Journal of Chemical Health Risks

www.jchr.org

JCHR (2026) 16(2), 1121-1126 | ISSN:2251-6727

Epidemiological Patterns of Cancer and the Human Development Index

M.A. Vekilyan[1,2], V.F. Osipov[3], L.I. Gerasimova[1,4], A.V. Fomina[2], V.I. Pak[2], A.E. Larkina[2]

[1]Vinogradov University Clinical Hospital, (branch) of the Patrice Lumumba Peoples' Friendship University of Russia, Moscow, Russia;

[2]Russian Peoples' Friendship University named after Patrice Lumumba (RUDN), 6 Miklouho-Maclay str., 117198, Moscow, Russia

[3]BU CHR "Republican Clinical Hospital for War Veterans," Cheboksary, Russian Federation

[4]Russian Biotechnological University (Ministry of Education and Science of the Russian Federation, Federal State Budgetary Educational Institution of Higher Education ROSBIOTECH), Moscow, Russian Federation

(Received: 16 January 2026 Revised: 25 February 2026 Accepted: 17 March 2026)

KEYWORDS

Malignant neoplasms, cancer risk factors, prostate cancer, prostate malignancy, prostate cancer incidence, prostate cancer mortality

ABSTRACT:

Introduction: The burden of oncological diseases remains one of the most pressing challenges in modern medicine. Prostate cancer ranks fourth in global cancer statistics and is the second most common malignancy among men worldwide. In the context of rising incidence rates, investigating the relationship between the level of human development and cancer epidemiology is becoming increasingly significant.

Objectives: The aim of this study was to investigate the relationship between the Human Development Index (HDI) and the epidemiological indicators of prostate cancer, as well as to identify factors contributing to disparities in incidence and mortality rates across countries with varying levels of socio-economic development.

Methods: This study is based on an analysis of scientific publications retrieved from international bibliographic databases (PubMed, Scopus, Web of Science, and eLibrary). The methodology includes a comprehensive analysis of data from large-scale population-based and biomedical studies. A standardized analysis of incidence rates was conducted, taking into account age-specific coefficients. Official statistical data from international organizations and the findings of epidemiological studies were utilized.

Results: The study revealed significant disparities in prostate cancer incidence rates between countries with different levels of human development. Regions with a very high HDI reported substantially higher numbers of cases. The leading modifiable risk factors identified include tobacco smoking, alcohol consumption, obesity, and unhealthy dietary patterns. It was found that approximately 40% of cancer cases could be prevented by eliminating these risk factors.

Conclusions: A direct correlation was established between the level of human development and prostate cancer incidence rates. The availability of screening programs and the quality of medical care significantly influence patient survival rates. It was found that countries with a very high HDI exhibit higher incidence rates; however, they also demonstrate better survival outcomes due to well-developed diagnostic and treatment systems. Limited access to healthcare services in countries with low HDI leads to late-stage diagnosis and poorer disease outcomes. This study underscores the need for the development of early detection programs and the improvement of access to oncological care in all countries, regardless of their development level.

1. Introduction

The risk of developing prostate cancer is influenced by a multitude of factors identified in large-scale population-based and biomedical studies. The primary risk factors for prostate cancer currently recognized are age and genetic predisposition [1]. However, the literature, particularly in recent years, describes numerous other risk factors, including conflicting evidence [2; 3; 4; 5].

Prostate cancer ranks fourth in global cancer statistics and is the second most common malignancy among men.

Journal of Chemical Health Risks

www.jchr.org

JCHR (2026) 16(2), 1121-1126 | ISSN:2251-6727

According to 2022 data, 1,467,854 new cases of this disease were diagnosed worldwide [6].

2. Objectives

The study aims to examine the correlation between human development levels and prostate cancer epidemiological indicators, as well as to identify factors contributing to disparities in incidence and mortality rates across countries with varying socio-economic status.

3. Methods

The study involved a comprehensive analysis of relevant scientific literature indexed in international bibliometric databases, including PubMed, Scopus, and Web of Science, as well as the Russian scientific electronic library eLibrary.

The study methodology was founded on a comprehensive analysis of data derived from large-scale population-based and biomedical research focused on the epidemiology of prostate cancer. To ensure a robust evidence base, the literature search was constrained to the period between 2005 and 2025. This temporal framework facilitated the inclusion of a wide spectrum of longitudinal and cross-sectional data, providing a thorough overview of the evolving trends and challenges associated with the disease.

