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Global Inequalities in Cervical Cancer Incidence and Mortality

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Abstract

Background: Cervical cancer is the third most common cancer in women after breast and colorectal cancers, and one of the leading causes of cancer death among women worldwide. The aim of this study is to determine the associations of cervical cancer incidence and mortality rates with the Human Development Index.

Methods: Information of the incidence and mortality rates for cervical cancer were obtained from the GLOBOCAN Cancer Project for 2012 and data for the Human Development Index for 2013 from the World Bank database. We used linear regression models to assess the Human Development Index effect on cervical cancer occurrence rates. Inequality in the age-standardized incidence and mortality rates of cervical cancer according to the Human Development Index were assessed by the concentration index.

Results: The results showed substantially higher cervical cancer incidence and mortality rates in regions with low and medium Human Development Index compared to regions that had substantially elevated Human Development Index. The death and incidence from cervical cancer were more concentrated in low Human Development Index countries. There was a significant negative association between the cervical cancer incidence and mortality rates with all the components of the Human Development Index, including life expectancy (B= -0.98, $P<0.001$), mean years of schooling (B= -1.86, $P<0.001$), gross national income (B= -0.38, $P<0.001$), urbanization level (B= -0.29, $P<0.001$), and age standardized obesity (B= -0.45, $P<0.001$).

Conclusion: Cervical cancer is a significant public health problem in countries with low Human Development Index and requires the implementation of prevention programs and screening for early detection and treatment.

Keywords: Human Development Index, Cervical cancer, Correlation, GLOBOCAN Cancer Project

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Introduction

Cancer is a major public health concern and the second leading cause of death behind cardiovascular diseases with over 8 million deaths worldwide in 2013.[1-3] Despite substantial progress in cancer prevention and treatment in recent years, the cancer burden and risk factors have increased worldwide.[4-6] Cervical cancer (CC) ranks third among the most common cancers of women after breast and colorectal cancers, and one of the main causes of cancer deaths throughout the world.[7] In 2008, approximately 530,000 women were diagnosed with CC worldwide and 257,000 women died from this cancer.[8] Cervical cancer has a higher incidence of mortality in most East African and South Asian countries compared to the rest of the world.[7,8] There is a vast variation in the incidence and mortality of CC in different regions of the world, such that 86% of all CC cancer cases and 88% of all CC deaths occur in developing countries.[7-9] In Iran, CC is the third leading cause of death with 50000 new cases each year.[10] The latest report from the Cancer Registry in Iran indicated CC incidence rate of 2.61 per 100,000 individuals.[11] According to the latest data from the World Health Organization, significant disparities exist in the incidence and mortality of CC worldwide.[7,8]

Some studies from developed countries have reported an association between socioeconomic gradients and CC incidence and mortality. In groups with lower socioeconomic status, the risk of CC was 2-3 times more compared to their affluent counterparts.[12,13] Assessment of the effects of socioeconomic status and Human Development Index (HDI) are significant because they represent underlying causes of health inequalities both within and between nations.[14,15] Examination of global inequalities is important in that CC tends to have greater impact on younger women (aged <45 years) compared to other major cancers, which contribute to higher years-of-life lost, especially among women in the developing world.

Various studies have examined the association of cancers with HDI,[16-19] however there appear to be few studies, particularly in developing countries, that have examined disparities in CC incidence and mortality rates between countries due to social inequality and human development factors. Therefore, the purpose of this study was

