RESEARCH COMMUNICATION

Cancer Incidence and Mortality in Mongolia - National Registry Data

Tuvshingerel Sandagdorj[1*], Erdenechimeg Sanjaajamts[1], Undarmaa Tudev[1], Dondov Oyunchimeg[1], Chimedsuren Ochir[2], David Roder[3]

Abstract

Background: The National Cancer Registry of Mongolia began as a hospital-based registry in the early 1960s but then evolved to have a population-wide role. The Registry provides the only cancer data available from Mongolia for international comparison. The descriptive data presented in this report are the first to be submitted on cancer incidence in Mongolia to a peer-reviewed journal. The purpose was to describe cancer incidence and mortality for all invasive cancers collectively, individual primary sites, and particularly leading sites, and consider cancer control opportunities. Methods: This study includes data on new cancer cases registered in Mongolia in 2003-2007. Incidence and mortality rates were calculated as mean annual numbers per 100,000 residents. Age-standardized incidence (ASR) and age-standardized mortality (ASMR) rates were calculated from age-specific rates by weighting directly to the World Population standard. Results: Between 2003 and 2007, 17,271 new cases of invasive cancer were recorded (52.2% in males, 47.7% in females). The five leading primary sites in males were liver, stomach, lung, esophagus, and colon/rectum; whereas in females they were liver, cervix, stomach, esophagus and breast. ASRs were lower in females than males for cancers of the liver at 63.0 and 99.1 per 100,000 respectively; cancers of the stomach at 19.1 and 42.1 per 100,000 respectively; and cancers of the lung at 8.3 and 33.2 per 100,000 respectively. Liver cancer was the most common cause of death in each gender, the ASMR being lower for females than males at 60.6 compared with 94.8 per 100,000. In females the next most common sites of cancer death were the stomach and esophagus, whereas in males, they were the stomach and lung. Discussion: Available data indicate that ASRs of all cancers collectively have increased over the last 20 years. Rates are highest for liver cancer, at about four times the world average. The most common cancers are those with a primary site of liver, stomach and esophagus, for which cases fatality rates are high in all populations. Emphasis is given in the National Cancer Control Program (NCCP) to limiting treatment for these and other high-fatality cancers to the small sub-set of potentially curable cases, while focusing on palliative care and patient support for the remainder. Meanwhile opportunities are being pursued to prevent liver cancer through hepatitis B vaccination and lung cancer through tobacco control, and to reduce cervical cancer mortality by finding lesions at a pre-malignant or early invasive stage.

Keywords: Cancer - incidence - mortality - cancer control - Mongolia

Asian Pacific J Cancer Prev, **11**, 1509-1514

Introduction

Mongolia is the fifth largest country in Asia, with a land area of 1,567 million square kilometers and a population approximating 2.6 million, 39% of whom reside in sparsely populated areas. The Mongolian population is young, in that 29% are aged 0-15 years, and only 4% in the age range of 65 years and over. Cardiovascular diseases, cancers and injuries have been leading causes of population mortality since 1995 and numbers of deaths due to these diseases have increased every year. Deaths from cancer account for 22 percent of deaths in females and 19 percent of deaths in males (Health Indicators of Mongolia, 2007).

The health care system in Mongolia provides three levels of services. Primary health care is provided by family doctors through 334 health units distributed throughout Mongolia. Secondary health care is delivered through general hospitals, including 7 in the capital city and 18 in the provinces, and 3 regional health care centers, with a total of 20 specialized oncologists being employed in inpatient units (Health Indicators of Mongolia, 2007). Tertiary cancer care is provided for the whole country through the National Cancer Center. The Center offers a range of medical services, training and research support. It houses the National Cancer Registry and undertakes research in cancer prevention, early detection, diagnosis and treatment.

*[1]Research Training and Information Department, National Cancer Center, Mongolia, [2]Public Health School, Health Sciences University, Mongolia, [3]Research and Information Science, Cancer Council South Australia *For correspondence : gerlee@gmx.de*

The National Cancer Registry began as a hospital-based registry in the early 1970s which then evolved to have a population-wide role (Dorzhgotov, 1989). The Registry collects data on newly diagnosed cancers, deaths from cancer, and cancer care from Mongolia's regional hospitals, which are distributed across 21 provinces and 9 districts, and from 16 specialized hospitals and centers in Ulaanbaatar. The Registry provides the only cancer incidence data available from Mongolia for international comparison.

Materials and Methods

Data for this study were abstracted from Annual Reports of the National Cancer Registry for 2003-2007. These data were notified by service providers on standard forms and processed using Excel software. Specialized cancer registry software is not yet available in Mongolia although its introduction is planned. Data are reported by five-year age, with an open-ended category of 65 years and over. Denominator population data were drawn from data reported by the National Center of Health Development, 2007.

