Epidemiology of Burden of Prostate Cancer in Iran during 2009-2019: Estimates from the Global Burden of Disease Study 2019

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What's Known

• In Iran, prostate cancer is reported as one of the most common cancers.
• There are varying reports of prostate cancer among men in different regions of Iran.

What's New

• The distribution of the burden of prostate cancer varies among the provinces. Provinces with a high Human Development Index have a higher incidence rate, possibly attributed to better screening programs in these provinces.
• The incidence and mortality rates of prostate cancer are increasing in Iran, with the highest incidence, mortality, and burden of prostate cancer being related to Bushehr province.

Abstract

Background: Prostate cancer (PC) is the second most common cancer in men and the fifth leading cause of death worldwide. The purpose of this study is to investigate the epidemiological situation concerning the incidence, prevalence, and burden of prostate cancer in Iran from 2009 to 2019.

Methods: The present research is a descriptive-analytical study. To assess the spatial distribution of prostate cancer, data on the incidence, mortality, Disability-adjusted life years (DALY), Years of Life Lost due to premature mortality (YLL), and Years of Life Lost due to disability (YLD) in each province of Iran from 2009 to 2019 were obtained from the Global Burden of Disease (GBD) 2019 website. The incidence and mortality zoning in Iran was mapped using the ArcGIS 10.3 environment. The two-variable Pearson correlation coefficient was used to analyze the data extracted to study the correlation between PC and the Human Development Index.

Results: The highest Age-Standardized Incidence Rate (ASIR) of prostate cancer (40.55 per 100,000), mortality (17.09 per 100,000), YLL (254.1 per 100,000), YLD (23.88 per 100,000), and DALY (277.98 per 100,000) is related to Bushehr province. The results of the Pearson correlation reveal a positive and statistically significant correlation between the ASIR of prostate cancer and the Human Development Index (r=0.651, P=0.0001) in Iran. The highest Percentage of Annual Changes (PAC) in ASIR, Age-Standardized Mortality Rate (ASMR), Age-Standardized Prevalence Rate (ASPR), YLL, YLD, and DALY were related to the provinces of West Azarbayejan (62.9%), Golestan (30.86%), West Azarbayejan (87.66%), Golestan (29.38%), West Azarbayejan (76.95%), and Alborz (31.45%), respectively.

Conclusion: The incidence and mortality rates of prostate cancer in all provinces of the country are on the rise. Therefore, screening programs for early detection to reduce the mortality of the disease, and etiology studies to identify the causes of increased incidence and related factors, can be effective in controlling this cancer in the country.

Introduction

Prostate cancer is the second most commonly diagnosed cancer and the fifth leading cause of cancer-related deaths among men

worldwide.[1] In Iran, prostate cancer is one of the most prevalent cancers among men.[2] Prostate cancer is the most commonly diagnosed cancer in 112 countries and the leading cause of cancer-related death in 48 countries worldwide.[3]

Prostate cancer is known to primarily affect older individuals.[2] The increase in the incidence of cancer can be attributed to various factors, including improved cancer registration, increased life expectancy, greater access to prostate cancer screening and diagnosis, changes in lifestyle and diet, higher exposure to occupational risk factors in the environment, and an increased prevalence of smoking.[4-6]

In Iran, the incidence of death from prostate cancer in the years 2004 to 2005 was reported in 29 provinces of the country totaling 1001 cases.[7]

Prostate cancer causes a high number of disability-adjusted life years (DALY).[8] Risk factors for this disease include genetic factors,[8] socio-economic factors,[9] as well as lifestyle and environmental factors[10] that are interrelated.

Studies have shown significant spatial variation in prostate cancer incidence and mortality across different geographic regions. They assessed the potential effects of individual and regional risk factors and found that spatial variations in cancer incidence and mortality rates were observed. Environmental and health factors at the regional level may contribute to spatial heterogeneity in prostate cancer mortality and incidence.[10, 11] Previous research has identified a strong link between human development or socio-economic development and cancer.[12, 13] Therefore, the aim of the current study is to investigate the epidemiology of prostate cancer in Iran and its relationship with the Human Development Index (HDI).

Materials and Methods

Sources of Data Collection

The study was approved by the ethics committee of Lorestan University of Medical Sciences with ID number IR.LUMS.REC.1402.007.