The evidence base for this study was synthesized from official statistical reports provided by international organizations, results of large-scale epidemiological cohorts, and peer-reviewed research focusing on prostate cancer risk factors and Human Development Index (HDI) metrics. The analytical framework incorporated age-standardization of incidence rates to ensure comparability across populations, a comparative analysis of oncological metrics in nations with disparate levels of development, and a correlation analysis to evaluate the relationship between incidence trends and the HDI. This integrated data-driven approach facilitated the identification of robust patterns in prostate cancer prevalence relative to the socio-economic trajectories of various global regions.

4. Results

Table 1 presents the top five countries with the highest prostate cancer incidence rates, expressed as age-standardized rates (ASR) per 100,000 person-years. The ASR serves as a summary measure representing the incidence level a population would exhibit if it possessed a standard age structure. This standardization is essential for comparing populations with disparate age profiles, as age significantly influences cancer-specific mortality risk. For this process, conventional age-specific mortality rates were applied to five-year age cohorts (0–4, 5–9, ..., 80–84, 85+ years) according to the following formula: ASR = Σri Pi / ΣPi, where ASR - is the age-standardized mortality rate, ri - is the age-specific mortality rate for the age group i… [7].

Table 1. Global leaders in prostate cancer incidence rates (ASR).

№	Country	Incidence rate , 2022 г.	ASR
1.	France, Guadeloupe	660	157,5
2.	Lithuania	3,208	135.0
3.	France, Martinique	610	134.3
4.	Norway	6,276	109.9
5.	Sweden	11,732	104.3

Source: [6].

In 2022, the highest absolute number of prostate cancer deaths was recorded in China, the United States, and Brazil. Table 2 presents the top 10 countries with the highest total mortality burden for prostate cancer in 2022, including the corresponding age-standardized mortality rates (ASR) for each nation.

Table 2. Top 10 countries by the highest absolute number of newly diagnosed prostate cancer cases and corresponding age-standardized incidence rates (ASR) in 2022

Rank	Country	Number of cases	ASR
	World	1,467,854	29.4
1.	USA	230,125	75.2
2.	China	134,156	9.7
3.	Japan	104,318	50.1
4.	Brazil	102,519	76.3
5.	Germani	65,269	54.2

Journal of Chemical Health Risks
www.jchr.org
JCHR (2026) 16(2), 1121-1126 | ISSN:2251-6727

6.	France(metropolitan)	57,357	82.3
7.	United Kingdom	55,485	74.0
8.	Russian Federation	52,712	47.4
9.	Italy	38,180	49,5
10.	Indian	37,948	5.6

Source: [6].

Prostate Cancer Incidence in Relation to the Human Development Index (HDI)

The Human Development Index (HDI) serves as a composite metric to evaluate average achievements across three fundamental dimensions of human development [8]:

1. Longevity and Health - measured by life expectancy at birth, reflecting the overall health status of the population.

2. Education (Knowledge): Assessed through two distinct parameters:

- Mean years of schooling for adults aged 25 and older;
- Expected years of schooling for children entering the education system.

3. Standard of Living: Measured by Gross National Income (GNI) per capita.

Following the calculation of the specific indices for each of these three dimensions, their values are integrated into a single composite index, providing a comprehensive assessment of human development levels [9].

However, it is important to acknowledge that the HDI captures only a specific portion of the broader human development concept. It does not account for socio-economic inequality, poverty, human security, empowerment, or various other qualitative factors [10; 11].

Table 3. Key determinants and dimensions of the Human Development Index (HDI).

(Dimensions)	(indicators)	Dimension index	Human Development Index (HDI)
Long and Healthy life	Life expectancy at birth	Life expectancy index	
Knowledge	Expected years of shooling Mean years of shooling	Education index	
A decent standard of living	CNI per capita	CNI index	

Source: [12]

The Human Development Index (HDI) is a summary measure of average achievement in key dimensions of human development: a long and healthy life, access to knowledge, and a decent standard of living. Mathematically, the HDI is defined as the geometric mean of normalized indices for each of these three dimensions (see Table 3) [12; 13].

According to the established methodology, the evaluation of the three core components is operationalized as follows [14]:

1. The Health Component - represented by life expectancy at birth, which serves as a proxy for the overall health status and longevity of the population.

2. The Education Component - measured through two distinct indicators:

- Mean years of schooling among the adult population aged 25 years and older;
- Expected years of schooling for children of school-entry age.