Incidence and mortality rates were calculated as mean annual numbers per 100,000 residents. Age-standardized incidence rates (ASRs) and age-standardized mortality rates (ASMRs) were calculated by the direct method (Jensen et al., 1991) by weighting age-specific incidence and mortality rates to the World Population. (Doll et al., 1966).

Table 1. Primary Sites for Cancers Diagnosed in Mongolia, 2003-2007

Site distribution	Male (%)	Site distribution	Female (%)
Liver	3,723 (41.3)	Liver	2,685 (32.5)
Stomach	1,644 (18.2)	Cervix	1,417 (17.2)
Lung	1,153 (12.8)	Stomach	868 (10.5)
Esophagus	745 (8.3)	Esophagus	686 (8.3)
Colon/rectum	168 (1.9)	Breast	408 (4.9)
Pancreas	151 (1.7)	Lung	352 (4.3)
Bone	140 (1.6)	Ovary	216 (2.6)
Brain/nervous	139 (1.5)	Colon/rectum	210 (2.5)
Lip/oral/pharynx	133 (1.5)	Pancreas	114 (1.4)
Leukemia	97 (1.1)	Lip/oral/pharynx	120 (1.5)
Others	929 (10.3)	Others	1,173 (14.2)
Total	9,022 (100)	Total	8,249 (100)

Results

Cancer incidence

During 2003-2007, 17,271 newly diagnosed cancer cases were recorded by the Registry (9,022 in males, 52%; 8249 in females, 48%). The five leading primary sites in males were liver (41% of male cancers), stomach (18%), lung (13%), esophagus (8%), and colon/rectum (2%); whereas in females, the leading sites were liver (33% of female cancers), cervix (17%), stomach (11%), esophagus (8%), and breast (5%), with lung cancer accounting for another 4% of cases (Table 1).

Tables 2 and 3 show mean annual age-specific incidence rates during 2003-2007, crude rates, and ASRs, both for females and males. Liver cancers accounted for 6,408 cases in both genders, with ASRs of 63.0 per 100,000 females and 99.1 per 100,000 males. In females, cervical and stomach cancers accounted for 1,417 and 868 cases respectively, giving ASRs of 25.4 and 19.1 per 100,000. In males, stomach and lung cancers accounted

Table 2. Total Numbers of Cancers Diagnosed and Mean Annual Age-Specific Incidence, Crude and Age-Standardized Rates (ASR)/100,000 : Females, 2003-2007

Primary site	ICD - 10	Total	0-4	5-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65<	CR	ASR
Lip, Oral, Pharynx	C00-14	120	0.0	0.0	0.0	0.6	0.5	1.2	0.6	2.3	1.4	3.7	8.2	10.2	17.9	1.85	2.60
Esophagus	C15	686	0.0	0.0	0.0	0.0	0.0	0.2	0.6	1.8	5.1	9.1	25.8	72.9	169	10.56	16.70
Stomach	C16	868	0.0	0.1	0.7	0.5	2.3	6.6	9.5	12.1	16.6	25.2	39.3	75.8	146	13.36	19.05
Colon, Rectum, Anus	C18, 19, 21	210	0.0	0.1	0.1	0.0	0.3	1.7	0.8	3.0	4.8	10.7	8.2	24.0	31.4	3.23	4.68
Liver	C22	2685	0.0	0.1	0.4	0.8	0.5	1.7	6.6	25.7	45.2	107	179	321	468	41.31	62.99
Pancreas	C25	114	0.0	0.0	0.0	0.3	0.0	0.2	0.8	0.9	3.4	4.5	6.5	10.2	19.0	1.75	2.56
Larynx	C32	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.4	1.2	2.2	3.8	0.28	0.43
Lung	C33-34	352	0.0	0.0	0.0	0.2	0.5	2.5	1.2	2.3	3.1	7.4	16.4	26.2	81.4	5.42	8.26
Bone	C40-C41	115	0.0	0.8	1.6	0.9	0.3	2.1	1.9	1.6	1.7	3.3	3.5	6.6	10.4	1.77	2.10
Melanoma	C43	32	0.0	0.0	0.0	0.5	0.2	0.0	1.0	0.0	0.3	1.2	0.0	2.9	5.2	0.49	0.67
Soft tissue etc.	C45-C49	99	0.2	0.5	0.3	0.8	0.5	0.6	1.0	1.8	2.0	2.1	4.7	7.3	12.4	1.52	2.01
Breast	C50	408	0.0	0.0	0.1	0.8	0.9	3.7	8.3	19.7	22.2	21.1	22.9	25.5	16.9	6.28	7.53
Cervix Uteri	C53	1417	0.0	0.0	0.1	0.6	5.4	20.9	38.5	61.4	71.0	80.1	60.5	61.2	66.3	21.80	25.40
Corpus Uteri	C54-C55	84	0.0	0.0	0.1	0.2	0.3	0.2	1.0	2.3	2.2	6.2	5.9	7.3	7.2	1.29	1.74
Ovary	C56	216	0.2	0.8	1.4	1.8	1.6	2.3	3.7	5.0	8.1	11.2	7.6	11.7	12.8	3.32	3.93
Kidney	C64	58	0.0	0.0	0.0	0.0	0.3	1.7	1.0	1.4	3.1	2.1	2.9	5.1	3.1	0.89	1.09
Bladder	C67	29	0.0	0.0	0.0	0.0	0.2	0.0	0.4	0.0	0.0	0.4	0.0	2.2	7.6	0.45	0.68
Eye	C69	18	1.3	0.1	0.1	0.0	0.0	0.0	0.4	0.0	0.0	0.4	0.0	1.5	1.4	0.28	0.38
Brain, Nervous	C70-C72	94	0.4	0.5	0.8	0.6	0.9	2.9	1.4	2.5	2.2	5.0	3.5	4.4	5.5	1.45	1.70
Hodgkin disease	C81	27	0.0	0.2	0.3	0.5	0.0	0.2	0.2	0.5	0.6	0.4	0.6	2.2	2.8	0.42	0.51
Non-Hodgkins lymphoma	C82-C85	81	0.2	0.3	0.4	0.0	0.3	0.8	0.0	1.1	1.1	3.7	7.0	9.5	8.3	1.25	1.75
Leukemia	C91-C95	86	0.9	0.7	1.4	1.4	1.2	1.7	0.8	2.3	1.4	0.8	3.5	2.2	2.4	1.32	1.38
Others		432	0.6	0.6	0.5	1.4	3.8	5.8	6.6	8.2	12.1	14.9	18.8	29.1	51.1	6.65	8.71
All Sites Total	C00-C96	8249	3.7	4.6	8.4	11.7	20.1	51.1	86.7	156	207	321	426	721	1150	126.9	176.9

