]. Other studies have also shown that declining life-course SES trajectory increased the risk of cancer, including reproductive behaviors and obesity[16 34].

One approach to improving cancer screening is the development of national comprehensive cancer control plans- such as the action plan and policy options included in the WHO Global Action Plan for the Prevention and Control of NCDs 2013-2020[42]. Such comprehensive plans may provide a roadmap for allocation of government funds, development of infrastructure and outreach programs to educate women about the benefits of routine cancer screening, although success ultimately depends on how well the plan is communicated with women who stand to benefit. While cancer incidence is projected to increase dramatically in LMICs in the coming decades[43], healthcare spending and infrastructure development is likely to lag behind the needs of cancer patients. Cancer outcomes may be improved by incorporating routine screening into clinical care, providing national or employment

based access to free cancer screening, and educating women on the benefits of routine screening. Comprehensive cancer control plans also include a strong focus on cancer prevention, and understanding the link between poor social status and biological factors relevant for cancer, including the distribution of risk factors such as obesity and/or genetic mutations that may be exacerbated by social inequalities will be critical to preventing cancer.

In summary, we observed very low rates of breast and cervical cancer screening among women in China, India, Mexico, South Africa and Russia, and strong influences of SES over the life-course on screening. Future studies are needed to better understand population groups that may benefit from targeted efforts to increase knowledge of cancer screening, as well as mechanisms by which employment-based and/or national policies may be implemented to mitigate SES differences in screening. Women with declining or low SES over the life-course are least equipped to overcome barriers to screening, and may also be least likely to afford quality cancer treatment if cancer is detected at later stages.

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COMPETING INTEREST

No competing interest to declare.

DATA SHARING STATEMENT

No additional data available.

TRANSPARENCY DECLARATION

I affirm that the manuscript is a honest and transparent account of the study being reported, no important aspect of the study is being omitted and any discrepancies have been explained. T.A.

CONTRIBUTORSHIP STATEMENT

TA conceived of the research question and statistical analysis, KO and VO conducted statistical analysis and initial draft of the manuscript, DB contributed to the interpretation of results and writing of the manuscript.

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STROBE statement?checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract			
	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) *Cohort study*?Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up*Case-control study*?Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls*Cross sectional study*?Give the eligibility criteria, and the sources and methods of selection	4

	Item No	Recommendation	Page No
		of participants	
		(*b*) *Cohort study*?For matched studies, give matching criteria and number of exposed and unexposed*Case-control study*?For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4
Bias	9	Describe any efforts to address potential sources of bias	16
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4&5
		(*b*) Describe any methods used to examine subgroups and interactions	4
		(*c*) Explain how missing data were addressed	4
		(*d*) *Cohort study*?If applicable,	

	Item No	Recommendation	Page No
		explain how loss to follow-up was addressed*Case-control study*?If applicable, explain how matching of cases and controls was addressed*Cross sectional study*?If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(*a*) Report numbers of individuals at each stage of study?eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(*b*) Give reasons for non-participation at each stage	
		(*c*) Consider use of a flow diagram	
Descriptive data	14*	(*a*)Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(*b*) Indicate number of participants with missing data for each variable of interest	
		(*c*) *Cohort study*?Summarise follow-up time (eg average and total amount)	
Outcome data	15*	*Cohort study*?Report numbers of outcome events or summary measures over time	8, 9
		*Case-control study?*Report	

	Item No	Recommendation	Page No
		numbers in each exposure category, or summary measures of exposure	
		Cross sectional study?Report numbers of outcome events or summary measures	
Main results	16	(*a*) Report the numbers of individuals at each stage of the study?eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6-12
		(*b*) Give reasons for non-participation at each stage	
		(*c*) Consider use of a flow diagram	
Other analyses	17	Report other analyses done?eg analyses of subgroups and interactions, and sensitivity analyses	9-12
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16

	Item No	Recommendation	Page No
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

Patient Involvement

Patients were not involved in this study. This study was based on WHO Study on Global Ageing and Adult Health (SAGE) data, a longitudinal multi- country study.
(http://www.who.int/healthinfo/sage/cohorts/en/).

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Life-Course Socio-Economic Status and Breast and Cervical Cancer Screening; Analysis of the WHO study on Global Ageing and Adult Health (SAGE)

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Life-Course Socio-Economic Status and Breast and Cervical Cancer Screening; Analysis of the WHO study on Global Ageing and Adult Health (SAGE)

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ABSTRACT

Objectives: Socio-economic differences in screening have been well documented in upper-income countries, however few studies have examined socio-economic status (SES) over the life-course in relation to cancer screening in lower and middle-income countries. Here, we examine individual, parental and life-course SES differences in breast and cervical cancer screening among women in India, China, Mexico, Russia and South Africa.

Setting: A cross-sectional analysis of the WHO Study on Global Ageing and Adult Health (SAGE) 2007-2008 data was conducted**.** We performed survey weighted multivariable regression analysis in SAS (v9.4, Cary NC), and examined the association between individual, parental and life-course SES in relation to breast and cervical cancer screening using both education and employment based measures of SES.

Participants: 22,283 women aged 18-65 years, recruited from China, India, Mexico, Russia and South Africa.

Results: Having a college degree (OR: 4.10, 95% CI: 2.52-6.71) increased the odds of breast cancer screening compared with those with no formal education. Stable higher life-course SES (OR: 3.07, 95% CI: 1.96 – 4.79) increased breast cancer screening by 3-fold, and increased cervical cancer screening by more than 4-fold (OR: 4.35, 95% CI: 2.94 – 6.45). However, declining life-course SES was less likely associated with breast cancer screening (OR: 0.26, 95% CI: 0.08-0.79) compared to low life-course SES. Women and both parents all with high SES were almost 10 times more likely to receive breast cancer screening (OR: 9.84, 95% CI: 1.75-55.5).

Conclusion: Higher life-course SES was positively associated with breast and cervical cancer screening, although education based SES measures were stronger predictors of screening compared with employment based measures. Addressing social inequality, improving knowledge of the benefits of cancer screening, and integrating cancer screening into routine healthcare practice for low SES women are actionable strategies that may significantly improve screening rates in low- and middle- income countries.

STRENGTH and LIMITATIONS

1. The strengths of this study include the use of data from the multi-country, nationally representative and standardized SAGE study. SAGE was designed to elicit response on a wide-range of health related questions and had very high response rates, which permitted robust assessment of comprehensive measures of life-course SES and cancer screening in multiple countries.

2. One potential limitation of this study includes the use of self-reported screening data, however since SAGE is a standardized survey of multiple health items, any recall bias of self-reported screening is unlikely to be differential with respect to country or SES.

3. Another potential limitation involves SES and potential country-level differences in the ability of education or employment measures to capture the full range of SES. We used both measures of education and employment to better capture variability in SES, as these are less vulnerable to recall bias or social desirability bias, and have been used in past studies as robust measures of SES.

INTRODUCTION

Breast and cervical cancers remain the most common malignancies in women worldwide.[1 2] In low- and middle- income countries (LMICs), incidence and mortality due to these cancers have increased in recent decades, for instance, the estimated mortality from breast cancer in LMICs increased from about 150,000 in 1990 to over 325,000 in 2012 and is projected to increase to over 500,000 by the year 2030, while cervical cancer mortality is estimated to increase from about 230,000 in 2012 to about 363,000 deaths by 2030[2 3]. Whereas in upper income countries (UICs), the estimated mortality from breast cancer is projected to increase from 197,000 in 2012 to over 243,000 while cervical cancer deaths is projected to increase from about 36,000 in 2012 to over 41,000 deaths by 2030, further thus widening the gap in cancer mortality between UIC and LMICs [3-7].

According to the International Agency for Research on Cancer (IARC), 84% and 53% of new cervical and breast cancer cases respectively, as well as 88% and 58% of cervical and breast cancer deaths respectively, occur in LMICs [2 7-10]. Concurrently, breast and cervical cancer mortality rates has declined significantly in UICs in the past few decades, a trend that has been attributed to widespread use of routine cancer screening and improved cancer treatment[1 6 11]. Routine screening and timely diagnostic follow-up is key to early diagnosis of cancer at stages where treatment is cheaper, less toxic and more effective [12]. Whereas IARC recommends mammograms for women ages 50 – 74 years and pap smears for women from 25 years triennially[13 14], low financial resources may account for non-compliance with screening guidelines. Other causes of non-compliance include poor implementation of comprehensive cancer control plans (in countries that have them), poor healthcare infrastructure to implement cancer screening programs, low levels of health literacy regarding the importance of routine cancer screening, and high prevalence of competing health issues[15]. Prior studies in the US have reported that socioeconomic status (SES) at both the individual and parental level, as well as over the entire life-course, strongly influences health outcomes [16-20], and is associated with screening utilization [21-24]. The life-course approach to understanding cancer screening recognizes the complex interplay of early life factors including parental and individual SES in shaping health behavior, either directly through financial resources and healthcare access or indirectly through awareness of cancer screening recommendations [25].

Although some studies in LMICs have shown that low individual SES negatively influences cancer screening rates [26-29], none to our knowledge have examined SES over the life-course in relation to breast cancer screening and cervical cancer screening. It remains unclear whether parental SES plays

a role in adherence to cancer screening guidelines above and beyond individual SES, or whether this association depends on the measure of SES, i.e. education or income measures, or based on maternal or paternal SES measures. The present analysis fills this gap by examining individual, parental and life-course SES in relation to breast and cervical cancer screening among adult women in India, China, Mexico, Russia and South Africa.

METHODS

Data Source and Sample Population: Data for this cross-sectional analysis included women ages 18 years and older from the WHO Study on Global Ageing and Adult Health (SAGE) conducted in China, Mexico, India, South Africa, Ghana and Russia in 2007-2008. SAGE is a longitudinal study of adults from nationally representative samples in these countries, and aimed to evaluate disease risk factors, access to healthcare, health status and wellbeing. The current analysis focuses on five countries: China, India, Mexico, Russia and South Africa, one from each continents, to allow examination of middle-income countries that have experienced major economic and health transitions over the past few decades and face rising burden of non-communicable diseases.

Cancer Screening Outcomes: Key self-reported outcomes were: 1) receipt of screening mammography in the past 5 years among women ages 40 years and older, 2) receipt of a pelvic examination and pap smear in the past 3 years among women ages 21 years and older.

Socio-Economic Status: Individual and parental SES (maternal and paternal) were assessed based on education and employment measures. Educational attainment was based on highest level of education completed, and categorized as no formal education, primary school only, high school graduate, and college or higher degree. Employment status was based on if individual and/or parent (maternal and paternal) is employed - in the public sector, private sector, self-employed or informal employment-, or unemployed for any reason-including homemakers, retirees and those unable to work.

Life-course SES: Change in SES status, i.e. social mobility, from parent to individual was assessed based on both education and employment measures. Life-course SES was defined based on maternal and paternal SES in relation to individual SES separately. Education based life-course SES was categorized based on whether the parent or daughter completed a primary school education: stable low i.e. < primary parental education and < primary daughter's education; declining i.e. >= primary and < primary; increasing i.e. < primary and >= primary; and stable high i.e. >= primary and >= primary. Employment based life-course SES was categorized based on whether the parent or the daughter were employed or unemployed: stable low, i.e. both the parent and the daughter were

unemployed; declining, i.e. employed and unemployed, if the parent was employed and the daughter was unemployed; increasing, i.e. unemployed and employed, if the parent was unemployed but the daughter was employed; and stable high, i.e. employed and employed, if both were employed.