3. The Standard of Living Component - quantified by the Gross National Income (GNI) per capita. Notably, the HDI calculation employs a logarithmic transformation of the income variable. This methodological approach accounts for the diminishing marginal utility of income, reflecting the premise that the relative significance of income increments decreases as the absolute level of GNI rises.

The final stage of the calculation involves the aggregation of the standardized values from the three specific indices into a single composite indicator. To combine these components, a geometric mean is employed, ensuring an equal weighting of all dimensions in the final assessment of human development [14].

However, it is essential to note that the Human Development Index (HDI) is a simplified metric that captures only a specific portion of the broader human development concept. It does not account for multidimensional inequality, poverty, human security, or social empowerment [10; 11]. To address these gaps, the Human Development Report Office (HDRO) provides additional composite indices as broader proxy indicators

Journal of Chemical Health Risks

www.jchr.org

JCHR (2026) 16(2), 1121-1126 | ISSN:2251-6727

for key issues such as gender disparity and multidimensional poverty.

A more comprehensive understanding of a nation's human development status necessitates the analysis of additional indicators and supplementary data provided in the Statistical Annex to the Human Development Report.

According to the Human Development Index (HDI) ranking, the Russian Federation occupies the 56th position globally (see Table 4).

Table 4. Gender Development Index

Gender Development Index		Human Development Index		SDG3		SDG4.3		SDG4.4		SDG8.5	
				Life expectancy at birth		Expected years of schooling		Mean years of schooling		Estimated gross national income per capita	
		Value		years		years		years		2017PPP$	
Value	Group	Fe	M	F	M	F	M	F	M	F	M
1,021	1	0,829	0,812	75,7	64,7	15,8	15,5	12,5	12,3	21781	33001

Source: [15]

The Human Development Index (HDI) was originally conceived to emphasize that people and their capabilities should remain the primary criteria for assessing national progress, rather than economic growth alone. Generally, cancer incidence is higher in more developed nations; however, incidence rates are also rapidly rising in many low-income countries [16].

Globally, both the absolute number of cancer cases and age-standardized incidence rates (ASR) correlate positively with development levels. In 2022, an estimated 9,296,171 new cases were reported in regions with a "Very High" HDI, contrasted with only 812,211 cases in "Low" HDI regions. The overall ASR for all cancers in 2022 stood at 285.7 per 100,000 in very high-HDI areas, compared to 110.6 per 100,000 in low-HDI areas.

Cancer currently stands as the second leading cause of death worldwide, trailing only cardiovascular diseases, and has become the primary cause of mortality in over 50 countries. In 2020, approximately 10 million cancer-related deaths were recorded globally, a figure projected to reach 16 million by 2040. The global cancer burden continues to exert significant pressure on individuals, communities, and healthcare systems—an impact that is expected to intensify as both incidence and mortality rates maintain their upward trajectory.

It should be noted that the rise in incidence rates for certain malignancies, such as prostate cancer, accelerated significantly in the early 1990s. This trend was primarily attributed to diagnostic advancements, specifically the clinical implementation of prostate-specific antigen (PSA) testing; however, a subsequent decline in incidence was observed by the late 1990s [17; 18; 19].

Beyond diagnostic shifts, other critical factors contribute to the observed disparities in cancer growth between high-income and low-income nations. Approximately 40% of cancer cases are driven by modifiable (lifestyle-related) risk factors and are, therefore, preventable. The most prominent modifiable risk factor is tobacco smoking [20], which accounts for half of all preventable cases, followed by alcohol consumption and obesity [21; 22]. Additionally, approximately 15% of preventable cancers are linked to dietary patterns characterized by low intake of leafy greens, fruits, and vegetables, as well as excessive consumption of sugar-sweetened beverages and ultra-processed foods [23; 24], compounded by low levels of physical activity [25].

Dietary recommendations emphasize the necessity of increasing the intake of leafy greens, fresh vegetables, and fruits, while reducing the consumption of red and processed meats. Furthermore, they advise against sugar-sweetened beverages and alcohol consumption, highlighting the importance of regular physical activity [26].

Significant global disparities persist regarding access to cancer control services, including screening and treatment. In some regions, these discrepancies stem from a lack of necessary infrastructure, while in others, such services remain economically inaccessible to certain population segments [27].

It is well-established that screening facilitates cancer diagnosis at earlier stages; conversely, when screening services are unavailable, malignancies are more likely to be detected at advanced stages. This, in turn, significantly reduces cancer survival rates [28].