The current study is descriptive-analytical. The data regarding ASIR (Age-Standardized Incidence Rate), ASPR (Age-Standardized Prevalence Rate), ASMR (Age-Standardized Mortality Rate), Years of Life Lost due to disability (YLD), Years of Life Lost due to premature death (YLL), and DALY in Iran from 2009 to 2019 were collected from http://ghdx.healthdata.org/gbd-results-tool. GBD 2019 has calculated the mortality rate, YLL, YLD, and DALY in 23 age groups among men and women in 204 countries, including Iran, from 1990 to 2019. GBD has followed a systematic approach to provide sufficient evidence regarding health consequences in humans. The data used by GBD have been collected from various sources. The framework for accurate estimation by GBD 2019 has been discussed previously.[14, 15]

Disability-Adjusted Life Year (DALY)

DALY is a health gap index that calculates the years of life lost, either due to premature death or non-fatal diseases. This index was defined and used in the GBD study to calculate the burden of diseases.[16, 17]

Years of Life Lost Due to Premature Death (Years of Life Lost, YLL)

To identify and prioritize the causes of premature deaths, it is possible to use the index of YLL, which was introduced by the World Health Organization for studying the global burden of diseases. This index depends not only on the number of deaths but also on the age of the deceased at the time of death. The younger the age of the deceased at the time of death, the greater the number of lost years of life increases. The lost years of life are the years that a person could have lived a productive life but, due to premature death, these years are lost.[17]

Years Lived with Disability (YLD)

YLD is the years that a person has been disabled or incapacitated due to illness.[17]

Human Development Index (HDI)

The HDI is a statistical tool used to measure the overall achievements of a country in its social and economic dimensions (https://hdr.undp.org/data-center/human-development-index#/indicies/HDI). Based on this index, the social and economic dimensions of a country are evaluated according to the health of its population, their educational attainment, and their standard of living. In its annual report, the United Nations measures the HDI for its member states, which is used to rank different countries.[18, 19]

Statistical Analysis

The software used to draw zoning types was ArcGIS version 10.3 (Esri, Redlands, CA, USA). The zoning method was based on the Natural Breaks classification system, which is a reliable georeferencing method for grouping values that are similar in distribution. In this method, based on the Jenks optimization algorithm, individuals or values assigned to a group will exhibit the highest similarity with other members within their group and the greatest dissimilarity with members of other groups.[20] In essence, this

method involves a calculation process aimed at minimizing the variance within each group and maximizing the variance between groups. The analyses and diagrams were created using Stata software version 12 (Stata Corp, College Station, TX, USA). The two-variable Pearson correlation coefficient was used to analyze the data extracted to study the correlation between PC and HDI. The significance level was P<0.05.

Results

According to the data recorded on the GBD website in 2019 in Iran, the incidence of prostate cancer was (30.00 per 100,000), mortality (12.83 per 100,000), prevalence (219.29 per 100,000), DALY (208.07 per 100,000), YLD (17.54 per 100,000), and YLL (190.53 per 100,000). The graph below illustrates the incidence and mortality rates of prostate cancer in Iran from 2009 to 2019, as reported by ASMR and ASIR. The incidence and mortality rates of prostate

cancer in Iran have an upward trend, with the incidence trend's slope being faster than that of the mortality trend (figure 1).
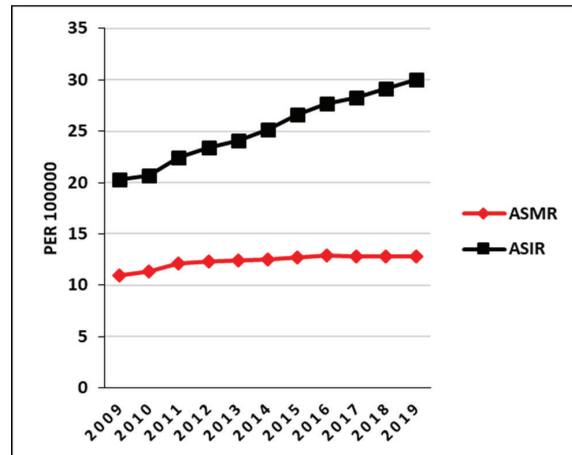

Figure 1: The time trends of ASMR and ASIR for prostate cancer from 2009 to 2019. ASMR: Age-Standardized Mortality Rate, AIPR: Age-Standardized Incidence Rate (Source: Global Burden of Disease)