Statistical Analysis: Descriptive analysis was conducted to assess the distribution of socio-demographic, SES and life-course SES variables among study participants. Breast and cervical cancer screening rates by SES and life-course SES was also assessed overall and in each country. Other study covariates examined included age, marital status, rural/urban residence, and current health status. To account for the SAGE sampling strategy, each country was assigned household and individual level analysis weights, which adjusts for sample selection and post stratification factors, using the most recent estimates of each country's population. All statistical analyses included these weights to ensure the generalizability of study results to individuals in the selected countries. Survey weighted multivariable logistic regression models were created to determine the relationship between each SES and life-course SES variable in relation to breast and cervical cancer screening. Regression models were adjusted for age, marital status, rural/urban residence, health status and country to obtain adjusted estimates of the odds of breast and cervical cancer screening. For all analyses, p values ≤ 0.05 were considered statistically significant. All statistical analyses were performed with SAS 9.4 (SAS Institute, Cary NC).

RESULTS

Characteristics of the Study Population: From a total of 22,283 women residing in five countries, cancer screening was assessed among 15,367 women between ages 21 and 65 years; 5,346 from China, 914 from Mexico, 6,064 from India, 1,596 from South Africa and 1,447 from Russia (Table 1). Although almost a half of women had at least a secondary school education (43%), a third of women had no formal education (34%), ranging from 58% in India, 28% in Mexico, 25% in China, 23% in South Africa through to 1.3% in Russia. Other than Russia, where most women had parents with at least a secondary school education and employed in the public sector, the majority of women in other countries had mothers (58% - 80%) and fathers (53% - 71%) with no formal education, and most were either unemployed or self-employed. While 44% of women ≥21 years received a pelvic examination in the past 3 years, out of this number, 56% had also received a pap smear, however only 28% of women ≥40 years had received a mammogram in the past 5 years. Mammography screening ranged from 11% in India to 44% in Russia, while pelvic examinations ranged from 15% in India to 87% in Russia.

Table 1: Baseline characteristics of female SAGE participants*

	Total N=22,283	China N=8,002	Mexico N=1,689	India N=7,489	South Africa N=2,427	Russia N=2,676
Age group						
<21	512 (4.6)	13 (1.2)	5 (0.3)	483 (9.5)	9 (1.9)	2 (0.4)
21-40	3234 (37.1)	400 (29.9)	159 (51.2)	2424 (45.3)	124 (42.0)	127 (31.2)
40-65	11451 (47.0)	4730 (58.3)	704 (38.0)	3357 (36.6)	1390 (46.8)	1270 (46.2)
>65	7086 (11.3)	2859 (10.6)	821 (10.5)	1225 (10.6)	904 (9.2)	1277 (22.2)
Marital status						
Married	14621 (77.3)	6315 (89.4)	869 (64.9)	5375 (77.8)	874 (37.9)	1188 (53.6)
Never married	1341 (7.6)	101 (3.7)	186 (19.9)	483 (8.3)	453 (34.0)	118 (8.1)
Widow/divorced	6321 (15.1)	1586 (6.9)	634 (15.2)	1631 (13.9)	1100 (28.1)	1370 (38.3)
Highest Education						
No formal education	10341 (34.5)	3911 (24.5)	879 (27.8)	4402 (57.9)	1053 (22.8)	96 (1.3)
Primary school	3311 (14.1)	1301 (16.2)	356 (30.8)	954 (16.0)	492 (15.6)	208 (2.6)
Secondary school	6311 (42.9)	2493 (50.5)	218 (31.0)	1265 (22.0)	473 (52.1)	1862 (76.8)
College/university	1321 (8.4)	297 (8.8)	169 (10.4)	260 (4.1)	86 (9.4)	509 (19.2)
Employment status						
Unemployed	8686 (24.1)	3746 (27.9)	368 (15.9)	1382 (14.9)	1438 (38.3)	1752 (37.0)
Private sector	962 (6.9)	268 (9.3)	70 (7.8)	273 (3.5)	221 (11.0)	130 (1.5)
Public sector	1438 (14.3)	489 (16.0)	41 (3.3)	116 (1.5)	103 (11.3)	689 (49.4)
Self-employed	11197 (54.7)	3499 (46.8)	1210 (73.0)	5718 (80.1)	665 (36.4)	105 (4.6)
Health Status						
Good	7152 (45.1)	1636 (12.3)	626 (49.4)	1076 (11.4)	908 (54.8)	340 (36.0)
Moderate	11075 (42.8)	2614 (49.5)	856 (40.6)	3749 (45.7)	1140 (33.0)	1578 (50.5)
Bad	4056 (12.1)	3752 (38.2)	207 (10.0)	1076 (11.4)	379 (12.2)	758 (13.5)
Mother's education						
No formal	17341 (73.3)	7040 (80.0)	1442 (81.2)	6145 (87.2)	1719 (58.0)	995 (19.1)
Primary school	1546 (9.4)	342 (10.7)	107 (10.3)	382 (6.5)	162 (22.9)	553 (10.3)
Secondary school	1809 (14.9)	325 (10.4)	38 (6.0)	323 (5.8)	142 (13.5)	981 (59.4)
College/university	289 (2.4)	42 (0.9)	35 (2.5)	31 (0.6)	43 (5.6)	138 (11.2)
Father's education						
No formal	14815 (58.4)	6095 (65.2)	1407 (71.1)	4886 (67.0)	1575 (52.8)	852 (16.4)
Primary school	2437 (13.1)	772 (14.7)	138 (19.3)	777 (12.5)	217 (12.7)	533 (10.3)
Secondary school	3106 (23.9)	766 (17.2)	48 (7.5)	1012 (17.3)	190 (27.8)	1090 (60.4)
College/university	592 (4.6)	130 (2.80	29 (2.2)	204 (3.2)	42 (6.6)	187 (12.9)
Mother's employment						
Unemployed	10064 (37.7)	3382 (30.6)	1021 (48.9)	4194 (54.2)	1107 (38.9)	360 (6.8)
Private sector	993 (3.4)	162 (2.3)	72 (5.8)	266 (3.3)	466 (18.3)	27 (1.9)
Public sector	3272 (20.0)	895 (17.5)	38 (3.9)	67 (1.0)	87 (9.4)	2185 (89.3)
Self-employed	79549 (38.9)	3563 (49.6)	558 (41.3)	2962 (41.5)	767 (33.4)	104 (2.1)
Father's employment						
Unemployed	3128 (8.9)	2230 (19.3)	357 (12.7)	134 (1.3)	314 (9.9)	93 (2.0)
Private sector	2049 (7.2)	261 (4.30	207 (20.9)	640 (7.9)	897 (41.2)	44 (2.5)
Public sector	5223 (28.0)	1761 (27.8)	133 (8.1)	705 (9.3)	244 (9.5)	2380 (92.0)
Self-employed	11883 (55.9)	3750 (48.6)	992 (58.3)	6010 (81.4)	972 (39.4)	159 (3.5)
Pelvic exam						
< 3 years	7831 (44.1)	3165 (61.4)	1108 (70.1)	878 (14.9)	587 (34.7)	2093 (86.7)
>=3 years	14452 (55.9)	4837 (38.6)	581 (29.9)	6611 (85.1)	1840 (65.3)	583 (13.3)
Pap smear+						
Yes	5769 (55.8)	1776 (43.1)	1134 (93.6)	129 (17.8)	549 (77.6)	2181 (91.3)
No	3238 (43.1)	2252 (56.9)	64 (6.4)	503 (81.5)	176(3.6)	243 (6.1)
Mammogram**						
<5 years	4908 (27.7)	2138 (38.4)	716 (32.1)	660 (10.8)	396 (15.6)	998 (44.1)
>= 5 years	17375 (73.5)	5864 (61.6)	973 (67.9)	6829 (89.2)	2031 (84.4)	1678 (55.9)

*Un-weighted n (Weighted %)

**Defined as women ages 40-65 years who reported receiving a mammogram in the past 5 years

+Defined as women ages 21 -65 years who reported receiving a pelvic examination and Pap smear in the past 3 years

SES and Cancer Screening: Breast cancer screening increased with increasing education, ranging from 10% among those with no formal education to 56% among those with a college education (Table 2). Similar trends were observed based on maternal education, however there was no clear gradient based on paternal education. Women employed in the public sector (60%) or with maternal (53%) or paternal (46%) employment in the public sector had the highest screening rates. Breast cancer screening was low (<10%) regardless of education among women in India, and highest among women with maternal self-employment (19%), while screening increased markedly with increasing education among women in China, Mexico and Russia. In South Africa, screening rates were low among women with no formal education (8%) and those with college education (8%), including those with maternal (6%) and paternal (8%) college education. Similarly, cervical cancer screening increased with increasing education overall, ranging from 5% among those with no formal education to 51% among those with a college education. Cervical cancer screening was highest in Russia (83%-85%), and lowest in India (<1%-2%) across education levels, with clear positive gradients for individual, maternal and paternal education. Cervical cancer screening was highest among those employed in the public sector (68%) across countries, ranging from 1.9% in India to 94% in Russia, while screening was lowest among women who were self-employed (29%), ranging from 2% in India to 60% in Mexico.