Table 3. Total Numbers of Cancers Diagnosed and Mean Annual Age-specific Incidence, Crude and Age-Standardized Rates (ASR)/100,000 : Males, 2003-2007

Primary site	ICD - 10	Total	0-4	5-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65<	CR	ASR
Lip, Oral cavity and Pharynx	C00-C14	133	0.2	0.1	0.3	0.5	0.5	0.6	1.6	3.5	3.3	8.5	5.9	14.0	19.5	2.15	3.27
Esophagus	C15	745	0.0	0.0	0.0	0.0	0.0	0.6	1.1	6.0	9.7	17.4	47.6	109	198	12.02	22.07
Stomach	C16	1644	0.0	0.0	0.3	0.5	2.4	9.2	20.5	43.4	51.1	64.1	114	172	284	26.53	42.14
Colon, Rectum, Anus	C18, C19,C21	168	0.0	0.0	0.7	1.1	1.3	2.0	3.6	4.0	4.6	10.2	5.9	15.6	19.1	2.71	3.80
Liver	C22	3723	0.2	0.1	0.1	0.8	1.6	4.9	17.0	58.4	125	234	375	467	589	60.08	99.13
Pancreas	C25	151	0.0	0.0	0.0	0.3	0.0	0.0	2.0	1.8	4.3	8.5	14.3	14.8	27.3	2.44	4.01
Larynx	C32	110	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	1.8	6.7	11.7	20.6	20.0	1.78	3.16
Lung	C33-34	1153	0.0	0.1	0.4	0.2	1.1	0.8	2.9	8.5	17.3	47.2	88.6	141	281	18.61	33.20
Bone	C40-C41	140	0.0	0.4	1.9	2.6	1.3	1.1	1.6	1.8	3.0	10.7	7.8	4.9	11.8	2.26	2.88
Melanoma of Skin	C43	14	0.0	0.1	0.3	0.0	0.0	0.0	0.2	0.3	0.3	0.4	0.0	2.5	1.8	0.23	0.33
Connective, Soft tissue etc	C45-C49	101	0.9	0.3	0.5	0.5	1.5	1.3	2.7	1.3	3.7	2.2	4.6	3.3	11.8	1.63	2.15
Breast	C50	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.8	0.9	0.06	0.12
Male genital organs	C60, C62-63	124	0.4	0.0	0.3	1.0	0.2	1.1	4.0	3.8	3.7	1.8	2.6	6.6	21.4	2.00	2.86
Prostate	C61	17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.7	0.8	5.9	0.27	0.52
Kidney	C64	54	0.2	0.1	0.1	0.3	0.0	0.0	1.1	1.8	1.5	2.2	3.9	2.5	8.2	0.87	1.28
Bladder	C67	72	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.8	2.7	4.9	5.9	4.9	13.6	1.16	1.89
Eye	C69	22	0.9	0.0	0.3	0.0	0.0	0.2	0.0	0.3	0.3	0.9	1.3	0.8	3.2	0.36	0.53
Brain, Nervous system	C70-C72	139	0.4	1.0	1.7	1.1	1.6	3.6	2.7	3.5	4.0	4.9	6.5	9.0	8.2	2.24	2.73
Hodgkin disease	C81	19	0.2	0.1	0.0	0.2	0.4	0.4	0.4	0.3	0.0	0.9	1.3	1.6	1.4	0.31	0.40
Non-Hodgkin lymphoma	C82-C85	81	0.0	0.4	0.5	0.3	0.4	0.0	1.1	0.8	2.1	5.8	5.2	6.6	10.9	1.31	1.94
Leukemia	C91-C95	97	2.4	1.0	1.9	1.3	1.3	2.0	2.9	1.3	0.6	0.9	1.3	3.3	2.3	1.57	1.62
Others		311	0.9	0.4	0.5	0.5	2.0	4.0	3.8	6.0	9.4	14.2	18.9	23.0	50.0	5.02	7.62
All Sites Total	C00-C96	9022	6.5	4.0	9.8	11.4	15.7	28.8	69.7	147	248	447	723	1025	1590	145.6	237.6

