RESEARCH ARTICLE

Epidemiology of Primary CNS Tumors in Iran: A Systematic Review

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Abstract

Background: Although primary malignant CNS tumors are registered in the national cancer registry (NCR) of Iran, there are no available data on the incidence of the primary malignant or benign CNS tumors and their common histopathologies in the country. This study analyzed the 10-year data of the Iranian NCR from March 21, 2000 to March 20, 2010, including a systematic review. Materials and Methods: The international and national scientific databases were searched using the search keywords CNS, tumor, malignancy, brain, spine, neoplasm and Iran. Results: Of the 1,086 primary results, 9 papers were selected and reviewed, along with analysis of 10-year NCR data. The results showed that primary malignant brain tumors have an overall incidence of 2.74 per 100,000 person-years. The analysis of the papers revealed a benign to malignant ratio of 1.07. The most common histopathologies are meningioma, astrocytoma, glioblastoma and ependymoma. These tumors are more common in men (M/F=1.48). Primary malignant spinal cord tumors constitute 7.1% of the primary malignant CNS tumors with incidence of 0.21/100,000. Conclusions: This study shows that CNS tumors in Iran are in compliance with the pattern of CNS tumors in developing countries. The NCR must include benign lesions to understand the definitive epidemiology of primary CNS tumors in Iran.

Keywords: Benign - malignant - tumor - CNS - epidemiology - incidence - Iran

Asian Pacific J Cancer Prev, **14 (6)**, 3979-3985

Introduction

The incidence of primary CNS Tumors has been estimated as 3.9 and 3.2 per 100,000 person-year worldwide in males and females, respectively (Ferlay et al., 2010). However, the reported incidence of primary CNS tumors is higher in developed countries (Bondy et al., 2008). Nevertheless, the incidence of primary malignant CNS tumors ranges from 2.1 to 5.8 per 100,000 population in the world (Bondy et al., 2008).

The reported incidence of primary CNS tumors has increased from 11.5 in 1994 to 20.1in 2008 per 100,000 persons in the US (Surawicz et al., 1999; Bondy et al., 2008). The incidences of brain and spinal cord tumors in USA are 19.5 and 0.6 per 100,000 individuals, respectively. The importance of descriptive data on the full spectrum of primary brain and spinal cord tumors is mainly for its role of assessing risk factors, finding at-risk populations and as a rich database for studying relatively rare brain tumors (Kurland et al., 1982; Deorah et al., 2006). For the first time, a CNS tumor registry was begun in 1902 by Harvey Cushing (Wahl et al., 2009) and subsequently the registry expanded to other countries. The epidemiologic data from such registries has been published in the US, Canada, France, Denmark, Norway, Finland, Sweden, Australia, India, Korea and Japan (Davis et al., 1999; Kaneko et al., 2002; Bauchet et al., 2007; Pirouzmand and Sadanand, 2007; Deltour et al., 2009; Lee et al., 2010; Baldi et al., 2011; Dobes et al., 2011; Manoharan et al., 2012).

A local cancer registry in Iran began in 1955 with the establishment of Cancer Institute at the University of Tehran (Etemadi et al., 2008). The first formal cancer related data from Iran were published by Habibi in 1962 (Habibi, 1962; Listed, 1977). The late professor Ameli (Ameli et al., 1979; Alimi and Rahimi-Movaghar, 2012) and Ardehali (1990) published the first reports on the brain and spinal cord tumors in Iran in 1979 and 1990, respectively. Since 1984, all pathology centers in Iran are required to (by law from parliament) report all tissues "diagnosed or suspected of cancer/malignant" to the Ministry of Health. Malignant cases are reported according to International Classification of Diseases-Oncology (ICD-O). After the foundation of the National Cancer Registry (NCR) module, several reports for incidence and prevalence of malignancies were published from single centers and/or different provinces/cities of the country

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(Larijani et al., 2004; Babaei et al., 2005; Mohagheghi et al., 2009; Mousavi et al., 2009). There are no accurate published nationwide CNS tumor epidemiology data for Iran, and this makes policy making for prevention, tumor screening and treatment modalities difficult.