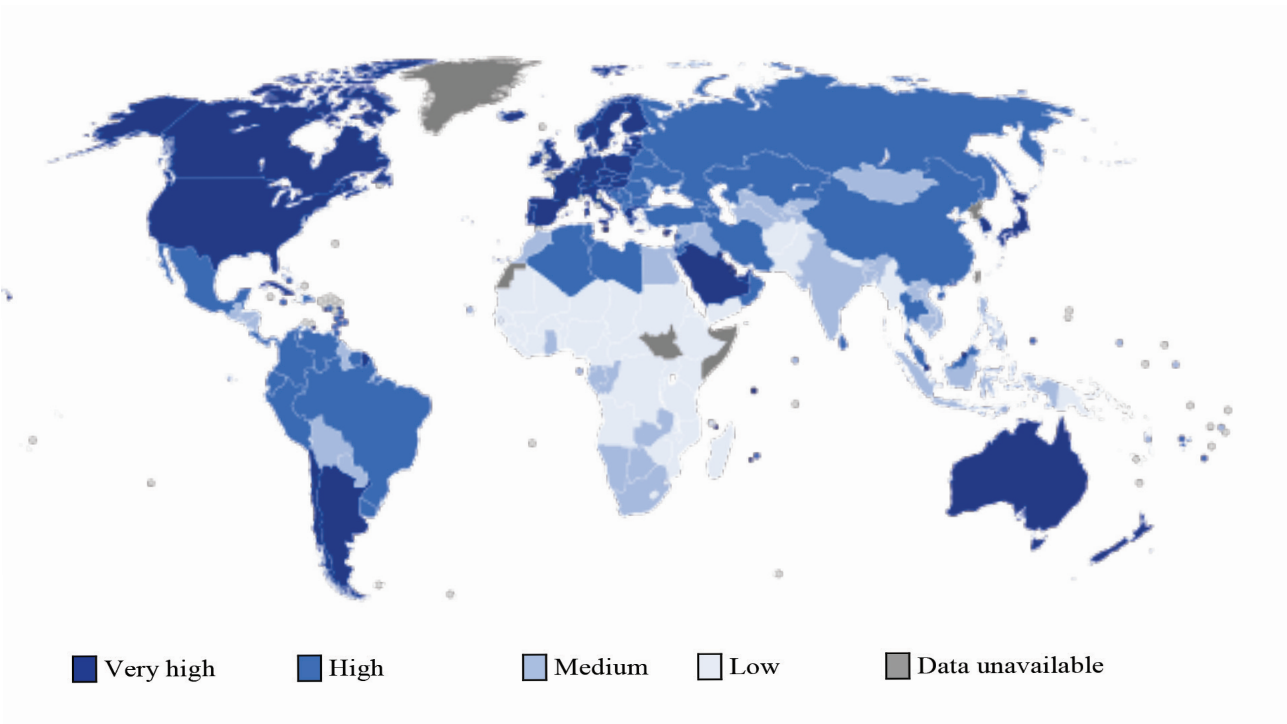

Figure 1. World map shows Human Development Index (HDI) categories by country (based on 2013 data).

Table 1. Concentration indexes for inequality of incidence and mortality of cervical cancer (CC) according to the Human Development Index (HDI).

Cancer type	New cases diagnosed in 2012 (1,000s)	Death from CC in 2012 (1,000s)	Incidence concentration index (95% CI)	Mortality concentration index (95% CI)
Cervical	528	266	-0.2 (-0.25, -0.15)	-0.3 (-0.38, -0.25)

to quantify the links between specific components of HDI [life expectancy at birth, education, gross national income (GNI) per 1000 capita, health, and living standards] with burden indicators of CC. We obtained data from the International Agency for Research on Cancer (IARC), which represented the most up-to-date information on the incidence of CC worldwide.[7]

Materials and Methods

We performed this ecological study on a dataset regarding the incidence and mortality rates of CC and some related health factors worldwide. Data that pertained to the incidence and mortality rates of cancers were obtained from the Global Cancer Project for 172 countries in 2012.[20] We obtained data about the HDI 2013 and its gradient that included the following: life expectancy at birth, mean years of schooling, GNI per capita, and other health-related variables from the World Bank database for 169 countries.[21]

