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Epidemiology of Primary Brain Tumors in the Middle Eastern Population in California, 2001–2005

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Abstract

Background—The fast growing Middle Eastern (ME) population has rarely been studied in the US. The purpose of this study was to compare the epidemiology of primary brain tumors in this ethnic population with the non-Hispanic, non-Middle Eastern White (NHNMW) in California.

Methods—ME cases were identified by surname in the California cancer registry and ME population estimates were based on ancestry. Data for 683 cases of primary brain tumors (429 benign, 238 malignant, 16 uncertain) in the ME and 15,589 cases (8,352 benign, 6,812 malignant, 425 uncertain) in the NHNMW were available for this study.

Results—ME patients were significantly ($p < 0.05$) younger and their age-adjusted incidence rates per 100,000 for benign tumors of 10.0 in men and 17.6 in women were higher than similar rates of 7.3 and 10.6 in the NHNMW group ($p < 0.05$). Rates for malignant tumors were similar. Meningioma was the main histology responsible for the observed increase in patients over 40 years of age. Also increased were benign tumors of the pituitary and pineal glands. The overall mortality in patients with benign tumors was significantly lower than malignant tumors.

Conclusions—This study presents a significantly high incidence of benign meningioma in the ME population in California. This may be due to higher susceptibility or exposure of this ethnic group to the risk factor(s) for this neoplasm. Considering the reported causal association of benign meningioma with childhood radiation exposure from Israel, exposure to this risk factor in this ethnic group needs to be evaluated in future studies.

Keywords

Middle Eastern ethnicity; Benign brain tumors; Descriptive epidemiology; Meningioma; Benign pituitary tumor; First generation immigrants

Introduction

Primary brain tumors account for a small percent of all malignant cancers, and only about two thousand cases are expected to be diagnosed in California in 2008 (1). However, due to the aggressive nature of some types of these tumors and their confined area, they are associated with significant interference with daily life of the patient and with high fatality. The average five-year relative survival of patients diagnosed with malignant brain tumors is highly associated with age at diagnosis and decreases from approximately 63 percent in patients less than 45 years of age to about six percent in patients over 65 (2). Studies of brain tumors have generally focused on malignant cases (3,4), mostly because of the lack of population-based data on benign brain tumors. Organized data collection on benign brain tumors in the United States (U.S.) was initiated in 1992 by the Central Brain Tumor Registry of the United States

(CBTRUS), a non-profit corporation that compiled voluntary submissions from cancer registries that collected data on all primary brain tumors (5). California began data collection of benign brain tumors with 2001 cases (6), and all cancer registries in the U.S. began data collection with the 2004 cases, as was mandated by the national Benign Brain Tumor Cancer Registries Amendment Act of 2002 (7). CBTRUS reported that the average incidence per 100,000 of nonmalignant (including benign and uncertain) and malignant brain tumors from 2000 through 2004 were, respectively, 9.2 and 7.3 (5). The SEER program reported that the incidence of malignant brain tumors for 2001 through 2005 was 6.5 per 100,000 and for benign brain tumors for 2004–2005 was 8.8 per 100,000 (2). Even with reliable data, benign brain tumors are seldom reported separately and are generally combined with malignant cases (8, 9). This clinical approach tends to skew the epidemiological picture of these tumors, particularly with respect to histology. The most frequent histology associated with benign brain tumors is meningioma, which accounts for 59 percent of all benign and only 3 percent of all malignant brain tumors, however, when reported as combined it accounts for only 31 percent (10).

Of all the suggested risk factors for primary brain tumors, ionizing radiation is a factor that although associated with different types of brain tumors, is proven to be in causal association with the primary lesions of the meninges (11). A significant source of radiation exposure is its therapeutic utility, which was commonly used for treatment of *Tinea capitis*, and tuberculosis adenitis in children in the middle part of the last century. This treatment was considered a safe and simple approach and was practiced in parts of the U. S. (12) and other places where these diseases were prevalent. It was also widely practiced in the Middle East. Although direct documentation of its use is lacking, its widespread use is mentioned by local researchers who have studied its long term effects in Iran (13,14) and Turkey (15). One of the major sequels of this treatment is a significant rise in incidence of benign meningiomas that is clearly documented in individuals who received this treatment and is so clear that is labeled as an “iatrogenic epidemic” (16,17).