The same principle applies to cancer treatment: limited access to therapeutic interventions negatively impacts post-diagnosis life expectancy. Additionally, an individual's decision to seek medical care is influenced by personal and cultural determinants, including

Journal of Chemical Health Risks

www.jchr.org

JCHR (2026) 16(2), 1121-1126 | ISSN:2251-6727

perceptions of healthcare systems and a low level of cancer literacy [29].

5. Discussion

The findings of this study demonstrate a significant correlation between human development levels and prostate cancer incidence rates. Notably, nations characterized by a high Human Development Index (HDI) exhibit elevated incidence figures, which may be attributed to enhanced diagnostic capabilities and superior standards of clinical care.

Risk factors play a pivotal role in shaping the epidemiological profile of the disease. Approximately 40% of prostate cancer cases are potentially preventable through the mitigation of modifiable risk factors, including:

- Tobacco smoking;
- Alcohol consumption;
- Obesity;
- Dietary imbalances;
- Physical inactivity.

Furthermore, healthcare accessibility exerts a substantial influence on patient survival outcomes. In countries with advanced healthcare systems, we observe not only higher detection rates but also improved survival benchmarks, facilitated by timely and effective therapeutic interventions.

Cultural and social barriers further impede the effectiveness of cancer control initiatives. A lack of public awareness regarding risk factors and preventive measures, combined with the social stigma surrounding oncological diseases, often results in delayed diagnosis and a significantly poorer prognosis.

Refrences

1. Kopyltsov E. I., et al. Oncological diseases of the genitourinary system: a textbook / ed. A. I. Novikov [et al.]. - Omsk: Publishing House of the Center for Medical Research and Information Technologies of Omsk State Medical Academy, 2008. - 197 p.
2. Odintsova I.N., Pisareva L.F., Khryapenkov A.V. Worldwide cancer epidemiology. Siberian journal of oncology. 2015;1(5):95-101.
3. Siraziev A.M., Khasanova G.R., Ulyanin M.Yu. Risk factors for prostate cancer // Medical Almanac. 2019. № 3-4 (60). P. 110-114.
4. Kanaeva M. D., Vorobtsova I. E. Genetic markers of predisposition to prostate cancer // OU. 2015. № 3. P. 16-23.
5. Smirnov A.V., Brusina E.B., Magaryll Yu.A., Gordeeva L.A. Epidemiological analysis of prostate cancer risk factors. Russian Journal of Preventive Medicine. 2022;25(8):75-82. https://doi.org/10.17116/profmed20222508175.
6. Prostate cancer.- World Cancer Research Fund.- URL: https://www.wcrf.org/preventing-cancer/cancer-types/prostate-cancer/#reduce-your-risk-of-prostate-cancer (Date of access: 10.02.2026).
7. IARC. GLOBOCAN 2022: Estimated cancer incidence, mortality and prevalence worldwide in 2022.
8. Niyazi A. Sh. UNDP Human Development Report 2018: Trends and Indicators in the World and Russia // Russia and the Muslim World. 2018. № 4 (310). P. 5-12.
9. Baganov Valery Yuryevich. Human Development Index as an Indicator of Sustainable Development of a Region // Baikal Research Journal. 2013. № 4. P. 9.
10. Ivashina N.S. Human Development Index as an Indicator of the Quality of Life of the Population [Text]: monograph / N. S. Ivashina, M. V. Kuznetsova; Ministry of Science and Higher Education of the Russian Federation, Federal State Budgetary Educational Institution of Higher Education "Magnitogorsk State Technical University named after G. I. Nosov". - Magnitogorsk: Bauman Moscow State Technical University, 2018. - 81 p.: ill., table.: 21 cm; ISBN 978-5-9967-1560-2
11. Rzhevskaya, T. A. Evolution of the methodology for assessing the human development index / T. A. Rzhevskaya // Structural and institutional transformations in economics and management: collection of materials from the III International scientific readings in memory of Professor Yu. M. Yasinsky (Minsk, November 26, 2025) / edited by O. N. Soldatova (editor-in-chief) [and others], - Minsk: Academy of Public Administration under the President of the Republic of Belarus, 2025. - P. 516-520.
12. Gorbunova O.N., Gegamyan M.A. HDI: calculation methodologies, indicators and indices // Socio-economic phenomena and processes. 2013. № 3 (049). P. 49-53.