Data analysis was restricted to 169 countries which had both the epidemiologic data from the GLOBOCAN database and HDI. These countries were placed into four categories: (1) very high human development (27 countries), (2) high human development (37 countries), (3) medium human development (89 countries), and (4) low human development (16 countries). We defined inequality in the age-standardized incidence and mortality rates (ASR) of CC according to the HDI by using the concentration index. The value of the concentration index ranged from -1 to +1 where the negative value indicated that the health variable was more concentrated in the poor population. A positive value indicated the rich population. One-way ANOVA was used to compare means of CC incidence and mortality in different HDI group countries. We also used linear

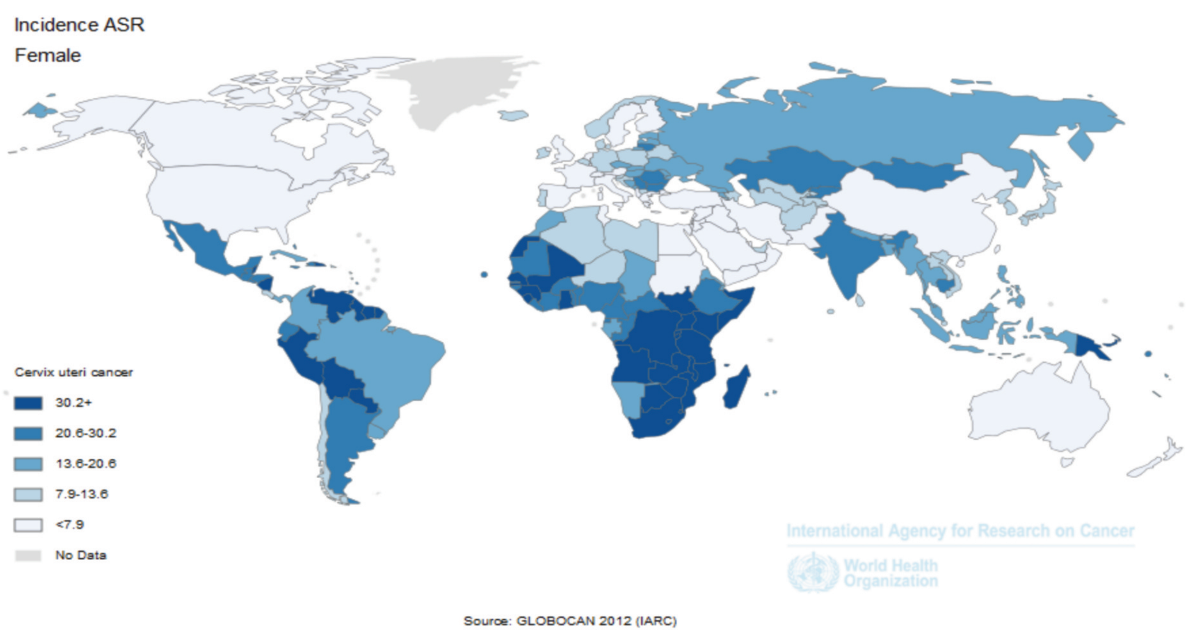

Figure 2. Worldwide age-standardized incidence rates (ASR) per 100,000 for cervical cancer (CC) in 2012.

Table 2. Cervical cancer (CC) incidence and mortality in different Human Development Index (HDI) regions in 2012.

Index		Region				*P*-value (F-test)
		Substantially high human development	High human development	Medium human development	Low human development	
CC incidence	CR	9.8±1	12.75±1.36	19.28±1.08	20.46±2	<0.001
	ASR	7.7±0.85	10.18±1	21.08±1.3	33.07±3.1	<0.001
CC mortality	CR	3.5±0.23	5.2±0.59	8.7±0.51	13.2±1.3<	0.001
	ASR	2±0.2	3.36±0.36	10.13±0.76	22.6±2.1	<0.001

CR: Crude rate; ASR: Age-standardized rates per 100,000

regression models to assess the HDI effect and other variables on SC occurrence rates. A *P*-value less than 0.05 was considered significant. All statistical analyses were performed with Stata software version 12 (StataCorp., College Station, TX, USA).