This study attempts to report a systematic review of the epidemiology of CNS tumors in Iran, in published and recently unpublished reports of NCR data, and in all available published data from authors in English and Farsi journals, and estimates the incidence of primary benign and malignant brain and spinal cord tumors and their common pathologies.

Materials and Methods

This systematic review was designed in accordance with the PRISMA group guideline of systematic review requirements (Moher et al., 2010). Keywords were selected under the supervision of a neurosurgeon and a medical librarian who designed the appropriate search strategy for each database (Table 1). On April 17th 2012, Medline, Embase, ISI web of knowledge and Google scholar for international papers and three Iranian databases of Scientific Information Database (SID) (http://www.sid.ir), MagIran (www.magiran.com), and IranMedex (www.iranmedex.com) for Farsi articles were searched. Keywords included: central nervous system, brain, intracranial, cerebroventricular, intraventricular, cerebrum, choroid plexus, infratentorial, posterior fossa, pontine, mesencephalic, midbrain, medullary, cerebellum, supratentorial, hypothalamus, pituitary, neoplasm, cancer, malignancy and Iran. Results were integrated into an EndNote X5 library and duplicates were then automatically removed. Two independent reviewers (VRM and SBJ) reviewed the remaining papers. We used ten-year (March 21, 2000- March 20, 2010) raw data of NCR (2000-2009) and percent of coverage of registered primary malignant tumors in 10 years to estimate the incidence of primary malignant brain and spinal cord tumors and their different pathologies.

During the ten years of the registry program, the coverage of 20% in 2000 has progressed to 93% in 2009. To estimate the incidence of common primary malignant brain and spinal cord tumors, we used the accurate data from the last verified year (from March 21, 2009 to March 20, 2010). In this study, metastatic tumors were excluded. Since papers have reported the total count of astrocytoma and glioblastoma together as gliomas, data of glioma were not included in the analysis. NCR data did not include the primary benign tumors of the brain and spinal cord. Therefore, we used data from all available comprehensive single center published papers for primary brain and spinal cord tumors. The ratio of benign to malignant tumors were calculated based on these reports and was used to estimate the incidence of benign tumors in the country. The same process was used for sex and age distributions of the tumors.

Table 1. Search Strategy of Systematic Review of Epidemiology of CNS Tumors in Iran

Medline via Ovid SP

1. exp central nervous system/
2. exp skull/
3. (central nervous system).tw,ot.
4. (skull or crani?).tw,ot.
5. (brain? or intracrani? or cerebroventricular or intraventricular or cerebr? or (choroid plexus) or infratentorial or (posterior fossa) or pontine or mesencephalic or midbrain or medullary or cerebell? or supratentorial or hypothalam? or pituitary or pineal).tw,ot.
6. meninge?.tw,ot.
7. ((spinal cord) or epidural).tw,ot.
8. or/1-7
9. exp neoplasms/
10. (neoplas? or tumor? or cancer? or benign or malignan? or metasta?).tw,ot.
11. (adenoma? or carcino?).tw,ot.
12. or/9-11
13. 8 and 12
14. central nervous system neoplasms/
15. brain neoplasms/
16. meningeal neoplasms/
17. spinal cord neoplasms/
18. (neurocytoma? or pinealoma? or pineoblastoma? or pinealocytoma? or pineocytoma?).tw,ot.
19. ((somatotroph? or corticotroph? or lactotroph?) adj adenoma?).tw,ot.
20. (prolactinoma? or microprolactinoma? or macroprolactinoma?).tw,ot.
21. meningioma.tw,ot.
22. (leptomeningeal adj (neoplas? or tumo?r? or cancer? or benign or malignan? or metasta?)).tw,ot.
23. or/13-22
24. iran/
25. (iran? or persia?).tw,ot,af.
26. or/24-25
27. 23 and 26
28. Limit 27 to animals
29. Limit 27 to humans

