



AGE-STANDARDIZED INCIDENCE RATE OF BREAST CANCER AND HUMAN DEVELOPMENT INDEX (HDI) IN IRAN, 2003-2009: AN ECOLOGICAL STUDY

M.S. BEYRANVAND^{1,2}, M. YOOSEFI², M. HASSAN², Z. KHAZAEI³, K. MANSORI⁴, M. ASADI ALIABADI⁵, F. GHORAT⁶, F. VARSE⁷, S. NADERPOUR⁷, Y. MORADI⁸

¹School of Medicine, Dezful University of Medical Sciences, Dezful, Iran

²Non-Communicable Diseases Research Center, Endocrinology and Metabolism Population Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran

³Social Determinants of Health Research Center, Research Institute for Health Development, Kurdistan University of Medical Sciences, Sanandaj, Iran

⁴Department of Epidemiology, School of Public Health, Shahid Beheshti University of Medical Sciences, Tehran, Iran

⁵Preventive Medicine and Public Health Research Center, Iran University of Medical Sciences, Tehran, Iran

⁶Iranian Research Center on Healthy Aging, Sabzevar University of Medical Sciences, Sabzevar, Iran

⁷Department of Epidemiology, School of Public Health, Iran University of Medical Sciences, Tehran, Iran

⁸Pars Advanced and Minimally Invasive Medical Manners Research Center, Pars Hospital, Iran University of Medical Sciences, Tehran, Iran

Abstract – Objective: Breast cancer is the most common cancer among women worldwide. This study was conducted to investigate the trend of Age-Standardized Incidence Rate (ASIR) of breast cancer and its relationship with Human Development Index (HDI) in Iran during 2003-2009.

Materials and Methods: This cross-sectional study was carried out using available HDI and ASIR data of breast cancer in Iran during 2003-2009. The HDI score for each Province, between 2003 and 2009, was obtained from another study. Also, ASIR of breast cancer for each Province during 2003 to 2009 was collected from National Cancer Registry System. Bivariate method was employed to evaluate the correlation between ASIR and HDI. The reported p-value is two-sided. p-value < 0.05 was considered to be statistically significant.

Results: During 2003-2009, ASIR of breast cancer in Iran increased from 15.96 to 28.25 per 100,000 women. The lowest and highest ASIRs were observed in 2003 (15.96 per 100,000 women) and 2008 (33.21 per 100,000 women), respectively. During the time period between 2003 and 2009, ASIR of breast cancer was higher in provinces with very high HDI value than provinces with very low HDI value. There was a positive correlation (0.61) between the HDI and ASIR of breast cancer. This relationship was statistically significant (p<0.001).

Conclusions: The present study indicates that there was a positive and significant correlation between HDI and ASIR of breast cancer in Iran, during 2003-2009. Also, it was found that provinces with higher HDI (mainly central provinces) had a higher ASIR of breast cancer. Implementing preventive measures, such as public educational programs, is suggested to decrease the incidence of breast cancer.

KEYWORDS: Breast cancer, Age-Standardized, Incidence Rate, Human Development Index, socio-economic status.

LIST OF ABBREVIATIONS: HDI: Human Development Index; ASIR: Age-Standardized Incidence Rate; GBD: Global Burden of Disease; GNI: Gross National Income.



INTRODUCTION

According to the global burden of disease study 2016 (GBD 2016), breast cancer had the highest incidence rate in females throughout the world (45.87 new cases per 100,000 people). Also, in 2016, breast cancer was the first leading cause of cancer death in females across the world, causing 14.60 deaths per 100,000 people.¹ It has been predicted that by 2050, approximately 3.2 million new cases of breast cancer will occur in the world annually².