The population with the Middle Eastern (ME) heritage is rapidly growing in the United States. They were tallied at half a million in California in the 2000 census (18), and are estimated to increase to 2.5 million by 2010 (19). Despite their large number and ethnic distinctions, epidemiologic information about this population is limited and rare because ME origin is officially included with the White race and is not identified as distinct ethnicity (20). The majority of the ME population in this study are recent immigrants and comparative studies of cancer incidence and mortality in them provides a unique opportunity for detecting differences that may be associated with ethnic specific risk factors and can result in opportunities for the development of more effective control measures. In a previous study it was shown that the patterns of cancer incidence and mortality in the ME population in California was sufficiently different from that of the NHHMW population to warrant further detailed analysis and research (21).

The objective of this study was to describe the epidemiological patterns of primary brain tumors in the Middle Eastern population of California and compare it with similar patterns in the non-Hispanic, non-Middle Eastern White population of the state.

Material and Methods

Cases

All cases of brain tumors that were diagnosed in California between 2001 and 2005, and were registered with the California Cancer Registry (CCR) by April 2008, were selected for this study. Cases were grouped into benign, malignant, and all tumors that include cases with uncertain behavior. CCR is a population-based, follow-up registry that began statewide data

collection for malignant cases in 1988 (22) and for benign brain tumors in 2001. CCR maintains data on over two million newly diagnosed primary cases. The standard grouping of race/ethnicity in CCR is the five mutually exclusive groups of non-Hispanic White, non-Hispanic Black, Hispanic, non-Hispanic Asian and Pacific Islanders, and non-Hispanic American Indian and Alaskan Native. Few specific ethnic groups, such as Hmongs, Vietnamese, and the Middle Easterners, which are predominantly identified through name recognition algorithms, are also available. Identification of Middle Eastern cases was based on a newly developed surname list (23). Briefly, this list includes 49,610 common ME surnames and has a sensitivity of 89 percent and specificity of over 99 percent for identifying individuals with this heritage from those with known place of birth. For the purposes of this identification, Middle East includes North African countries because their residents are primarily Arab, and excludes Pakistan that is grouped with Asians. This surname list is directly matched with the last names in the incidence file in a deterministic manner. To reduce the impact of cross ethnic marriages in this matching process, the last name of women is replaced by their maiden names when available and different. In the CCR dataset, about 24 percent of women have their maiden name recorded and of those, 93 percent are different from their married names. In the current study, replacement of married name by maiden name resulted in the addition of 63 cases to the ME group. Since over 86 percent of all ME cases are identified as non-Hispanic White and other race/ethnicity groups are not common in this geographic area, all identified cases were combined into one group. In addition, by subtracting the ME cases from the non-Hispanic White group, a new category of non-Hispanic, non-Middle Eastern White (NHNMW) was created and used for comparison. The surname matching process resulted in identification of 429 cases of benign, 238 cases of malignant brain tumors, and 16 cases of uncertain behavior in individuals with ME heritage. For 172 of these cases (25 percent) the place of birth was not recorded. Of the remaining 209 cases (41 percent) were born in Iran, 99 cases (19 percent) were born in an Arab country, and 76 cases (15 percent) were born in the U.S. (Table S-1).