Table 2: Breast and cervical cancer screening rates by country and SES

Socio-Economic Status (%)	Breast Cancer Screening* China (n=4946)	India (n=3640)	Mexico (n=755)	South Africa (n=1472)	Russia (n=1320)	Total (n=12133)	Cervical Cancer Screening+ China (n=53466)	India (n=6064)	Mexico (n=9144)	South Africa (n=1596)	Russia (n=1447)	Total (n=15367)
Own Education												
No formal education	27.4	0.8	52.4	7.6	6.4	10.2	16.4	0.8	67.4	10.6	83.2	5.1
Primary school	31.5	0.7	56.7	19.4	14.1	20.2	20.5	1.8	76.1	28.4	70.8	12.5
Secondary/High School	43.7	0.6	52.8	37.1	52.1	41.9	32.4	1.8	57.3	28.7	88.3	39.6
College/university/Post-graduate	83.7	0.2	66.3	7.8	54.5	55.7	48.2	1.6	69.3	38.1	85.4	51.1
Mother's Education												
No formal education	35.1	0.8	53.6	21.0	43.0	21.4	26.6	1.2	66.4	22.2	71.3	15.0
Primary school	57.2	0.3	64.5	16.0	48.9	44.5	34.7	1.6	71.5	27.1	84.1	31.1
Secondary/High School	69.6	1.5	81.4	54.1	53.8	53.5	38.6	1.3	57.1	35.4	92.7	64.5
College/university/post-graduate	48.6	0.0	63.8	6.3	65.3	55.7	63.8	0.0	89.5	28.9	78.3	67.5
Father's Education												
No formal education	32.8	0.7	52.4	23.5	43.5	20.4	23.4	1.3	64.3	18.7	77.1	13.9
Primary school	47.8	1.6	74.1	12.8	39.9	31.1	35.3	0.8	84.8	50.8	85.0	27.0
Secondary/High school	61.5	0.7	62.2	37.2	56.0	48.2	41.4	1.1	33.8	23.1	90.7	47.6
College/University/post-graduate	49.8	0.0	63.2	7.6	54.7	39.3	34.8	2.1	100.0	37.6	82.7	47.4
Own Employment												
Public sector	68.9	0.0	55.8	6.4	59.2	60.3	46.6	1.9	59.7	61.8	93.8	67.6
Private sector	46.6	1.8	34.1	13.3	47.3	37.1	43.2	0.9	69.0	49.2	83.2	42.6
Self-employed	27.6	9.4	56.7	27.9	44.3	18.6	17.3	1.7	60.3	12.5	44.0	7.6
Unemployed	40.8	0.7	57.6	23.5	40.1	29.5	32.3	2.8	59.9	23.9	82.2	29.5
Mother's Employment												
Public sector	56.5	0.0	45.7	6.1	52.3	52.6	40.6	1.4	76.4	51.4	88.6	67.4
Private sector	53.9	3.8	86.9	15.5	48.2	24.7	57.6	3.1	63.5	26.3	96.0	32.5
Self-employed	34.9	19.3	59.3	15.7	57.4	29.3	19.7	0.9	69.9	32.3	58.2	12.4
Unemployed	34.8	0.7	50.9	33.1	53.0	16.1	33.9	1.1	63.1	21.1	74.2	13.6
Father's Employment												
Public sector	50.0	0.7	62.4	41.6	51.6	46.2	38.0	0.7	67.1	40.6	88.0	53.3
Private sector	43.2	2.2	68.3	17.8	40.5	17.9	55.9	3.6	82.1	27.0	81.6	26.1
Self-employed	35.2	8.7	54.2	22.2	71.2	21.3	19.0	0.9	60.0	29.3	81.4	8.9
Unemployed	31.9	1.2	46.0	12.6	58.8	30.2	33.1	0.0	69.5	22.0	87.5	31.4

Proportion of women screened among all eligible women based on age
+ Pelvic exam and pap smear in the past 3 years among women ages 21 years and older
*Mammograms in the past 5 years among women ages 40 years and older

Life-course SES and Cancer Screening: Significant differences in breast and cervical cancer screening were observed based on life-course SES (Table 3). Breast cancer screening was higher among women with either stable high (52%) or increasing (32%) life-course SES based on maternal education, and among those with stable high (45%) or increasing (32%) life-course SES based on paternal education (all p-values < 0.001). Breast cancer screening was also higher among women with stable (56%) or increasing (49%) life-course SES based on maternal employment, and stable (55%) or increasing (50%) life-course SES based on paternal employment. However, breast cancer screening was lowest among women with declining life-course SES (5%) based on mother's education. Cervical cancer screening was also higher among women with stable high (55%) or increasing (23%) life-course SES based on maternal education, and stable high (45%) or increasing (24%) life-course SES based on paternal education. The highest cervical cancer screening rate was observed among women with stable high life-course SES based on maternal employment (74%) and paternal employment (68%), and the lowest screening rates are observed among women with declining life-course SES based on mother's education (6%) and stable low life-course SES based on paternal education (5%).

Table 3: Breast and cervical cancer screening rates by life-course SES

Life-Course Socio-Economic Status N (%)		Breast cancer Screening**	P-value*	Cervical cancer Screening+	P-value*
Mother's education	**Own education**				
Greater than primary	Greater than primary	819 (51.7)	<.0001	1274 (54.5)	<.0001
Less than primary	Greater than primary	1206 (31.8)		1341 (22.9)	
Greater than primary	Less than primary	11 (4.8)		14 (5.3)	
Less than primary	Less than primary	979 (15.7)		643 (5.5)	
Father's Education	**Own Education**				
Greater than primary	Greater than primary	1074 (45.3)	<.0001	1513 (44.6)	<.0001
Less than primary	Greater than primary	951 (31.9)		1102 (23.5)	
Greater than primary	Less than primary	43 (10.9)		57 (10.5)	
Less than primary	Less than primary	947 (16.1)		600 (4.9)	
Mother's Employment	**Own Employment**				
Employed	Employed	467 (56.2)	<.0001	749 (73.4)	<.0001
Employed	Unemployed	551 (40.1)		757 (43.3)	
Unemployed	Employed	267 (48.9)		321 (37.4)	
Unemployed	Unemployed	1730 (19.3)		1445 (9.6)	
Father's Employment	**Own Employment**				
Employed	Employed	563 (54.6)	<.0001	854 (68.4)	<.0001
Employed	Unemployed	825 (29.6)		1044 (28.3)	
Unemployed	Employed	171 (50.4)		216 (37.9)	
Unemployed	Unemployed	1456 (19.6)		1158 (8.7)	

*Estimated using chi-squared test

**Defined as women ages 40-65 years who reported receiving a mammogram in the past 5 years

+Defined as women ages 21-65 years who reported receiving a pelvic examination and Pap smear in the past 3 years

Multivariable Adjusted Model of SES and Cancer Screening: After adjusting for age, health status, rural/urban residence and marital status, having a college degree (OR: 4.18, 95% CI: 2.36-7.4), or secondary school education (OR: 1.86, 95% CI: 1.27-2.78) was associated with higher odds of breast cancer screening compared with those with no formal education (Table 4). Having a parent with a secondary school education (mother OR: 2.50, 95% CI: 1.60 – 3.92; father OR: 2.48, 95% CI: 1.73 – 3.55) or higher increased the odds of breast cancer screening. In addition, women who themselves (OR: 2.38, 95% CI: 1.60-3.53), had mothers (OR: 2.39, 95% CI: 1.60 - 3.59) or fathers (OR 1.83, 95% CI: 1.21 – 2.78) employed in the public sector were significantly more likely to receive screening. Similarly, having a secondary school (OR: 2.24, 95% CI: 1.52 – 3.30) or a college education (OR: 4.18, 95% CI: 2.44 – 7.15), or having a mother (OR: 2.34, 95% CI: 1.60 – 3.42) or a father (OR: 2.13, 95% CI: 1.55 – 2.94) with a secondary education significantly increased cervical cancer screening after adjustment for potential confounders. Being employed in the public sector (OR: 1.92, 95% CI: 1.31-2.81), or having a mother (OR: 1.48 95% CI: 1.04-2.12) employed in the public sector significantly increased the likelihood of cervical cancer screening.

Table 4: Multivariable logistic regression analysis of breast and cervical cancer screening by SES, SAGE 2008

Socio-Economic Status[b]	Breast cancer Screening OR (95% CI)[a]	P-value	Cervical cancer Screening OR (95% CI)[a]	P-value
Own Education				
College/University/post-graduate	4.18 (2.36-7.40)	<.00	4.18 (2.44-7.15)	<.00
Secondary/high school	1.86 (1.27-2.78)	0.53	2.24 (1.52-3.30)	0.09
Primary school	1.17 (0.73-1.89)	0.01	1.34 (0.84-2.14)	0.02
No formal education	Ref	Ref	Ref	Ref
Mother's education				
College/University/post-graduate	2.81 (1.13-6.97)	0.27	1.77 (0.65-4.85)	0.73
Secondary/high school	2.50 (1.60-3.92)	0.18	2.34 (1.60-3.42)	0.03
Primary school	1.97 (1.26-3.09)	0.91	1.38 (0.92-2.07)	0.55
No formal education	Ref	Ref	Ref	Ref
Father's Education				
College/University/post-graduate	1.94 (0.91-4.14)	0.59	1.66 (0.80-3.43)	0.84
Secondary/high school	2.48 (1.73-3.55)	0.01	2.13 (1.55-2.94)	0.034
Primary school	1.59 (1.07-2.36)	0.79	1.71 (1.20-2.44)	0.56
No formal education	Ref	Ref	Ref	Ref
Own Employment				
Public sector	2.38 (1.60-3.53)	<.00	1.92 (1.31-2.81)	<.00
Private sector	1.10 (0.66-1.84)	0.86	1.36 (0.88-2.09)	0.03
Self-employed	0.64 (0.48-0.86)	<.00	0.38 (0.28-0.53)	<.00
Unemployed	Ref	Ref	Ref	Ref
Mother's Employment				
Public sector	2.39 (1.60-3.59)	0.00	1.48 (1.04-2.12)	0.04
Private sector	1.64 (0.86-3.14)	0.81	1.99 (1.13-3.50)	0.01
Self-employed	1.47 (1.11-1.96)	0.66	0.54 (0.39-0.75)	<.00
Unemployed	Ref	Ref	Ref	Ref
Father's Employment				

Public sector	1.83 (1.21-2.78)	0.01	1.21 (0.85-1.74)	0.09
Private sector	1.26 (0.68-2.34)	0.83	1.58 (0.89-2.80)	0.02
Self-employed	1.30 (0.88-1.93)	0.92	0.51 (0.36-0.74)	<.00
Unemployed	Ref	Ref	Ref	Ref

[a]Adjusted for smoking, alcohol, physical activity, rural/urban residence, marital status, country, age , health status

Bold indicates significant p-value <0.05

[b]Each model includes own SES variable and parental SES variable adjusted for covariates

Multivariable Adjusted Model of Life-course SES and Cancer Screening: In adjusted models, women with stable higher life-course SES based on maternal education i.e. high maternal education and high own education (OR: 2.53, 95% CI: 1.69 – 3.80), or increasing life-course SES based on maternal education i.e. low maternal education and high own education (OR: 1.23, 95% CI: 0.90 – 1.66) had greater odds of breast cancer screening (Table 5). However, those with declining life-course SES had significantly lower odds of breast cancer screening (OR: 0.26, 95% CI: 0.08 – 0.79) compared with stable low life-course SES. Likewise, stable higher life-course SES based on father's education was associated with increased likelihood of breast cancer screening (OR: 2.01, 95% CI: 1.43 – 2.82). Similar associations were observed for cervical cancer screening among women with stable high life-course SES based on maternal education (OR: 2.47, 95% CI: 1.47 – 4.16) and paternal education (OR: 2.74, 95% CI: 1.66 – 4.54), and for increasing life-course SES based on education. Stable higher life-course SES based on maternal (OR: 3.07, 95% CI: 1.96 – 4.79) and paternal employment (OR: 2.62, 95% CI: 1.77 – 3.89) increased breast cancer screening by 2 to 3-fold, and increased cervical cancer screening by more than 4-fold (OR mothers: 4.35, 95% CI: 2.94 – 6.45; OR fathers: 4.24, 95% CI: 2.95 – 6.11). Women with high education and high parental (both maternal and paternal) education were almost 10 times more likely to receive breast cancer screening compared with those with at least one parent with low education (OR: 9.84, 95% CI: 1.55-55.5), and women who were employed with both parents also employed had a 3-fold higher odds of being screened (OR: 3.18, 95% CI: 1.18-8.62). Similarly, women who were employed and had both parents who were also employed had a 4-fold increased likelihood of receiving cervical cancer screening (OR: 4.02, 95% CI: 1.98-8.16) compared to unemployed women with both parents also unemployed.