for 1,644 and 1,153 cases respectively, giving ASRs of 42.1 and 33.2 per 100,000.

Cancer mortality

During 2003-2007, 14,007 cancer deaths were recorded by the Registry (7,942 in males, 57%; 6,065 in females, 43%). The five leading causes of cancer deaths in males were liver (44% of male cancer deaths), stomach (18%), lung (14%), esophagus (9%), and pancreas (2%); whereas in females the leading causes were liver (42% of female cancer deaths), stomach (13%), esophagus (10%), cervix (8%), and lung (6%), with colorectal cancers accounting for another 3% and breast cancer another 2% of cancer deaths (Table 4).

Tables 5 and 6 show mean annual age-specific mortality rates for 2003-2007, plus crude mortality rates and ASMRs, per 100,000 in females and males. Liver cancer accounted for 6,080 deaths in both genders, equating with an ASMR of 60.7 per 100,000 population in females and 95.0 per 100,000 in males. In females, the next most common causes of cancer death were stomach and esophageal cancers, accounting for 818 and 587 deaths respectively, and giving ASMRs of 18.6 and 14.2 per 100,000. In males, stomach and lung cancers accounted for 1,403 and 1,129 deaths respectively, giving ASMRs of 37.5 and 32.7 per 100,000.

Table 4. Primary Site Distributions for Cancer Deaths in Mongolia, Total Deaths 2003-2007

Site distribution	Male (%)	Site distribution	Female (%)
Liver	3,515 (44.3)	Liver	2,565 (42.3)
Stomach	1,403 (17.7)	Stomach	818 (13.5)
Lung	1,129 (14.2)	Esophagus	587 (9.7)
Esophagus	700 (8.8)	Cervix	470 (7.7)
Pancreas	136 (1.7)	Lung	366 (6.0)
Colon/ rectum	112 (1.4)	Colon/rectum	179 (3.0)
Brain/nervous	109 (1.4)	Breast	146 (2.4)
Bone/cartilage	98 (1.2)	Pancreas	109 (1.8)
Lip/oral/pharynx	88 (1.1)	Ovary	93 (1.5)
Male genital orgs	79 (1.0)	Bone/cartilage	77 (1.3)
Others	573 (7.2)	Others	655 (10.8)
Total	7,942	Total	6,065

Discussion

The descriptive data presented in this report are the first to be submitted on cancer incidence in Mongolia for publication in a peer-reviewed journal. The purpose is to describe cancer incidence and mortality for all invasive cancers collectively, individual primary sites, and in particular, leading sites. An earlier study indicated that the ASR of total cancer increased in males from 171.3 to 199.1 per 100,000 in 1973-1987 (Dorjgotov, 1987). This compares with the ASR estimate from GLOBOCAN 2002 (based on 1999 Mongolian data) of 238.6 and the present 237.6 per 100,000 males. In females, total cancer ASR increased from 103.2 to 138.5 per 100,000 in 1973-1987 (Dorjgotov, 1987), whereas in GLOBOCAN 2002, the ASR was 174 and the present 176.9 per 100.000.