Site and histology

Utilizing the ICD-O-3 coding scheme (24), brain tumors selected for this study were grouped by primary site and histology into few categories. For primary site the groups were: all meninges (C70.0–C70.1, C70.9), cerebral meninges (C70.0), brain lobes (C71.1–C71.4), cerebrum (C71.0), ventricle (C71.5), cerebellum (C71.6), brain stem (C71.7), other brain (C71.8, C71.9), spinal cord and cauda equina (C72.0–C72.1), cranial nerves (C72.2–C72.5), other nervous system (C72.8–C72.9), and pituitary and pineal glands (C75.1, C75.3). For histology, the benign cases were grouped into meningioma (9530–9535, 9538, 9537, 9359); neurilemoma (9560) and all others combined. Malignant cases were grouped into glioma (9380–9382); astrocytoma (9400–9401, 9410–9411, 9420–9421); glioblastoma (9440); oligodendroglioma (9450–9451); and ependymoma (9391–9394). Causes of death were grouped based on ICD-10 (25) into: benign tumors of the meninges (D32.0–D32.1, D32.9), all other benign tumors of the brain (D33.0–D33.4, D33.7, D33.9, D35.2, D35.4), malignant tumors of the meninges (C70.0–C70.1, C70.9), other malignant tumors of the brain (C71.0–C71.9), other malignant tumors of the nervous system (C72.0–C72.5, C72.8, C72.9, C75.1–C75.3), and brain tumors with uncertain behavior (D42.0, D42.9, D43.0–D43.2, D43.7, D43.9, D44.3, D44.5).

Population estimates

Official estimates for ME population in California with the detail required for calculation of age adjusted rates is not available. Generally, when official estimates are lacking, data from decennial censuses is used with linear extrapolation for intercensal years. This method was used on place of birth to estimate foreign born population in the U.S. (26) and on race/ethnicity (27,28) for estimation of various ethnic populations within the Asian race group. This extrapolation approach assumes linear changes in population over the intercensal years. This

assumption may not hold for the ME population that rapidly increased in the 1990s, but is the only practical method that is currently applicable. Estimation of the Middle Eastern population was based solely on the self-declared ancestry as reported in the Public Use Microdata Samples (PUMS) (29), and was available for 92 percent of the sample. The average annual increase between 1990 and 2000 was used for estimating the population in years 2001 to 2005 in a simple linear algorithm. .. The following ancestries were selected to represent the Middle East: Aden, Afghan, Algerian, Alhucemas, Arab, Armenian, Assyrian, Azerbaijani, Bahraini, Baluchi, Bedouin, Berber, Chaldean, Egyptian, Gazan, Ifni, Iranian, Iraqi, Israeli, Jebel Druse, Jordanian, Kurdish, Kuwaiti, Lebanese, Libyan, Middle Eastern, Moor, Moroccan, Muscat, North African, Omani, Other Arab, Palestinian, Qatar, Saudi Arabian, South Yemeni, Syriac, Syrian, Transjordan, Trucial Oman, Tunisian, Turkish, Turkish Cypriote, United Arab Emirates, West Bank, Yemeni. Population estimates for NHNMW was created by subtracting the estimated ME population from the non-Hispanic White figures that was obtained from the California Cancer Registry (30).

Statistical analysis

Incidence rates were age adjusted to the US 2000 standard population with 18 age categories of 5-year intervals each and expressed per 100,000. SEER*Stat (31) and SAS statistical software (32) were used. The mean age evaluation was done in PROC GLM in SAS. Rates were directly compared with the confidence limits set at 95 percent (33). To reduce the erratic fluctuation of age-specific incidence rates that is inherent in small samples, and to provide a better graphic presentation of the incidence trends by age, the age-specific rates based on 5-year age groups were smoothed by a simple three-point moving average (34).