Table 5: Multivariable Logistic Regression Analysis of Breast and Cervical Cancer Screening by Life-Course SES, SAGE 2008

Life-Course Socioeconomic Status[b]		Breast cancer Screening OR (95% CI)[a]	P-value	Cervical cancer Screening OR (95% CI)[a]	P-value
Mother's Education	**Own Education**				
Greater than primary	Greater than primary	2.53 (1.69-3.80)	<.00	2.47 (1.47-4.16)	0.08
Less than primary	Greater than primary	1.23 (0.90-1.66)	0.12	1.67 (1.10-2.52)	0.99
Greater than primary	Less than primary	0.26 (0.08-0.79)	0.00	1.89 (0.43-8.24)	0.82
Less than primary	Less than primary	Ref		Ref	
Father's Education	**Own Education**				
Greater than primary	Greater than primary	2.01 (1.43-2.82)	<.00	2.7 (1.66-4.54)	0.01
Less than primary	Greater than primary	1.08 (0.78-1.49)	0.96	1.72 (1.08-2.72)	0.59
Greater than primary	Less than primary	0.64 (0.27-1.56)	0.1	2.45 (1.12-5.39)	0.29
Less than primary	Less than primary	Ref		Ref	
Mother's employment	**Own employment**				
Employed	Employed	3.07 (1.96-4.79)	0.00	4.35 (2.94-6.45)	<.00
Employed	Unemployed	1.68 (1.12-2.52)	0.40	1.83 (1.21-2.75)	0.24
Unemployed	Employed	2.53 (1.68-3.82)	0.07	2.90 (2.00-4.24)	0.06
Unemployed	Unemployed	Ref		Ref	
Father's employment	**Own employment**				
Employed	Employed	2.62 (1.77-3.89)	0.00	4.24 (2.95-6.11)	<.00
Employed	Unemployed	1.27 (0.92-1.76)	0.01	1.90 (1.36-2.66)	0.15
Unemployed	Employed	2.66 (1.63-4.34)	0.02	3.32 (2.12-5.21)	0.02
Unemployed	Unemployed	Ref		Ref	
Both Parents Education	**Own Education**				
Both greater than primary	Greater than primary	9.84 (1.75-55.5)	0.001	0.63 (0.12-3.20)	0.62
Both greater than primary	Less than primary	1.22 (0.13-11.8)	0.18	0.32 (0.03-3.85)	0.50
>=1 less than primary	Greater than primary	4.98 (0.91-27.3)	0.05	0.40 (0.08-1.98)	0.36
>=1 less than primary	Own less than primary	Ref		Ref	
Both Parent Employment	**Own Employment**				
Both parent's employed	Employed	3.18 (1.18-8.62)	0.001	4.02 (1.98-8.16)	.001
Both parent's employed	Unemployed	2.00 (0.75-5.36)	0.45	1.76 (0.84-3.70)	0.87
>= 1parent unemployed	Own employment	1.44 (0.55-3.72)	0.24	1.21 (0.61-2.40)	0.01
>= 1 parent unemployed	Unemployed	Ref		Ref	

[a]Adjusted for smoking, alcohol, physical activity, rural/urban residence, marital status, country, age, health status
[b]Each life-course SES variable analysed in separate models adjusted for study covariates
Bold indicates significant p-value <0.05

DISCUSSION

This study provides a comprehensive assessment of the association between individual, parental and life-course socio-economic status in relation to breast and cervical cancer screening among women in China, India, Mexico, South Africa and Russia. In 2008, only 27% of women ≥40 years old had received a mammogram in the past five years, and only 23% of women ≥21 years old had received a pelvic examination with Pap smear in the past three years. There were clear SES gradients in screening rates, and between country differences in the association of SES and screening. For instance, although Russia had the highest proportion of women with a secondary school or college education (95%), only 44% had received age-appropriate breast cancer screening. In contrast, only

41% of Mexican women had a secondary school or college education, yet over 30% of Mexican women had received age-appropriate breast cancer screening. Women with high SES defined based on education or public sector employment were most likely to have received breast or cervical cancer screening, and those with stable high or increasing life-course SES were more likely to be screened. Having a college degree or higher was by far the strongest predictor of screening, increasing the likelihood of breast or cervical screening by more than 4-fold. In contrast, women who were self-employed or unemployed or who had maternal or paternal self-employment or unemployment were significantly less likely to receive screening. Stable high or increasing life-course SES was associated with increased cancer screening, however declining life-course SES based on maternal education was associated with even lower odds of breast cancer screening compared with stable low life-course SES. Women who were educated and had both parents also educated had an almost 10-fold increase in the odds of breast cancer screening.

A growing number of studies have documented positive associations between childhood (or parental) and adult SES on health outcomes[15 30-34], with low SES consistently liked with increased risk of heart disease, diabetes, cancer and stroke. Low SES and the associated financial hardship may influence health outcomes through: 1) limited resources needed for disease prevention or health promotion activities, 2) lack of knowledge about the health impact of lifestyle risk factors, behaviors or routine screening, 3) reduced access to healthcare due to financial, physical or social barriers to accessing the healthcare system, and 4) psychosocial stress due to continued financial hardship. Cancer screening is likely influenced by consistently low SES via lack of timely information about recommended cancer screening guidelines, lack of financial resources to afford routine screening, and limited availability of cheaper or subsidized screening programs. Our findings provide evidence that there are major barriers to screening for low SES women in all the countries included countries; however higher SES women are more successful in overcoming these barriers. Our observation that women with high SES based on education have the highest cancer screening rates suggests that health information is likely a critical factor- and improving access to and understanding of the importance of routine screening is a strategy that may help increase cancer screening among lower SES women. Additionally, women with higher SES based on employment, in particular public sector employment, also experienced high screening rates-suggesting that access to stable employment that may include healthcare benefits, may improve screening through increased financial resources and/or better access to employment based healthcare.

We observed strong associations between life-course SES and cancer screening, adding to the growing body of literature on the importance of early life and adult factors in human health, and cancer prevention, in particular. The consistently low cancer screening rates in resource-poor settings, particularly in many LMICs [35 36], and higher cancer screening rates in higher SES groups have been consistently reported [37-40]. However, few studies have examined life-course SES in relation to cancer screening[41], with results showing that childhood conditions result in reduced probability of breast cancer screening. A recent study by Schmeisser et al showed a higher risk of cancer in men with a downward social trajectory over the life-course compared with those at high social trajectory over the life-course[42]. Other studies have also shown that declining life-course SES trajectory increased the risk of cancer, including reproductive behaviors and obesity [18 43]. Consistently low SES over the life-course likely leads to cumulative disadvantage due to mechanisms including low health literacy, poor access to high quality healthcare, competing health risks, psychosocial stress, and lack of financial resources for health, leading to stronger associations of life-course SES with health outcomes compared with SES measures at any single point in time. Although no formal definition for SES or life-course SES exists, education based SES measures have emerged as stronger predictors of screening compared with employment based measures. This suggests that factors related to literacy, awareness of the benefits of screening, low self-efficacy regarding cancer prevention and early detection options may be more important for health outcomes including cancer screening[26 29] compared with income and financial factors [44]. This is supported by our observation, as well as other studies showing a stronger influence of maternal education on cancer screening and daughter's adult health [43 45], that may be due to the fact that women may be strongly socialized and view their mothers as role models compared with their fathers. If highly educated mothers are more likely to receive screening or are well informed about the importance of routine cancer screening, this may potentially shape daughters' own health-related behavior, including cancer screening.

The observation that although 44% of women received a pelvic examination in the past 3 years but only 55% of those also received a Pap smear suggests that even when access to healthcare barriers are eliminated or reduced, appropriate screening still may not occur. Educating healthcare professionals on cancer screening guidelines, and integrating cancer screening within routine healthcare settings may go a long way in increasing cancer screening rates, particularly for cervical cancer. While current recent recommendations for cervical cancer screening involves HPV DNA testing at ages 35 and/or 40, and HPV vaccination may contribute to significantly reducing the global

burden of cervical cancer[46], these approaches still require significant initial investments in the healthcare infrastructure and substantial out of pocket costs to patients, limiting the immediate uptake of HPV testing as a routine cancer screening strategy. Regardless of screening method, community outreach programs to improve knowledge of the importance of screening and increase cultural acceptability in among low SES women will be important in all LMICs, while integration of routine screening into routine medical care and improved training of health personnel about communicating the benefits of screening to patients will likely increase cancer screening rates. Simply providing cancer screening technology such as mammography machines is unlikely to be sufficient to ensure successful utilization by women at risk of cancer[47]. Additionally, national policies regarding screening may eliminate some of the structural barriers to screening. For instance, national cancer prevention policies that include financial subsidies for screening, free screening programs, and/or employment-based routine screening programs, may mitigate some of the effects of low SES on screening. In Russia, 66% of women employed in the public sector received breast and cervical cancer screening, and over 90% of women with maternal and paternal employment in the public sector had been screened for both cancers. This is in contrast with India and Mexico where comparable screening rates were 2.6% and 3.3% respectively for public sector employment. These between-country differences warrant further study, specifically country-level differences in healthcare infrastructure, health insurance coverage and screening costs, availability of medical personnel, and population knowledge about cancer screening.

The strengths of this study include the use of data from the multi-country, nationally representative and standardized SAGE study. SAGE was designed to elicit response on a wide-range of health related questions and had very high response rates, which permitted robust assessment of comprehensive measures of life-course SES and cancer screening in multiple countries. One potential limitation of this study includes the use of self-reported screening data, however since SAGE is a standardized survey of multiple health items, any recall bias of self-reported screening is unlikely to be differential with respect to country or SES. Another potential limitation involves SES and potential country-level differences in the ability of education or employment measures to capture the full range of SES. We used both measures of education and employment to better capture variability in SES, as these are less vulnerable to recall bias or social desirability bias, and have been used in past studies as robust measures of SES.

In summary, we observed SES gradients in breast and cervical cancer screening among women in China, India, Mexico, South Africa and Russia, and a stronger influence of life-course SES on screening. Future studies are needed to better understand and implement public health strategies focused on improving cancer screening rates among women with low SES over the life-course. For instance, targeted outreach programs to increase knowledge of the benefits of cancer screening, integration of cancer screening within routine healthcare settings, as well as national and/or employment-based policies designed to mitigate SES differences in screening. Women with declining or low SES over the life-course experience cumulative disadvantage, are least equipped to overcome financial and structural barriers to screening, and are also least likely to afford the financial catastrophe that often accompanies a late stage cancer diagnosis.

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COMPETING INTEREST

No competing interest to declare

DATA SHARING STATEMENT

No additional data available

TRANSPARENCY DECLARATION

I affirm that the manuscript is a honest and transparent account of the study being reported, no important aspect of the study is being omitted and any discrepancies have been explained. T.A

CONTRIBUTORSHIP STATEMENT

TA conceived of the research question and oversaw the statistical analysis and writing of the manuscript, KO, SS and VO contributed to the statistical analysis and initial draft of the manuscript, DB contributed to the interpretation of results and writing of the manuscript.