Liver cancer was found to be the leading primary site in both genders. Incidence data for 1973-1987 showed that liver cancer increased in males from 41.0 to 80.6

Table 5. Total Numbers of Cancer Deaths and Mean Annual Age-Specific, Crude and Age-Standardized Rates (ASMR)/100,000 : Females, 2003-2007

Primary site	ICD-10	Total	0-4	5-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	55-59	60-64	65-69	CDR	ASMR
Lip, Oral cavity and Pharynx	C00-C14	74	0.0	0.0	0.0	0.2	0.0	0.2	1.2	0.7	0.6	2.2	7.3	14.5	1.14	1.68
Esophagus	C15	587	0.0	0.0	0.0	0.0	0.0	0.4	0.6	1.4	3.4	10.9	55.4	153	9.03	14.24
Stomach	C16	819	0.0	0.0	0.3	0.2	0.9	4.5	7.0	8.0	9.8	23.0	70.7	169	12.60	18.63
Colon, Rectum, Anus	C18, C19,C21	179	0.0	0.0	0.3	0.3	0.2	1.5	1.7	1.6	2.8	7.5	16.8	30.0	2.75	3.97
Liver	C22	2571	0.0	0.1	0.3	0.8	0.0	1.9	2.9	21.8	37.6	123	315	472	39.56	60.72
Pancreas	C25	110	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.9	2.0	4.8	13.1	19.7	1.69	2.56
Larynx	C32	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.5	3.1	0.23	0.36
Lung	C33-34	369	0.0	0.2	0.0	0.2	0.2	0.6	0.8	1.8	2.2	10.4	23.3	91.8	5.68	8.65
Bone	C40-C41	77	0.0	0.4	1.0	0.6	0.2	0.8	0.8	1.1	0.6	1.5	7.3	9.7	1.18	1.53
Melanoma of Skin	C43	7	0.0	0.0	0.0	0.2	0.0	0.4	0.2	0.2	0.0	0.2	0.0	0.3	0.11	0.11
Connective, Soft tissue etc	C45-C49	62	0.2	0.1	0.4	0.5	0.3	0.6	0.4	2.1	0.6	2.2	2.2	8.3	0.95	1.22
Breast	C50	146	0.0	0.0	0.0	0.3	0.3	1.1	2.9	5.3	5.1	9.7	8.7	10.0	2.25	2.84
Cervix Uteri	C53	470	0.0	0.0	0.0	0.0	1.0	3.6	7.2	13.3	20.5	27.9	32.1	41.4	7.23	9.45
Corpus Uteri	C54-C55	64	0.0	0.0	0.1	0.0	0.0	0.0	0.2	1.8	0.6	3.2	7.3	10.0	0.98	1.44
Ovary	C56	93	0.0	0.1	0.4	0.3	0.7	0.4	1.2	1.4	2.0	5.3	9.5	9.3	1.43	1.94
Bladder	C67	22	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.3	0.7	1.5	4.8	0.34	0.50
Kidney	C64	22	0.0	0.0	0.1	0.0	0.0	0.0	0.4	0.0	0.3	1.2	0.7	4.1	0.34	0.48
Eye	C69	5	0.0	0.1	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.7	0.08	0.09
Brain, Nervous system	C70-C72	74	0.6	0.6	0.4	0.5	0.5	0.2	0.8	0.9	1.7	3.2	5.8	6.2	1.14	1.46
Hodgkin disease	C81	15	0.0	0.0	0.0	0.3	0.2	0.4	0.2	0.2	0.0	0.2	2.2	1.4	0.23	0.29
Non-Hodgkin lymphoma	C82-C85	40	0.0	0.3	0.0	0.0	0.3	0.2	0.0	0.2	0.8	1.7	2.9	6.2	0.62	0.87
Leukemia	C91-C95	59	0.9	0.5	0.7	0.9	0.9	0.6	0.4	1.1	1.4	1.7	2.2	2.4	0.91	1.02
Others		196	0.4	0.3	0.1	0.2	1.0	1.1	2.1	1.8	4.8	6.5	16.8	31.4	3.02	4.26
All Sites Total	C00-C96	6078	2.0	2.6	4.2	5.2	6.8	18.5	32.3	66.0	96.8	249	603	1101	93.5	138.4

Table 6. Total Numbers of Cancer Deaths and Mean Annual Age-Specific, Crude and Age-Standardized Rates (ASMR)/100,000 : Males, 2003-2007