Results

During the five year period from 2001 through 2005, 26,109 cases of brain tumors: 10,608 malignant, 14,734 benign, and 767 cases with uncertain behavior were registered in 23,673 California residents of all race and ethnicity groups (Table 1). Ninety-one percent of the benign and 95 percent of malignant cases were single primaries. Eighty percent of the ME cases and 76 percent of NHNMW cases were microscopically confirmed and the difference was statistically significant ($p < 0.05$). Radiology was the next most frequent method of diagnosis for these tumors. The proportion of radiological diagnosis in benign cases (29.2 percent) is more than double the 10.4 percent in malignant cases. Incidence rates of benign tumors in women of all race/ethnicity groups are uniformly higher than the incidence rates of malignant tumors. The ME group has the highest incidence rate of benign brain tumors in California which is higher by about 40 percent in men and 70 percent in women when compared to the NHNMW population. Incidence rates in the NHNMW are uniformly higher than all other race/ethnicity groups, except for the benign tumors in the non-Hispanic Black that are barely higher than the benign rates in NHNMW group. The overall incidence of benign tumors in women is higher while their incidence of malignant tumors is less. Incidence of benign and malignant tumors in ME women are, respectively, 76 percent higher and 29 percent lower. Incidence rates of malignant tumors in the ME are close to that of the NHNMW populations and higher than rates in any of the other race/ethnicity groups, Table 1.

The distribution of benign and malignant cases by ethnicity and primary site is presented in Table 2. These results suggests that the observed increase in benign tumors in the ME population is probably due to the significantly higher rates for benign tumors of the cerebral meninges, and the benign tumors of the pituitary and pineal glands. Rates for all other sites are similar between the two ethnic groups, although for some specific anatomical sites, reliable rates could not be calculated due to small numbers.

Significant differences occur in the mean age at diagnosis. ME patients are about five and a half years younger than the NHNMW patients. In both ethnic groups, malignant tumors occur at younger age, about seven years earlier in the ME and four years earlier in the NHNMW populations. Ages at diagnosis in the male and female patients in either of the ethnic groups are very similar, Table 3.

The age distribution of the incidence of benign and malignant brain tumors (Figure 1) suggests that in children and young adults, incidence of brain tumors in the ME and NHNMW patients is the same and incidence of malignant cases are higher. The crossover of malignant and benign incidence occurs around age 30. At around age 30, the incidence of benign tumors gain the dominance and begins a rapid raise in the Middle Eastern that continues to age 75 and then levels off. During this same age span, incidences of other tumors remain substantially the same with slight elevation of benign tumors in the NHNMW group.

Table 4 presents the incidence of brain tumors by histology, ethnicity, and sex. Significant differences between the two ethnic groups is limited to benign meningiomas in both male and female, and other benign tumors in men. The incidence rate ratio of meningioma in the Middle Eastern men and women relative to NHNMW men and women are, respectively, 54 percent and 88 percent higher. Stable rates for some specific histologies could not be calculated due to lack of sufficient numbers

Mortality from benign brain tumors is very low and is limited to the tumors of the meninges, whereas in malignant cases, the most significant site is the brain itself. Mortality rates in the ME population is similar to the mortality rates in the NHNMW population, except for malignant tumors of the brain which is significantly lower in ME men, (Table 5).

The odds ratio of death in brain tumor cases by major causes of death, behavior of the original diagnosis, sex, and ethnicity are presented in Table 6. Significant differences between ME and NH,NM White populations are limited to lower odds of dying from brain tumors in male ME patients diagnosed with malignant brain tumors, and lower odds of dying from other causes in female ME patients diagnosed with benign brain tumors.