Results

Primary searches found 1086 entities in addition to the database of NCR data. Of the primary results, 562 duplicates were removed, and this limited resources to 524 papers. One hundred thirty four papers were then selected based on their relevance to the subject after reading titles and abstracts. Of the initial 134 selected articles, 36 papers were removed because the report was limited to specific tumor types or specific treatment methods, 17 papers were deleted because the reports were limited to data of a specific age groups, 22 papers were reporting the same data of the NCR along with 6 case reports, 17 papers which had no epidemiologic data and 27 papers were rejected following quality control. Therefore, the 10-years data of NCR (2000-2009) and nine papers (Ameli et al., 1979; Ketabchi and Ghodsi, 1989; Ardehali, 1990; Rezaee and Hadadian, 1997; Meshkini et al., 2000; Mahzoni and Mohammadizadeh, 2003; Reyhani-Kermani, 2003; Mehrazin et al., 2006; Seddighi et al., 2010) related to the CNS tumors were selected (Figure 1). These nine CNS papers consisted of seven papers for brain (Ameli et al., 1979; Ketabchi and Ghodsi, 1989; Meshkini et al., 2000; Mahzoni and Mohammadizadeh, 2003; Reyhani-Kermani, 2003; Mehrazin et al., 2006; Seddighi et al., 2010) and two papers for spinal cord tumors (Ardehali, 1990; Rezaee and Hadadian, 1997).

The NCR reports have been published regularly in

Farsi since 2000-2009 and while in its first year, only 20% of the estimated cancer cases were reported; this rate has increased to 93% in 2009. Primary malignant CNS tumors in Iran encompass 2.3% (95%CI: 2.3-2.4) of all primary malignant tumors (Table 2). A total of 10,868 cases of primary malignant brain tumors were registered between 2000 and 2009. In the rechecking the details of the entered data, 66 cases were found to have incompatible site and histologic coding values in the raw data; these cases were removed from the study, hence, 10,802 cases are shown (Table 3). Histologic confirmation was achieved in 94.7% (10,227/10,802) of the cases. Astrocytoma and glioblastoma together form 60.4% of the primary malignant registered brain tumors in Iran (Table 4). Astrocytoma is the most common pathology of the registered tumors, except in 2000 where glioblastoma is registered as the most common type. Astrocytoma and glioblastoma are both more common in males (M/F=1.5 and 1.8, respectively). The incidence of primary malignant CNS tumors was 2.73 per 100,000 for primary malignant

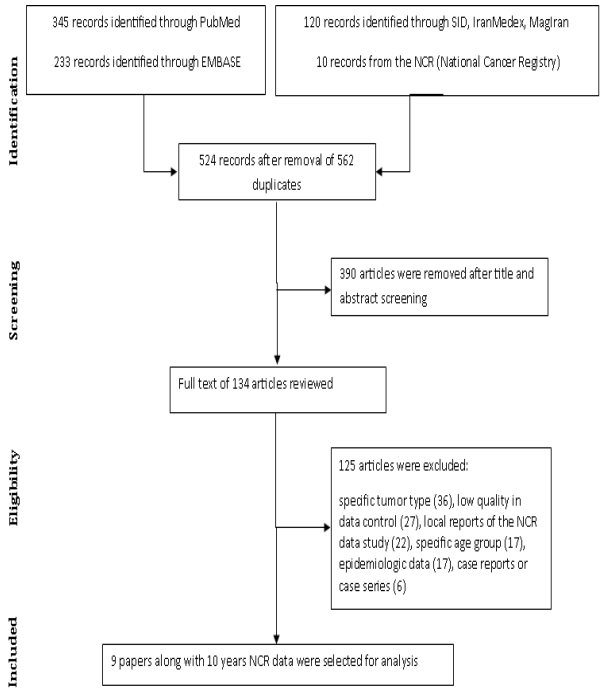

Figure 1. The Algorithm of Paper and Resource Selection

Table 2. Primary Malignant Brain Tumors in Iran Registered in the NCR Database

Year	Brain Tumors			All organ sites	Coverage
	Male	Female	Total		
2000	161	94	255 (1.93)	13240	20%
2001	140	87	227(1.66)	13703	20%
2002	277	185	462(1.76)	26248	41%
2003	543	333	876(2.28)	38468	60%
2004	668	428	1096(2.32)	47217	70%
2005	712	450	1162(2.08)	55855	81%
2006	793	544	1337(2.24)	59786	83%
2007	862	624	1486(2.39)	62040	87%
2008	1183	785	1968(2.66)	74076	93%
2009	1150	849	1999(2.70)	74068	-
Total	6489	4379	10,868(2.34)	464,701	