Primary site	ICD-10	Total	0-4	5-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	55-59	60-64	65-69	CDR	ASMR
Lip, Oral cavity and Pharynx	C00-C14	88	0.0	0.0	0.0	0.2	0.0	0.0	0.9	1.0	1.2	6.6	8.2	18.2	1.42	2.40
Esophagus	C15	701	0.0	0.0	0.0	0.0	0.0	0.6	0.4	4.5	9.4	26.2	90.4	199	11.31	20.81
Stomach	C16	1404	0.0	0.0	0.1	0.7	1.5	5.8	11.6	27.8	39.6	64.5	146	294	22.66	37.52
Colon, Rectum, Anus	C18, C19,C21	112	0.0	0.0	0.4	0.3	0.2	0.8	1.8	2.8	2.1	5.3	11.5	19.1	1.81	2.80
Liver	C22	3521	0.0	0.1	0.3	1.3	2.0	3.4	12.7	49.4	110	252	456	616	56.82	94.96
Pancreas	C25	136	0.0	0.0	0.0	0.2	0.0	0.4	1.6	2.0	3.7	9.3	12.3	25.5	2.19	3.58
Larynx	C32	65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.2	3.4	10.7	15.5	1.05	1.91
Lung	C33-34	1132	0.0	0.2	0.1	0.5	0.5	1.0	1.8	8.8	16.7	55.5	138	291	18.27	32.69
Bone	C40-C41	98	0.4	0.1	0.9	0.8	0.4	0.8	2.0	1.5	2.7	6.3	9.0	8.2	1.58	2.17
Melanoma of Skin	C43	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.5	1.6	2.3	0.16	0.29
Connective, Soft tissue etc	C45-C49	64	0.5	0.0	0.4	0.3	0.7	0.6	1.1	0.3	2.7	2.1	4.9	9.1	1.03	1.49
Breast	C50	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.02	0.03
Male genital organs	C60, C62-63	79	0.0	0.0	0.1	0.3	0.4	0.8	2.0	0.3	2.1	0.3	8.2	19.1	1.27	2.07
Prostate	C61	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.8	5.5	0.24	0.46
Kidney	C64	28	0.0	0.0	0.0	0.2	0.0	0.0	0.9	0.3	0.6	0.8	2.5	6.4	0.45	0.73
Bladder	C67	48	0.0	0.1	0.0	0.2	0.2	0.0	0.2	0.3	1.2	3.2	6.6	8.6	0.77	1.30
Eye	C69	12	0.2	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.3	0.0	2.5	2.3	0.19	0.32
Brain, Nervous system	C70-C72	109	0.4	0.6	1.1	0.3	1.5	0.8	1.3	1.5	3.0	5.8	9.9	9.5	1.76	2.38
Hodgkin disease	C81	11	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.8	0.8	2.3	0.18	0.29
Non-Hodgkin lymphoma	C82-C85	58	0.2	0.1	0.1	0.3	0.0	0.0	0.4	0.3	1.5	5.8	3.3	8.2	0.94	1.45
Leukemia	C91-C95	73	1.3	0.6	1.1	0.7	2.2	1.4	1.6	1.8	0.3	1.3	1.6	2.3	1.18	1.23
Others		186	0.7	0.3	0.1	0.2	0.9	1.6	2.2	1.8	5.8	7.4	13.2	37.7	3.00	4.76
All Sites Total	C00-C96	7952	3.6	2.3	4.8	6.4	10.6	18.2	42.7	105	205	458	940	1601	128.3	215.7

per 100,000 (Dorjgotov, 1987) and compares with the ASR estimate from GLOBOCAN 2002 of 98.9 per 100,000 males and the present 99.1 per 100,000 males. In females, liver cancer ASRs increased from 17.7 to 43.6 per 100,000 in 1973-1987 (Dorjgotov, 1987), whereas in GLOBOCAN 2002, the ASR was 57.3 per 100,000 and the present 63.0 per 100.000. Both GLOBOCAN 2002 and the present data show very high ASRs for liver cancer in Mongolia that are more than double the ASRs recorded for the 1970s. Present ASRs appear to be about 4 times the world average for males and about 17 times the world average for females. Even allowing for the potential for some erroneous coding of metastatic lesions of the liver to liver as the primary site, these ASRs are very high. Since 1982-1986, when liver cancer was recorded as the most common cancer in Mongolia, the incidence has increased progressively (Dorjgotov, 1987). The principal factor responsible for high liver cancer rates in Mongolia is considered to be endemic hepatitis infection, although a contribution would be expected in some cases from excess alcohol consumption and tobacco smoking. HCV mono-infection is common in Mongolia and co-infection with HBV and HDV have shown a strong association with the diagnosis of hepatocellular carcinoma at a younger age (Oyunsuren et al., 2002; Franceschi et al., 2008). The great majority of patients with hepatocellular carcinoma (96%) have shown evidence of chronic hepatitis virus infection (Oyunsuren et al., 2006). Since 1990, HBV vaccination of children has taken place and now been extended to cover almost all the childhood population. Hopefully this will lead in time to a reduced incidence of liver cancer. Other initiatives to prevent spread of hepatitis infection through blood transfusion, unprotected sexual activity and other means should also assist.