Discussion

Published reports on benign brain tumors are not common, and this report is the first to describe it in a population that has not been studied in the past. The overall incidence rate of 9.0 per 100,000 for benign brain tumors in the NHNMW population of California is close to the rate of 8.8 per 100,000 reported by the SEER (2) and 9.2 per 100,000 that is reported by CBTRUS (5), but is significantly lower than the incidence rate of 13.6 per 100,000 in the population with ME heritage in California. Reliable population- based cancer registries are not common in the Middle East and benign brain tumors are not reported from the few that collect reliable data (35). Reports from the newly established Middle East Cancer Consortium (MECC) suggests little variation in the incidence of malignant brain tumors among the Middle Eastern countries in comparison to the U.S., except for the high rates in the Jewish population of Israel (36). Due to their intracranial location, brain tumors are generally associated with severe morbidity and poor prognosis that makes the distinction between the benign and malignant cases of little clinical value. However, as presented in this report, benign and malignant brain tumors can have significant epidemiological differences. The observed increase in the incidence rates of benign tumors in the ME population is basically due to higher frequency of meningiomas that are causally associated with childhood radiation therapy (11,16), and the benign tumors of the pituitary and pineal glands that may share the same risk factor(s). The average induction period for detection of benign brain tumors post therapeutic irradiation is 30 years (17). The observation in this study of the increase of benign brain tumors after the age of 30, particularly

in ME population, and the reported dominance of meningioma in the U.S. patients older than 35 years of age (10), strongly suggests a possible association with this risk factor that was widely practiced as a therapeutic measure in the middle of the last century in the U.S. (12), and parts of the Middle East (13,15–17). Benign brain tumors are diagnosed at a significantly ($p<0.05$) higher rate in women of all race and ethnicity groups, are diagnosed at older age, and are less fatal. This sex difference that is particularly notable in individuals with Middle Eastern ethnicity may reflect increased susceptibility in women, or higher exposure to the possible risk factor(s).

The majority of ME cases are first generation immigrants who were born outside the U. S. with Iranians making up to 41 percent of them (Supplementary Table S-1). Seventy seven percent of Iranians with benign cases were older than 50 at the time of diagnosis (Supplementary Table S-2), representing a cohort who had higher chance of being exposed to radiation therapy in their childhood. This assumption of exposure to radiation therapy is further supported by an observed increase in incidence of the highly radio-sensitive thyroid cancer in the same ME population (37). The association of the observed increase with the childhood exposure to radiation, although circumstantially proposed in this study, is well documented in studies in Israel, and is suggested to be considered as an important risk factor in the future epidemiological studies of cancer. The main concern with this study is the inherent question about the accuracy of ethnic identification of cases and population denominator. Since Middle Eastern heritage is not recognized as a distinct ethnicity and relevant data that is necessary for direct identification of these cases are generally not collected by statewide cancer registries, name recognition remains the only practical option. Data on place of birth can only identify the first generation immigrants and will erroneously include non-Middle Easterners who were born in that area to expatriate parents. Moreover, the percent of cases in the cancer databases with unknown place of birth has largely increased in recent years (38). A concern with surname lists is the possibility of erroneous identification of cross culturally married women who use their married names. The only practical way to control for this kind of cross identification is to replace the married name of women with their maiden names that will help to distinguish ME women who are married to non-ME men and non-ME women who are married to ME men. This procedure was performed in this study, however, due to lack of complete capturing of maiden names only few cases were added and the overall impact of this approach cannot be further evaluated. In addition, because of significant overlap of the diverse ethnic populations within the Middle Eastern countries, surname recognition has low resolution for differentiating the Arabs, Iranians, Armenians, Jews, and Turks who tend to follow the dominant naming conventions of the countries they live in. Estimation the ME population denominator is also of some concern, although it was based on the ancestry information in the decennial censuses, and followed the accepted model of linear interpolation for intercensal years. The choice of ancestry is particularly relevant for this study because it includes individuals with this heritage regardless of their place of birth. However, the linear assumption may be questioned based on the fact that the number of immigrants from the Middle East seems to have peaked in the 1990–2000 period (19). This suggests that the estimates for 2001–2005, based on the intercensal average, might have slightly over-estimated the ME population resulting in a slightly lower rates.

In conclusion, this study clearly shows that benign brain tumors have unique characteristics that warrant their study as a separate group. It also provide circumstantial evidence for a possible association between childhood radiation to the head and neck area and incidence of benign meningioma that should be evaluated in further epidemiological studies. This study also underlines the significance of Middle Eastern heritage as a specific ethnic population in epidemiological studies.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Age-specific incidence rate of brain tumors by ethnicity and behavior, California 2001–2005. Trend line is smoothed by 15-year moving averages.