Table 1: Prostate cancer incidence, prevalence, mortality, and burden (DALY, YLL, YLD) in Iran by province in 2019 (source: Global Burden of Disease)

Province	ASMR	ASIR	ASPR	ASDR	YLL	YLD
Alborz	13.00	36.34	278.88	215.93	194.17	21.75
Ardebil	15.17	33.50	237.36	248.53	229.05	19.48
Bushehr	17.09	40.55	292.54	277.98	254.1	23.88
Chahar Mahaal and Bakhtiari	12.09	31.63	240.43	197.36	178.46	18.89
East Azarbayejan	16.99	35.31	244.32	263.17	243.12	20.04
Fars	13.96	34.71	257.82	227.15	206.75	20.40
Gilan	13.89	35.57	265.56	232.93	211.75	21.17
Golestan	12.64	26.43	181.83	211.37	195.98	15.39
Hamadan	11.36	26.58	195.58	192.88	177.19	15.69
Hormozgan	9.52	20.86	151.18	161.68	149.47	12.21
Ilam	13.81	32.34	238.15	220.52	201.75	18.77
Isfahan	14.21	35.13	262.21	229.82	209.26	20.56
Kerman	13.93	27.69	190.04	218.13	202.44	15.68
Kermanshah	12.78	28.49	205.97	214.83	198.23	16.60
Khorasan-e-Razavi	13.24	27.49	192.03	211.27	195.75	15.52
Khuzestan	11.42	25.70	184.84	188.27	173.24	15.02
Kohgiluyeh and Boyer-Ahmad	11.73	29.20	221.24	191.87	174.90	16.97
Kurdistan	13.75	30.05	216.23	227.30	210.09	17.20
Lorestan	15.05	35.13	257.00	246.79	226.31	20.48
Markazi	12.67	28.62	209.95	205.94	189.46	16.48
Mazandaran	14.80	39.37	298.73	242.16	218.91	23.25
North Khorasan	9.85	20.24	141.70	164.33	152.55	11.78
Qazvin	16.10	35.33	249.84	257.74	237.36	20.37
Qom	12.80	28.48	204.15	208.27	191.67	16.60
Semnan	15.93	36.69	267.20	255.03	233.89	21.13
Sistan and Baluchistan	9.967	16.21	102.96	162.80	153.91	8.897
South Khorasan	13.06	25.97	181.78	201.28	186.86	14.42
Tehran	9.662	24.15	181.98	152.89	138.38	14.51
West Azarbayejan	16.40	31.59	211.39	249.85	232.17	17.68
Yazd	16.24	37.91	276.98	249.53	227.80	21.73
Zanjan	12.04	26.15	186.42	194.55	179.52	15.02

ASMR: Age-standardized mortality rate; AIPR: Age-standardized incidence rate; ASPR: Age-standardized prevalence rate; ASDR: Age-standardized DALY rate; DALY: Disability-adjusted life years; YLL: Years of life lost due to premature mortality; YLD: Years of life lost due to disability (Source: Global Burden of Disease 2019)

Table 1 presents the incidence, mortality, prevalence, YLL, YLD, and DALY of prostate cancer in different provinces in 2019. As observed, in 2019, the highest ASIR of prostate cancer was in Bushehr (40.55 per 100,000), while the lowest was in Sistan and Baluchistan (16.21 per 100,000). The highest ASPR was in Mazandaran province (298.73 per 100,000) and the lowest was in Sistan and Baluchistan province (102.96 per 100,000). The highest AASMR was in Bushehr province (17.09 per 100,000), and the lowest was in Hormozgan province (9.52 per 100,000). The highest YLL rate (254.1 per 100,000), YLD rate (23.88 per 100,000), and ASDR (277.98 per 100,000) are associated with Bushehr province.

