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Epidemiological and clinical characteristics of cancer in Mongolia from 2017 to 2021

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Epidemiological and clinical characteristics of cancer in Mongolia from 2017 to 2021

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LIST OF ABBREVIATIONS

NCD – No communicable disease

SDG – Sustainable development goal

WHO- World Health Organization

UN – United Nations

CVD- Cardiovascular disease

NMSC -Nonmelanoma skin cancer

UB City – Ulaanbaatar city

LMIC- Low and middle-income countries

HDI - Human Development Index

ASRs- Age-Standardized Rate

SD- Standard division

ABSTRACT

Introduction: the overall rate of cancer incidence is increasing and it remains one of the most common and lethal disease worldwide. Cancer incidence and mortality rates vary significantly around the world. Geographical differentiation is one of cancer's most distinguishing features. Effective prevention and early detection strategies are the most critical public health interventions for various types of cancer. Notably, understanding the risk factors associated with cancer is required for identifying high-risk groups that may require screening for prevention. As a result, current statistics on cancer occurrence and outcome are critical for primary disease prevention.

Cancer is the second leading cause of death globally, accounting for an estimated 9.6 million deaths, or one in six deaths, in 2018. Alterations in the environment, technology, and lifestyle have changed the pattern of diseases in Mongolia. Currently, in Mongolia, non-communicable diseases such as heart disease, obesity, liver disease, lung disease, and cancer are more dominant.

According to the GLOBOCAN 2020 report, Mongolia has the world's highest incidence and mortality rate for liver cancer at 86.5 per 100,000 population ([Cancer Today \(iarc.fr\)](https://gco.iarc.fr/)).

Purpose: This thesis examines the epidemiological characteristics of cancer and factors associated with new cancer cases among the Mongolian population from 2017 to 2021.

Objective: To compare differences in cancer diagnosis in the Mongolian population sub-grouped by residence area, sex, and age.

Methodology: A cross-sectional descriptive study was conducted using secondary data on new cancer cases registered in Mongolia from 2017 to 2021, 23,499 cancer cases were recorded. Among them, our analysis focuses on 15,439 new cases of seven most prominent cancer types in all regions of Mongolia. Our data were converted using Jamovi version 2.3.8, and descriptive statistics were performed using frequencies and percentages.

Association of cancer type compared with age, sex, cancer status, and residence area was calculated by Pearson's Chi-square analysis or Fisher's exact test, and the factors associated with cancer type and socio-demographic characteristics of the patient were examined by the direct method of age-standardized rate.

Exposures: Residence (UB city, western, eastern, Khangai, and central-Gobi regions), sex (male and female), age (0-30, 31-45, 46-60, 61-85 and >85 years), and stage of cancer (primary, metastasis, and malignant).

Results: According to the findings of this study, 41.03% of new cases from the study period were diagnosed with liver cancer, 21.22% were diagnosed with stomach cancer, 11.64% with lung cancer, and esophagus 8.73%. The remaining 6.56%, 6.49%, and 4.3% were diagnosed with breast cancer, cervical, and rectum cancer, respectively. About 85.8% of all newly diagnosed cancer patients were aged 46–85, and 53.4% were male. Approximately 51.68% were living in UB city, and 82.2% were diagnosed at the metastasis stage. The Central-Govi region had a higher incidence of 672.53 per 100,000 population. Compared to the residents of the Central-Govi region (OR: 0.62362 95%CI=0.56165-0.69241 P<.001), UB city was more likely to be associated with liver cancer than stomach cancer.

Conclusion: This study's magnitude shows that liver cancer has been most commonly diagnosed in the last five years, which is similar to Ferlay's survey (Ferlay et al., 2013). Liver cancer is by far leading type of cancer in Mongolia, contributing almost two-fifths of the total cancer burden, the highest rate in the world. Although the highest number of cancer cases have been registered in Ulaanbaatar city, according to the age-standardized incidence rate per 100,000 population, the highest number of incidences have been registered in the Central-Govi region (673.52 / 100,000 population) followed by the second highest indicate rate of 616.38/100,000 population in UB city.

Keywords: Cancer registry, Mongolia, cancer new case

CHAPTER ONE: INTRODUCTION

1.1. Background

Cancer is a broad group of diseases that can begin in almost any organ or tissue of the body when abnormal cells grow uncontrollably, invade neighboring organs, and spread to other organs. The latter process is known as metastasizing and is a leading cause of cancer related deaths (WHO, 2022a).

Cancer is the second most common cause of death globally, accounting for an estimated 9.6 million deaths in 2018 (WHO, 2020).

In 2018, world leaders agreed to take responsibility for preventing and treating cancer and other non-communicable diseases (NCDs), including fiscal measures to protect people from cancer-causing products, promoting evidence-based treatment, and working toward universal health coverage at the United Nations General Assembly. NCDs are a group of conditions not primarily caused by an acute infection, they have long-term health consequences, and frequently necessitate long-term treatment and care. Cancers, cardiovascular disease, diabetes, and chronic lung diseases are examples of these conditions.

The global cancer burden is rapidly increasing due to the aging population and the adoption of new unhealthy lifestyle behaviors (Torre LA, 2012). In 2020, there was an estimated 19.3 million new cancer cases and nearly 10 million cancer deaths (9.9 million excluding non-melanoma skin cancer) (Sung et al., 2021).

Cancer is expected to have the most significant impact and the fastest increase in the cancer burden in low- and middle-income countries (LMICs), many of which are already struggling to cope with the current load. Cancer has massive impact on social

inequalities, with significant differences in incidence, survival, and mortality across social groups (WHO, 2020).

Many cancer cases can be prevented; even when prevention is not possible, early diagnosis saves lives. Cancer is a complicated disease whose mortality patterns and trends vary significantly between countries and among particular types of cancer. Changes in the environment (e.g., synthetic changes to the physical environment, including structural conditions that have impacts on mobility and recreation, diet, and exposure to environmental pollutants), as well as differences in changing lifestyles and local exposures to known or putative determinants, are the causes of these variations. The divergent patterns and trends in cancer mortality are also influenced by the inherent disparities and widening gaps in medical practice and health infrastructure between and within nations.

1.2. Statement of the problem

The United Nations, within the Sustainable Development Goals (SDG) agenda, has set a target to reduce the total premature mortality from NCDs by one-third by 2030. For men, the probability of dying from NCDs were highest in central Asia (e.g., Mongolia and Kazakhstan), eastern Europe (e.g., Russia and Belarus), parts of Oceania (e.g., Fiji and Kiribati), North Korea, and Yemen, with 30-year-old men having a more than one-in-three risk of dying from one of these four diseases before their 70th birthday (James E Bennett, 2018).

The cancer burden continues to grow globally, exerting tremendous physical, emotional, and financial strain on individuals, families, communities, and health systems. Many health systems in LMICs are least prepared to manage this burden, and many cancer patients globally do not have access to timely and quality diagnosis and treatment (Shah, 2019). In countries with robust health systems, survival rates of many types of cancers are improving thanks to accessible early detection, quality treatment, and survivorship care.

Mongolia is the world's least densely populated country, with a population of 3.4 million across a vast plain in eastern Asia. Rapid transitions have affected the health sector and population health over the last 25 years since the fall of the Communist regime. Mongolia has the world's highest incidence and mortality rate from liver cancer, accounting for 43% of all cancer deaths in the country in 2012 (Ferlay et al., 2013).

Based on the study conducted by the National Cancer Registry of Mongolia between 2008 and 2012, cancer is the second leading cause of death in Mongolia. Over the past five years, 21,564 new cancer cases were diagnosed, with men having a slightly higher percentage (52% of the cases). Liver cancer was the most common cancer site in both sexes (ASRs of 114.7 and 74.6 per 100,000 males and females, respectively) and accounted for nearly two-fifths of all cancer diagnoses, followed by stomach, lung, and esophageal cancers in men and cervical, stomach, and esophageal cancers in women (Chimed et al., 2017).

1.3. Significance of the study

There have been few studies on the extent and associated factors of cancer among the Mongolian population exposed to cancer. From the standpoint of environmental risk factors, unhealthy living styles like overeating, lack of physical exercise, smoking, alcohol consumption, and so on, contribute to the prevalence of cancer. The study findings can be used as a first step to combat cancer among the Mongolian population. The study makes recommendations to stakeholders such as regulatory authorities to strengthen tobacco and alcohol control policies, and give attention to NCD control and treatment.

This study is also essential for raising awareness about the community's health-seeking behavior for early diagnosis and treatment, healthy living habits, and the risk of smoking and alcohol consumption. It also serves as a starting point for additional research and evidence-based planning of health intervention or promotion programs aimed at improving the quality of life and health of the general population.

This study's findings will also help mobilize stakeholders and donor organizations to work collaboratively to create awareness among people at risk of cancer and other NCDs and also help mobilize resources to combat the deadliest types of cancer.

1.4. Research questions

1. What is the relationship between residence area, age, sex, and cancer diagnosis?
2. What type of cancer is dominating Mongolia?
3. What is the incidence rate of cancer in the last five years per 100,000 population?

1.5. Purpose

This thesis aims to determine the epidemiological characteristics of cancer and factors associated with new cancer cases among the Mongolian population from 2017 to 2021. The statistical details of the scales and profiles of cancer in different areas, gender, and age groups can be used to effectively promote evidence-informed health policymaking, better prevention, and response in the future in Mongolia.

Findings will provide better insights into what factors influence cancer cases.

1.6. Study objectives

1. To determine the frequency of new cancer cases among the population from 2017 to 2021.
2. To compare differences in cancer diagnosis in the Mongolian population sub-grouped by residence area, sex, and age.

CHAPTER TWO: LITERATURE REVIEW

A literature review is a systematic and logical organization of information carefully chosen from scientific writings. The ultimate goal of a good literature review is to find the best available evidence from various updated sources and to organize it scientifically within the context of the current research project. This assisted us in providing statistical support for our study. It is simply an annotated bibliography; it describes the facts and may include comments to highlight the themes; it is also one of the critical analyses of the truths found in previous research.

The literature review assists us in identifying the previous research topic's strengths and weaknesses and the research gap. It accounts for what has already been published (or established) by a research scholar and researchers.

The related literature for the current study has been organized under the following subheadings:

2.1 Global trend and burden of cancer

Cancer is a leading cause of death and a significant barrier to increasing life expectancy in every country. According to World Health Organization (WHO) estimates for 2019, cancer is the first or second leading cause of death before the age of 70 in 112 of 183 countries and ranks third or fourth in the remaining. For every ten people who die prematurely from NCDs, four die from cardiovascular disease (CVD), and three die from cancer. (Bray et al., 2021).

Overall, the global burden of cancer incidence and mortality is rapidly increasing; this reflects both population aging and growth, as well as changes in the prevalence and distribution of the primary cancer risk factors, several of which are linked to socioeconomic development. (Gersten & Wilmoth, 2002).

Of the 15.2 million premature deaths from NCDs worldwide in 2016, 6.2 million (40.8%) were due to cardiovascular diseases, 4.5 million (29.8%) to cancer, 1.1 million (7.0%) to chronic respiratory diseases, and 0.7 million (4.5%) to diabetes (WHO, 2020).

Mortality rates from NCDs, particularly cancer, are declining in most higher-income countries. Still, such progress is lacking in lower-income countries, posing challenges in meeting the SDG target. Attaining the goal of SDG reducing premature mortality by one-third in of the four major types of NCDs would increase the average expected years lived in the 30–69 age group by 0.64 years worldwide, with more significant gains foreseen in countries with low or medium levels of the Human Development Index (HDI).

Female breast cancer has surpassed lung cancer as the most commonly diagnosed cancer, with an estimated 2.3 million new cases (11.7%), followed by lung (11.4%), colorectal (10.0 %), prostate (7.3%), and stomach (5.6%) cancers. Lung cancer remained the leading cause of cancer death, with an estimated 1.8 million deaths (18%), followed by colorectal (9.4%), liver (8.3%), stomach (7.7%), and female breast (6.9%) cancers.