Results

The study analyses constituted a global overview of the current patterns of cancer incidence and mortality in relation to predefined levels of HDI. Figure 1 shows the HDI categories by country based on 2013 data. Figure 2 shows the worldwide distribution of incidence of ASR for CC per 100,000 in 2012.

The concentration index and 95% confidence interval for incidences, mortality, and incidence/mortality rates for CC are presented in table 1. The negative value for the concentration index in table 1 and results from figure 2 for death and incidence from CC indicated that this cancer was more concentrated in low HDI countries.

Table 2 shows the incidence and mortality rates of CC in various regions according to HDI. The incidence and mortality rates for CC were substantially higher in regions with low and medium HDI compared to regions that had substantially high and high HDI.

Table 3 shows the associations of CC incidence and mortality rates with HDI components. Results of the linear regression model in this table show a significant negative association of CC incidence and mortality rates with all components of HDI - including life expectancy (B= -0.98, *P*<0.001), mean years of schooling (B= -1.86, *P*<0.001), GNI (B= -0.38, *P*<0.001), urbanization level (B= -0.29, *P*<0.001), and age standardized obesity (B= -0.45, *P*<0.001).

Discussion

This study aimed to perform a global survey of the current patterns of cancer incidence and mortality in relation to predefined levels of HDI. We used the HDI as an indicator of socioeconomic development and incidence and mortality rates for CC as indicators of the extent of the cancer transition globally. The results of this study showed that the incidence of CC and mortality rates varied widely. The incidence and mortality of CC in various regions differed according to HDI in these regions. Incidence and mortality rates of CC were substantially higher in regions with low and medium human development compared to regions that had substantially high and high human development. The high rates of incidence and mortality for many low- and middle-income countries showed CC to be a significant public health problem in developing countries.

Our study showed that the highest ASR for CC were related to countries that had medium and low human development. These results were consistent with similar studies performed in this field.[22-25] Possibly, in countries with medium and low human development, the frequency of important risk factors that include early age at first sexual intercourse, early age at first delivery, high number of pregnancies, smoking, failure to be screened and treated for precancerous lesions, long-term use of hormonal contraceptives, numerous sexual partners, high-risk partners, infection with human immunodeficiency virus (HIV) or other sexually transmitted infections (STI) such as herpes virus or Chlamydia trachomatis, immunosuppression

Table 3. Effect of the Human Development Index (HDI) components and demographic variables on cervical cancer (CC) incidence and mortality rate.

Variable	CC incidence			CC mortality		
	B	95% CI	*P*-value	B	CI	*P*-value
Life expectancy at birth	-0.98	(-1.16, -0.8)	<0.001	-0.79	(-0.9, -0.68)	<0.001
Mean years of schooling	-1.86	(-2.5, -1.22)	<0.001	-1.77	(-2.17, -1.38)	<0.001
Gross national income (GNI) per 1000 capita	-0.38	(-0.49, -0.3)	<0.001	-0.28	(-0.35, -0.2)	<0.001
HDI	-51.33	(-62.6, -40)	<0.001	-43.7	(-50.3,-37)	<0.001
Urbanization level (%)	-0.29	(-0.38, -0.2)	<0.001	-0.24	(-0.29, -0.18)	<0.001
Age standardized obesity in adults	-0.45	(-0.64,-0.25)	<0.001	-0.41	(-0.54, -0.29)	<0.001