Stomach cancer is the second leading cancer incidence site in males and the third leading incidence site in females. Incidence data for 1973-1987 showed that stomach cancer ASRs decreased from 52.5 to 48.4 per 100,000 males (Dorjgotov, 1987). The corresponding GLOBOCAN 2002 ASR was 39.2 per 100,000 males, compared with the present 42.4 per 100.000. In females, an increase in ASRs from 23.2 to 29.4 per 100,000 was evident during 1973-1987 (Dorjgotov, 1987), which compares with the GLOBOCAN 2002 estimate of 23.3 per 100,000 females and the present 19.05 per 100,000 females. Collectively, these data point to a reduction in stomach cancer incidence since 1973-1987. A possible reason for this decrease in stomach cancer incidence is improved living conditions and reduction in prevalence of Helicobacter pylori infection. Dietary factors may also be risk factors for this cancer, including a high meat intake and poor food preservation and refrigeration, and potentially high salt intake, low intake of fruit and vegetables and regular alcohol intake (Dorzhgotov. 1989; Nutrition Survey, 2002; Steps Survey, 2006). Salt intake has been recorded as more than two times higher for Mongolians (15g per day) than the salt intake limit (6g per day) recommended by WHO (Steps survey, 2006). In addition, daily intake of fruit and vegetables does not meet the WHO recommendations (400g per day) (Nutrition Survey, 2002). The alcohol consumption of the Mongolian population has been high, with about 61 percent drinking occasionally, 5 percent having moderate amounts, and 0.7 percent drinking frequently (Steps survey, 2006). Further reductions in stomach cancer incidence are likely to follow with better living conditions and improvements in diet.

Cervical cancer was the second leading cancer site in Mongolian females in 2003-2007. Results of the 1973-1987 study showed an increase in cervical cancer ASRs from 24.2 to 32.6 per 100,000 (Dorjgotov, 1987). By comparison, the ASR rate from GLOBOCAN 2002 was 18. 0 per 100,000, compared with the present 25.4 per 100.000 populations. Both figures indicate that the incidence may have reduced since 1987. Squamous cell carcinoma of the cervix continues to be a major health problem in many areas of the Asia Pacific, including the Indian subcontinent and Papua New Guinea, and to a lesser extent South East Asia, Korea and Mongolia (Moore, Tajima, 2004). Human papilloma (HPV) prevalence in Ulaanbaatar is recorded at higher levels than in most other populations in Asia, (Dondog et al., 2008), with HPV-16 being found in 91% samples of all cervical cases (Chimeddorj et al., 2008). HPV vaccination is now being introduced in many countries with advanced economies as an addition to cervical screening. Opportunities exist to trial vaccination in Mongolia, while promoting existing policies to detect cervical cancers at an earlier stage.

Lung cancer is the third leading incidence site in Mongolian males and the sixth leading site in females. During 1973-1987, the male ASR increased from 28.5 to 40.3 per 100,000 (Dorjgotov, 1987). By comparison, GLOBOCAN 2002 indicated an ASR of 31.8 per 100,000 males, compared with the present 33.2 per 100,000. In females, the corresponding ASR increased from 5.1 to 14.5 per 100,000 (Dorjgotov, 1987), with GLOBOCAN 2002 estimating 11.3 per 100,000, and the present study indicating 8.3 per 100.000 population. Overall these data point to a higher incidence of lung cancer in Mongolia now than applying in the 1970s. Smoking is the main risk factor for lung cancer, although regular alcohol intake has also been cited as a possible contributor in Mongolia (Dorzhgotov, 1989). The majority of males smoke and smoking prevalence seems to be increasing. Meanwhile the proportion of females, who smoke, although relatively small, is increasing as well. The importation of tobacco products has increased markedly in Mongolia in recent years. For instance, the number of manufactured cigarettes imported per person increased by 10-15 times between 1997 and 2000, reflecting a rise in tobacco use by the population. Currently 28% of Mongolians are smokers, of which 24% are daily smokers and 3% are non-daily smokers, and the proportion of daily smokers in males is ten times higher than for females (Steps survey 2006). Notably, about 14% of teenagers smoke and 66% are exposed to second-hand smoke (Japan joint survey 2002). The average age of commencement of tobacco smoking has been recorded to be 20 years and the average duration of smoking about 18 years. This long duration of smoking poses a high risk for regular smokers. Most of the regular smokers use manufactured cigarettes (Steps survey 2006). These statistics underscore the primary importance of combating tobacco smoking in Mongolia for the control

of lung and other cancers and for broader chronic disease control.

Esophagus cancer is the fourth leading cancer incidence site in both genders in the Mongolian population. In 1973-1987, the male ASR increased from 24.3 to 29.9 per 100,000 (Dorjgotov, 1987). The corresponding estimate from GLOBOCAN 2002 was 24.5 per 100,000 compared with the present figure of 22.7 per 100,000. Meanwhile the ASR for females increased from 13,4 to 17.3 per 100,000 (Dorjgotov, 1987), which compared with the figure from GLOBOCAN 2002 of 19.6 per 100,000 and the present 16.7 per 100.000. Tobacco smoking is an important risk factor for this cancer, whereas other possible risk factors in Mongolia would include consumption of large amounts of hot tea, or salted hot tea with roast flour and cereals, and perhaps the habit of eating meat at the evening meals and half-chewed food (Dorzhgotov, 1989).