Table 3. Summary of Registered Brain Tumors between 2000 and 2009 by Sex and Histology in Iran

Histology	ICD-O	Male	Female	Total	Relative frequency (%)
Neoplasm malignant	8000	308	267	575	5.32
Tumor cells, malignant	8001	6	3	9	0.08
Malignant tumor, small cell type	8002	35	20	55	0.51
Malignant tumor, giant cell type	8003	1	0	1	0.01
Malignant tumor, spindle cell type	8004	0	1	1	0.01
Malignant melanoma, NOS	8720	2	1	3	0.03
Sarcoma, NOS	8800	3	1	4	0.04
Spindle cell sarcoma	8801	0	1	1	0.01
Small cell sarcoma	8803	1	0	1	0.01
Desmoplastic small round cell	8806	2	0	2	0.02
Fibrosarcoma, NOS	8810	0	1	1	0.01
Liposarcoma	8851	0	1	1	0.01
Embryonal rhabdomyosarcoma	8910	1	0	1	0.01
Germinoma	9064	16	17	33	0.31
Teratoma, malignant	9080	1	1	2	0.02
Mixed germ cell tumor	9085	2	1	3	0.03
Hemangioendothelioma, malignant	9130	0	1	1	0.01
Hemangiopericytoma, malignant	9150	5	4	9	0.08
Hemangioblastoma	9161	0	1	1	0.01
Pineoblastoma	9362	1	0	1	0.01
Chordoma	9370	3	2	5	0.05
Glioma, malignant	9380	51	31	82	0.76
Gliomatosis cerebri	9381	2	0	2	0.02
Mixed glioma	9382	137	111	248	2.30
Subependymal giant cell astrocytoma	9384	1	0	1	0.01
Choroid plexus papilloma, malignant	9390	8	15	23	0.21
Ependymoma, NOS	9391	188	133	321	2.97
Ependymoma, anaplastic	9392	44	32	76	0.70

Table 4. Number and Relative Frequency of Five Major Primary Malignant Brain Tumors from 2000 to 2009 in Iran

Year	Astrocytoma	Glioblastoma	Oligodendroglioma	Medulloblastoma	Ependymoma	Others	Total
2000	70 (27.6)	98 (38.6)	21 (8.3)	17 (6.7)	6 (2.4)	42 (16.5)	254 (100)
2001	71 (32.6)	72 (33.0)	8 (3.7)	16 (7.3)	9 (4.1)	42 (19.3)	218 (100)
2002	149 (33.3)	119 (26.6)	28 (6.3)	31 (6.9)	17 (3.8)	104 (23.2)	448 (100)
2003	315 (36.0)	240 (27.4)	49 (5.6)	52 (5.9)	32 (3.7)	187 (21.4)	875 (100)
2004	381 (34.8)	324 (29.6)	67 (6.1)	42 (3.8)	33 (3.0)	249 (22.7)	1096 (100)
2005	426 (36.7)	342 (29.5)	76 (6.5)	67 (5.8)	50 (4.3)	200 (17.2)	1161 (100)
2006	459 (34.4)	371 (27.8)	85 (6.4)	96 (7.2)	47 (3.5)	277 (20.7)	1335 (100)
2007	449 (30.5)	444 (30.2)	85 (5.8)	79 (5.4)	59 (4.0)	354 (24.1)	1470 (100)
2008	553 (28.4)	535 (27.5)	124 (6.4)	91 (4.7)	68 (3.5)	576 (29.6)	1947 (100)
2009	555 (27.8)	556 (27.8)	135 (6.8)	85 (4.3)	76 (3.8)	591 (29.6)	1998 (100)
Total	3428 (31.7)	3101 (28.7)	678 (6.3)	576 (5.3)	397 (3.7)	2622 (24.3)	10802 (100)
*	(15.2)	(13.8)	(3)	(2.5)	(1.8)		

*Percentage of different primary malignant brain tumors in all primary benign and malignant brain tumors

brain tumors (Table 5), which comprises incidence rates of 3.10 and 2.37 for males and females, respectively.