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STROBE statement?checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract			
	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2,3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) *Cohort study*?Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up*Case-control study*?Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls*Cross sectional study*?Give the eligibility criteria, and the sources and methods of selection	4

	Item No	Recommendation	Page No
		of participants	
		(*b*) *Cohort study*?For matched studies, give matching criteria and number of exposed and unexposed*Case-control study*?For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4
Bias	9	Describe any efforts to address potential sources of bias	16
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4,5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5
		(*b*) Describe any methods used to examine subgroups and interactions	4,5
		(*c*) Explain how missing data were addressed	4
		(*d*) *Cohort study*?If applicable,	

	Item No	Recommendation	Page No
		explain how loss to follow-up was addressed*Case-control study*?If applicable, explain how matching of cases and controls was addressed*Cross sectional study*?If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(*a*) Report numbers of individuals at each stage of study?eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5,6
		(*b*) Give reasons for non-participation at each stage	
		(*c*) Consider use of a flow diagram	
Descriptive data	14*	(*a*)Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5,6
		(*b*) Indicate number of participants with missing data for each variable of interest	
		(*c*) *Cohort study*?Summarise follow-up time (eg average and total amount)	
Outcome data	15*	*Cohort study*?Report numbers of outcome events or summary measures over time	7,8, 9
		*Case-control study?*Report	

	Item No	Recommendation	Page No
		numbers in each exposure category, or summary measures of exposure	
		Cross sectional study?Report numbers of outcome events or summary measures	
Main results	16	(*a*) Report the numbers of individuals at each stage of the study?eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6-12
		(*b*) Give reasons for non-participation at each stage	
		(*c*) Consider use of a flow diagram	
Other analyses	17	Report other analyses done?eg analyses of subgroups and interactions, and sensitivity analyses	9-12
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15,16

	Item No	Recommendation	Page No
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

Patient Involvement

Patients were not involved in this study. This study was based on WHO Study on Global Ageing and Adult Health (SAGE) data, a longitudinal multi- country study.
(http://www.who.int/healthinfo/sage/cohorts/en/).

BMJ Open

Life-Course Socio-Economic Status and Breast and Cervical Cancer Screening; Analysis of the WHO study on Global Ageing and Adult Health (SAGE)

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Life-Course Socio-Economic Status and Breast and Cervical Cancer Screening; Analysis of the WHO study on Global Ageing and Adult Health (SAGE)

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Keywords: breast cancer screening; cervical cancer screening; socio-economic status; life-course socio-economic status

Word count: 3786

ABSTRACT

Objectives: Socio-economic differences in screening have been well documented in upper-income countries, however few studies have examined socio-economic status (SES) over the life-course in relation to cancer screening in lower and middle-income countries. Here, we examine individual, parental and life-course SES differences in breast and cervical cancer screening among women in India, China, Mexico, Russia and South Africa.

Setting: Data from the WHO Study on Global Ageing and Adult Health (SAGE) 2007-2008 data was used for survey weighted multivariable regression analysis. We examined the association between individual, parental and life-course SES in relation to breast and cervical cancer screening using both education and employment based measures of SES.

Participants: 22,283 women aged 18-65 years, recruited from China, India, Mexico, Russia and South Africa.

Results: Having a college degree (OR: 4.18, 95% CI: 2.36-7.40) increased the odds of breast cancer screening compared with no formal education. Women with higher parental SES were almost 10 times more likely to receive breast cancer screening (OR: 9.84, 95% CI: 1.75-55.5) compared with women with low parental SES. Stable higher life-course (OR: 3.07, 95% CI: 1.96 – 4.79) increased breast cancer screening by 3-fold, and increased cervical cancer screening by more than 4-fold (OR: 4.35, 95% CI: 2.94 – 6.45), however, declining life-course SES was associated with reduced breast cancer screening (OR: 0.26, 95% CI: 0.08-0.79) compared to low life-course SES.

Conclusion: Higher individual, parental and life-course SES was positively associated with breast and cervical cancer screening, although education based SES measures were stronger predictors of screening compared with employment based measures. Improving knowledge of the benefits of cancer screening, and integrating cancer screening into routine healthcare practice for low SES women are actionable strategies that may significantly improve screening rates in low- and middle-income countries.

STRENGTH and LIMITATIONS

1. The strengths of this study include the use of data from the multi-country, nationally representative and standardized SAGE study. SAGE was designed to elicit response on a wide-range of health related questions and had very high response rates, which permitted robust assessment of comprehensive measures of life-course SES and cancer screening in multiple countries.

2. One potential limitation of this study includes the use of self-reported screening data, however since SAGE is a standardized survey of multiple health items, any recall bias of self-reported screening is unlikely to be differential with respect to country or SES.

3. Another potential limitation involves SES and potential country-level differences in the ability of education or employment measures to capture the full range of SES. We used both measures of education and employment to better capture variability in SES, as these are less vulnerable to recall bias or social desirability bias, and have been used in past studies as robust measures of SES.

INTRODUCTION

Breast and cervical cancers remain the most common malignancies in women worldwide.[1 2] In low- and middle- income countries (LMICs), incidence and mortality due to these cancers have increased in recent decades, for instance, the estimated mortality from breast cancer in LMICs increased from about 150,000 in 1990 to over 325,000 in 2012 and is projected to increase to over 500,000 by the year 2030, while cervical cancer mortality is estimated to increase from about 230,000 in 2012 to about 363,000 deaths by 2030[2 3]. Whereas in upper income countries (UICs), the estimated mortality from breast cancer is projected to increase from 197,000 in 2012 to over 243,000 while cervical cancer deaths is projected to increase from about 36,000 in 2012 to over 41,000 deaths by 2030, further thus widening the gap in cancer mortality between UIC and LMICs [3-7].

According to the International Agency for Research on Cancer (IARC), 84% and 53% of new cervical and breast cancer cases respectively, as well as 88% and 58% of cervical and breast cancer deaths respectively, occur in LMICs [2 7-10]. Concurrently, breast and cervical cancer mortality rates has declined significantly in UICs in the past few decades, a trend that has been attributed to widespread use of routine cancer screening and improved cancer treatment[1 6 11]. Routine screening and timely diagnostic follow-up is key to early diagnosis of cancer at stages where treatment is cheaper, less toxic and more effective [12]. Whereas IARC recommends mammograms for women ages 50 – 74 years and pap smears for women from 25 years triennially[13 14], low financial resources may account for non-compliance with screening guidelines. Other causes of non-compliance include poor implementation of comprehensive cancer control plans (in countries that have them), poor healthcare infrastructure to implement cancer screening programs, low levels of health literacy regarding the importance of routine cancer screening, and high prevalence of competing health issues[15]. Prior studies in the US have reported that socioeconomic status (SES) at both the individual and parental level, as well as over the entire life-course, strongly influences health outcomes [16-20], and is associated with screening utilization [21-24]. The life-course approach to understanding cancer screening recognizes the complex interplay of early life factors including parental and individual SES in shaping health behavior, either directly through financial resources and healthcare access or indirectly through awareness of cancer screening recommendations [25].

Although some studies in LMICs have shown that low individual SES negatively influences cancer screening rates [26-29], none to our knowledge have examined SES over the life-course in relation to breast cancer screening and cervical cancer screening. It remains unclear whether parental SES plays a role in adherence to cancer screening guidelines above and beyond individual SES, or whether this association depends on the measure of SES, i.e. education or income measures, or based on maternal or paternal SES measures. The present analysis fills this gap by examining individual, parental and life-course SES in relation to breast and cervical cancer screening among adult women in India, China, Mexico, Russia and South Africa.

METHODS

Data Source and Sample Population: Data for this cross-sectional analysis included women ages 18 years and older from the WHO Study on Global Ageing and Adult Health (SAGE) conducted in China, Mexico, India, South Africa, Ghana and Russia in 2007-2008. SAGE is a longitudinal study of adults from nationally representative samples in these countries, and aimed to evaluate disease risk factors, access to healthcare, health status and wellbeing. The current analysis focuses on five countries: China, India, Mexico, Russia and South Africa, one from each continents, to allow examination of middle-income countries that have experienced major economic and health transitions over the past few decades and face rising burden of non-communicable diseases.

Cancer Screening Outcomes: Key self-reported outcomes were: 1) receipt of screening mammography in the past 5 years among women ages 40 years and older, 2) receipt of a pelvic examination and pap smear in the past 3 years among women ages 21 years and older.

Socio-Economic Status: Individual and parental SES (maternal and paternal) were assessed based on education and employment measures. Educational attainment was based on highest level of education completed, and categorized as no formal education, primary school only, high school graduate, and college or higher degree. Employment status was based on if individual and/or parent (maternal and paternal) is employed - in the public sector, private sector, self-employed or informal employment-, or unemployed for any reason-including homemakers, retirees and those unable to work.

Life-course SES: Change in SES status, i.e. social mobility, from parent to individual was assessed based on both education and employment measures. Life-course SES was defined based on maternal and paternal SES in relation to individual SES separately. Education based life-course SES was

categorized based on whether the parent or daughter completed a primary school education: stable low i.e. < primary parental education and < primary daughter's education; declining i.e. >= primary and < primary; increasing i.e. < primary and >= primary; and stable high i.e. >= primary and >= primary. Employment based life-course SES was categorized based on whether the parent or the daughter were employed or unemployed: stable low, i.e. both the parent and the daughter were unemployed; declining, i.e. employed and unemployed, if the parent was employed and the daughter was unemployed; increasing, i.e. unemployed and employed, if the parent was unemployed but the daughter was employed; and stable high, i.e. employed and employed, if both were employed.

Statistical Analysis: Descriptive analysis was conducted to assess the distribution of socio-demographic, SES and life-course SES variables among study participants. Breast and cervical cancer screening rates by SES and life-course SES was also assessed overall and in each country. Other study covariates examined included age, marital status, rural/urban residence, and current health status. To account for the SAGE sampling strategy, each country was assigned household and individual level analysis weights, which adjusts for sample selection and post stratification factors, using the most recent estimates of each country's population. All statistical analyses included these weights to ensure the generalizability of study results to individuals in the selected countries. Survey weighted multivariable logistic regression models were created to determine the relationship between each SES and life-course SES variable in relation to breast and cervical cancer screening. Regression models were adjusted for age, marital status, rural/urban residence, health status and country to obtain adjusted estimates of the odds of breast and cervical cancer screening. For all analyses, p values ≤ 0.05 were considered statistically significant. All statistical analyses were performed with SAS 9.4 (SAS Institute, Cary NC).

RESULTS

Characteristics of the Study Population: Among a total of 22,283 women residing in five countries, almost half of women had at least a secondary school education (43%), a third of women had no formal education (34%), ranging from 58% in India, 28% in Mexico, 25% in China, 23% in South Africa through to 1.3% in Russia (Table 1). Other than Russia, where most women had parents with at least a secondary school education and employed in the public sector, the majority of women in other countries had mothers (58% - 80%) and fathers (53% - 71%) with no formal education, and most were either unemployed or self-employed. While 44% of women ≥21 years received a pelvic examination in the past 3 years, out of this number, 56% had also received a pap smear, however

only 28% of women ≥40 years had received a mammogram in the past 5 years. Mammography screening ranged from 11% in India to 44% in Russia, while pelvic examinations ranged from 15% in India to 87% in Russia.