Journal of Chemical Health Risks

www.jchr.org

JCHR (2026) 16(2), 1121-1126 | ISSN:2251-6727

13. Priemyshev A.A., Arysheva M.V., Lavrova Z.I. Analysis of the calculation of the human development index. Comparison of the old and updated methods // π-Economy. 2015. No. 2 (216). P. 85-93.
14. Prishchepova, A. O. Statistical study of the human development index / A. O. Prishchepova. - Text: direct // Questions of Economics and Management. - 2016. - No. 3.1 (5.1). - P. 114-117.
15. Human Development Reports.- URL: https://hdr.undp.org/data-center/documentation-and-downloads
16. Alkire, S., Kanagaratnam, U., and Suppa, N. A methodological note on the global Multidimensional Poverty Index (MPI) 2024 changes over time results for 86 countries // OPHI MPI Methodological Note 60, Oxford Poverty and Human Development Initiative. - 2024. - URL: https://ophi.org.uk/global-mpi.
17. Zhu Y, Sorkin JD, Dwyer D, Groves C, Steinberger EK. Predictors of repeated PSA testing among black and white men from the Maryland Cancer Survey, 2006. Prev Chronic Dis. 2011; 8: A114.
18. Zaridze D.G., Maksimovich D.M., Stilidi I.S. A new paradigm of screening and early diagnosis: assessment of benefits and harms // Voprosy onkologii. 2020. Vol. 66. No. 6. Pp. 589-602.
19. Welch H.G., Black W.C. Verdiagnosis in Cancer // J. Atl. Cancer Inst. — 2010. — Vol. 102. — Pp. 605-13.
20. Dedov I.I., Melnichenko G.A., Butrova S.A. Adipose tissue as an endocrine organ // Obesity and Metabolism. – 2006. No. 1. [Electronic resource] – URL: https://cyberleninka.ru/article/n/zhirovayatkan-kak-endokrinnyy-organ (date of access 03.12.2024)]
21. What can increase the risk of cancer [Electronic resource] – URL: https://www.wcrf-uk.org/preventing-cancer/what-canincrease-your-risk-of-cancer/obesity-weight-and-cancer-risk/. (date of access: 16.12.2024)
22. Tantamango-Bartley Y., Knutsen S.F., Knutsen R., Jacobsen B.K., et al. Are strict vegetarians protected against prostate cancer? // Am. J. Clin. Nutr. - 2016. No. 103 (1). 153-160 p. DOI: 10.3945/ajcn.114.106450
23. Ibrayev Y. Utilization of prostate cancer screening according to dietary patterns and other demographic variables. The adventist health study-2. / Y. Ibrayev, K. Oda, G.E. Fraser, S.F. Knutsen // J Cancer. – 2013. No. 4(5). 416-426 p. DOI: 10.7150/jca.6442.
24. Physical activity statistics come from the Active Life Adult Survey 2019-20, Sport England, the National Survey for Wales 2019-20, the Scottish Health Survey 2019, and the Health Survey Northern Ireland 2016/17.
25. Our Cancer Prevention Recommendations [Electronic resource] - URL: https://www.wcrf.org/preventing-cancer/cancerprevention/our-cancer-prevention-recommendations/ (date of access: 12/16/2024).
26. Research Policy. Evidence for Our Recommendations. [Electronic resource] - URL: https://www.wcrf.org/research-policy/evidence-for-our-recommendations/ (date of access: 12/16/2024).
27. Morov OV, Chernichenko AV, Khasanov RSh. Availability of radiotherapy under the present conditions of specialized treatment in cancer patients. P.A. Herzen Journal of Oncology. 2016;5(6):65-70. https://doi.org/10.17116/onkolog20165665-70
28. Valkova L. E., Merabishvili V. M., Pankratyeva A. Yu., Agaeva A. V., Ryzhov A. Yu., Potekhina E. F., Shcherbakov A. M., Dyachenko A. A., Voroshilov Yu. A., Valkov M. Yu. Survival of patients with malignant neoplasms included in the program of the first stage of medical examination of certain groups of the adult population: an epidemiological analysis based on cancer registry data // Issues of Oncology. 2021. № 4. P. 501-510
29. Varfolomeeva S. R., Dobrenkov K. V., Kachanov D. Yu., Inyushkina E. V., Shamanskaya T. V., Zeitlin G. Ya. Analysis of the reasons for refusal of treatment in pediatric oncology // Pediatrics. Journal named after G. N. Speransky. 2008. № 2. P. 25