Figure 2 shows the percentage of annual changes in the indices of incidence, mortality, prevalence, YLL, YLD, and DALY related to prostate cancer in provinces of the country. The provinces with the highest percentage of annual changes in incidence, mortality, prevalence, YLL, YLD, and DALY were West Azarbayejan (62.9%), Golestan (30.86%), West Azarbayejan (87.66%), Golestan (29.38%), West Azarbayejan (76.95%), and Alborz (31.45%), respectively.
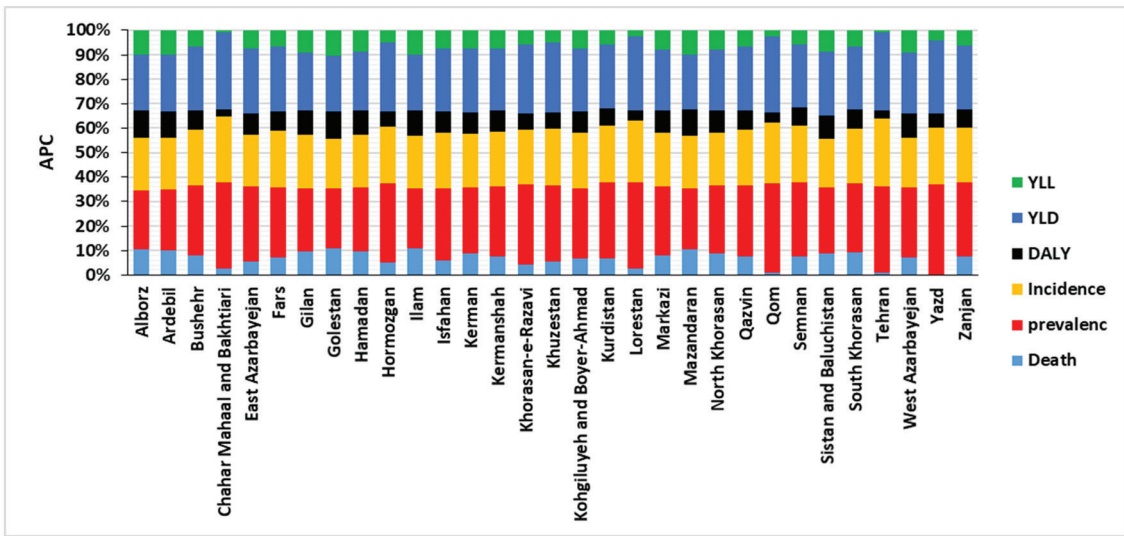

Figure 2: The annual percentage changes in prostate cancer by province. DALY: Disability-adjusted life years; YLL: Years of life lost due to premature mortality; YLD: Years of life lost due to disability; APC: Annual percentage change (Source: Global Burden of Disease 2019)
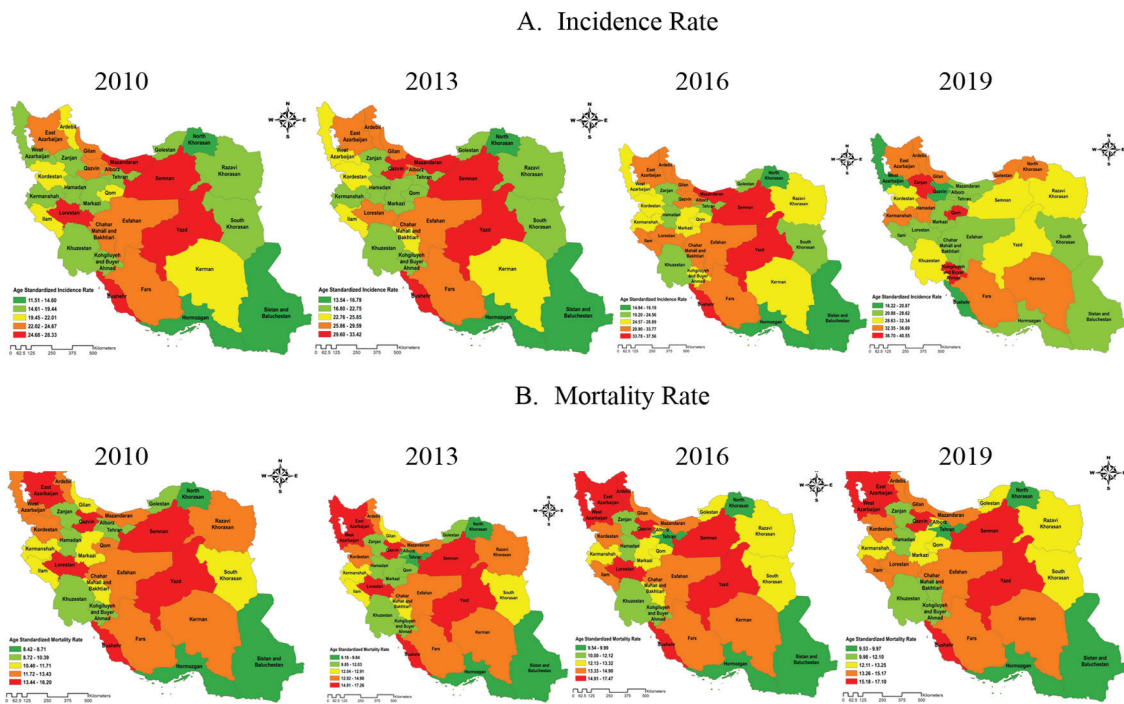
A. Incidence Rate