Table 1: Baseline characteristics of female SAGE participants*

	Total N=22,283	China N=8,002	Mexico N=1,689	India N=7,489	South Africa N=2,427	Russia N=2,676
Age group						
<21	512 (4.6)	13 (1.2)	5 (0.3)	483 (9.5)	9 (1.9)	2 (0.4)
21-40	3234 (37.1)	400 (29.9)	159 (51.2)	2424 (45.3)	124 (42.0)	127 (31.2)
40-65	11451 (47.0)	4730 (58.3)	704 (38.0)	3357 (36.6)	1390 (46.8)	1270 (46.2)
>65	7086 (11.3)	2859 (10.6)	821 (10.5)	1225 (10.6)	904 (9.2)	1277 (22.2)
Marital status						
Married	14621 (77.3)	6315 (89.4)	869 (64.9)	5375 (77.8)	874 (37.9)	1188 (53.6)
Never married	1341 (7.6)	101 (3.7)	186 (19.9)	483 (8.3)	453 (34.0)	118 (8.1)
Widow/divorced	6321 (15.1)	1586 (6.9)	634 (15.2)	1631 (13.9)	1100 (28.1)	1370 (38.3)
Highest Education						
No formal education	10341 (34.5)	3911 (24.5)	879 (27.8)	4402 (57.9)	1053 (22.8)	96 (1.3)
Primary school	3311 (14.1)	1301 (16.2)	356 (30.8)	954 (16.0)	492 (15.6)	208 (2.6)
Secondary school	6311 (42.9)	2493 (50.5)	218 (31.0)	1265 (22.0)	473 (52.1)	1862 (76.8)
College/university	1321 (8.4)	297 (8.8)	169 (10.4)	260 (4.1)	86 (9.4)	509 (19.2)
Employment status						
Unemployed	8686 (24.1)	3746 (27.9)	368 (15.9)	1382 (14.9)	1438 (38.3)	1752 (37.0)
Private sector	962 (6.9)	268 (9.3)	70 (7.8)	273 (3.5)	221 (11.0)	130 (1.5)
Public sector	1438 (14.3)	489 (16.0)	41 (3.3)	116 (1.5)	103 (11.3)	689 (49.4)
Self-employed	11197 (54.7)	3499 (46.8)	1210 (73.0)	5718 (80.1)	665 (36.4)	105 (4.6)
Health Status						
Good	7152 (45.1)	1636 (12.3)	626 (49.4)	1076 (11.4)	908 (54.8)	340 (36.0)
Moderate	11075 (42.8)	2614 (49.5)	856 (40.6)	3749 (45.7)	1140 (33.0)	1578 (50.5)
Bad	4056 (12.1)	3752 (38.2)	207 (10.0)	1076 (11.4)	379 (12.2)	758 (13.5)
Mother's education						
No formal	17341 (73.3)	7040 (80.0)	1442 (81.2)	6145 (87.2)	1719 (58.0)	995 (19.1)
Primary school	1546 (9.4)	342 (10.7)	107 (10.3)	382 (6.5)	162 (22.9)	553 (10.3)
Secondary school	1809 (14.9)	325 (10.4)	38 (6.0)	323 (5.8)	142 (13.5)	981 (59.4)
College/university	289 (2.4)	42 (0.9)	35 (2.5)	31 (0.6)	43 (5.6)	138 (11.2)
Father's education						
No formal	14815 (58.4)	6095 (65.2)	1407 (71.1)	4886 (67.0)	1575 (52.8)	852 (16.4)
Primary school	2437 (13.1)	772 (14.7)	138 (19.3)	777 (12.5)	217 (12.7)	533 (10.3)
Secondary school	3106 (23.9)	766 (17.2)	48 (7.5)	1012 (17.3)	190 (27.8)	1090 (60.4)
College/university	592 (4.6)	130 (2.80	29 (2.2)	204 (3.2)	42 (6.6)	187 (12.9)
Mother's employment						
Unemployed	10064 (37.7)	3382 (30.6)	1021 (48.9)	4194 (54.2)	1107 (38.9)	360 (6.8)
Private sector	993 (3.4)	162 (2.3)	72 (5.8)	266 (3.3)	466 (18.3)	27 (1.9)
Public sector	3272 (20.0)	895 (17.5)	38 (3.9)	67 (1.0)	87 (9.4)	2185 (89.3)
Self-employed	79549 (38.9)	3563 (49.6)	558 (41.3)	2962 (41.5)	767 (33.4)	104 (2.1)
Father's employment						
Unemployed	3128 (8.9)	2230 (19.3)	357 (12.7)	134 (1.3)	314 (9.9)	93 (2.0)
Private sector	2049 (7.2)	261 (4.30	207 (20.9)	640 (7.9)	897 (41.2)	44 (2.5)
Public sector	5223 (28.0)	1761 (27.8)	133 (8.1)	705 (9.3)	244 (9.5)	2380 (92.0)
Self-employed	11883 (55.9)	3750 (48.6)	992 (58.3)	6010 (81.4)	972 (39.4)	159 (3.5)
Pelvic exam						
< 3 years	7831 (44.1)	3165 (61.4)	1108 (70.1)	878 (14.9)	587 (34.7)	2093 (86.7)
>=3 years	14452 (55.9)	4837 (38.6)	581 (29.9)	6611 (85.1)	1840 (65.3)	583 (13.3)
Pap smear+						
Yes	5769 (55.8)	1776 (43.1)	1134 (93.6)	129 (17.8)	549 (77.6)	2181 (91.3)
No	3238 (43.1)	2252 (56.9)	64 (6.4)	503 (81.5)	176(3.6)	243 (6.1)
Mammogram**						
<5 years	4908 (27.7)	2138 (38.4)	716 (32.1)	660 (10.8)	396 (15.6)	998 (44.1)
>= 5 years	17375 (73.5)	5864 (61.6)	973 (67.9)	6829 (89.2)	2031 (84.4)	1678 (55.9)

*Un-weighted n (Weighted %)

**Defined as women ages 40-65 years who reported receiving a mammogram in the past 5 years

+Defined as women ages 21 -65 years who reported receiving a pelvic examination and Pap smear in the past 3 years

SES and Cancer Screening: Breast cancer screening increased with increasing education, ranging from 10% among those with no formal education to 56% among those with a college education (Table 2). Similar trends were observed based on maternal education, however there was no clear gradient based on paternal education. Women employed in the public sector (60%) or with maternal (53%) or paternal (46%) employment in the public sector had the highest screening rates. Breast cancer screening was low (<10%) regardless of education among women in India, and highest among women with maternal self-employment (19%), while screening increased markedly with increasing education among women in China, Mexico and Russia. In South Africa, screening rates were low among women with no formal education (8%) and those with college education (8%), including those with maternal (6%) and paternal (8%) college education. Similarly, cervical cancer screening increased with increasing education overall, ranging form 5% among those with no formal education to 51% among those with a college education. Cervical cancer screening was highest in Russia (83%-85%), and lowest in India (<1%-2%) across education levels, with clear positive gradients for individual, maternal and paternal education. Cervical cancer screening was highest among those employed in the public sector (68%) across countries, ranging from 1.9% in India to 94% in Russia, while screening was lowest among women who were self-employed (29%), ranging from 2% in India to 60% in Mexico.

Table 2: Breast and cervical cancer screening rates by country and SES

Socio-Economic Status (%)	Breast Cancer Screening*						Cervical Cancer Screening+					
	China (n=4946)	India (n=3640)	Mexico (n=755)	South Africa (n=1472)	Russia (n=1320)	Total (n=12133)	China (n=53466)	India (n=6064)	Mexico (n=9144)	South Africa (n=1596)	Russia (n=1447)	Total (n=15367)
Own Education												
No formal education	27.4	0.8	52.4	7.6	6.4	10.2	16.4	0.8	67.4	10.6	83.2	5.1
Primary school	31.5	0.7	56.7	19.4	14.1	20.2	20.5	1.8	76.1	28.4	70.8	12.5
Secondary/High School	43.7	0.6	52.8	37.1	52.1	41.9	32.4	1.8	57.3	28.7	88.3	39.6
College/university/Post-graduate	83.7	0.2	66.3	7.8	54.5	55.7	48.2	1.6	69.3	38.1	85.4	51.1
Mother's Education												
No formal education	35.1	0.8	53.6	21.0	43.0	21.4	26.6	1.2	66.4	22.2	71.3	15.0
Primary school	57.2	0.3	64.5	16.0	48.9	44.5	34.7	1.6	71.5	27.1	84.1	31.1
Secondary/High School	69.6	1.5	81.4	54.1	53.8	53.5	38.6	1.3	57.1	35.4	92.7	64.5
College/university/post-graduate	48.6	0.0	63.8	6.3	65.3	55.7	63.8	0.0	89.5	28.9	78.3	67.5
Father's Education												
No formal education	32.8	0.7	52.4	23.5	43.5	20.4	23.4	1.3	64.3	18.7	77.1	13.9
Primary school	47.8	1.6	74.1	12.8	39.9	31.1	35.3	0.8	84.8	50.8	85.0	27.0
Secondary/High school	61.5	0.7	62.2	37.2	56.0	48.2	41.4	1.1	33.8	23.1	90.7	47.6
College/University/post-graduate	49.8	0.0	63.2	7.6	54.7	39.3	34.8	2.1	100.0	37.6	82.7	47.4
Own Employment												
Public sector	68.9	0.0	55.8	6.4	59.2	60.3	46.6	1.9	59.7	61.8	93.8	67.6
Private sector	46.6	1.8	34.1	13.3	47.3	37.1	43.2	0.9	69.0	49.2	83.2	42.6
Self-employed	27.6	9.4	56.7	27.9	44.3	18.6	17.3	1.7	60.3	12.5	44.0	7.6
Unemployed	40.8	0.7	57.6	23.5	40.1	29.5	32.3	2.8	59.9	23.9	82.2	29.5
Mother's Employment												
Public sector	56.5	0.0	45.7	6.1	52.3	52.6	40.6	1.4	76.4	51.4	88.6	67.4
Private sector	53.9	3.8	86.9	15.5	48.2	24.7	57.6	3.1	63.5	26.3	96.0	32.5
Self-employed	34.9	19.3	59.3	15.7	57.4	29.3	19.7	0.9	69.9	32.3	58.2	12.4
Unemployed	34.8	0.7	50.9	33.1	53.0	16.1	33.9	1.1	63.1	21.1	74.2	13.6
Father's Employment												
Public sector	50.0	0.7	62.4	41.6	51.6	46.2	38.0	0.7	67.1	40.6	88.0	53.3
Private sector	43.2	2.2	68.3	17.8	40.5	17.9	55.9	3.6	82.1	27.0	81.6	26.1
Self-employed	35.2	8.7	54.2	22.2	71.2	21.3	19.0	0.9	60.0	29.3	81.4	8.9
Unemployed	31.9	1.2	46.0	12.6	58.8	30.2	33.1	0.0	69.5	22.0	87.5	31.4

Proportion of women screened among all eligible women based on age
+ Pelvic exam and pap smear in the past 3 years among women ages 21 years and older
*Mammograms in the past 5 years among women ages 40 years and older

Life-course SES and Cancer Screening: Significant differences in breast and cervical cancer screening were observed based on life-course SES (Table 3). Breast cancer screening was higher among women with either stable high (52%) or increasing (32%) life-course SES based on maternal education, and among those with stable high (45%) or increasing (32%) life-course SES based on paternal education (all p-values < 0.001). Breast cancer screening was also higher among women with stable (56%) or increasing (49%) life-course SES based on maternal employment, and stable (55%) or increasing (50%) life-course SES based on paternal employment. However, breast cancer screening was lowest among women with declining life-course SES (5%) based on mother's education. Cervical cancer screening was also higher among women with stable high (55%) or increasing (23%) life-course SES based on maternal education, and stable high (45%) or increasing (24%) life-course SES based on paternal education. The highest cervical cancer screening rate was observed among women with stable high life-course SES based on maternal employment (74%) and paternal employment (68%), and the lowest screening rates are observed among women with declining life-course SES based on mother's education (6%) and stable low life-course SES based on paternal education (5%).