Although incidence rate of breast cancer is relatively low in low-and middle-income countries, the rate in these countries has increased over the recent years^{3,4}. Iran is a middle-income country with the gross national income (GNI) per capita of 6650 USD⁵. In 2015, breast cancer was the most common cancer among Iranian females with 266.81 prevalent cases per 100,000 people. Also, with 6.59 deaths per 100,000 people, breast cancer was the first leading cause of cancer death in Iranian females in 2015¹. Comparing to developed countries, in Iran, breast cancer has been diagnosed more in advanced stages and among younger age groups⁶. In countries like Iran, where risk factors such as aging population, urbanization and Western life-style are prevalent, breast cancer will be a great challenge for the health care system in near future⁷.

Socioeconomic status plays an important role in cancer incidence disparity⁸. This measure can be indicated by Human Development Index (HDI)⁹. Some studies have reported a positive relationship between breast cancer incidence rate and socioeconomic status^{10,11}. In Iran, few studies have shown this positive association^{12,13}. Elimination of socioeconomic disparities in health can be achieved by understanding its components such as disparities in Age-Standardized Incidence rate (ASIR)¹³. ASIR can play an important role in developing health programs to help preventing and controlling diseases such as breast cancer. Therefore, this study was performed to investigate the ASIR trend of breast cancer and its relationship with socioeconomic disparities across all provinces in Iran during 2003-2009.

MATERIALS AND METHODS

This cross-sectional study was conducted using available data on HDI and ASIR of breast cancer in Iran. The study was approved by the Local Ethics Committee of Iran University of Medical Sciences.

Human Development Index (HDI) measures the socioeconomic status by combining three basic indicators of human development including life expectancy at birth, educational attainment, and GNI per capita¹⁴. HDI score for each Iranian province,

during 2003 to 2009, was obtained from a study conducted by Kiadaliri¹³. In his study, Kiadaliri estimated mean HDI for each Iranian province, from 2003 to 2009. Then, considering HDI scores, all provinces were categorized into five quartiles (very low, low, medium, high, and very high).

Data on ASIR of breast cancer for each province during 2003 to 2009 were calculated by direct method, based on the world standard population¹⁵ acquired from Iranian National Cancer Registry System.. The National Cancer Registry System covers all pathology laboratories in the country and collects the data through an active and pathology-based method. In this study, we used bivariate method to evaluate the correlation between ASIR and HDI. p -value < 0.05 was considered to be statistically significant. Also, the reported p -value is two-sided and all data analyses were performed using R statistical software version 3.1.0 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

During 2003-2009, ASIR of breast cancer in Iran increased from 15.96 to 28.25 per 100,000 women. The lowest and highest ASIRs were observed in 2003 (15.96 per 100,000 women) and 2008 (33.21 per 100,000 women), respectively. During this time period, the lowest ASIRs were observed in Kohkiluyeh and Boyerahmad province (0.717 per 100,000 people) in 2003, Sistan and Baluchestan province (1.96 per 100,000 people) in 2004, Kohkiluyeh and Boyerahmad province (3.51 per 100,000 people) in 2005, East Azerbaijan province (5.18 per 100,000 people) in 2006, Sistan and Baluchestan province (5.70 per 100,000 people) in 2007, Sistan and Baluchestan province (5.73 per 100,000 people) in 2008, and Sistan and Baluchestan province (5.37 per 100,000 people) in 2009. On the other hand, the highest ASIRs were observed in Tehran (36.91 per 100,000 people), Yazd (25.46 per 100,000 people), Esfahan (31.51 per 100,000 people), Tehran (32.08 per 100,000 people), Tehran (33.86 per 100,000 people), Tehran (55.84 per 100,000 people), and Tehran (43.36 per 100,000 people) provinces in 2003, 2004, 2005, 2006, 2007, 2008, and 2009, respectively. The lowest and the highest mean HDI were observed in Sistan and Baluchestan (0.639) and Tehran (0.813) provinces, respectively (Table 1).

Considering the mean HDI in provinces where HDI scores were very low (West Azerbaijan, Ilam, North Khorasan, Sistan and Baluchestan, Lorestan, Kurdistan, Kohkiluyeh and Boyerahmad), ASIRs of breast cancer increased from 5.99 per 100,000 women in 2003 to 14.32 per 100,000 women in 2009. Also, in provinces where HDI scores were very

TABLE 1. Mean HDI and Age-standardized incidence rate of breast cancer in Iran, by province, 2003-2009.