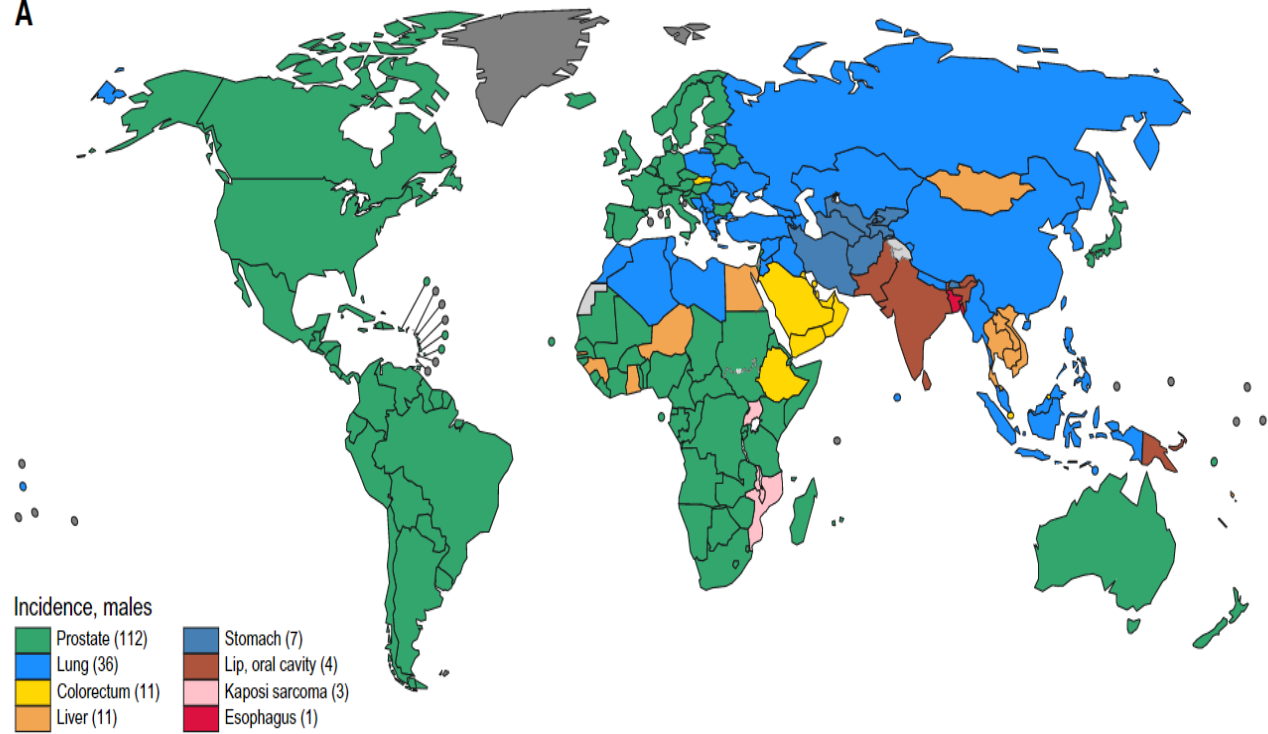
However, death rates for female breast and cervical cancers were considerably higher in transitioning versus transitioned countries (15.0 vs. 12.8 per 100,000 and 12.4 vs. 5.2 per 100,000, respectively) (Sung et al., 2021).

Lung cancer is the most common cause of cancer death in men, followed by prostate and colorectal cancer in terms of incidence and liver and colorectal cancer in terms of mortality (Ferlay et al., 2021). Prostate cancer is the most common cancer in men in 112 countries, followed by lung cancer in 36 countries, colorectal cancer in 11 countries, and liver cancer in 11 countries (Fig. 1A).

In terms of mortality, lung cancer is the leading cause of cancer death in men in 93 countries (Fig. 2A), owing in part to its high fatality rate, and is followed by prostate cancer (48 countries) and liver cancer (48 countries) (23 countries). In contrast to men, breast cancer (159 countries) and cervical cancer (23 of the remaining 26 countries) are the most commonly diagnosed cancers in women (Fig. 1B). The mortality profile in women is more

diverse (Fig. 2B), with breast and cervical cancer being the leading causes of cancer death in 110 and 36 countries, respectively, and lung cancer being the leading cause of cancer death in 25 countries.

A



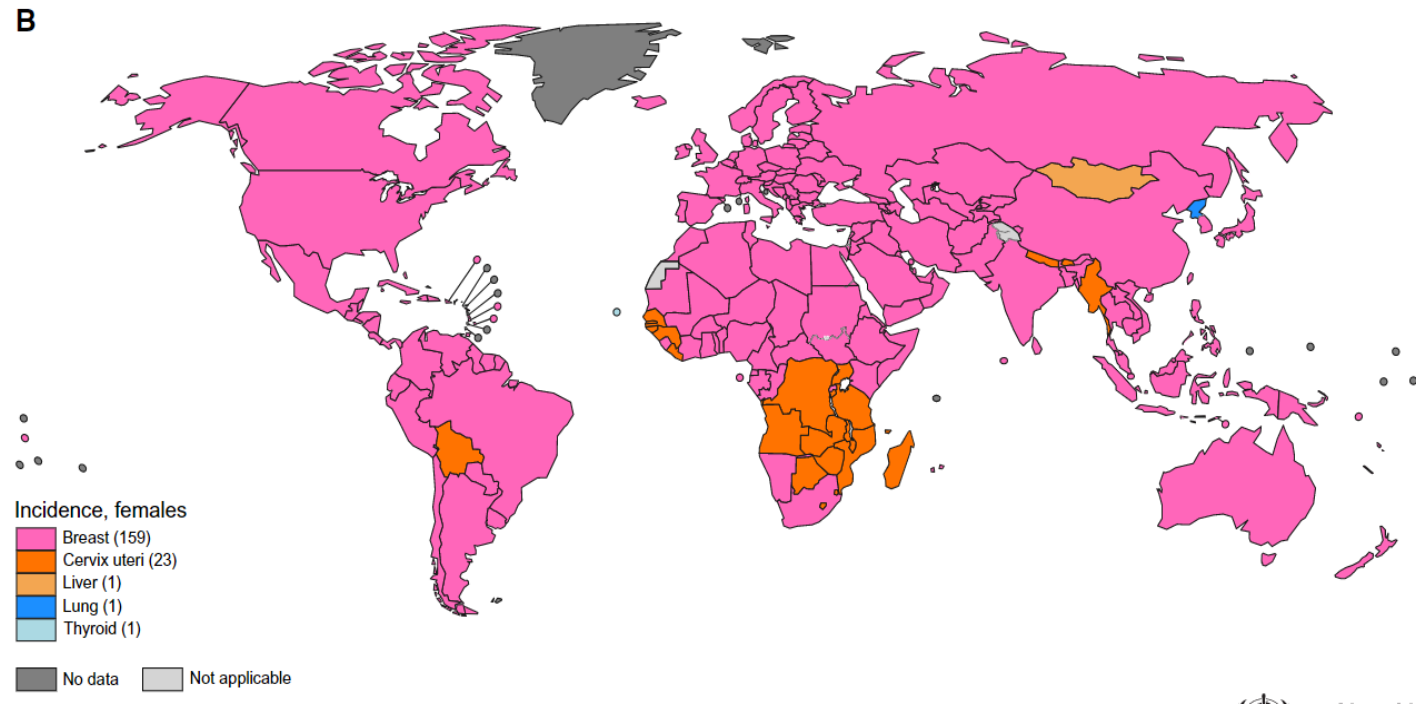
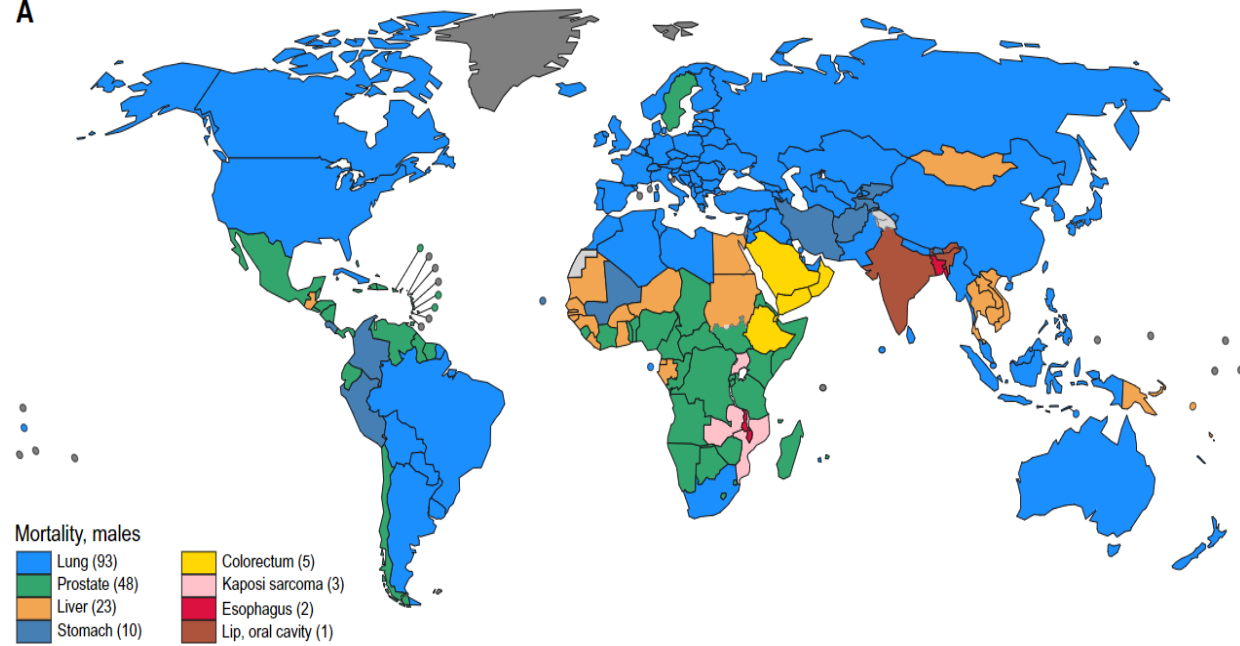


Figure 1 Most Common Type of Cancer Incidence in 2020 in Each Country among (A) Men and (B) Women.

The numbers of countries represented in each ranking group are included in the legend.

(Source: Global Cancer Statistics 2020, Globocan)

A



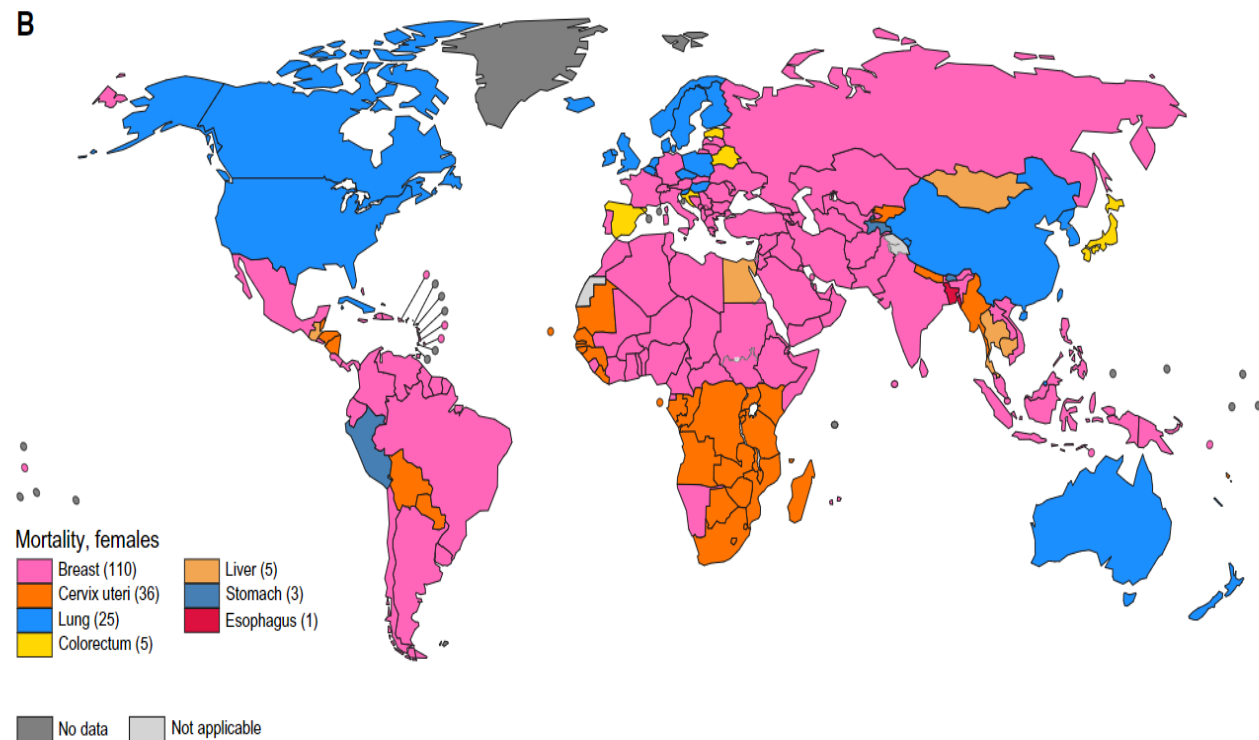


Figure 2. Most Common Type of Cancer Mortality by Country in 2020 among (A) Men and (B) Women.