Benign brain tumors are not registered in NCR data. A summary of published data is shown in Table 6. Benign CNS tumors range from 30.3% (Seddighi et al., 2010) to 58.2% of all CNS tumors indifferent studies (Meshkini et al., 2000). In the analyzes of the seven available studies, benign tumors composed 51.9% of all primary brain tumors. Meningioma (27.8%), pituitary adenoma (11.3%) and schwannoma (5.9%) are the most common pathologies in benign brain tumors (Table 6). The gender distribution of benign brain tumors was reported in three papers, (Meshkini et al., 2000; Reyhani-Kermani, 2003; Mehrazin et al., 2006) which were analyzed to determine the sex distribution of benign tumors in Iran. Although brain tumors are generally more common in males, meningioma was more common in females (M/F: 0.69).

The mean age and incidence of the most common pathologies of primary brain tumors are shown in Table 7. Analysis of NCR data and published evidence revealed incidence of 2.95 per 100,000 persons for primary benign brain tumors. Three papers have reported the total count of astrocytoma and glioblastoma together as gliomas: these data were not included in the analysis (Ameli et al., 1979; Mahzoni and Mohammadizadeh, 2003; Reyhani-Kermani, 2003). Meningioma as the most common pathology of benign brain tumors has incidence of 1.58 per 100,000 person-years.

Primary malignant spinal cord tumors registered in the NCR are shown in Table 7. In the rechecking process for spinal cord registered tumors, 21 cases were excluded because of coding miss-match. Primary malignant spinal cord tumors composed 7.1% of primary malignant brain tumors which has incidence of 0.21 per 100,000. Malignant neoplasm composes 34.4% of all malignant spinal cord tumors in the NCR data. Primary malignant spinal cord tumors are more common in males, with a male to female ratio of 1.26. A total of 767 cases of primary malignant spinal cord tumors were registered between 2000 and 2009 (Table 8). Published papers of spinal cord tumors in Iran are limited to two studies, (Ardehali, 1990; Rezaee and Hadadian, 1997) which reported the most common pathologies as nerve sheath tumors, meningioma and neuroepithelial tumors (Table 9). Nerve sheath tumors and meningioma together formed 56.4% of primary spinal cord tumors. Therefore, the incidence of these two benign tumors is 0.27 per 100,000. The total primary spinal cord tumors are estimated to be 0.48 per 100,000.Three common pathologies of spinal cord tumors consist of neurofibroma (30.7%), meningioma (25.7%), and malignant neoplasm (15.0%).

Table 5. Age Specific Rate (ASR) of Malignant Brain Tumors in Iran (2009)

		No.	ASR
Age group	0-4	99	1.67
	5-9	68	1.21
	10-14	71	1.17
	15-19	81	1.09
	20-24	115	1.33
	25-29	143	1.77
	30-34	175	2.73
	35-39	180	3.39
	40-44	156	3.41
	45-49	162	4.23
	50-54	165	5.13
	55-59	149	6.3
	60-64	148	8.69
	65-69	114	8.87
	70-74	78	6.97
	74-79	52	6.3
	80+	43	5.31
Overall		1999	2.73

Table 7. Incidence Rate and the Mean Age of Patients of Common Pathologies of Malignant Brain Tumors in Iran Based on NCR Data

	Age at diagnosis (Mean± SD)			Incidence per 100,000 (CI 95%)
	Female	Male	Overall	Overall
Astrocytoma	36.1±17.6	38.0±17.7	37.2±17.7	0.76 (0.70-0.83)
Ependymoma	25.7±17.7	25.7±19.0	25.7±18.4	0.10 (0.08-0.13)
Glioblastoma	50.3±17.0	50.8±16.9	50.6±16.9	0.76 (0.70-0.83)
Medulloblastoma	15.8±12.3	15.6±12.4	15.7±12.4	0.12 (0.09-0.14)
Oligodendroglioma	39.3±14.6	40.0±14.8	39.7±14.6	0.19 (0.16-0.22)
Malignant brain tumors	39.5±19.8	40.7±19.7	40.2±19.8	2.74 (2.62-2.86)