B. Mortality Rate

Figure 3: The incidence (A) and mortality (B) of prostate cancer by province in 2010 to 2019.

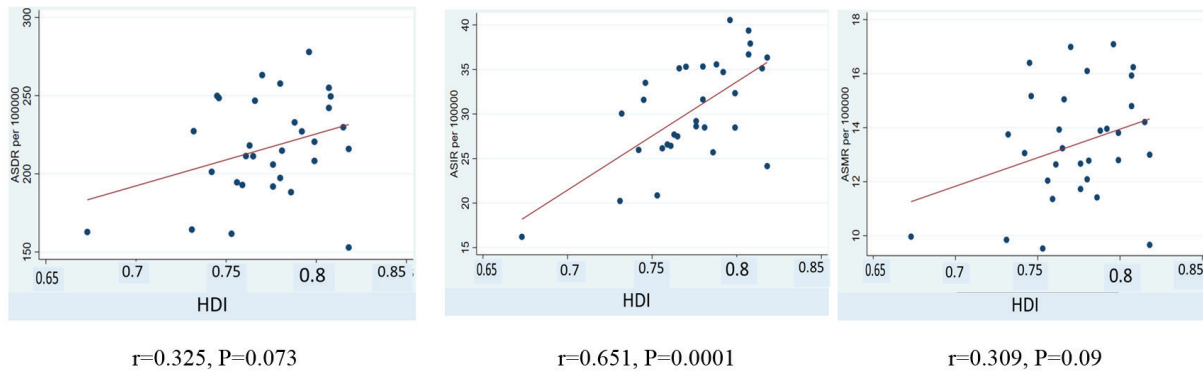r=0.325, P=0.073   r=0.651, P=0.0001   r=0.309, P=0.09

Figure 4: Correlation between the HDI to ASDR, ASMR, and ASIR in Iran in 2019. Pearson correlation analysis reflected a significantly positive correlation between the ASIR to HDI levels. ASDR: Age-Standardized DALY Rate, AIPR: Age-Standardized Incidence Rate, ASMR: Age-Standardized Mortality Rate, HDI: Human Development Index

The highest ASIR of prostate cancer in 2010 (28.32 per 100,000), 2013 (33.42 per 100,000), and 2016 (37.55 per 100,000) was observed in the province of Bushehr. In 2019, the highest ASIR was in Zanjan (40.55 per 100,000). The highest ASMR for prostate cancer in the year 2010 was recorded in the province of Yazd (16.19 per 100,000). In the years 2013 (17.26 per 100,000), 2016 (17.47 per 100,000), and 2019 (17.09 per 100,000), the highest ASMR was associated with the province of Bushehr (figure 3).

The results of Pearson correlation analysis indicate a positive and statistically significant correlation between the ASIR of prostate cancer and the HDI in Iran (r=0.651, P=0.0001). In contrast, the study shows a positive correlation between ASDR and ASMR with the HDI, although this correlation is not statistically significant (P=0.073 and P=0.09, respectively) (figure 4).

Discussion

The current study shows an increasing trend of prostate cancer incidence and death in Iran and its different provinces. The highest ASIR, ASMR, ASDR, YLL, and YLL of prostate cancer in 2019 is related to Bushehr, and the highest ASPR is related to Mazandaran province.