The numbers of countries represented in each ranking group are included in the legend.

(Source: Global Cancer Statistics 2020, Globocan)

Based on Ferlay et al. report, liver cancer is the sixth most commonly diagnosed cancer and the third leading cause of cancer death worldwide in 2020, with approximately 906,000 new cases and 830,000 deaths. (Ferlay et al., 2021)

Liver cancer incidence rates among men are 2.4-fold greater in transitioned countries (Fig. 2); still, the highest rates are observed mainly in transitioning countries, with the disease being the most common cancer in 11 geographically diverse countries in Eastern Asia (e.g., Mongolia, which has rates far exceeding any other country), South-Eastern Asia (e.g., Thailand, Cambodia, and Vietnam), and Northern and Western Africa (e.g., Egypt and Niger). Liver cancer is the leading cause of cancer death in Mongolia, Thailand, Cambodia, Egypt, and Guatemala among both men and women and in an additional 18 countries among men.

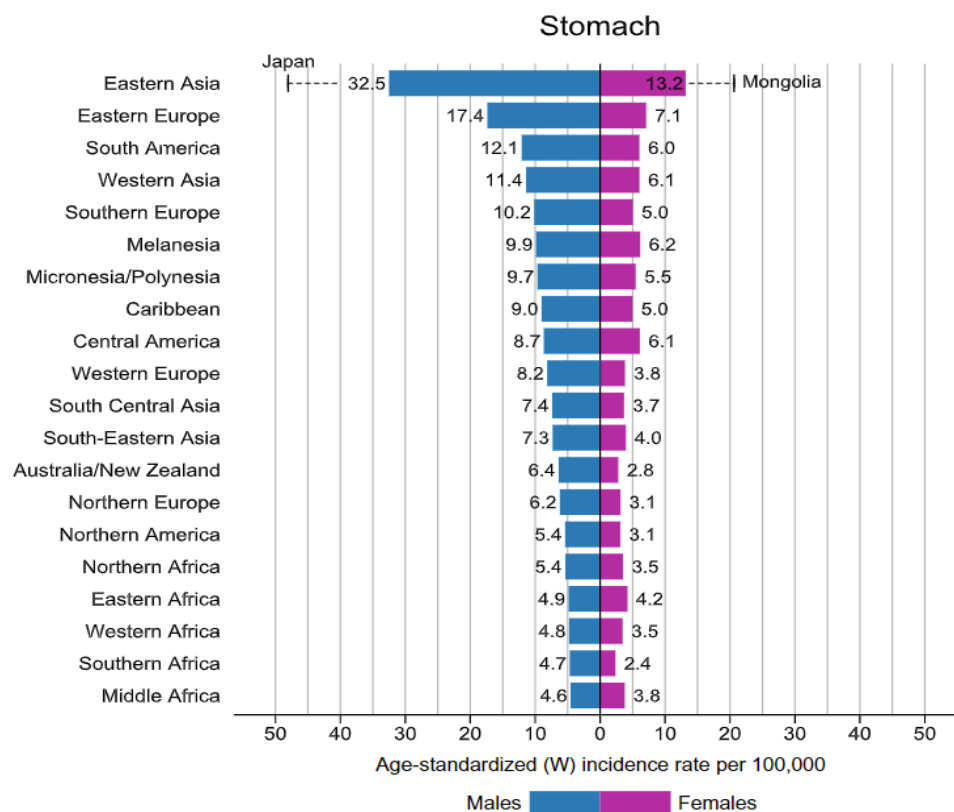


Figure 3. Region-specific Incidence Age-Standardized

Rates by Sex for Stomach Cancer in 2020.

Rates are shown in descending order of the world (W) age-standardized rate among men, and the highest national rates among men and women are superimposed.

(Source: Global Cancer Statistics 2020, Globocan)

Stomach cancer is still a significant cause of death worldwide, accounting for over one million new cases in 2020 and an estimated 769,000 deaths (equating to one out of every 13 deaths), ranking fifth in incidence and fourth in mortality. Stomach cancer incidence rates are highest in Eastern Asia (Japan and Mongolia have the highest incidence rates in men and women, respectively) and Eastern Europe 18. In contrast, rates in Northern

America and Northern Europe are generally low and comparable to those across African regions. (Fig.3)

Low socioeconomic status groups are more likely to use tobacco products, consume unhealthy foods, be physically inactive, and be overweight or obese (Shaikh, 2015). Behavioral and metabolic risk factors contribute significantly to NCDs (Esmailnasab, 2012). They are often interrelated and include unhealthy diet, insufficient physical activity, smoking, excessive use of alcohol, raised blood pressure, overweight and obesity, and abnormal blood lipid levels. Further, socio-demographic factors such as age, gender, and education have been associated with increased NCD risk (Ahmed, 2019).

According to the WHO, "Behavioral and metabolic risk factors play a significant role in the development of disease, chronic respiratory disease, and cancer." These risks are mainly artificial and relate to how we live, age, work, and play, and are driven by urbanization, population aging, and trade, so premature death and disability due to NCDs can be viewed as failures of a more extensive socioeconomic system

Along with higher mortality from cancer over the following decades, an increased burden for health systems is expected in line with population projections (Nations, 2019).

The global cancer burden is expected to be 28.4 million cases in 2040, a 47% rise from 2020, with a more significant increase in transitioning (64% to 95%) versus transitioned (32% to 56%) countries due to demographic changes. However, this may be further exacerbated by increasing risk factors associated with globalization and a growing economy (Sung et al., 2021). The predicted global cancer burden is expected to exceed 27 million new cancer cases annually by 2040, a 50% increase from the estimated 18.1 million new cancer cases in 2018 (WHO, 2020).

2.2 Socioeconomic and health status of Mongolia

Mongolia is the world's 19th largest country by land mass, located in Eastern Asia and bordered by the Russian Federation and China. With a total land area of 1.6 million square kilometers, the country is one of the world's least populated.

Mongolia is a low-income country with a population of 3.49 million people. By 2021, children under the age of 15 were 32.2, people aged 15 to 64, and people aged 65 and up accounted for approximately 63.4 and 4.5 percent of the total population, respectively. Around 69.4 percent of the total population lives in cities, while the remaining 30.6 percent lives in rural areas. Ulaanbaatar, the capital city, has a population of nearly 1.6 million people (48.1% of the total). With a sex ratio of 96 men per 100 women, 49.1% of the population is male, and 50.9% is female.

The average life expectancy of a Mongolian person was 65.5 in 1965, adding five years in the last 50 years and reaching 70.7 in 2021. Globally, by 2016 the average life expectancy difference between males and females was 4.4 years.

United Nations and World Bank published a report for the performance index on SDG in all countries. Mongolia is listed in 106th place, compared to 165 other countries by SDG performance, and the index was 63.8. Mongolian SDG index score suggests that it will reach the goals; performance is moderate and improving with slow implementation. It shows the performance is average and progressing.

UN SDGs 2030, Mongolia's Sustainable Development Concept 2030, Goal 3, Objective 3, are to reduce the prevalence of common noncommunicable diseases, their risk factors, and preventable mortality and ultimately to reduce the number of deaths from cardiovascular disease and the number of deaths from cancer to 16 and 9 respectively per 10,000 population. (WHO, 2022b)

SDG3 – Good Health and Well-Being

Maternal mortality rate (per 100,000 live births)	45	2017	●	↑
Neonatal mortality rate (per 1,000 live births)	7.9	2020	●	↑
Mortality rate, under-5 (per 1,000 live births)	15.4	2020	●	↑
Incidence of tuberculosis (per 100,000 population)	437.0	2020	●	↓
New HIV infections (per 1,000 uninfected population)	0.0	2020	●	↑
Age-standardized death rate due to cardiovascular disease, cancer, diabetes, or chronic respiratory disease in adults aged 30–70 years (%)	35.0	2019	●	→
Age-standardized death rate attributable to household air pollution and ambient air pollution (per 100,000 population)	156	2016	●	●
Traffic deaths (per 100,000 population)	21.0	2019	●	↓
Life expectancy at birth (years)	68.1	2019	●	→
Adolescent fertility rate (births per 1,000 females aged 15 to 19)	30.5	2019	●	→
Births attended by skilled health personnel (%)	99.3	2018	●	↑
Surviving infants who received 2 WHO-recommended vaccines (%)	96	2020	●	↑
Universal health coverage (UHC) index of service coverage (worst 0–100 best)	63	2019	●	→
Subjective well-being (average ladder score, worst 0–10 best)	5.7	2021	●	↑

Figure 4. Sustainable development goal

Performance indicators by value, year, rating, and trend (SDG, 2022)

According to SDG 2022 global health and well-being report, the tuberculosis incidence rate, probability of dying for a 30-year old person due to cardiovascular, cancer, diabetes, and chronic respiratory diseases, and death rate due to road traffic injuries indicators trend is shown by the "score is declining and needs to improve."

In the long-term development policy document "Vision 2050" of the Mongolian government, the goal was to develop an active lifestyle with healthy habits and develop a quality, accessible and effective system of healthcare. Additionally, the government is supporting the establishment of community health centers in local areas following the goal of strengthening the public health system at the national level.

2.3 Cancer situation in Mongolia

Cancer is the leading cause of death and produces a heavy disease burden in Mongolia. According to WHO estimation, the probability of dying in 30-70 years-old Mongolian population due to 4 leading causes of NCDs is 30.2% which is higher than global (18.3%) and regional (16.2%) averages by 11.9% and 14%, respectively (Ministry of Health, 2019).

In Mongolia, during 2008–2012 years the leading cancer sites in men were liver (43% of male cancers), stomach (18%), lung (12%), esophagus (7%), and colorectal (3%), while in women, liver (35% of female cancers), cervix (15%), stomach (11%), esophagus (7%) and breast (6%) cancers were most common (Chimed et al., 2017).

Liver cancer was the most frequently diagnosed in both sexes across regions, with the ASRs much higher than other cancers (114.7 for males, 74.6 for females). Liver cancer was the most frequently diagnosed in both sexes and across regions, with the ASRs much higher than other cancers (114.7 for males, 74.6 for females). The Eastern part had the highest rates of liver cancer (148.9 and 103.8 for men and women, respectively). Stomach cancer was the second leading site for men with ASRs of 48.8 and third in women (21.9). Both sexes observed the highest incidence rates of stomach cancer in the Western region. Among women, cancer of the cervix uteri was the second leading site with a national average ASRs of 24.6 and the highest incidence rates in the Central-Gobi region (Chimed et al., 2017).

Mongolia ranks first in the world in terms of cancer deaths, leading in the incidence and mortality of liver cancer.

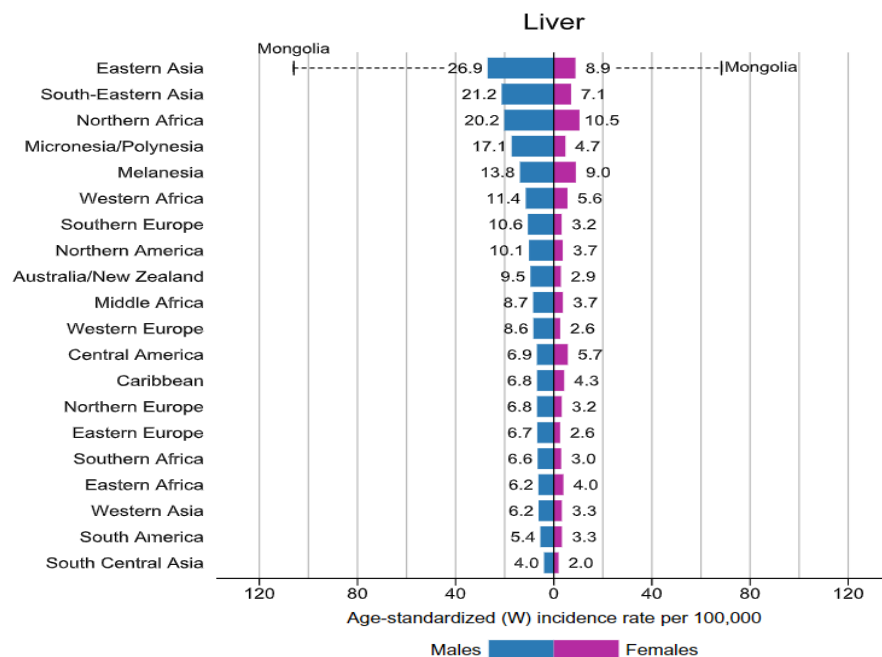


Figure 5. Region-specific incidence Age-Standardized Rates
by sex for liver cancer in 2020.