Province	Mean HDI	Age-standardized incidence rate per 100,000						
		2003	2004	2005	2006	2007	2008	2009
Ardabil	0.723	6.10	9.60	8.07	25.06	8.28	9.75	13.40
Bushehr	0.762	11.40	16.17	18.62	22.13	24.83	26.97	25.64
Chaharmahal and Bakhtiari	0.733	2.89	10.66	8.75	11.33	11.44	18.72	20.23
East Azerbaijan	0.744	4.90	12.77	8.28	5.18	22.83	34.10	28.89
Fars	0.762	16.52	15.88	23.67	23.41	29.22	32.22	36.17
Gilan	0.762	12.85	15.08	26.19	25.38	29.48	32.67	27.73
Golestan	0.723	8.39	11.81	16.32	19.84	17.57	20.42	17.68
Hamadan	0.725	7.81	8.19	14.94	19.11	17.78	24.59	23.29
Hormozgan	0.747	4.33	10.41	9.15	15.20	12.83	18.61	11.93
Ilam	0.714	3.70	7.23	6.36	13.13	14.53	12.04	13.85
Isfahan	0.788	17.29	20.61	31.51	30.36	33.33	37.32	39.67
Kerman	0.734	11.25	14.68	12.59	18.03	15.77	16.4	23.01
Kermanshah	0.727	12.40	14.75	15.07	16.50	26.92	27.18	25.12
Khuzestan	0.763	15.02	16.45	17.77	23.49	26.07	41.00	32.04
Kohkiluyeh and Boyerahmad	0.717	0.00	8.79	3.51	7.80	6.03	7.16	15.09
Kurdistan	0.679	3.49	10.52	8.84	12.78	15.53	21.22	19.00
Lorestan	0.712	5.80	12.45	12.99	13.93	17.76	19.77	19.16
Markazi	0.767	7.47	11.05	12.57	18.84	19.82	19.86	36.63
Mazandaran	0.756	12.32	16.60	22.76	23.72	24.90	39.80	27.99
North Khorasan	0.718	17.61	18.58	9.21	6.47	8.79	15.81	11.39
Qazvin	0.770	9.62	16.01	14.71	18.69	19.05	27.79	18.43
Qom	0.762	16.1	17.07	14.15	20.41	24.36	24.80	13.05
Razavi Khorasan	0.757	17.61	18.58	15.21	23.13	27.26	28.81	23.46
Semnan	0.784	10.08	17.85	16.36	19.81	20.44	41.51	28.10
Sistan and Baluchestan	0.639	3.08	1.96	4.00	5.89	5.70	5.73	5.37
South Khorasan	0.723	17.61	18.58	11.33	12.66	15.62	20.52	11.49
Tehran	0.813	36.91	20.28	27.00	32.08	33.86	55.84	43.36
West Azerbaijan	0.705	8.29	13.00	13.01	12.80	19.83	13.53	16.42
Yazd	0.784	24.83	25.46	23.5	31.98	25.60	31.43	38.52
Zanjan	0.733	5.40	6.41	12.56	7.93	13.58	10.21	11.63
Total	0.741	15.96	18.24	23.16	25.06	27.15	33.21	28.25
HDI (Human Development Index)								

high (Isfahan, Tehran, Semnan, Qazvin, Markazi, and Yazd) ASIRs of cancer increased from 17.70 per 100,000 women in 2003 to 34.11 per 100,000 women in 2009 (Figure 1, Table 2).

Furthermore, between 2003 to 2009, ASIR of breast cancer was higher in provinces with very high mean HDI compared to the provinces with very low mean HDI (Figure 2). There was a positive correlation of 0.61 between the HDI and ASIR of breast cancer. This relationship was statistically significant ($p < 0.001$).