Table 1

Incidence of brain tumors by behavior, race/ethnicity, and sex, California 2001–2005

	Male		Female		Both Sexes	
	Rate [†]	Cases	Rate Ratio (95% CI)	Rate [†]	Cases	Rate Ratio (95% CI)
All Tumors [‡]						
All Races [*]	15.0	11,669	-	16.5	14,440	-
NH, NM White	17.0	7,215	1	17.5	8,374	1
Middle Eastern	19.6	313	1.2(1.0–1.3)	24.6	370	1.4(1.2–1.6)
Hispanic	12.9	2,449	0.8(0.7–0.8)	15.7	3,250	0.9(0.9–0.9)
NH Black	13.5	591	0.8(0.7–0.9)	15.8	851	0.9(0.8–1.0)
NH Asian/PI	10.6	994	0.6(0.6–0.7)	13.2	1,471	0.8(0.7–0.8)
Benign Tumors						
All Races	7.0	5,368	-	10.7	9,366	-
NH, NM White	7.3	3,152	1	10.6	5,200	1
Middle Eastern	10.0	160	1.4(1.1–1.7)	17.6	269	1.7(1.4–1.9)
Hispanic	6.2	1,080	0.9(0.8–0.9)	10.4	2,093	1.0(0.9–1.0)
NH Black	8.2	341	1.1(1.0–1.3)	11.5	616	1.1(1.0–1.2)
NH Asian/PI	6.1	561	0.8(0.8–0.9)	9.6	1,075	0.9(0.8–1.0)
Malignant Tumors						
All Races	7.5	5,926	-	5.3	4,682	-
NH, NM White	9.2	3,851	1	6.4	2,961	1
Middle Eastern	9.1	145	1.0(0.8–1.2)	6.5	93	1.0(0.8–1.3)
Hispanic	6.3	1,277	0.7(0.6–0.7)	4.8	1,062	0.8(0.7–0.8)
NH Black	4.9	229	0.5(0.5–0.6)	3.7	203	0.6(0.5–0.6)
NH Asian/PI	4.1	393	0.4(0.4–0.5)	3.2	353	0.5(0.5–0.5)

[†] Rates are per 100,000 and age-adjusted to the US Standard population.

[‡] All brain tumors include cases with uncertain behavior.

^{*} All races include American Indian/Alaskan Natives.

[~] Not applicable. Rate ratio compares other race/ethnicities with non-Hispanic (NH), non-Middle Eastern (NM) White.

Table 2

Age-adjusted incidence rate of brain tumors[†] by primary site, behavior and ethnicity California 2001–2005

	Benign Tumors					Rate Ratio (95% CI)	Malignant Tumors					
	NH, NM Rate*	NH, NM Count	White Count	Middle Rate	Eastern Count		NH, NM Rate	NH, NM Count	White Count	Middle Rate	Eastern Count	Rate Ratio (95% CI)
All tumors	9.0	8,352	13.6	429	~	1.5(1.3–1.7)	7.7	6,812	7.8	238	~	1.0(0.9–1.2)
Meninges, all	5.0	4,769	8.5	263	~	1.7(1.5–2.0)	0.1	111	0.2	5	~	1.5(0.5–4.4)
Meninges, cerebral	4.3	4,126	7.1	221	~	1.7(1.4–2.0)	0.1	89	~	~	~	~
Brain lobes	0.3	223	0.3	8	~	1.1(0.5–2.3)	4.3	3,875	3.8	119	~	0.9(0.7–1.1)
Cerebrum	0.0	8	~	~	~	~	0.3	252	0.4	11	~	1.2(0.6–2.4)
Ventricle	0.1	35	~	~	~	~	0.1	96	0.2	6	~	1.5(0.6–4.1)
Cerebellum	0.1	99	~	~	~	~	0.4	284	0.5	15	~	1.2(0.7–2.1)
Brain stem	0.0	21	~	~	~	~	0.3	205	0.2	7	~	0.8(0.4–1.5)
Other brain	0.1	124	0.2	8	~	1.6(0.7–3.9)	1.8	1,652	2.1	61	~	1.2(0.9–1.6)
Spinal cord & Coda equina	0.1	106	~	~	~	~	0.2	195	0.3	10	~	1.4(0.6–3.0)
Cranial nerves	1.5	1,378	1.8	57	~	1.2(0.9–1.5)	0.1	45	~	~	~	~
Other nervous system	0.0	9	~	~	~	~	0.0	11	~	~	~	~
Pituitary & pineal glands	1.8	1,580	2.6	85	~	1.5(1.1–1.9)	0.1	86	~	~	~	~