Table 3: Breast and cervical cancer screening rates by life-course SES

Life-Course Socio-Economic Status N (%)		Breast cancer Screening**	P-value*	Cervical cancer Screening+	P-value*
Mother's education	**Own education**				
Greater than primary	Greater than primary	819 (51.7)	<.0001	1274 (54.5)	<.0001
Less than primary	Greater than primary	1206 (31.8)		1341 (22.9)	
Greater than primary	Less than primary	11 (4.8)		14 (5.3)	
Less than primary	Less than primary	979 (15.7)		643 (5.5)	
Father's Education	**Own Education**				
Greater than primary	Greater than primary	1074 (45.3)	<.0001	1513 (44.6)	<.0001
Less than primary	Greater than primary	951 (31.9)		1102 (23.5)	
Greater than primary	Less than primary	43 (10.9)		57 (10.5)	
Less than primary	Less than primary	947 (16.1)		600 (4.9)	
Mother's Employment	**Own Employment**				
Employed	Employed	467 (56.2)	<.0001	749 (73.4)	<.0001
Employed	Unemployed	551 (40.1)		757 (43.3)	
Unemployed	Employed	267 (48.9)		321 (37.4)	
Unemployed	Unemployed	1730 (19.3)		1445 (9.6)	
Father's Employment	**Own Employment**				
Employed	Employed	563 (54.6)	<.0001	854 (68.4)	<.0001
Employed	Unemployed	825 (29.6)		1044 (28.3)	
Unemployed	Employed	171 (50.4)		216 (37.9)	
Unemployed	Unemployed	1456 (19.6)		1158 (8.7)	

*Estimated using chi-squared test

** Defined as women ages 40-65 years who reported receiving a mammogram in the past 5 years

+ Defined as women ages 21-65 years who reported receiving a pelvic examination and Pap smear in the past 3 years

Multivariable Adjusted Model of SES and Cancer Screening: After adjusting for age, health status, rural/urban residence and marital status, having a college degree or higher (OR: 4.18, 95% CI: 2.36-7.40), or secondary school education (OR: 1.86, 95% CI: 1.27-2.78) was associated with higher odds of breast cancer screening compared with those with no formal education (Table 4). Having a parent with a secondary school education (mother OR: 2.50, 95% CI: 1.60 – 3.92; father OR: 2.48, 95% CI: 1.73 – 3.55) or higher increased the odds of breast cancer screening. In addition, women who themselves (OR: 2.38, 95% CI: 1.60-3.53), had mothers (OR: 2.39, 95% CI: 1.60 - 3.59) or fathers (OR 1.83, 95% CI: 1.21 – 2.78) employed in the public sector were significantly more likely to receive screening. Similarly, having a secondary school (OR: 2.24, 95% CI: 1.52 – 3.30) or a college education (OR: 4.18, 95% CI: 2.44 – 7.15), or having a mother (OR: 2.34, 95% CI: 1.60 – 3.42) or a father (OR: 2.13, 95% CI: 1.55 – 2.94) with a secondary education significantly increased cervical cancer screening after adjustment for potential confounders. Being employed in the public sector (OR: 1.92, 95% CI: 1.31-2.81), or having a mother (OR: 1.48 95% CI: 1.04-2.12) employed in the public sector significantly increased the likelihood of cervical cancer screening.

Table 4: Multivariable logistic regression analysis of breast and cervical cancer screening by SES, SAGE 2008

Socio-Economic Status[b]	Breast cancer Screening OR (95% CI)[a]	P-value	Cervical cancer Screening OR (95% CI)[a]	P-value
Own Education				
College/University/post-graduate	4.18 (2.36-7.40)	<.00	4.18 (2.44-7.15)	<.00
Secondary/high school	1.86 (1.27-2.78)	0.53	2.24 (1.52-3.30)	0.09
Primary school	1.17 (0.73-1.89)	0.01	1.34 (0.84-2.14)	0.02
No formal education	Ref	Ref	Ref	Ref
Mother's education				
College/University/post-graduate	2.81 (1.13-6.97)	0.27	1.77 (0.65-4.85)	0.73
Secondary/high school	2.50 (1.60-3.92)	0.18	2.34 (1.60-3.42)	0.03
Primary school	1.97 (1.26-3.09)	0.91	1.38 (0.92-2.07)	0.55
No formal education	Ref	Ref	Ref	Ref
Father's Education				
College/University/post-graduate	1.94 (0.91-4.14)	0.59	1.66 (0.80-3.43)	0.84
Secondary/high school	2.48 (1.73-3.55)	0.01	2.13 (1.55-2.94)	0.034
Primary school	1.59 (1.07-2.36)	0.79	1.71 (1.20-2.44)	0.56
No formal education	Ref	Ref	Ref	Ref
Own Employment				
Public sector	2.38 (1.60-3.53)	<.00	1.92 (1.31-2.81)	<.00
Private sector	1.10 (0.66-1.84)	0.86	1.36 (0.88-2.09)	0.03
Self-employed	0.64 (0.48-0.86)	<.00	0.38 (0.28-0.53)	<.00
Unemployed	Ref	Ref	Ref	Ref
Mother's Employment				
Public sector	2.39 (1.60-3.59)	0.00	1.48 (1.04-2.12)	0.04
Private sector	1.64 (0.86-3.14)	0.81	1.99 (1.13-3.50)	0.01
Self-employed	1.47 (1.11-1.96)	0.66	0.54 (0.39-0.75)	<.00
Unemployed	Ref	Ref	Ref	Ref
Father's Employment				

Public sector	1.83 (1.21-2.78)	0.01	1.21 (0.85-1.74)	0.09
Private sector	1.26 (0.68-2.34)	0.83	1.58 (0.89-2.80)	0.02
Self-employed	1.30 (0.88-1.93)	0.92	0.51 (0.36-0.74)	<.00
Unemployed	Ref	Ref	Ref	Ref

[a]Adjusted for smoking, alcohol, physical activity, rural/urban residence, marital status, country, age , health status
Bold indicates significant p-value <0.05
[b]Each model includes own SES variable and parental SES variable adjusted for covariates

Multivariable Adjusted Model of Life-course SES and Cancer Screening: In adjusted models, women with stable higher life-course SES based on maternal education i.e. high maternal education and high own education (OR: 2.53, 95% CI: 1.69 – 3.80), or increasing life-course SES based on maternal education i.e. low maternal education and high own education (OR: 1.23, 95% CI: 0.90 – 1.66) had greater odds of breast cancer screening (Table 5). However, those with declining life-course SES had significantly lower odds of breast cancer screening (OR: 0.26, 95% CI: 0.08 – 0.79) compared with stable low life-course SES. Likewise, stable higher life-course SES based on father's education was associated with increased likelihood of breast cancer screening (OR: 2.01, 95% CI: 1.43 – 2.82). Similar associations were observed for cervical cancer screening among women with stable high life-course SES based on maternal education (OR: 2.47, 95% CI: 1.47 – 4.16) and paternal education (OR: 2.74, 95% CI: 1.66 – 4.54), and for increasing life-course SES based on education. Stable higher life-course SES based on maternal (OR: 3.07, 95% CI: 1.96 – 4.79) and paternal employment (OR: 2.62, 95% CI: 1.77 – 3.89) increased breast cancer screening by 2 to 3-fold, and increased cervical cancer screening by more than 4-fold (OR mothers: 4.35, 95% CI: 2.94 – 6.45; OR fathers: 4.24, 95% CI: 2.95 – 6.11). Women with high education and high parental (both maternal and paternal) education were almost 10 times more likely to receive breast cancer screening compared with those with at least one parent with low education (OR: 9.84, 95% CI: 1.55-55.5), and women who were employed with both parents also employed had a 3-fold higher odds of being screened (OR: 3.18, 95% CI: 1.18-8.62). Similarly, women who were employed and had both parents who were also employed had a 4-fold increased likelihood of receiving cervical cancer screening (OR: 4.02, 95% CI: 1.98-8.16) compared to unemployed women with both parents also unemployed.

Table 5: Multivariable Logistic Regression Analysis of Breast and Cervical Cancer Screening by Life-Course SES, SAGE 2008

Life-Course Socioeconomic Status[b]		Breast cancer Screening OR (95% CI)[a]	P-value	Cervical cancer Screening OR (95% CI)[a]	P-value
Mother's Education	**Own Education**				
Greater than primary	Greater than primary	2.53 (1.69-3.80)	<.00	2.47 (1.47-4.16)	0.08
Less than primary	Greater than primary	1.23 (0.90-1.66)	0.12	1.67 (1.10-2.52)	0.99
Greater than primary	Less than primary	0.26 (0.08-0.79)	0.00	1.89 (0.43-8.24)	0.82
Less than primary	Less than primary	Ref		Ref	
Father's Education	**Own Education**				
Greater than primary	Greater than primary	2.01 (1.43-2.82)	<.00	2.7 (1.66-4.54)	0.01
Less than primary	Greater than primary	1.08 (0.78-1.49)	0.96	1.72 (1.08-2.72)	0.59
Greater than primary	Less than primary	0.64 (0.27-1.56)	0.1	2.45 (1.12-5.39)	0.29
Less than primary	Less than primary	Ref		Ref	
Mother's employment	**Own employment**				
Employed	Employed	3.07 (1.96-4.79)	0.00	4.35 (2.94-6.45)	<.00
Employed	Unemployed	1.68 (1.12-2.52)	0.40	1.83 (1.21-2.75)	0.24
Unemployed	Employed	2.53 (1.68-3.82)	0.07	2.90 (2.00-4.24)	0.06
Unemployed	Unemployed	Ref		Ref	
Father's employment	**Own employment**				
Employed	Employed	2.62 (1.77-3.89)	0.00	4.24 (2.95-6.11)	<.00
Employed	Unemployed	1.27 (0.92-1.76)	0.01	1.90 (1.36-2.66)	0.15
Unemployed	Employed	2.66 (1.63-4.34)	0.02	3.32 (2.12-5.21)	0.02
Unemployed	Unemployed	Ref		Ref	
Both Parents Education	**Own Education**				
Both greater than primary	Greater than primary	9.84 (1.75-55.5)	0.001	0.63 (0.12-3.20)	0.62
Both greater than primary	Less than primary	1.22 (0.13-11.8)	0.18	0.32 (0.03-3.85)	0.50
>=1 less than primary	Greater than primary	4.98 (0.91-27.3)	0.05	0.40 (0.08-1.98)	0.36
>=1 less than primary	Own less than primary	Ref		Ref	
Both Parent Employment	**Own Employment**				
Both parent's employed	Employed	3.18 (1.18-8.62)	0.001	4.02 (1.98-8.16)	.001
Both parent's employed	Unemployed	2.00 (0.75-5.36)	0.45	1.76 (0.84-3.70)	0.87
>= 1parent unemployed	Own employment	1.44 (0.55-3.72)	0.24	1.21 (0.61-2.40)	0.01
>= 1 parent unemployed	Unemployed	Ref		Ref	