DISCUSSION

This study investigated the correlation between HDI score and ASIR of breast cancer in Iran from 2003 to 2009. Our findings indicate that higher level of

mean HDI results in higher ASIR of breast cancer. Therefore, between 2003 and 2009, Iranian provinces with very high mean HDI, had higher ASIR of breast cancer compared to other provinces. This finding is consistent with the results of the other studies carried out worldwide¹⁶⁻²⁰ and in Iran^{10,21-23}. This positive relationship may be explained by the fact that, firstly, females living in geographical areas with higher HDI, have older age at the time of marriage and first pregnancy, have few children, and are more likely to experience late menopause^{24,25}. Secondly, people from various ethnic groups reside in different geographical areas in Iran and this may have impact on ASIR of breast cancer²³. Another study reports that in industrial areas, air pollutants may increase the growth rate of cancerous cells by affecting genetic contents such as DNA, raising the ASIR of breast cancer²⁶. The present study in-

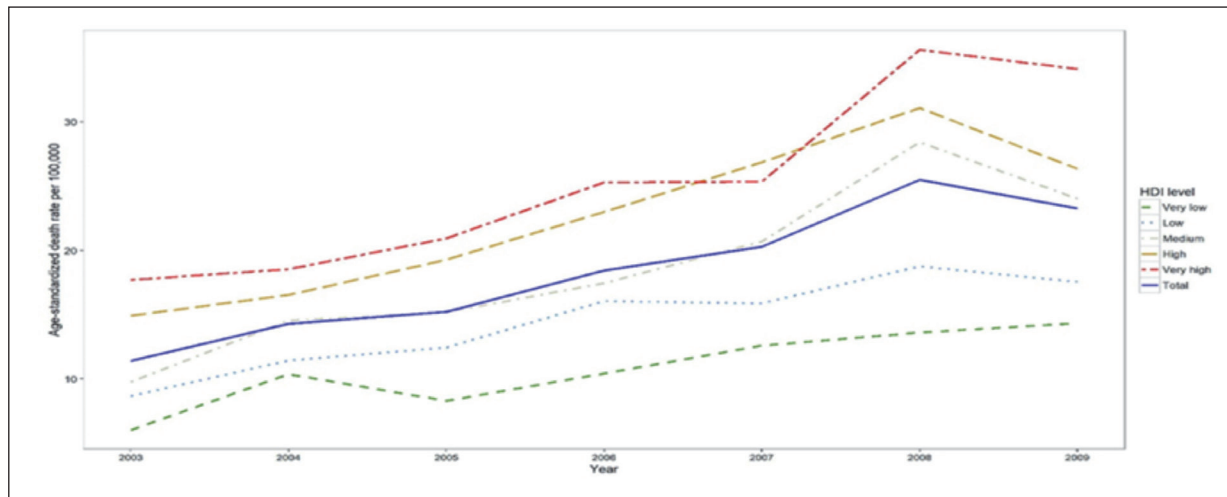
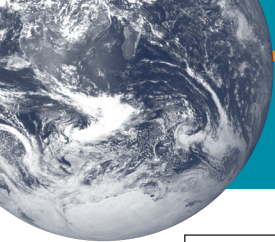


Fig. 1. Age-Standardized Incidence Rate of breast cancer in Iran, by mean Human Development Index level, 2003-2009.

indicates that the industrial provinces located in the center of Iran had the highest ASIR of breast cancer in the country. These provinces have a huge number of motor vehicles which are the main source of air pollution. For instance, in the Iran capital city of Tehran, vehicles are responsible for 80-85% of air pollution²⁷. Detection of breast cancer by mammography, which is easily available in the industrial provinces²⁸, could be another reason for high incidence rate of breast cancer in these provinces. The first basic indicator of HDI is life expectancy at birth. The risk of developing breast cancer increases with age^{29,30}. The most likely reason is that, by increasing life expectancy, the time of exposure to risk factors increases as well, and consequently, the risk of non-communicable diseases such as breast cancer increases³¹. Therefore, compared to females with lower life expectancy, females with higher life expectancy are more likely to have breast cancer. The second basic indicator of HDI is educational status. As educational level increases, the probability that the female seek diagnosis for breast cancer increases as well^{32,33}. Therefore, compared to those with lower educational attainment, females with higher level of education are more likely to be di-