NH: non-Hispanic, NM: non-Middle Eastern

NH: non-Hispanic, NM: non-Middle Eastern

[†] Excludes cases with uncertain behavior.

* Rates are per 100,000 and age-adjusted to the 2000 US Standard population.

~ Cells with less than 5 cases are not presented.

Average age at diagnosis of brain tumors by ethnicity, behavior, and sex. California 2001–2005

Table 3

	NH, NM White*		Middle Eastern*	
	All tumors	Benign [‡]	All tumors	Benign [‡]
Both sexes	56.58	59.37	55.73	52.11
Male [†]	55.55	58.61	54.63	52.00
Female [†]	57.61	60.25	56.86	52.23

* Differences in the average age between the two ethnic population are statistically significant at p>0.05.

[‡] Differences in the average age between benign and malignant cases are statistically significant at p>0.05.

[†] Differences in the average age between NH, NM White male and female cases are statistically significant at p>0.05

Table 4

Age adjusted rate and rate ratio for incidence of brain tumors by ethnicity, histology, and sex, California 2001–2005

Histology	NH, NM		White		Middle Eastern		Rate Ratio (95% CI)
	Rate	Cases	Rate	Cases	Rate	Cases	
Male							
Benign Meningioma	3.0	1,306	4.6	72	1.54 (1.15–2.07)		
Benign Neurilemoma	1.8	811	1.8	30	0.99 (0.67–1.45)		
Other Benign tumors	2.4	1,035	3.5	58	1.45 (1.06–2.00)		
Glioma	0.8	303	1.0	17	1.26 (0.72–2.20)		
Astrocytoma	1.7	660	1.9	32	1.15 (0.78–1.70)		
Glioblastoma	4.7	2,050	4.1	63	0.89 (0.70–1.13)		
Oligodendroglioma	0.6	267	0.5	10	0.79 (0.45–1.41)		
Ependymoma	0.3	121	~	~	~		
Other Malignant tumors	1.2	450	1.4	20	1.15 (0.71–1.88)		
Female							
Benign Meningioma	6.6	3,387	12.3	186	1.88 (1.54–2.30)		
Benign Neurilemoma	1.7	777	2.2	34	1.28 (0.87–1.90)		
Other Benign tumors	2.4	1,036	3.1	49	1.30 (0.93–1.81)		
Glioma	0.6	238	~	~	~		
Astrocytoma	1.4	544	1.6	25	1.20 (0.77–1.87)		
Glioblastoma	2.8	1,431	3.2	41	1.13 (0.80–1.60)		
Oligodendroglioma	0.5	212	~	~	~		
Ependymoma	0.3	122	0.4	7	1.47 (0.58–3.70)		
Other Malignant tumors	0.9	414	0.8	12	0.86 (0.50–1.48)		

* Rates are per 100,000 and age adjusted to the 2000 US Standard population. NH: non-Hispanic, NM: non-Middle Eastern.

** Ratio of Middle Eastern rate over NH, NM White rate with 95% Confidence Interval.

~ Data for cells with less than 5 cases are not presented.