Rates are shown in descending order of the world (W) age-standardized rate among men,
 and the highest national rates among men and women are superimposed

(Source: Global Cancer Statistics 2020, Globocan).

According to an International Journal of Cancer report, In Mongolia, 21,564 new cancer cases were diagnosed between 2008 and 2012, with males accounting for 52% of the cases. In men, the most common cancer sites were the liver (43% of male cancers), the stomach (18%), the lung (12%), the esophagus (7%), and the colorectal (3%), while in women, the most common cancer sites were the cervix (15%), the stomach (11%), the esophagus (7%), and the breast (6%) (Chimed et al., 2017).

Among the population of Mongolia, 5981 new cancer cases were registered in 2021. The structure of cancer cases was liver cancer at 32.7%, stomach cancer at 16.1%, lung cancer at 7.5%, esophagus at 5.7%, cervical cancer at 5.2%, and the above cancers account for 67.2% of all cancers (Mongolia, 2021). Among men, cancer of the liver, stomach, lung, trachea, esophagus, colon, and rectal cancer is the most prevalent, and among women, cancer of the liver, cervix, stomach, breast, and esophagus. The incidence rate of liver cancer is 68 per 100,000 males and 52 per 100,000 females. A total of 25% of all newly registered cancer cases were diagnosed in stages 1-2, and 75% in late stages (Mongolia, 2021).

According to cancer incidence and control in Mongolia: Results from the National Cancer Registry 2008–2012 research, liver cancer was the most commonly diagnosed cancer in both sexes and across regions, with ASRs significantly higher than other cancers (114.7 for males, 74.6 for females). The Eastern part had the highest rates of liver cancer (148.9 and 103.8 for men and women, respectively) (Chimed et al., 2017)

In 2021, 115 new cancer cases were registered in children aged 0-19 in Mongolia. Leukemia accounts for 37%, cancer of the brain and nerve 15%, cancer of bone cartilage 6%, and ovarian cancer 3% in the structure of cancer incidence in children aged 0-19 years.

A total of 24,141 people died from cancer in Mongolia at the end of 2021, of which 456 (1.8% of the total population) were children aged 0-19. A total of 41% of people living five years or more have cancer under control (Mongolia, 2021).

As of 2021, deaths due to cardiovascular system diseases are 18.9 per 10,000 population, cancer 12.9, accidents and external causes 9.2, digestive system disorders 3.5, and respiratory system disorders 2.9, the leading five mortality causes.

Noncommunicable diseases account for 85.9 percent of the population's deaths, including one in three cases of CVD, one in four cancer, and one in five deaths from injury, poisoning, and external causes.

Cancer has been the second mortality reason in Mongolia in the last ten years. (Fig. 6).

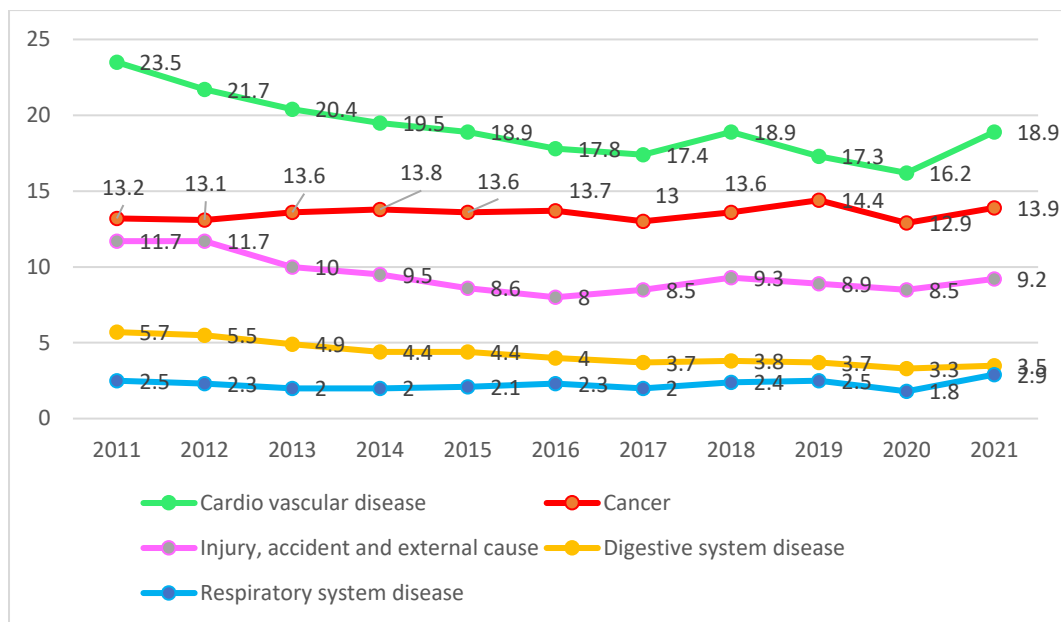


Figure 6. The leading five causes of population mortality,
Mongolia 2011-2021 (per 10,000 population)

Compared to other LMICs, Mongolia has the second highest prevalence of cancer and NCDs in the world. In addition, the evaluation determined that more than 70% of the health sector's budget is spent on expensive diagnosis and treatment of chronic and late-stage diseases.

Affects the development of cancer and NCDs among Mongolians

- Regular smoking every day
- Consumption of fewer than five units of fruits and vegetables per day
- lack of mobility
- Overweight and obese

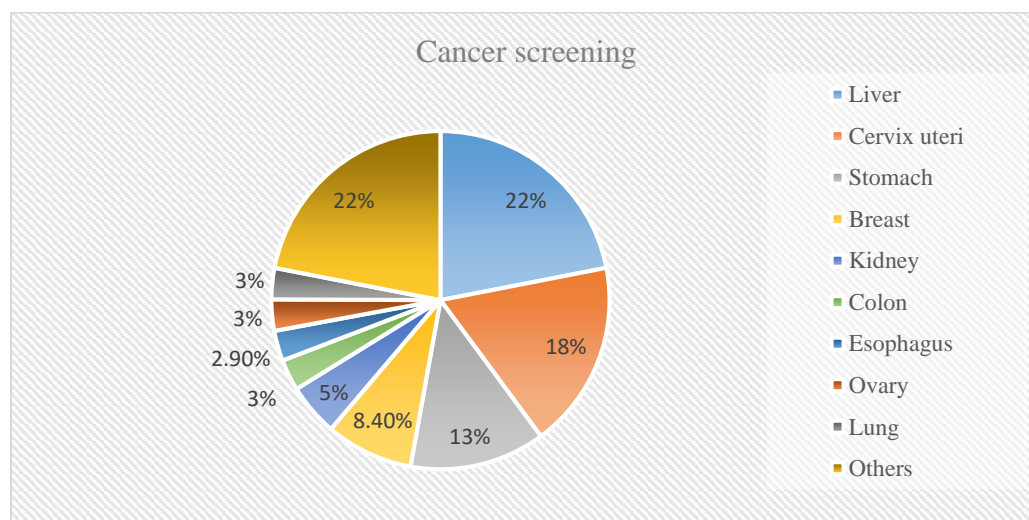
Only 3.9% of the population do not have any of these five risk factors of high pressure or are not at risk of developing CKD (Ministry of Health, 2019). In Mongolia, HBV and HCV and co-infections of HBV carriers with HCV or hepatitis delta viruses, as well as

alcohol consumption, all contribute to the high burden (Sandagdorj et al., 2010). As of 2016, more than 5,900 people were diagnosed with cancer annually, 78 percent of which were diagnosed at an advanced stage, and the number of new cancer cases was expected to increase to 7,500 by 2025. (Ministry of Health, 2019)

2.4 National cancer registry data in Mongolia

National cancer registry data with good quality and representativeness can reflect the country's cancer burden. In Mongolia, the Ministry of Health launched the national program cancer registry in 2011. The national cancer registry department is included in the National Cancer Center, responsible for collecting, evaluating, and publishing national cancer statistics from local population-based cancer registries of Mongolia.

According to the year-end report of 2021 in Mongolia, 24,141 people are under the supervision of district oncologists due to cancer, of which 36.3% are men and 63.7% are women. Of the 456 children aged 0-19 who are being monitored due to cancer, 57% are male, and 43% are female.



**Figure 7. The structure of cancer incidence percentage in Mongolia
by cancer screening (2021)**

Figure 7 illustrates that liver cancer accounted for 22%, cervix uteri cancer 18%, stomach cancer 13%, breast cancer 8%, and kidney cancer 5%; they are 66% of the cancer screening control.

In the number of years lived by date from first diagnosed cancer, 26% are up to 1 year, 10% are 1-2 years, 2-3 years are 8%, 3-4 years are 8%, and 4-5 years are 7%, more than five years accounted for 41%. In terms of survival rate of more than five years after screening, cervix uteri cancer is 62%, which is higher than other cancer sites (Mongolia, 2021 #32).

Table 1. New cases of cancer, percentage, incidence per 100,000 in Mongolia, 2021

(Source: Health indicators of Mongolia, 2021)

Cancer type	Male			Female			Total		
	Case number/ (%)	Per 100,000	World wide	Case number/ (%)	Per 100,000	World wide	Case number/ (%)	Per 100,000	World wide
Liver	1,092 (34.9)	68.7	98.8	864 (30.3)	52.8	61.9	1956 (32.7)	60.6	78.4
Stomach	659 (21.0)	41.4	59.6	304 (10.7)	18.6	21.6	963 (16.1)	29.9	37.8
Lungs and trachea	364 (11.6)	22.9	36.6	82 (2.9)	5.0	5.8	446 (7.5)	13.8	18.6
Cervix				312 (10.9)	19.1	18.4	312 (10.9)	19.1	18.4
Esophagus	191 (6.1)	12.0	18.8	147 (5.2)	9.0	10.8	338 (5.7)	10.5	14.2
Colon and rectal	142 (4.5)	8.9	12.2	136 (4.8)	8.3	8.9	278 (4.6)	8.6	10.3

Table 1 shows that the incidence of liver cancer was 60.6 per 100.000 people in 2021; men were 68.7, and women were 60.6 in Mongolia. Liver cancer, stomach, lung and trachea, cervix, esophagus, and rectal cancers were most commonly registered in 2021.

CHAPTER THREE: CONCEPTUAL FRAMEWORK

3.1 Conceptual framework

We developed a conceptual framework exploring pathways between socio-demographic indicators and cancer outcomes. Based on the evidence obtained from literature reviews, this article attempts to predict several factors and attitudes as mediators in influencing cancer cases among the population.

The framework of this thesis illustrates the three groups of variables. The group variables are personal, social, and cancer special characteristic factors. The personal factor includes age and gender; the social factor includes living area. Cancer's unique characteristic factors include the stage and type of cancer.

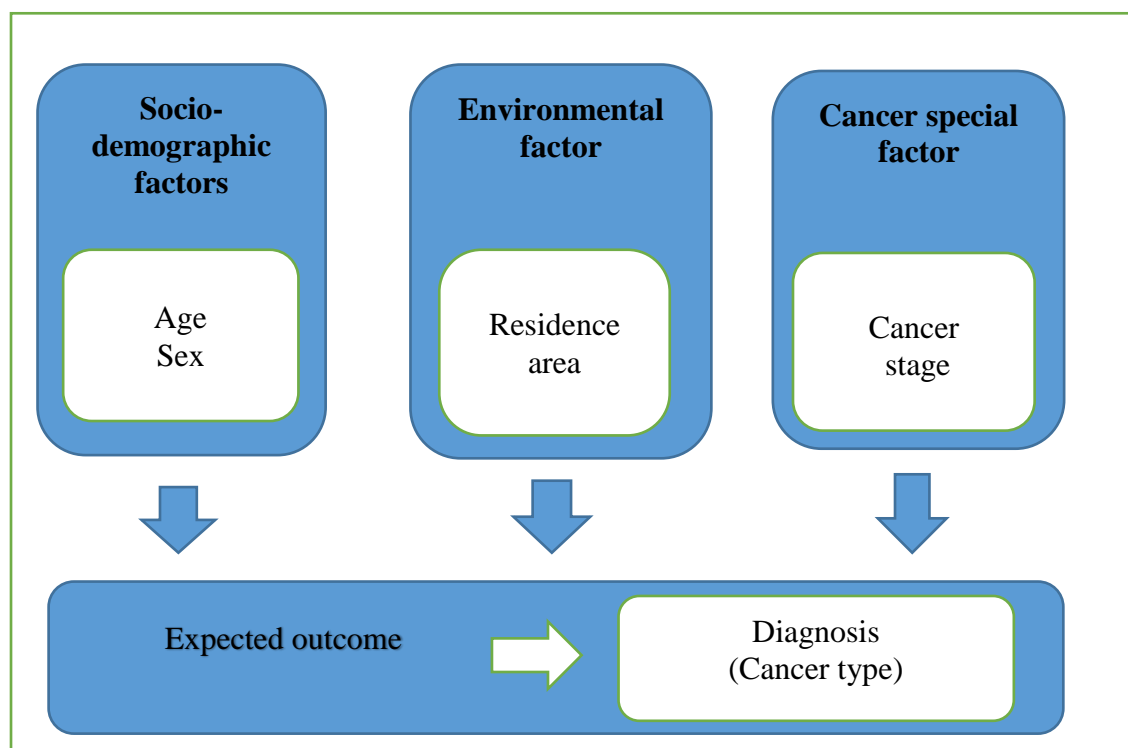


Figure 8. Conceptual framework of cancer and associated factors

3.2 Hypothesis

1. Liver cancer is more common than any other cancer.
2. People who live in urban areas show higher cancer cases than those in rural areas.
3. Most of the tumors were detected at the late stage in Mongolia.
4. Cancer in children is less than in adult cancer cases.