agnosed with breast cancer at earlier stages. The third basic indicator of HDI is GNI. Higher Gross National Income (GNI) per capita results in higher detection of breast cancer. This may be explained by the fact that compared to those with lower GNI, females with higher GNI live longer, have lower pregnancy rate, and are more likely to be exposed to risk factors of breast cancer including unhealthy dietary habits³⁴, overweight, and insufficient physical activity³⁵. Prior studies have suggested that by increasing the levels of education^{4,36-38} and GNI^{4,39}, the incidence of breast cancer increases as well. The present study identified an increasing trend in ASIR of breast cancer during the study period. Through 2003 to 2009, the central provinces had the highest ASIRs of breast cancer, while the lowest ASIRs of this cancer were reported in the South-Eastern provinces of Iran. There may be several probable reasons for this increasing trend. Changes in life style, including relatively higher age at marriage and at first pregnancy, alcohol consumption, exposure to radiation, insufficient physical activity level, and overweight⁴⁰⁻⁴³ may explain the increasing trend of breast cancer in Iran. Improvement in quality of screening, development of both quality and coverage of cancer

TABLE 2. Provincial categories in Iran, by mean HDI.

Mean HDI level	Province
Very low (0.639-0.718)	West Azerbaijan, Ilam, North Khorasan, Sistan and Baluchestan, Lorestan, Kurdistan, Kohkiluyeh and Boyer-Ahmad
Low (0.719-0.733)	Ardabil, Chaharmahal and Bakhtiari, South Khorasan, Zanjan, Golestan, Hamadan, Kermanshah
Medium (0.734-0.756)	East Azerbaijan, Mazandaran, Hormozgan, Kerman
High (0.757-0.763)	Bushehr, Razavi Khorasan, Khuzestan, Fars, Qom, Gilan
Very high (0.764-0.813)	Isfahan, Tehran, Semnan, Qazvin, Markazi, Yazd