Table 6. Relative Frequency of Brain Tumors in Published Papers of Iran

	Mehrazin et al (1978-2003)	Ketabchi et al (1977-1986)	Ameli et al (1949-1978)	Meshkini et al (1997-2006)	Mahzoni et al (1996-2000)	Reyhani-Kermani et al (1997-2001)	Seddighi et al (2007-2009)	Total
Astrocytoma	747(23.7)	328(13.3)	460(30.7)	158 (13)	135(33.8)	119(35.2)	20 (22.5)	1253/6792 (18.4)
Glioblastoma	162 (5.1)	226 (9.2)		203(16.6)			27 (30.3)	618/6792 (9.0)
Oligodendroglioma	26 (0.8)	48 (1.9)	46 (3.1)	28 (2.4)	26 (6.5)	16 (4.7)	-	190/8961* (2.1)
Ependymoma	143 (4.5)	93 (3.8)	55 (3.7)	54 (4.5)	4 (1)	20 (5.9)	4 (4.5)	373/8961 (4.1)
Medulloblastoma	145 (4.6)	99 (4)	71 (4.7)	5 (0.5)	5 (1.3)	-	3 (3.4)	328/8961 (3.7)
Meningioma	821(26.0)	591(23.9)	435 (29)	353 (29)	184 (46)	97(28.7)	15(16.9)	2496/8961 (27.8)
Pituitary adenoma	448(14.2)	257(10.4)	91 (6.1)	206 (17)	-	-	8 (9)	1010/8961 (11.3)
Schwannoma	255 (8.1)	150 (6.1)	-	86 (7)	28 (7)	16 (4.7)	-	535/8961 (5.9)
Congenital tumors	-	178 (7.2)	23 (1.5)	-	-	15 (4.4)	-	216/8961 (2.4)
Metastasis	-	94 (3.8)	48 (3.2)	40 (3.3)	-	21 (6.3)	5 (5.5)	207/8961 (2.3)
Others	406(12.9)	405(16.4)	271(18.1)	82 (6.7)	18 (4.5)	34 (10)	8 (8.9)	1224/8961 (13.6)
Total	3153 (100)	2469 (100)	1500 (100)	1220(100)	400(100)	338 (100)	89 (100)	9169

*Metastases are excluded from the total number. Parenthesis shows the percentage

Table 8. Primary Malignant Spinal Cord Tumors Registered between 2000 and 2009 in Iran

Morphology	ICD-O	Male	Female	Total	Relative frequency (%)
Neoplasm malignant	8000	137	127	264	34.4
Malignant tumor, small cell type	8002	38	28	66	8.6
Malignant tumor, spindle cell type	8004	3	1	4	0.52
Sarcoma, NOS	8800	1	0	1	0.13
Spindle cell sarcoma	8801	1	1	2	0.26
Small cell sarcoma	8803	1	0	1	0.13
Desmoplastic small round cell tumor	8806	0	1	1	0.13
Germinoma	9064	1	1	2	0.26
Hemangiopericytoma, malignant	9150	0	1	1	0.13
Chordoma	9370	6	5	11	1.43
Glioma, malignant	9380	3	5	8	1.04
Ependymoma, NOS	9391	58	48	106	13.8
Ependymoma, anaplastic	9392	2	3	5	0.65
Papillary ependymoma	9393	4	2	6	0.78
Astrocytoma, NOS	9400	44	25	69	9
Astrocytoma, anaplastic	9401	6	6	12	1.56
Fibrillary astrocytoma	9420	11	6	17	2.22
Pilocytic astrocytoma	9421	3	2	5	0.65
Pleomorphic xanthoastrocytoma	9424	0	1	1	0.13
Glioblastoma, NOS	9440	5	3	8	1.04
Oligodendroglioma, NOS	9450	1	1	2	0.26
Medulloblastoma, NOS	9470	0	1	1	0.13
Primitive neuroectodermal tumor	9473	6	2	8	1.04
Ganglioneuroblastoma	9490	0	2	2	0.26
Neuroblastoma, NOS	9500	3	7	10	1.3
Neuroepithelioma, NOS	9503	0	1	1	0.13
Meningioma, malignant	9530	3	0	3	0.39
Neurofibrosarcoma	9540	6	13	19	2.48
Neurilemmoma, malignant	9560	2	5	7	0.91
Malignant lymphoma					
NOS	9590	27	4	31	4.04
Non Hodgkin, NOS	9591	8	7	15	1.96
Hodgkin disease, NOS	9650	5	2	7	0.91
Malignant lymphoma:					
Small lymphocytic, NOS	9670	4	4	8	1.04
Small cleaved cell, diffuse	9672	2	0	2	0.26
Mixed small & large cell, diffuse	9675	2	5	7	0.91
Large B cell, diffuse, NOS	9680	15	10	25	3.26
Immunoblastic, NOS	9684	2	0	2	0.26
Burkitt's lymphoma, NOS	9687	2	0	2	0.26
Plasmacytoma, NOS	9731	17	7	24	3.13
Multiple myeloma	9732	0	1	1	0.13
Total		429	338	767	