CHAPTER FOUR: METHODOLOGY

4.1 Study Design

A cross-sectional descriptive study was conducted to investigate the association between cancer and risk factors using secondary data on new cancer cases registered in Mongolia from 2017 to 2021.

4.2 Participants

We used secondary data registered in the Health development center for new cancer cases nationwide in Mongolia from 2017 to 2021. Twenty-three thousand four hundred ninety-nine cancer cases were recorded among the population during the target period; our analysis focuses on 18,443 new cases of the typical seven cancer types in all regions of Mongolia.

The population numbers by regions, years, age group, and gender for the last 5 years were downloaded from the website of the National Statistics Committee in Mongolia <https://www.1212.mn/mn>

4.3 Inclusion and exclusion criteria

The eligible subject for this study was the most common seven types (liver, stomach, lung, rectum, breast, cervix, and esophagus) of cancer from 2017 to 2021. The exclusion criteria were different cancer diagnoses that are common types.

4.4 Variables

Dependent variable: - Cancer type (diagnosis)

Independent variables: - Age, sex, residence area, and cancer stage

The age variable was categorized as follows:

1. Represent (0-30 years)
2. Represent (31-45 years)
3. Represent (46-60 years)
4. Represent (61-84 years)
5. Represent (85 years and above)

As for the residence variable, Figure 9 shows that Mongolia is divided into four regions by geographical location, and the capital Ulaanbaatar is included as a separate region.

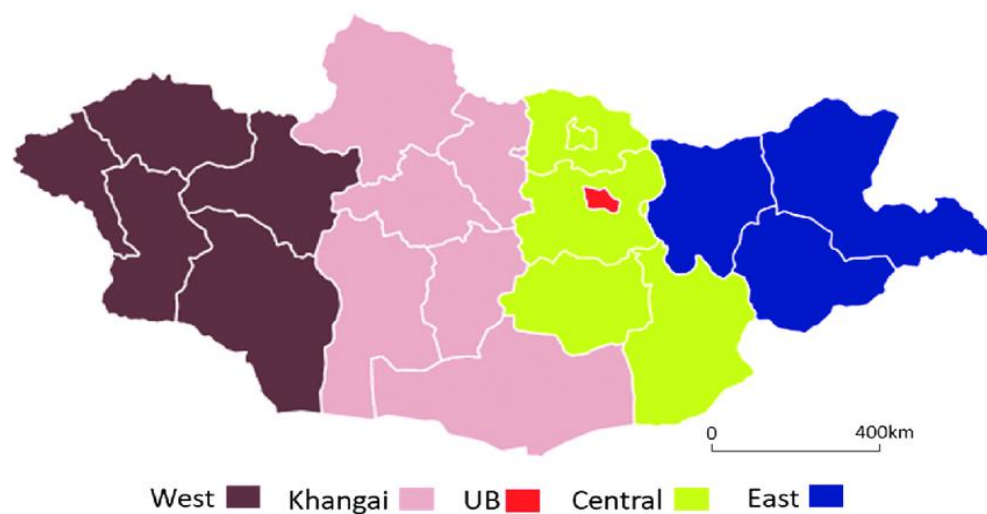


Figure 9. Mongolian map divided by four regions and UB city

In terms of population, 48% (1,639,172) of the total population lives in UB, 17.7% (606,430) people live in the Khangai region, 15.2% (518,344) in the Central-Govi region, 12.2% (418,607) in the Western part, and 6.6% (227,386) in the Eastern Region.

I considered the average human development index and life expectancy by the regions, the highest in the Centra-Govi region, 0.804 (72.26 years). In UB city, and Eastern part (0.797 (71.8 years). In the Western area, 0.791 (71.40 years), and Khangai region, 0.784 (70.95 years).

Regarding the income index, Ulaanbaatar city (0.804) is 0.072 points higher than the national average. At the same time, Eastern Region (0.721), Khangai Region (0.697), Central-Govi Region (0.675), and Western Region (0.620) is 0.011-0.112 points lower than the national average.

The variable of cancer status was classified by tumor stage (primary, malignant, and metastasis period) which is based on registered national cancer data in the health development center of Mongolia.

4.5 Data collection

New confirmed cancer cases are registered with a special "cancer reporting sheet" form at all hospitals and reported to the local health department. Every month, every local health department will send the data to the National Cancer Research Center. The registration and information department of the National Cancer Center will consolidate the data and send it to the Health development center.

National cancer registry data with good quality and representativeness can reflect the country's cancer burden. From 2017 to 2021, 23,499 cancer registries from all 21 provinces in Mongolia, cancer registry data to the national cancer register department at the county level. All cancer cases were coded according to the International Classification of Diseases for Oncology, 3rd edition (ICD-O-3) and the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10).

Cancer registry data submitted to the national cancer register department underwent quality control based on 2019 order A/611 of the Ministry of Health. All

information (diagnosis, gender, age, location, and cancer stage) is included in the national cancer data.

Table 2. The GLOBOCAN 2020 database ICD-10 codes and cancer types

ICD codes	Cancer types
C15	Esophagus
C16	Stomach
C19-C20	Rectum
C22	Liver (including intrahepatic bile ducts)
C33-C34	Lung (including trachea and bronchus)
C50	Female breast
C53	Cervix uteri

4.6 Data analysis

Data were inputted using in Jamovi software program (2.3.18) for analyses (The jamovi project (2022). *jamovi* Retrieved from <https://www.jamovi>)

According to research question №1, the association cancer type compared with age, sex, cancer status, and residence area was calculated using Pearson's Chi-square analysis test. The Chi-square test was used to test how all independent variables relate to the cancer case dependent variable.

Descriptive statistics were performed using frequencies and percentages according to research question №2 (What type of cancer dominates in Mongolia?) The descriptive analysis was used to find standard deviation frequencies and the mean of the respondent's data.

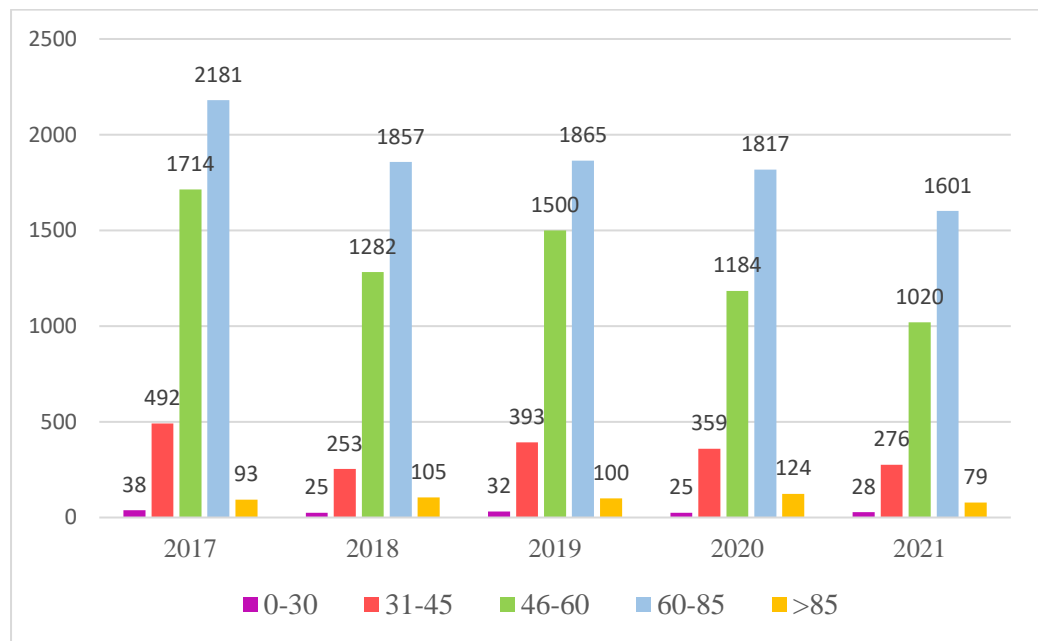
The factors associated with cancer type and socio-demographic characteristics of the patient were examined by the direct method of age-standardized rate with cancer

incidence per 100,000 population based on the research question №3 (What incidence character of last 5 years cancer in per 100,000 population?).

CHAPTER FIVE: RESULTS

5.1 General characteristics of the study population

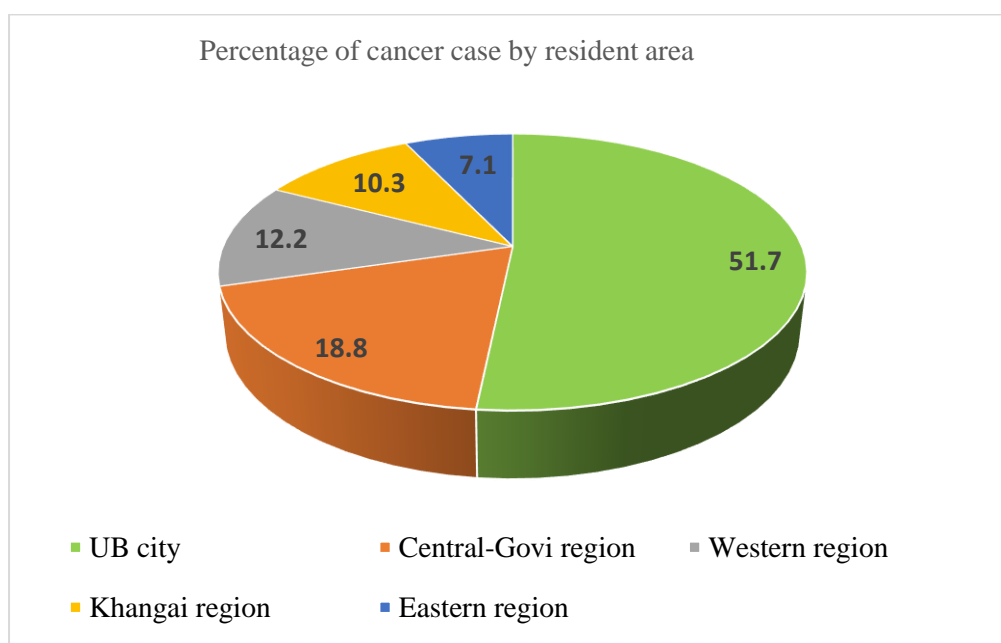
This study includes 18,443 of the seven leading types of new cancer cases registered on the Mongolian national cancer registry. From the data, half of the vast majority, 9321 (50.54%), were aged 61–85, 6700 (36.4%) were aged 46–60, 1773 (9.61%) of the study participants were 31–45 years old, 501 (2.72%) of the participants were above 85 years old, and the remaining 148 (0.8%) were those between the ages of 0–30.



**Figure 10. Age category of the study, registered
by new cancer cases in 2017–2021**

The mean age of the study participants was 60.8 years, and the SD was 13 (Fig 10). Regarding sex, 9851(53.4%) of the new cases were male. The remaining 46.6 % were female.

Additionally, 9530 (51.7%) were living in UB city, 18.8% were from the Central-Govi region, 12.2% (2257) were from the Western part, the remaining 10.3% (1894) and 7.1% (1302) were from the Khangai region and Eastern region, respectively.