According to Globocan 2018, prostate cancer is one of the most common cancers among Iranian men.[18] In the systematic review study by Moradi and others, the overall incidence of prostate cancer was estimated at 8.7 per 100,000 population, while nationwide reports indicated a rate of 10 per 100,000 population.[1]

Mousavi and others investigated the incidence and mortality rates of cancers in Iran from 2003 to 2006. They found that the standardized death rate for prostate cancer in men during the years 2003, 2004, and 2005 was 5.7, 24.7, and 41.9, respectively. The death rates obtained in this study are consistent with other global estimates for developing and less developed regions.[21] Fidler and colleagues' study estimated the age-standardized death rate for prostate cancer to be 7.5 worldwide. In studies conducted worldwide, the mortality rate from prostate cancer is on the rise in Asian and African countries, in contrast to Western countries.[12] The current study has confirmed the increasing trend in Iran. A reason for the increasing trend may be attributed to the expansion of the cancer registration system's coverage.[1, 2]

Compared to all cancer cases, it can be concluded that the incidence of this type of cancer is increasing in the country. As it became clear, the incidence of prostate cancer in Iran has shown a higher rate in recent years, aligning with the global increasing trend. The prostate cancer screening program in Iran, along with population aging and behavioral factors such as smoking and Western diets, are among the factors contributing to the rising incidence of prostate cancer in the country.[1, 22]

The results of the studies showed that the ASIR of prostate cancer in Iran in 2019 is (ASIR=30.00 per 100,000), while Asian countries such as Turkey (40.6 per 100,000) and Lebanon (37.2 per 100,000) have higher standard incidence rates. Furthermore, countries such as Bhutan (1.2 per 100,000), Nepal (1.5 per 100,000), and Bangladesh (1.7 per 100,000) have the lowest ASIR. 100,000) and North America (97.2 per 100,000) have the highest SIR. Countries in South Central Asia (4.5 per 100,000) and Southeast Asia (5.5 per 100,000) have the lowest incidence. This difference can be explained by the difference in environmental contexts, income level, lifestyle, and presence of screening.[2, 5, 23] The results of this study showed a positive and statistically significant correlation between the ASIR of prostate cancer and the HDI in Iran.

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The incidence of prostate cancer is significantly higher in developed countries than in developing countries. This difference can mainly be attributed to population-based prostate cancer screening and the utilization of advanced diagnostic methods (i.e., PSA: Prostate-Specific Antigen), which is prevalent in most developed countries but is not widely adopted in developing societies. It can be predicted that the number of new cases with early cancer diagnosis will increase more in Western countries than in Eastern countries. This could be due to improved completeness of cancer registries, increased life expectancy, greater access to prostate cancer screening and diagnosis, changes in lifestyle and diet, greater exposure to environmental and occupational risk factors, and increased prevalence of smoking.[24, 25]

Studies have shown that screening men at risk with the PSA test for early-stage prostate cancer diagnosis reduces mortality from this cancer. Therefore, it is likely that implementing a screening program in Iran could help reverse the rising trend of prostate cancer mortality by enabling prompt diagnosis and treatment.[26, 27]

Bouchardy and colleague's study has positively identified the role of PSA testing in reducing prostate cancer mortality in the U.S. Studies have shown that screening at-risk populations, such as men over 40 years of age, is effective in reducing prostate cancer mortality.[28]

Therefore, considering the rising trend of prostate cancer-related deaths in Iran and the high mortality rate among elderly men, implementing a screening program for men with risk factors is crucial for preventing prostate cancer.[2]

The results of the study showed that the highest incidence, mortality, and burden of prostate cancer are related to Bushehr province. The difference in the incidence and death rates of prostate cancer in various provinces can be attributed to demographic characteristics and lifestyle variances.[1, 2]

This study suffers from the general limitations typically found in the GBD studies. While GBD studies provided updated data, some limitations were unavoidable due to limited diagnostic accuracy, misreporting, and misdiagnosis. Such restrictions are improving over time.

Conclusion

Finally, it can be concluded that prostate cancer is on the rise in Iran, with its prevalence increasing compared to all other types of cancer. Additionally, the disease trend in all provinces shows a consistent increase. This varying trend in the country's provinces may be attributed to differences in lifestyle, nutrition, and genetics, as well as variations in disease diagnosis and treatment. Therefore, considering the rising trend of this cancer, it is recommended to implement screening programs for early diagnosis and conduct etiology studies to determine the reasons behind the increasing incidence of this cancer.

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Authors' Contribution

E.G: Design, Data Collection and Processing, Analysis and Interpretation, Literature Review, Writing; S.R.R: Data Collection and Processing, Writing; S.R.P: Data Collection and Processing, Analysis and Interpretation; M.A: Analysis and Interpretation, Writing; F.F.Sh: Design, Literature Review. All authors reviewed the manuscript. All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflict of Interest: None declared.

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