Table 9. Number and Relative Frequency (%) of Spinal Cord Tumors in Published Literature of Iran

	Rezaee et al.	Ardehali*	Total
Neurofibroma	23 (20.9)	44 (40.7)	67 (30.7)
Meningioma	20 (18.2)	36 (33.3)	56 (25.7)
Ependymoma	12 (10.9)	10 (9.3)	22 (10.1)
Astrocytoma	6 (5.5)	5 (4.6)	11 (5.0)
Others	49 (44.5)	13 (12)	62 (28.4)
M:F	1.27	1.08	1.2
Total	110	108	218 (100)

*Metastasis and vertebral malignancies are excluded

Discussion

Based on systematic reviews, the incidence of primary brain tumors in Iran is estimated to be 5.69 per 100,000; benign and malignant brain tumors are estimated to be 2.95 and 2.74 per 100,000, respectively. Percentages of common brain tumor histopathologies are Meningioma (27.8%), Astrocytoma (15.2%), Glioblastoma (13.8%), Pituitary adenoma (11.3%), Schwannoma (5.9%) Oligodendroglioma (3.0%), Medulloblastoma (2.5%) and Ependymoma (1.8%). The incidence of primary spinal cord tumors in Iran is estimated to be 0.48 per 100,000; benign and malignant spinal cord tumors are estimated to be 0.27 and 0.21 per 100,000, respectively. Percentages of common spinal cord tumor histopathologies are Neurofibroma (30.7%), Meningioma (25.7%), and Malignant neoplasm (15.0%).

Between 2004 and 2008, primary brain tumors included 295,986 cases–126,350 males and 169,636 females- across the US with a total incidence rate of 20.1 per 100,000 -7.2 for malignant and 12.9 for non-malignant tumors. The overall incidence is higher in females than males-21.34 versus18.32 per 100,000 persons (Ostrom and Barnholtz-Sloan, 2011; Dolecek et al., 2012). In Saskatchewan, between 1970 to 2001, the incidence of primary brain tumors was 11.1 per 100,000 persons: 12.5 for males and 9.8 for females (Pirouzmand and Sadanand, 2007). In registries of Australia from 2000 to 2008 the overall incidence of primary brain tumors was 11.3 per 100,000 person-years (Dobes et al., 2011).

In a study between 1986-1993 in Spain the incidence of primary brain tumors was 8.34 and 5.40 per 100,000 population of males and females, respectively (Lopez-Abente et al., 2003). The incidence of primary brain tumors in France (Bauchet et al., 2007). was 15.8 per 100,000. The French study shows 39.6% benign, 56.3% malignant and 4.1% unknown cases (Bauchet et al., 2007). In the report of the cancer registry of Korea in 2005, the incidence of primary brain tumors was 11.69 per 100,000 population (Lee et al., 2010). Manoharan et al. (2012) reported primary brain tumors in Delhi showing an incidence rate of 3 and 2 for males and females per100,000, respectively (Manoharan et al., 2012).