**Figure 11. Percentage of new cancer cases
from 2017 to 2021 by resident area**

5.2. Cancer diagnosis and stages

Based on the data extracted from Mongolia's national cancer registry 2017–2021, the cancer diagnosis in stages are described in Table 3 from the study population. The majority of the study population, 82.2 % (14,618), reported to the health facility at

metastasis stage, around 2705 (15.2%) were screened at the malignant, and the rest 2.6 % were screened at the primary stage.

Regarding cancer diagnosis, 7567 (41%) new cases from the study period were diagnosed with liver cancer, 21.2% were diagnosed with stomach cancer, 11.7% of the study population were lung cancer, and the remaining 8.7%, 6.8%, 6.3%, and 4.3% were diagnosed for esophagus, breast cancer, cervix, and rectum cancer, respectively.

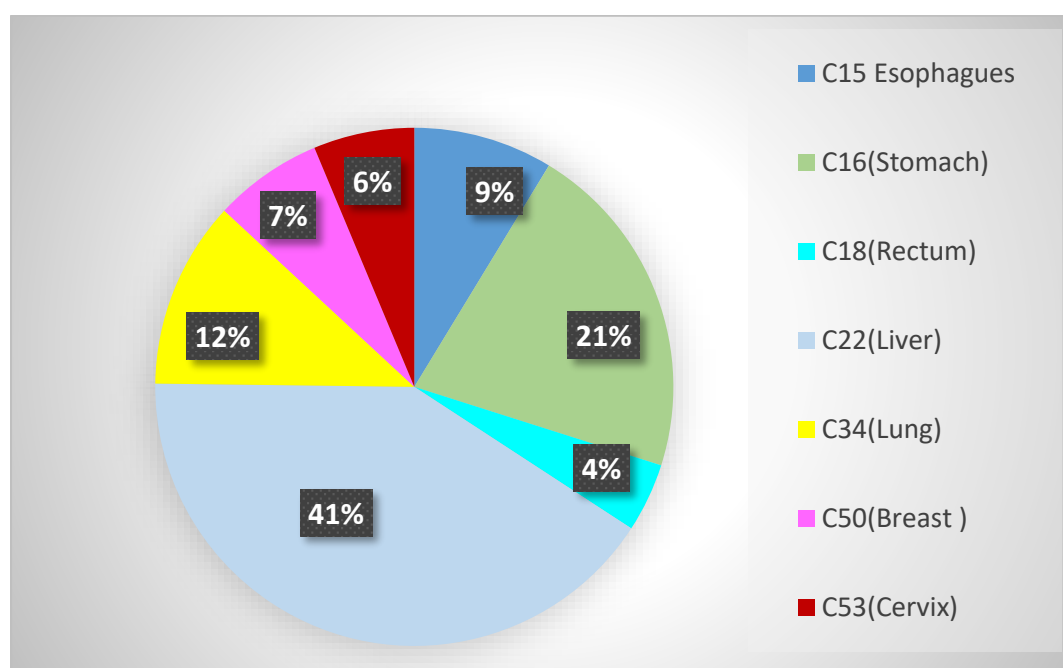
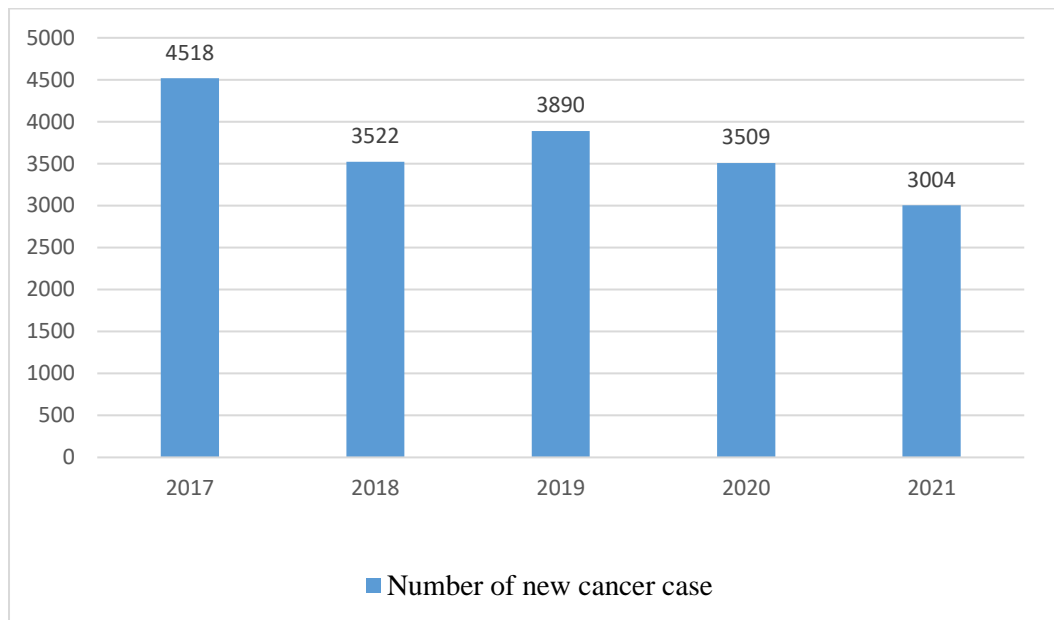


Figure 12. Cancer type registered in 2017-2021, Mongolia

Based on the data from Mongolia's national cancer registry, in the last five years, a total of 21,499 new cancers were registered, 85% (18,433) of which were the leading seven types (liver, stomach, lung, esophagus, rectum, breast and cervix) of cancer.

Within the selected period, 24.5% of all newly registered cancers were diagnosed in 2017, 19.1% in 2018, 21.1% in 2019, 19% in 2020, and 16.3% in 2021.



***Figure 13. The case number of the leading seven types of cancer
 from 2017 to 2021 in Mongolia***

*Table 3. General characteristics of new cancer cases from the
Mongolian national cancer registry, 2007–2021*

Categories	Description	2017-2021 (n=18443)	
		Frequency (n)	%
Age categories	0-30	148	0.8
	31-45	1773	9.6
	46-60	6700	36.4
	61-85	9321	50.5
	>85	501	2.7
Sex	Female	8592	46.6
	Male	9851	53.4
Residence area	UB city	9530	51.7
	Central-Govi region	3460	18.8
	Western Region	2257	12.2
	Khangai region	1894	10.3
	Eastern Region	1302	7.1
Cancer status	Cancer status	missed=658	
	Primary	462	2.6
	Malignant	2705	15.2
	Metastasis	14618	82.2
Cancer type (Diagnosis)	C15 Esophagus	1610	8.7
	C16(Stomach)	3914	21.2
	C18(Rectum)	798	4.3
	C22(Liver)	7567	41
	C34(Lung)	2147	11.7
	C50(Breast)	1210	6.8
	C53(Cervix)	1197	6.3
Period	2017	4518	24.5
	2018	3522	19.1
	2019	3890	21.1
	2020	3509	19
	2021	3004	16.3

5.3 Association between general characteristics and cancer type

Table 4 illustrates the relationship between general characteristics and new cancer cases in Mongolia from 2017 to 2021. The age, sex, residence, and cancer stage gain using Pearson's Chi-square analysis was conducted to examine the association between general characteristics of the seven common types of cancer.

Based on the analysis, the patients' ages, genders, locations, and cancer stages all showed a significant association with cancer type ($p < 0.05$).

Regarding the association between the seven common types of cancer registered in 2017–2021 by age group, liver cancer had the highest association between the ages of 61–85 (22.3%) and 46–60 (15.5%), while stomach cancer had the highest association with the 61–85 age group (10.4%).

In the 0–30 years age group, liver tumors had the highest association (32 cases), but esophagus and lung cancers were the lowest (6) registered. About 9.6% of all cancers occurred in the age group of 31–45, and stomach cancer (440 cases -2.4%) and cervical cancer (415 cases 2.3%) were highly related.

In the 46–60 years age group, 36.4% of cancers occurred of the total number, and the highest association was found in liver cancer, 2855(15.5%), stomach cancer, 1415(7.7), and lung cancer, 696(3.8), respectively.

The 61–85 age group had the most significant number (50.5%) registered from all total tumors. In contrast, liver tumors was the most highly (22.3%) associated, however, breast (1.5%) and cervical tumors (1.2%) were the lowest cases registered in this age group.

Five hundred and one cases were diagnosed among those over 85 years of age, and 211(1.1%) cases were liver tumors.

According to gender, liver tumors, 4176 (22.6%), occurred as the leading case among men, followed by stomach tumors, 2641 (14.3%), and lung tumors, 1745 (9.2%). Among the women, liver cancer was highly associated with 1273 (6.9%) participants, stomach tumors with 3391 (18.4%), and breast and cervix cancer were associated with 1197 (6.5%) participants. Lung cancer was 4.3 times, and stomach cancer was 2.07 more likely than women among men. Rectum cancer cases were similar in both sexes (2.1%; 2.2%).

According to residence variables, 51.7% of all tumors occurred in UB city, and 48.3% occurred in rural areas. Liver cancer, 3126 (16.9%), and stomach cancer, 2078 (11.3%), were the most common in UB city, while rectum cancer showed the lowest association, 502 (2.7%). About 18.8% of all tumors occurred in the Central-Govi region, liver tumors were the highest at 9.0%, and rectal tumors were the lowest at 0.7%.

In the Western Region, liver tumors were about 5.2%, stomach tumors were 3.1%, and esophagus tumors were 1.7%, indicating the first three places association. In the Khangai region, among the 10.3% of total registered cancer patients, 5.6% had liver cancer, 2.1% had stomach cancer, and 2.1% had lung cancer; these were the leading types of cancers. In the Eastern region, liver cancer patients were 4.3% and stomach cancer patients were 1.0%; these were the most common types of cancers.

Considering the type of cancer, esophagus cancer was highly associated in Western region 314 (1.7%), followed by stomach cancer 690 (3.7%), rectum cancer 138 (0.7%), liver cancer 1665 (9.0%), lung cancer 396 (2.1%), breast cancer 133 (0.7%), and cervical cancer 246 (1.3%) in the Central-Govi region.

Cancer status variable: liver cancer (35.6%) was highly associated with diagnosis after the metastasis stage, stomach cancer was at 16.1%, and lung cancer was at 9.9%. The relationship between malignant stage and liver cancer was highly relative (5.7%). If comparing metastasis and primary stage, breast cancer was diagnosed 61.6 time later, while esophageal cancer and liver cancer were diagnosed 52.8 and 47.9 times later, respectively.

**Table 4. Association between independent variables and cancer type (diagnosis)
of new cancer cases in the Mongolian population, 2017–2021 (n=18443)**

Categories	Description	Cancer type							x ²	P
		Esophagus (C15)	Stomach (C16)	Rectum (C18)	Liver (C22)	Lung (C34)	Breast cancer (C50)	Cervical (C53)		
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)		
Age categories	0–30	2(0)	42(0.2)	13(0.1)	37(0.2)	4(0)	19(0.1)	31(0.2)	2624	<0.001
	31–45	51(0.3)	440(2.4)	117(0.6)	358(1.9)	60(0.3)	332(1.8)	415(2.3)		
	46–60	399(2.2)	1415(7.7)	250(1.4)	2855(15.5)	696(3.8)	574(3.1)	511(2.8)		
	61–85	1065(5.8)	1927(10.4)	395(2.1)	4106(22.3)	1318(7.1)	280(1.5)	230(1.2)		
	>85	93(0.5)	90(0.5)	23(0.1)	211(1.1)	69(0.4)	5(0)	10(0.1)		
Sex	Male	892(4.8)	2641(14.3)	384(2.1)	4176(22.6)	1745(9.2)	13(0.1)	0	3706	<0.001
	Female	718(3.9)	1273(6.9)	414(2.2)	3391(18.4)	402(2.2)	1197(6.5)	1197(6.5)		

Categories	Description	Cancer type							x ²	P
		Esophagus (C15)	Stomach (C16)	Rectum (C18)	Liver (C22)	Lung (C34)	Breast cancer (C50)	Cervical (C53)		
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)		
Residence area	UB city	922(5.0)	2078(11.3)	502(2.7)	3126(16.9)	1221(6.6)	917(5.0)	764(4.1)	1106	<0.001
	Central-Govi region	192(1.0)	690(3.7)	138(0.7)	1665(9.0)	396(2.1)	133(0.7)	246(1.3)		
	Western Region	314(1.7)	578(3.1)	64(0.3)	959(5.2)	202(1.1)	63(0.3)	77(0.4)		
	Khangai region	136(0.7)	385(2.1)	47(0.3)	1027(5.6)	190(1.0)	48(0.3)	61(0.3)		
	Eastern Region	46(0.2)	183(1.0)	47(0.3)	790(4.30)	138(0.7)	49(0.3)	49(0.3)		
Cancer status	Metastasis	1269(7.1)	2855(16.1)	501(2.8)	6332(35.6)	1754(9.9)	1048(5.9)	859(4.8)	230	<0.001
	Malignant	217(1.2)	638(3.6)	123(0.7)	1005(5.7)	285(1.6)	144(0.8)	293(1.6)		
	Primary	24(0.1)	125(0.7)	31(0.2)	132(0.7)	91(0.5)	17(0.1)	42(0.2)		
Period	2017	345(1.9)	872(4.7)	215(1.2)	2007(10.9)	416(2.3)	288(1.6)	375(2.0)	400	<0.001
	2018	370(2.0)	699(3.8)	152(0.8)	1537(8.3)	475(2.6)	265(1.4)	24(0.1)		
	2019	379(2.1)	856(4.6)	149(0.8)	1428(7.7)	453(2.5)	306(1.7)	319(1.7)		
	2020	281(1.5)	819(4.4)	136(0.7)	1361(7.4)	447(2.4)	183(1.0)	282(1.5)		
	2021	235(1.3)	668(3.6)	146(0.8)	1234(6.7)	356(1.9)	168(0.9)	197(1.1)		

Table 5 presents the association between independent variables and cancer type by target years. The result of the analysis of age, gender, location, and cancer stages all showed a significant association with the cancer type ($p < 0.001$) by year.