[a]Adjusted for smoking, alcohol, physical activity, rural/urban residence, marital status, country, age, health status
[b]Each life-course SES variable analysed in separate models adjusted for study covariates
Bold indicates significant p-value <0.05

DISCUSSION

This study provides a comprehensive assessment of the association between individual, parental and life-course socio-economic status in relation to breast and cervical cancer screening among women in China, India, Mexico, South Africa and Russia. In 2008, only 27% of women ≥40 years old had received a mammogram in the past five years, and only 23% of women ≥21 years old had received a pelvic examination with Pap smear in the past three years. There were clear SES gradients in screening rates, and between country differences in the association of SES and screening. For instance, although Russia had the highest proportion of women with a secondary school or college education (95%), only 44% had received age-appropriate breast cancer screening. In contrast, only

41% of Mexican women had a secondary school or college education, yet over 30% of Mexican women had received age-appropriate breast cancer screening. Women with high SES defined based on education or public sector employment were most likely to have received breast or cervical cancer screening, and those with stable high or increasing life-course SES were more likely to be screened. Having a college degree or higher was by far the strongest individual-level predictor of screening, increasing the likelihood of breast or cervical screening by more than 4-fold. In contrast, women who were self-employed or unemployed or who had maternal or paternal self-employment or unemployment were significantly less likely to receive screening. Stable high or increasing life-course SES was associated with increased cancer screening, however declining life-course SES based on maternal education was associated with even lower odds of breast cancer screening compared with stable low life-course SES. Women who were educated and had both parents also educated had an almost 10-fold increase in the odds of breast cancer screening.

A growing number of studies have documented positive associations between childhood (or parental) and adult SES on health outcomes[15 30-34], with low SES consistently liked with increased risk of heart disease, diabetes, cancer and stroke. Low SES and the associated financial hardship may influence health outcomes through: 1) limited resources needed for disease prevention or health promotion activities, 2) lack of knowledge about the health impact of lifestyle risk factors, behaviors or routine screening, 3) reduced access to healthcare due to financial, physical or social barriers to accessing the healthcare system, and 4) psychosocial stress due to continued financial hardship. Cancer screening is likely influenced by consistently low SES via lack of timely information about recommended cancer screening guidelines, lack of financial resources to afford routine screening, and limited availability of cheaper or subsidized screening programs. Our findings provide evidence that there are major barriers to screening for low SES women in all the countries included countries; however higher SES women are more successful in overcoming these barriers. Our observation that women with high SES based on education have the highest cancer screening rates suggests that health information is likely a critical factor- and improving access to and understanding of the importance of routine screening is a strategy that may help increase cancer screening among lower SES women. Additionally, women with higher SES based on employment, in particular public sector employment, also experienced high screening rates-suggesting that access to stable employment that may include healthcare benefits, may improve screening through increased financial resources and/or better access to employment based healthcare.

We observed strong associations between life-course SES and cancer screening, adding to the growing body of literature on the importance of early life and adult factors in human health, and cancer prevention, in particular. The consistently low cancer screening rates in resource-poor settings, particularly in many LMICs [35 36], and higher cancer screening rates in higher SES groups have been consistently reported [37-40]. However, few studies have examined life-course SES in relation to cancer screening[41], with results showing that childhood conditions result in reduced probability of breast cancer screening. A recent study reported a higher risk of cancer in men with a downward social trajectory over the life-course compared with those at high social trajectory over the life-course[42]. Other studies have also shown that declining life-course SES trajectory was associated with increased cancer-related risk factors, including reproductive behaviors and obesity [18 43]. Consistently low SES over the life-course likely leads to cumulative disadvantage due to mechanisms including low health literacy, poor access to high quality healthcare, competing health risks, psychosocial stress, and lack of financial resources for health, leading to stronger associations of life-course SES with health outcomes compared with SES measures at any single point in time. Although no formal definition for SES or life-course SES exists, education based SES measures have emerged as stronger predictors of screening compared with employment based measures. This suggests that factors related to literacy, awareness of the benefits of screening, low self-efficacy regarding cancer prevention and early detection options may be more important for health outcomes including cancer screening[26 29] compared with income and financial factors [44]. This is supported by our observation, as well as other studies showing a stronger influence of maternal education on cancer screening and daughter's adult health [43 45], that may be due to the fact that women may be strongly socialized and view their mothers as role models compared with their fathers. If highly educated mothers are more likely to receive screening or are well informed about the importance of routine cancer screening, this may potentially positively shape daughters' own health-related behavior, including cancer screening.

The observation that although 44% of women received a pelvic examination in the past 3 years but only 55% of those also received a Pap smear suggests that even when access to healthcare barriers are eliminated or reduced, appropriate screening still may not occur. Educating healthcare professionals on cancer screening guidelines, and integrating cancer screening within routine healthcare settings may go a long way in increasing cancer screening rates, particularly for cervical cancer. While current recent recommendations for cervical cancer screening involves HPV DNA testing at ages 35 and/or 40, and HPV vaccination may contribute to significantly reducing the global

burden of cervical cancer[46], these approaches still require significant initial investments in the healthcare infrastructure and substantial out of pocket costs to patients, limiting the immediate uptake of HPV testing as a routine cancer screening strategy. Regardless of screening method, community outreach programs to improve knowledge of the importance of screening and increase cultural acceptability in among low SES women will be important in all LMICs, while integration of routine screening into routine medical care and improved training of health personnel about communicating the benefits of screening to patients will likely increase cancer screening rates. Simply providing cancer screening technology such as mammography machines is unlikely to be sufficient to ensure successful utilization by women at risk of cancer[47]. Additionally, national policies regarding screening may eliminate some of the structural barriers to screening. For instance, national cancer prevention policies that include financial subsidies for screening, free screening programs, and/or employment-based routine screening programs, may mitigate some of the effects of low SES on screening. In Russia, 66% of women employed in the public sector received breast and cervical cancer screening, and over 90% of women with maternal and paternal employment in the public sector had been screened for both cancers. This is in contrast with India and Mexico where comparable screening rates were 2.6% and 3.3% respectively for public sector employment and likely reflect the lack of national comprehensive cancer screening programs and/or integration of cancer screening into routine clinical practice. These between-country differences warrant further study, specifically country-level differences in healthcare infrastructure, health insurance coverage and screening costs, availability of medical personnel, and population knowledge about cancer screening.

The strengths of this study include the use of data from the multi-country, nationally representative and standardized SAGE study. SAGE was designed to elicit response on a wide-range of health related questions and had very high response rates, which permitted robust assessment of comprehensive measures of life-course SES and cancer screening in multiple countries. One potential limitation of this study includes the use of self-reported screening data, however since SAGE is a standardized survey of multiple health items, any recall bias of self-reported screening is unlikely to be differential with respect to country or SES. Another potential limitation involves SES and potential country-level differences in the ability of education or employment measures to capture the full range of SES. We used both measures of education and employment to better capture variability in SES, as these are less vulnerable to recall bias or social desirability bias, and have been used in past studies as robust measures of SES.

In summary, we observed SES gradients in breast and cervical cancer screening among women in China, India, Mexico, South Africa and Russia, and a stronger influence of life-course SES on screening. Future studies are needed to better understand and implement public health strategies focused on improving cancer screening rates among women with low SES over the life-course. For instance, targeted outreach programs to increase knowledge of the benefits of cancer screening, integration of cancer screening within routine healthcare settings, as well as national and/or employment-based policies designed to mitigate SES differences in screening. Women with declining or low SES over the life-course experience cumulative disadvantage, are least equipped to overcome financial and structural barriers to screening, and are also least likely to afford the financial catastrophe that often accompanies a late stage cancer diagnosis.

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COMPETING INTEREST

No competing interest to declare

DATA SHARING STATEMENT

No additional data available

TRANSPARENCY DECLARATION

I affirm that the manuscript is a honest and transparent account of the study being reported, no important aspect of the study is being omitted and any discrepancies have been explained. T.A

CONTRIBUTORSHIP STATEMENT

TA conceived of the research question and oversaw the statistical analysis and writing of the manuscript, KO, SS and VO contributed to the statistical analysis and initial draft of the manuscript, DB contributed to the interpretation of results and writing of the manuscript.

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STROBE statement?checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract			
	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2,3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) *Cohort study*?Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up*Case-control study*?Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls*Cross sectional study*?Give the eligibility criteria, and the sources and methods of selection	4

	Item No	Recommendation	Page No
		of participants	
		(*b*) *Cohort study*?For matched studies, give matching criteria and number of exposed and unexposed*Case-control study*?For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4
Bias	9	Describe any efforts to address potential sources of bias	16
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4,5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5
		(*b*) Describe any methods used to examine subgroups and interactions	4,5
		(*c*) Explain how missing data were addressed	4
		(*d*) *Cohort study*?If applicable,	

	Item No	Recommendation	Page No
		explain how loss to follow-up was addressed*Case-control study*?If applicable, explain how matching of cases and controls was addressed*Cross sectional study*?If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(*a*) Report numbers of individuals at each stage of study?eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5,6
		(*b*) Give reasons for non-participation at each stage	
		(*c*) Consider use of a flow diagram	
Descriptive data	14*	(*a*)Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5,6
		(*b*) Indicate number of participants with missing data for each variable of interest	
		(*c*) *Cohort study*?Summarise follow-up time (eg average and total amount)	
Outcome data	15*	*Cohort study*?Report numbers of outcome events or summary measures over time	7,8, 9
		*Case-control study?*Report	

	Item No	Recommendation	Page No
		numbers in each exposure category, or summary measures of exposure	
		Cross sectional study?Report numbers of outcome events or summary measures	
Main results	16	(*a*) Report the numbers of individuals at each stage of the study?eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6-12
		(*b*) Give reasons for non-participation at each stage	
		(*c*) Consider use of a flow diagram	
Other analyses	17	Report other analyses done?eg analyses of subgroups and interactions, and sensitivity analyses	9-12
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15,16

	Item No	Recommendation	Page No
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

Patient Involvement

Patients were not involved in this study. This study was based on WHO Study on Global Ageing and Adult Health (SAGE) data, a longitudinal multi- country study.
(http://www.who.int/healthinfo/sage/cohorts/en/).