Table 5

Age adjusted mortality rate for brain tumors by sex, primary site, and ethnicity, California 2001–2005

	NH		NM		White		Middle Eastern		Rate Ratio (95% CI)	
	Rate	Deaths	Rate	Deaths	Rate	Deaths	Rate	Deaths		
Both sexes										
Benign, All	0.3	305	0.2	6	0.80 (0.38–1.71)					
Benign, Meninges	0.3	284	0.2	6	0.87 (0.40–1.89)					
Malignant, All	5.3	5,015	4.9	145	0.92 (0.78–1.08)					
Malignant, Brain	5.2	4,914	4.7	140	0.90 (0.77–1.07)					
Malignant, Meninges	0.1	49	~	~	~					
Malignant, Spinal Cord, NOS	0.0	35	~	~	~					
Uncertain Behavior	0.8	766	0.4	13	0.54 (0.36–0.82)					
Male										
Benign, All	0.3	109	~	~	~					
Benign, Meninges	0.2	98	~	~	~					
Malignant, All	6.5	2,837	5.1	79	0.78 (0.63–0.95)					
Malignant, Brain	6.4	2,786	4.8	75	0.75 (0.61–0.92)					
Malignant, Meninges	0.1	23	~	~	~					
Malignant, Spinal Cord, NOS	0.0	21	~	~	~					
Uncertain Behavior	0.9	375	~	~	~					
Female										
Benign, All	0.3	196	~	~	~					
Benign, Meninges	0.3	186	~	~	~					
Malignant, All	4.3	2,178	4.8	66	1.12 (0.85–1.47)					
Malignant, Brain	4.2	2,128	4.7	65	1.13 (0.86–1.49)					
Malignant, Meninges	0.1	26	~	~	~					
Malignant, Spinal Cord, NOS	0.0	14	~	~	~					
Uncertain Behavior	0.7	391	0.6	10	0.88 (0.49–1.60)					

* Rates are per 100,000 and age adjusted to the 2000 US Standard population. NH: non-Hispanic, NM: non-Middle Eastern.

** Ratio of Middle Eastern rate over NH, NM White rate with 95% Confidence Interval.

~ Data for cells with less than 5 deaths are not presented.

Table 6

Odds of death by ethnicity, cause of death, type of original brain tumor, and sex California 2001–2005

Death due to brain tumors				
Tumor type	Sex	NH, NM White Percent fatality	Middle Eastern Percent fatality	Odds-Ratio [†] (95% CI)
Benign	Both Sexes	3.0	2.1	0.69(0.31–1.34)
	Male	3.3	2.5	0.76(0.20–2.04)
	Female	2.9	1.9	0.64(0.20–1.55)
Malignant	All	56.4	49.6	0.76(0.58–0.99)
	Male	56.8	43.5	0.58(0.41–0.83)
	Female	55.8	59.1	1.15(0.74–1.79)
Death due to other cancers				
Benign	Both Sexes	3.0	2.3	0.78(0.37–1.48)
	Male	3.0	1.9	0.62(0.12–1.91)
	Female	2.9	2.6	0.88(0.34–1.89)
Malignant	All	2.0	3.4	0.95(0.40–1.96)
	Male	1.7	3.5	2.02(0.62–5.06)
	Female	2.3	3.2	1.40(0.28–4.39)
All other causes of death				
Benign	Both Sexes	11.1	7.5	0.65(0.43–0.93)
	Male	11.4	11.3	0.98(0.56–1.63)
	Female	10.9	5.2	0.45(0.24–0.77)
Malignant	All	13.3	11.8	0.87(0.56–1.30)
	Male	14.5	15.7	1.11(0.67–1.77)
	Female	11.9	5.4	0.42(0.13–1.03)

NH: non-Hispanic, NM: non-Middle Eastern.

[†] Odds ratio for Middle Eastern cases.[‡] All tumors include tumors with uncertain behavior.