Esophageal cancer had the highest association in 2019 for ages 61–85 (5.8%). Estimates of lung cancer showed an association of 0–8.3%, with the highest association between 61–85 years of age and the highest in 2020.

When calculating how breast cancer depends on age, the highest association (2.9%–3.4%) was shown in the 46–60 age group, while cervical cancer showed the highest association in 2020 at 3.7% in the 46–60 age group.

When estimating the sex ratio of the seven most common types of cancer (excluding breast and cervical cancer), men were 49.9% in 2017, 55.3% in 2018, 53.4% in 2019, 54% in 2020, and 55.1% in 2021. The five years average relationship between cancer and gender was 53.54% in men and 46.6% in women. On an average of 5 years, stomach cancer was 14.42% in men, 6.9% in women, and lung cancer was 9.56% in men and 2.2% in women.

According to the location of new cancer cases, liver cancer was the most relevant (21.4%) in 2017, and stomach cancer (11.6%) was the most highly associated in 2020 in UB city. Liver cancer was most relevant in Khangai (6.6%), Western (5.8%), and Eastern (4.9%) regions, while stomach cancer was highest in the Central-Govi region (9.7%) in 2020.

When calculating the cancer stage by an average of 5 years, liver cancer was 34.52% metastasized, and 0.7% were diagnosed at the initial stage. The relationship between the stages of stomach cancer was 15.72% in the metastatic stage and 4.06% in the malignant stage. The primary stage association between esophageal and breast cancers was extremely low at 0.1%.

*Table 5. Association between independent variables and cancer type
of new cancer cases in the Mongolian population by years*

Year	Categories	Cancer type							x ²	P
		Esophagus (C15)	Stomach (C16)	Rectum (C18)	Liver (C22)	Lung (C34)	Breast cancer (C50)	Cervical (C53)		
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)		
2017	Age categories									
	0–18	0	0	0	8(0.2)	0	0	1(0)	638	<0.001
	19–30	0	6(0.1)	3(0.1)	6(0.1)	0	5(0.1)	9(0.20)		
	31–45	12(0.3)	133(2.9)	24(0.5)	100(2.2)	9(0.2)	86(1.9)	128(2.8)		
	46–60	92(2.0)	316(7.0)	71(1.6)	793(17.6)	150(3.3)	130(2.9)	162(3.6)		
	61–85	225(5.0)	398(8.8)	111(2.5)	1060(23.5)	250(5.5)	66(1.5)	71(1.6)		
	>85	16(0.4)	19(0.4)	69(0.1)	40(0.9)	7(0.2)	1(0)	4(0.1)		
2018	0–18	0	1(0)	0	1(0)	1(0)	0	0	277	<0.001
	19–30	1(0)	7(0.2)	4(0.1)	3(0.1)	1(0)	5(0.1)	1(0)		
	31–45	12(0.3)	67(1.9)	24(0.7)	57(1.6)	18(0.5)	71(2.0)	4(0.1)		
	46–60	84(2.4)	256(7.3)	48(1.4)	608(17.3)	159(4.5)	120(3.4)	7(0.2)		
	61–85	255(7.2)	350(9.9)	73(2.1)	830(23.6)	269(7.6)	69(2.0)	11(0.3)		
	>85	18(0.5)	18(0.5)	3(0.1)	38(1.1)	27(0.8)	0	1(0)		

Year	Categories	Cancer type							x ²	P
		Esophagus (C15)	Stomach (C16)	Rectum (C18)	Liver (C22)	Lung (C34)	Breast cancer (C50)	Cervical (C53)		
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)		
2019	0-18	0	1(0)	0	2(0.1)	0	0	0	584	<0.001
	19-30	1(0)	7(0.2)	3(0.1)	7(0.2)	2(0.1)	5(0.1)	4(0.1)		
	31-45	10(0.3)	83(2.1)	21(0.5)	75(1.9)	11(0.3)	77(2.0)	116(3.0)		
	46-60	104(2.7)	319(8.2)	48(1.2)	569(14.6)	164(4.2)	156(4.0)	140(3.6)		
	61-85	241(6.2)	432(11.1)	71(1.8)	733(18.8)	262(6.7)	67(1.7)	59(1.5)		
	>85	23(0.6)	14(0.4)	6(0.2)	42(1.1)	14(0.4)	1(0)	0		
2020	0-18	0	0	1(0)	2(0.1)	0	0	0	510	<0.001
	19-30	0	9(0.3)	0	2(0.1)	0	2(0.1)	9(0.3)		
	31-45	14(0.4)	95(2.7)	23(0.7)	75(2.1)	12(0.3)	50(1.4)	90(2.6)		
	46-60	57(1.6)	277(7.9)	36(1.0)	462(13.2)	127(3.6)	95(2.7)	130(3.7)		
	61-85	193(5.5)	411(11.7)	72(2.1)	763(21.7)	293(8.3)	34(1)	51(1.5)		
	>85	17(0.5)	27(0.8)	4(0.1)	57(1.6)	15(0.4)	2(0.1)	2(0.1)		

Year	Categories	Cancer type							x ²	P
		Esophagus (C15)	Stomach (C16)	Rectum (C18)	Liver (C22)	Lung (C34)	Breast cancer (C50)	Cervical (C53)		
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)		
2021	0-18	0	0	0	4(0.1)	0	0	0	523	<0.001
	19-30	0	11(0.4)	2(0.1)	2(0.1)	0	2(0.1)	7(0.2)		
	31-45	0(0.1)	62(2.1)	25(0.8)	51(1.7)	10(0.3)	48(1.6)	77(2.6)		
	46-60	62(2.1)	247(8.2)	47(1.6)	423(14.1)	96(3.2)	73(2.4)	72(2.4)		
	61-85	151(5.0)	336(11.2)	68(2.3)	720(24.0)	244(8.1)	44(1.5)	38(1.3)		
	>85	19(0.6)	12(0.4)	4(0.1)	34(1.1)	6(0.2)	1(0)	3(0.1)		
2017	Male	156(3.5)	316(7.0)	118(2.6)	923(20.4)	76(1.7)			903	<0.001
	Female	189(4.2)	556(12.3)	97(2.1)	1084(24.0)	340(7.3)	288(6.4)	375(8.3)		
2018	Male	171(4.9)	233(6.6)	79(2.2)	697(19.8)	110(3.1)			474	<0.001
	Female	199(5.7)	466(13.2)	73(2.1)	840(23.9)	365(10.4)	265(3.1)	24(0.7)		
2019	Male	159(4.1)	249(6.4)	78(2.0)	618(15.9)	85(2.2)			974	<0.001
	Female	220(5.7)	607(15.6)	71(1.8)	810(20.8)	368(9.5)	306(7.9)	319(8.2)		
2020	Male	132(3.8)	270(7.7)	63(1.8)	607(17.3)	76(2.2)			738	<0.001
	Female	149(4.2)	549(15.6)	73(2.1)	754(21.5)	371(10.6)	183(5.5)	282(8.0)		
2021	Male	100(3.3)	205(6.8)	76(2.5)	546(18.2)	55(1.8)			618	<0.001
	Female	135(4.5)	463(15.4)	70(2.3)	688(22.9)	301(10.0)	168(5.6)	197(6.6)		

Year	Categories	Cancer type							x ²	P
		Esophagus (C15)	Stomach (C16)	Rectum (C18)	Liver (C22)	Lung (C34)	Breast cancer (C50)	Cervical (C53)		
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)		
Residence area										
2017	Khangai region	24(0.5)	81(1.8)	15(0.3)	296(6.6)	39(0.9)	13(0.3)	18(0.4)	280	<0.001
	Central-Govi region	38(0.8)	138(3.1)	26(0.6)	346(7.7)	71(1.6)	18(0.4)	48(1.1)		
	Eastern Region	14(0.3)	30(0.7)	8(0.2)	171(3.8)	22(0.5)	8(0.2)	8(0.2)		
	Western Region	63(1.4)	94(2.1)	12(0.3)	226(5.0)	28(0.6)	14(0.3)	21(0.5)		
	UB city	206(4.6)	529(11.7)	154(3.4)	968(21.4)	256(5.7)	235(5.2)	280(6.2)		
2018	Khangai region	19(0.5)	60(1.7)	5(0.1)	164(4.7)	23(0.7)	2(0)	0	277	<0.001
	Central-Govi region	44(1.2)	116(3.3)	22(0.6)	341(9.7)	87(2.5)	18(0.5)	6(0.2)		
	Eastern Region	8(0.2)	23(0.7)	9(0.3)	142(4.0)	20(0.6)	12(0.3)	0		
	Western Region	78(2.2)	119(3.4)	14(0.4)	200(5.7)	50(1.4)	12(0.3)	3(0.1)		
	UB city	221(6.3)	381(10.8)	102(2.9)	690(19.6)	295(8.4)	221(6.3)	15(0.40)		
2019	Khangai region	37(1)	80(2.1)	7(0.2)	241(6.2)	42(1.1)	16(0.4)	16(0.4)	468	<0.001
	Central-Govi region	41(1.1)	155(4.0)	24(0.6)	378(9.7)	80(2.1)	50(1.3)	62(1.6)		
	Eastern Region	7(0.2)	38(1.0)	13(0.3)	191(4.9)	36(0.9)	3(0.1)	10(0.3)		
	Western Region	66(1.7)	123(3.2)	12(0.3)	190(4.9)	42(1.1)	15(0.4)	18(0.5)		
	UB city	228(5.9)	460(11.8)	93(2.4)	428(11.0)	253(6.5)	222(5.7)	213(5.5)		

Year	Categories	Cancer type							x ²	P
		Esophagus (C15)	Stomach (C16)	Rectum (C18)	Liver (C22)	Lung (C34)	Breast cancer (C50)	Cervical (C53)		
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)		
2020	Khangai region	31(0.9)	94(2.7)	10(0.3)	179(5.1)	51(1.5)	7(0.2)	15(0.4)	188	<0.001
	Central-Govi region	32(0.9)	144(4.1)	35(1.0)	342(9.7)	81(2.3)	27(0.8)	67(1.9)		
	Eastern Region	7(0.2)	47(1.3)	8(0.2)	142(4)	33(0.9)	11(0.3)	18(0.5)		
	Western Region	52(1.5)	127(3.6)	13(0.4)	170(4.8)	42(1.2)	7(0.2)	20(0.6)		
	UB city	159(4.5)	407(11.6)	70(2.0)	528(15)	240(6.8)	131(3.7)	162(4.6)		
2021	Khangai region	25(0.8)	70(2.3)	10(0.3)	146(4.8)	35(1.2)	10(0.3)	12(0.4)	112	<0.001
	Central-Govi region	37(1.2)	137(4.6)	31(1.0)	258(8.6)	77(2.6)	20(0.7)	63(2.1)		
	Eastern Region	10(0.3)	45(1.5)	9(0.3)	144(4.8)	27(0.9)	15(0.5)	13(0.4)		
	Western Region	55(1.8)	115(3.8)	13(0.4)	173(5.8)	40(1.3)	15(0.5)	15(0.5)		
	UB city	108(3.6)	301(10.0)	83(2.8)	513(17.1)	177(5.9)	108(3.6)	84(3.1)		