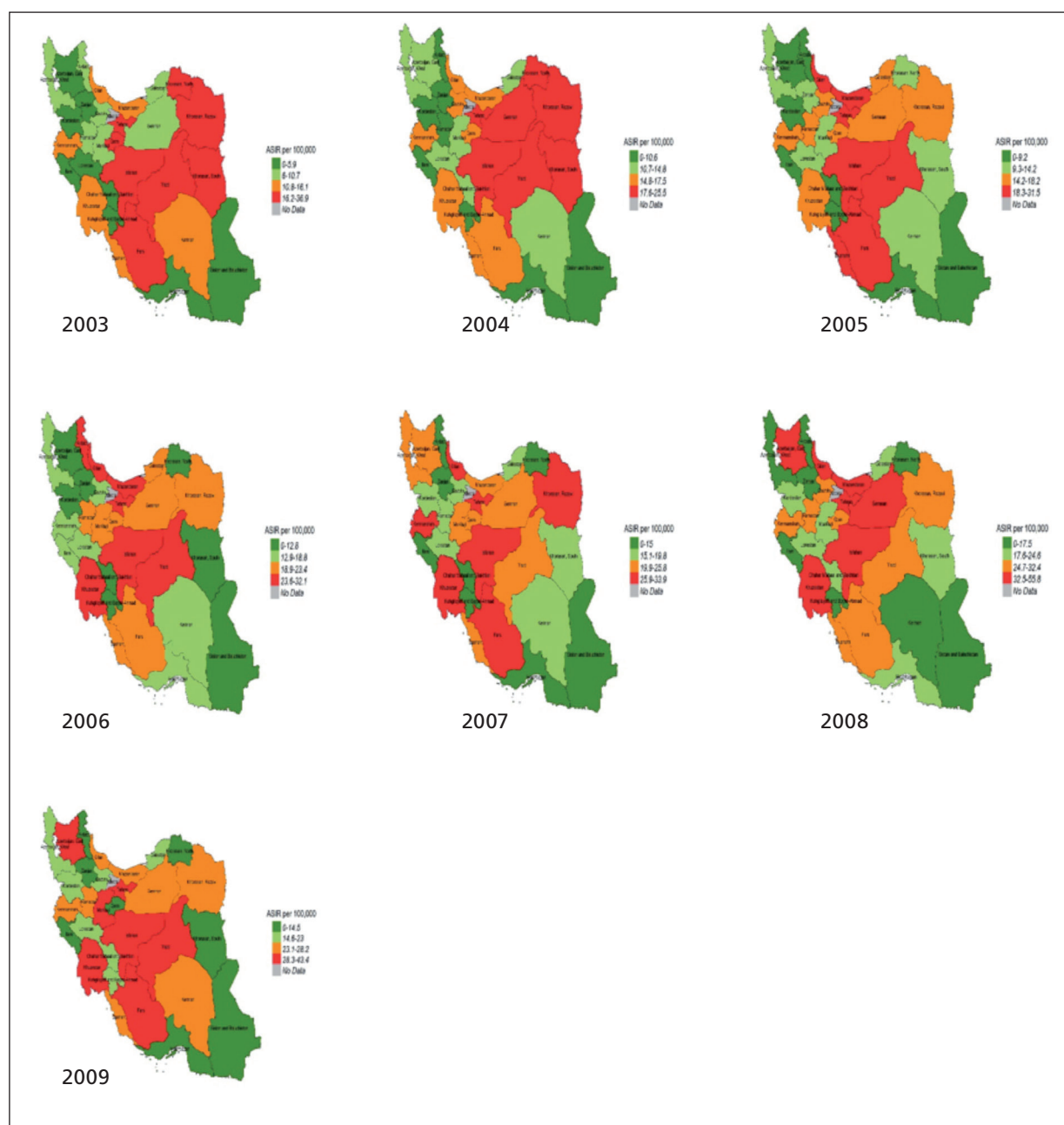


Fig. 2. Geographical distribution of Age-Standardized Incidence Rate of breast cancer in Iran (2003-2009).

registry system¹³, using post-menopausal synthetic hormone therapy^{44,45}, using birth-control pills, the number of live births⁴⁶, and positive family history of breast cancer⁴⁷ are the other probable reasons behind this increasing trend. This study had some limitations. First, the authors did not have access to breast cancer stage data; therefore, they could not conduct more detailed survey. Second, the National Cancer Registry did not provide data for the geographic divisions that are smaller than province. Therefore, the results which are generalized at the provincial level cannot be specified to smaller geographical units.

CONCLUSIONS

The present study indicates that there was a positive and significant correlation between HDI and ASIR of breast cancer in Iran, during 2003-2009. In this study, provinces with higher HDI (mainly central provinces) had higher ASIR of breast cancer. Our findings can be used by health care decision-makers to allocate health resources according to the needs and requirements of each Iranian province; so that, all females would have equal access to health care and medical services. Adoption of cost-effective healthy behaviors (such as physical activity, smoking



guit, and healthy diet) and policies such as public educational programs can substantially decrease the incidence of breast cancer. Further studies are necessary to investigate the relationship between HDI and ASIR of breast cancer.

AUTHOR CONTRIBUTIONS

All authors contributed to the design of the research. MSB, MY,VF, JS ,MH, and ZKH collected the data. MAA, YM conducted analyses and interpreted the data. Also, All authors contributed in drafting the first version of the manuscript. MSB, MY,MH, SKH, MAA, MK, and YM edited the first draft. All authors reviewed, commented and approved the final draft.

CONFLICT OF INTEREST

The Authors declare that they have no conflict of interests.

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