B: Beta coefficient that reflects the strength of association between incidence and mortality rate of CC and HDI

due to HIV, other diseases, chemotherapy, or other causes associated with CC are more common compared to countries with substantially high and high human development.[22,24] Drain et al. reported that countries with high incidence rates tended to have more total fertility, lower ages at first childbirth, and a higher percentage of males with non-regular sex partners. Countries with high CC rates tended to have younger, less educated, and more illiterate populations.[24] On the other hand, one of the most important factors for CC is human papilloma virus (HPV) infection. The virus is transmitted through sexual contact and has high incidence and prevalence due to the lack of sexual health in countries with low human development. The Pap smear screening test is used to identify HPV.[26,27] In developed countries with high human development, the incidence and mortality rates of CC have significantly decreased through regular Pap smear screening and early detection.[28,29] In developing countries with low HDI, despite the increased frequency of the virus due to poor sexual health, there are no regular screening programs and a large number of these countries screen for CC with very poor quality screening tests, low coverage rates, and little financial support.[30] As a result, these countries have CC incidence and mortality rates more than those of developed countries that have national CC prevention programs.[7,27]

In the current study, results of the linear regression model showed a significant association of CC incidence and mortality rates with HDI components that included life expectancy, education, GNI, urbanization level, and age standardized obesity.

Life expectancy at birth was one of the components of HDI that had a negative association with CC incidence and mortality rates. This result was consistent with similar studies that conducted in this field.[23,24] It might be because the majority of risk factors of this cancer have been attributed to many sexual and reproductive behaviors. Exposure to these important risk factors occurs before aging. One of the most important risk factors for CC is infection with HPV where the person becomes infected during sexual activity. On the other hand, there is little sexual activity in the elderly. As a result, the high incidence and mortality rates of CC occur in earlier ages.[24,31]

Education and years of schooling is another component of HDI that can affect incidence and mortality rates of CC. In the current study, we have shown that this dimension had a negative association with these rates where, with higher educational levels, the incidence and mortality of CC were lower. Perhaps this was due to the fact that women with low educational levels had less information about risk factors of this cancer and its prevention. Less educated women were more likely to face numerous factors such as insufficient access to medical care, lack of culturally competent care, and lack of effective health education about STI prevention and Pap screening.[24,32] Therefore, these factors would cause the woman not to pay attention to risk factors and screening at the proper time. Therefore, she would be diagnosed at an advanced stage where the risk of death was higher.

One of the components of the HDI is adequate income, as specified by GNI per 1000 capita. This factor in the study had a negative association with CC incidence and mortality. This finding was consistent with the results of similar studies.[23,24] In developed countries with higher socio-economic levels and income, people have more appropriate and easier access to diagnostic services and screening tests compared to developing countries with lower income levels. As a result, cancer would be diagnosed at the local stage with a lower risk for mortality.

Another component of HDI is the urbanization level that had a negative association with incidence and mortality of CC. This inverse relationship might be partly due to differences in socioeconomic deprivation in urban and rural areas.[33] Poverty, unemployment, low educational level, and low income are higher in rural areas compared to urban areas. People in these regions have little information about risk factors and screening programs, and insufficient access to diagnostic and screening services. As a result, people who live in rural areas have "higher" incidences and mortality rates of CC.[17,33]

The final component of HDI is age standardized obesity in adults. This dimension had also a negative association with the incidence and mortality of CC. This result was not consistent with other studies in this field. Excessive fat leads to increased estrogen levels, and subsequent development of endometrial and CC. Thus, overweight women are at high risk for morbidity and from CC.[34-37] In this study, the inverse relationship between CC and obesity may have been the result of a lack of control of confounders. Possibly the reason is that obese women who reside in urban areas have higher educational levels and socio-economic status with better access to diagnostic and screening services. Thus, an inverse relationship between obesity with incidence and mortality rates of CC should be interpreted with caution.

In conclusion, CC incidence and mortality rates varied widely according to HDI. The incidence and mortality rates of CC were substantially higher in regions with low HDI compared to high HDI. On the other hand, HDI was a strong predictor for CC incidence and mortality rates. All components of HDI had a negative association and significance with incidence and mortality of CC. It seemed that CC was a significant public health problem in countries with low HDI and would require implementation of prevention programs and screening for early detection and treatment.

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Conflict of interest

No conflict of interest is declared.

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