Year	Categories -ies	Cancer type							x ²	P
		Esophagu s (C15)	Stomach (C16)	Rectum (C18)	Liver (C22)	Lung (C34)	Breast cancer (C50)	Cervical (C53)		
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)		
Cancer statues										
2017	Primary	3(0.1)	25(0.6)	4(0.1)	40(0.9)	16(0.4)	1(0)	6(0.1)	218	<0.001
	Malignant	7(0.2)	62(1.5)	9(0.2)	68(1.6)	5(0.1)	2(0)	71(1.7)		
	Metastasis	306(7.2)	671(15.7)	124(2.9)	1872(43.9)	388(9.1)	285(6.7)	296(6.9)		
2018	Primary	3(0.1)	15(0.4)	3(0.1)	20(0.6)	9(0.3)	1(0)	1(0)	87.9	<0.001
	Malignant	11(0.3)	52(1.5)	8(0.2)	32(0.9)	1(0)	6(0.2)	1(0)		
	Metastasis	340(10.1)	559(16.5)	97(2.9)	1481(43.8)	463(13.7)	257(7.6)	22(0.7)		
2019	Primary	7(0.2)	25(0.70)	990.2)	20(0.5)	21(0.6)	2(0.1)	2(0.1)	216	<0.001
	Malignant	10(0.3)	43(1.2)	12(0.3)	19(0.5)	13(0.3)	5(0.1)	55(1.5)		
	Metastasis	334(8.9)	723(19.4)	123(3.3)	1337(35.8)	413(11.1)	299(8.0)	262(7.0)		
2020	Primary	6(0.2)	27(0.8)	9(0.3)	29(0.8)	32(0.9)	8(0.2)	7(0.2)	213	<0.001
	Malignant	13(0.4)	38(1.1)	5(0.1)	9(0.3)	5(0.1)	3(0.1)	45(1.3)		
	Metastasis	239(6.9)	724(21.0)	120(3.5)	1323(38.3)	409(11.8)	172(5)	230(6.7)		
2021	Primary	5(0.2)	33(1.1)	6(0.2)	23(0.8)	13(0.4)	5(0.2)	26(0.9)	742	<0.001
	Malignant	176(6.0)	443(15.0)	89(3.0)	877(29.7)	261(8.8)	128(4.3)	121(4.1)		
	Metastasis	50(1.7)	178(6.0)	37(1.3)	319(10.8)	81(2.7)	35(1.2)	49(1.7)		

**Table 6. Average annual numbers of new cases and age-standardized rates
(ASR) per 100,000 population of leading cancers in Mongolia, by region,
gender, cancer type, 2017–2021**

Categories	No. of cases	Person-year at risk	Age-specific cancer incidence (per 100,000/ years)
Age group			
0-30	148	1,779,363.00	8.32
31-45	1773	779,290.00	227.51
46-60	6700	504,980.00	1,326.79
>61	9822	232,511.00	4,224.32
Residence area			
UB city	9530	1,546,124.00	616.38
Central-Govi region	3460	513,718.00	673.52
Western Region	2257	411,083.00	549.04
Khangai region	1894	602,769.00	314.22
Eastern Region	1302	222,451.00	585.30
Year			
2017	4518	3,177,899	142.17
2018	3522	3,238,479	108.75
2019	3890	3,296,866	117.99
2020	3509	3,357,542	104.51
2021	3004	3,409,939	88.10
Sex			
Female	8592	1,676,779	512.41
Male	9851	1,619,366	608.32
Cancer type			
Esophagus	1610	3,296,145	48.84
Stomach	3914		118.74
Rectum	798		24.21
Liver	7567		229.57
Lung	2147		65.14
Breast	1210	1,676,779	72.162
Cervical	1197	1,676,779	71.387

5.4 Age-standardized rate

According to the age-standardized rate (Table 6), the age group above 60 had a high incidence rate when compared with other age groups which were 4224 per 100,000 population whereas young age groups below 30 had a low incidence rate of 8.32 per 100,000 population.

Conversely, the average cancer incidence in Mongolia in comparison with the residence area Central-Govi region had a higher incidence of 672.53 per 100,000 population. UB city had the second highest incidence rate of 616.38 per 100,000 population and Khangai region had the lowest incidence rate 314.22 per 100,000 population.

According to gender, compared to women (512.41), men had a higher incidence rate of 608.32 per 100,000 population.

In 2017, the largest incidence of cancer was registered (142.17 per 100,000) and in 2021, the lowest incidence (88.10 per 100,000) rate was diagnosed.

Based on ASR average result, liver cancer had a high incidence rate in Mongolia, which was 229.57 per 100,000 population, and stomach cancer had the second highest cancer incidence rate at 118.74. Rectum cancer had the lowest incidence rate at 24.12 per 100,000.

CHAPTER SIX: DISCUSSION

This study investigated the impact of risk factors on the socioeconomic status and personal lives of newly registered cancer patients in Mongolia in the last five years.

According to the findings of this study, 41 % of new cases from the study period were diagnosed with liver cancer, 21.2% were diagnosed with stomach cancer, 11.7% were diagnosed with lung cancer, those who had cancer of the esophagus amounted to 8.7 %, and the remaining 6.8 %, 6.3 %, and 4.3% were diagnosed with breast cancer, cervix, and rectum cancer, respectively.

Approximately 86.9 % of all newly diagnosed cancer patients were aged 46–85, and 53.4% were male between 2017–2021. Based on this survey, 51.7% lived in UB city, and 82.2% were diagnosed at the metastasis stage. Age, sex, residence area, and cancer stages were statistically significant factors positively associated with liver cancer.

This finding is the relative result in other studies conducted in Mongolia 2008–2012 (Chimed et al., 2017), where the leading cancer sites were liver (43% of cancers), with a 2 % decrease, stomach (18%), a 3.2% increase, lung (12%) 0.3% decrease, esophagus (7%) 1.7% increase with this study result, and 3% for colorectal. While in women, liver (35% of female cancers), cervix (15%), stomach (11%), esophagus (7%), and breast (6%) cancers were most common.

Between 2003 and 2007, 17,271 new cases of invasive cancer were recorded (52.2% in males and 47.7% in females). The five leading primary sites in males were

the liver, stomach, lung, esophagus, and colon/rectum, whereas in females, they were the liver, cervix, stomach, esophagus, and breast (Sandagdorj et al., 2010).

This study shows that liver cancer has been most commonly diagnosed in the last five years, which is similar to a study conducted by Ferlay (Ferlay et al., 2013). Liver cancer is by far a leading type of cancer in Mongolia, contributing almost two-fifths of the total cancer burden, the highest rate in the world.

The leading causes of primary liver cancer in Mongolia are chronic infections with hepatitis B (HBV) and C (HCV) viruses, and co-infections of hepatitis B virus carriers with hepatitis C or delta (HDV) viruses, as well as alcohol abuse (Jazag et al., 2012).

The prevalence of hepatitis B and C in Mongolia has the highest ranking among countries of the Western Pacific region (Shin HR (2015 Nov 12.) and globally, with about 10–25% of the population being infected by at least one or more types of viruses. Many are unaware of their status. (de Martel C, 2015 Oct).

In this study, stomach cancer was the second most frequently diagnosed cancer in Mongolia (21.22%), those between 61–85 years most highly associated with stomach cancer ($P < .001$), and men were two times more likely diagnosed than women.

Despite the unexpected triumph of the decline in stomach cancer, the disease remains common worldwide, particularly in Eastern and Southeastern Asia (Ferlay et al., 2019), with the highest incidence of non-cardia gastric cancer estimated in Korea and Japan, as well as in Mongolia (Colquhoun A (2015 Mar 6).

Stomach cancer is associated with overcrowding and *Helicobacter pylori* infections (Goh LY, 2014 Sep;15). *H. pylori* infection prevalence is high in Mongolia,

with around 67% of patients with gastric complaints affected and 76% of those with initially diagnosed stomach cancer (Matsuhisa, (2015)).

Based on the report “Cancer incidence and mortality in Mongolia - National Registry Data,” lung cancer rates were much higher among men than women, with some increases in the rates in men and a slight decrease in women observed relative to the previous period (Sandagdorj et al., 2010).

In this thesis, lung cancer accounted for 11.7% of all cancers, and the case number increased with age. The highest case number was reported in Ulaanbaatar city, and men were four times more affected than women ($P < 0.001$) within the target period.

A study assessing air pollution and related mortality has reported that 40% of lung cancer deaths in Ulaanbaatar may be attributable to urban air pollution, which account for almost 10% of total deaths in the city (Allen RW, 2013 Mar;).

According to the residence variable, 51.6% occurred in urban areas, and 48.4% were in rural areas. The leading sites in the Central Gobi, Khangai, and Eastern regions were liver, stomach, and lung cancers. In the Western part, liver, stomach, and esophagus cancer cases were registered in the first three regions.

Although the highest number of cancer cases had been registered in Ulaanbaatar city, considering the incidence per 100,000 population, the highest number of incidences had been registered in the Central-Govi region (673.52 per 100,000 population) and UB city was the second at 616.38/100,000.

The Eastern region registered the lowest number (1302) of new cancer cases, but the Khangai region had the lowest incidence of cancer cases (314.22) per 100,000 population.

In 2017, the largest incidence of cancer was registered at 142.17 per 100,000 population, which has decreased in the last two years; in 2021, the lowest incidence (88.2 per 100,000) occurred.

In the last two years, due to the COVID-19 pandemic, border controls, lockdowns, isolations, quarantines, and community containments were established, and the number of diagnoses in hospitals has probably decreased.

In this study, the variables showed a significant relationship between increasing age, male gender, and urbanization with cancer.

The focus was to investigate the high number of cases of cancer in Ulaanbaatar city and the Gobi region concerning other risk factors.

About 85% of all tumors were diagnosed in the metastatic stage, thus, there is a need to clarify the causal relationship. Additionally, the study of cancer mortality and morbidity in comparison with other countries is important for the development of evidence-based policies to reduce cancer in the future.

CHAPTER SEVEN: CONCLUSION AND SUGGESTIONS

7.1 Conclusion

The occurrence of cancer is increasing because of the growth and aging of the population, as well as the increasing prevalence of established risk factors such as smoking, being overweight, physical inactivity, HBV, HCV, and H. Pylori associated with urbanization and economic development.

A substantial proportion of cancer can be prevented through the widespread application of existing cancer control knowledge, including tobacco control, vaccination (for liver and cervical cancers), early detection, and the promotion of physical activity and healthy dietary patterns.

Among the general population, liver, stomach, and lung cancer are leading types of cancers, and most people with cancer are over 40 years old.

In many middle-income countries, risk factors for NCDs continue to prevail. The highest levels of smoking prevalence, harmful alcohol consumption, and high blood pressure, globally, are observed in countries from the former Soviet Union and other countries leading to high rates of premature mortality from NCDs, including cancer (WHO, 2020).

The high incidence of liver and stomach cancer can be directly related to food consumption. Thus, it is necessary to promote healthy food, reduce the consumption of sweet products and meat, consume more vegetables, and reduce the consumption of alcohol and tobacco.

Considering this study's results, 82.2% of the tumors were diagnosed after metastases to other organs (the last stage of cancer) in Mongolia.

The following four hypotheses were proposed in the study.

Liver cancer is more common than any other cancer.

People who live in urban areas present with higher cancer cases than those in rural areas.

Most of the tumors were detected at the late stage in Mongolia.

Cancer in children is less than in adults.

According to the results of the study, these hypotheses are confirmed.

7.2 Suggestions

Measures for liver cancer control in Mongolia and prevention programs for viral hepatitis and liver cancer should be implemented.

Early detection health activities at pre-malignant stages should be organized.

Prevention and early detection programs should be implemented for the above 40-years age group.

A coordinated and intensified response from all sectors of society, including governments, civil society, the private sector, and individuals, is required to seize control of the growing burden of cancer.

Healthy habits, such as physical activity, healthy diet, and abstinence from tobacco and alcohol, should be instilled in early life to achieve long-term health benefits.

Since the incidence of liver and stomach cancer in Mongolia is higher than the rest of the world, the specific factors affecting it should be examined.

Limitations of the study

This study is conducted based on secondary data from the national Cancer registry. Some information was not included such as cancer-causing risk factors, number of deaths, health seeking behavior of the family, etc I recommend that other researchers should include basic risk factor information.

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