The worldwide incidence of primary malignant brain tumors is reported as 3.7 for males and 2.6 for females per 100,000. These rates are higher in developed countries: 5.8 and 4.1 in 100,000 males and females, respectively. Underdeveloped countries report a lower incidence as 3 and 2.1 per 100,000 cases in males and females (Bondy et al., 2008).

It seems that the reported incidence of brain tumors is related in part to the economy of various countries. The highest rates of incidence are seen in North America, Australia (Dobes et al., 2011), and Western Europe, (Deltour et al., 2009) and the lowest incidences are reported in Asia, Central and South American regions (Ferlay et al., 2010). The GLOBOCAN 2008 study published in 2010, estimated the highest incidence of primary brain tumors in North Europe, and the lowest incidence in Eastern Africa (Ferlay et al., 2010). The incidence of brain tumors in Iran is lower than in developed countries. Primary malignant brain tumors in Iran are more common in males with a male to female ratio of 1.48; the higher proportion of tumors in males is in accordance with global distribution of tumors. In

our study all tumors except meningioma were diagnosed more commonly in males, which is in compliance with the worldwide distribution of primary brain tumors. However, the incidence of primary brain tumors in the US (Dolecek et al., 2012), Korea (Lee et al., 2010) and France (Baldi et al., 2011) is more frequent in females. This might be due to the higher rate of meningiomas (30.6% and 35%) and lower rates for gliomas (17% and 30%) in Korea and US, respectively. It might be noted that the broad category of benign tumors is registered in the series from the US and Korea, while benign tumors in Iran are estimated based on available evidence.

Spinal cord tumors in Iran composed 7.1% of all CNS tumors, while in the US spinal cord tumors form only 3% of all CNS tumors (Dolecek et al., 2012). The most common pathologies for spinal cord tumors of US are meningeal tumors, nerve sheath tumors and ependymoma. (Dolecek et al., 2012).

Su et al. (1997) have reported the results of surgically treated spinal cord tumors between 1988 and 1995 in Taiwan. In their report of 117 patients, 69 were males and 48 were females. The most common pathologies were metastasis (45.3%), nerve sheath tumors (28.2%), meningioma (12%), and neuroepithetial (6%) tumors. Studies in Iran (Ardehali, 1990; Rezaee and Hadadian, 1997) have also reported the same common pathologies. However, it should be noted that one third of primary malignant spinal cord tumors are in malignant neoplasm group of unknown pathology, some of which may be due to radiologic diagnosis, non-operated or inoperable cases. Nevertheless, in the US only 2.6% of spinal cord tumors are in the unclassified neoplasm category (Dolecek et al., 2012).

In the registry process many cases had failed to be diagnosed pathologically due to early death, refusing surgery, inappropriate tumor location for biopsy or surgery, etc. These tumors are collectively accounted for as malignant neoplasm in the registry system.

The main limitation of the NCR system is that benign lesions are not registered. Although every effort was made to select the best available data in analyzing benign tumors, the single center or single author nature of these studies may affect the overall analysis.

Meanwhile, metastasis is another interesting subject, which we did not include in this study. The age distribution of each tumor, especially in the pediatric age group will be discussed in a separate paper.

To our knowledge, this report contains the most recent incidence data for primary malignant CNS tumors in Iran. Iranian NCR data have an average lag time of 4 years from data gathering to the final report, similar to the CBTRUS program of the US (Dolecek et al., 2012). Contrary to the CBTRUS program in the US, the Iranian NCR does not register benign CNS tumors. Our study emphasizes the need for separating within the CNS tumor registry program both benign and malignant tumors. The incidence of CNS tumors in Iran is in accordance with the incidence of CNS tumors in developing countries. These data estimate incidence of 2.74 malignant and 2.95 benign lesions per 100,000 person-years, and a total of 5.69 per 100,000 person-years for primary brain tumors in Iran.

Acknowledgements

We authors acknowledge Prof. Edward R. Laws, Jr. (Department of Neurosurgery, Brigham & Women's Hospital) and Mrs. Bita Pourmand (Sina Hospital, Research Development Center) for their careful editing.

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