"Down staging" of cancers should be pursued to increase cancer survivals. The ratios of ASRs to ASMR are a crude indicator of survival. The ratios for all cancer sites combined were 1:0.78 for females and 1:0.91 for males in Mongolia, which compare unfavorably with corresponding world-wide estimates from GLOBOCAN 2002 of 1:0.57 for females and 1:0.66 for males. Meanwhile the ASR to ASMR ratio was: for liver cancer - 1:0.96 for females and 1: 0.95 for males, suggesting similarly poor survival outcomes compared with other cancers; for cervical cancer - 1:0.37, indicating better survivals; for stomach cancers - 1:0.97 for females and 1:0.89 for male, indicating poor outcomes broadly similar to those for liver cancer; and for female breast cancer - 1:0.38, indicating similar outcomes to those for cervical cancer.

Several limitations of this study deserve mention. First, the descriptive data provided do not indicate causal relationships. Second, as a specialized registry system was not employed, there is uncertainty about data comparability with data from countries using such systems. Nonetheless the results suggest that total cancer incidence and mortality has increased in the past 20 years in Mongolia, with the leading cancer sites being liver, stomach, and cervix. Emphasis is given in the National Cancer Control Program (NCCP) to limiting treatment resources for liver, stomach, lung, esophageal and other high-fatality cancers to a small sub-set of potentially curable lesions. For the remainder, emphasis is given to palliative services and patient support.

Meanwhile there are opportunities for prevention through reduced tobacco smoking, avoidance of excessive alcohol consumption, continued hepatitis B vaccination, and improvements in diet and living standards. In particular, there are opportunities to prevent: liver cancer through continued hepatitis B vaccination and avoidance of excessive alcohol consumption; and lung cancer through tobacco control. There are also opportunities to finding cervical lesions at a pre-malignant or early invasive stage to reduce mortality from this disease.

Acknowledgments

We specially thank Prof. DM Parkin and MP Curado for their encouragement and help to complete this study.

References

Chimeddorj B, Pak CY, Damdin A, et al (2008). Distribution of HPV-16 intratypic variants among women with cervical intraepithelial neoplasia and invasive cervical cancer in Mongolia. *Asian Pac J Cancer Prev*, **9**, 563-8.

Doll R, PayneP, Waterhouse J (1966). Cancer Incidence in Five Continents: a Technical Report, Berlin, Springer-verlag

Dondog B, Clifford GM, Vaccarella S, et al (2008). Human papillomavirus infection in ulaanbaatar, Mongolia: a population based study. *Cancer Epidemiol Biomarkers Prev*, **17**, 1731-8.

Dorjgotov B (1987). Epidemiology and risk factors of cancers, Mongolia. Mongolia

Dorzhgotov B (1989). Risk factors in the manifestations of the 5 principal forms of cancer in the People's Republic of Mongolia. *Sante Publique*, **32**, 361-7.

Franceschi S, Raza SA (2009). Epidemiology and prevention of hepatocellular carcinoma. *Cancer Lett1*, **286**, 5-8.

Japan joint survey (2002). Mongolia, public health institute of Mongolia and Japan, Kagawa nutrition university, 2002.

Jensen O, Parkin DM, Maclennan R, et al (1991). Cancer registration: Principles and methods. Iarc scientific pub 95, lyon: International agency for research on cancer.

Health Indicators of Mongolia (2007). National center of health development: Ministry of health mongolia

http://www-dep.iarc.fr/Globocan 2002. 2009-10-08

Mongolian steps survey on the prevalence of noncommunicable disease risk factors 2006. Manila, World Health Organization, 2007.

Moore MA, Tajima K (2004). Cervical cancer in the asian pacific-epidemiology, screening and treatment. *Asian Pac J Cancer Prev*, **5**, 349-61.

National cancer control program 2007-2017, Mongolia, Ministry of Health of Mongolia, 2007.

National Cancer Report (2003-2007). National cancer center, Mongolia.

Oyunsuren T, Togos S, Sharav Ch (1996). Prevalence of HBV and HCV in Ulaanbaatar population. *Mongolian Med*, **3**, 21-4.

Oyunsuren T, Kurbanov F, Tanaka Y, et al (2006). High frequency of hepatocellular carcinoma in Mongolia; association with mono-, or co-infection with hepatitis C, B, and delta viruses. *J Med Virol*, **12**, 1688-95.