RESEARCH COMMUNICATION

# Cancer Incidence Rates in Turkey in 2006: A Detailed Registry Based Estimation

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## Abstract

**Purpose: The purpose of this study is to provide a detailed report on cancer incidence in Turkey, a relatively large country with a population of 72 million. We present the estimates of the cancer burden in Turkey for 2006, calculated using data from the eight population based cancer registries which have been set up in selected provinces representative of sociodemographic patterns in their regions. Methods: We calculated age specific and age adjusted incidence rates (AAIR–world standard population) for each of registries separately. We assigned a weighting coefficient for each registry proportional to the population size of the region which the registry represents. Results: We pooled a total of 24,428 cancers (14,581 males, 9,847 females). AAIRs per 100 000 were: 210.1 in men and 129.4 in women for all cancer sites excluding non-melanoma skin cancer. The AAIR per 100 000 men was highest for lung cancer (60.3) followed by prostate (22.8), bladder (19.6), stomach (16.3) and colo-rectal (15.4) cancers. Among women the rate per 100 000 was highest for breast cancer (33.7) followed by colorectal (11.5), stomach (8.8), thyroid (8.8) and lung (7.7). The most striking findings about the cancer incidence in the provinces were the high incidence rates for stomach and esophageal cancers in Erzurum and high stomach cancer incidence rates in Trabzon for both sexes. Conclusions: We are thus able to present the most accurate and realistic estimations for cancer incidence in Turkey so far. Lung, prostate, bladder, stomach, colorectal, larynx cancers in men and breast, colorectal, stomach, thyroid, lung, corpus uteri cancers in women are the leading cancers respectively. This figure shows us tobacco related cancers, lung, bladder and larynx, predominate in men. Concurrently, we analyzed the data for each province separately, giving us the opportunity to present the differences in cancer patterns among provinces. The high incidences of stomach and esophageal cancers in East and high incidence of stomach cancer in Northeast regions are remarkable.**

**Keywords:** Cancer incidence data - Turkey - population-based registries - geographical variation - data quality

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## Introduction

Turkey occupies 779,452 km$^2$ at the crossroads between Europe, Asia and the Middle East, with a population of 72.5 million in 2009 (Turkish Statistical Institute, Address Based Population Registration System (http://www.turkstat.gov.tr ). Cancer, which occupied the fourth rank among causes of death in Turkey during 1970s, has risen to the second rank following cardiac disease in most of the regions today (Akgun et al, 2007).

Before 1991, any estimates of cancer incidence in Turkey came from a nationwide passive cancer surveillance system; it is estimated that only a quarter of all cancers were captured in this way. In 1991 the first active cancer surveillance registry was established in Izmir and later became the first population based registry of the country. Izmir Cancer Registry (ICR) runs the accumulation of know-how and promotion of the cancer registration in Turkey.

Following the experience of ICR, the Turkish Cancer Registry system was established with eight cancer registries located in sentinel provinces of the country. It is an active surveillance system in which quality control is carried out in line with International Association of Cancer Registries (IACR) criteria. In 2000, the other registries were established gradually in selected provinces by the Cancer Control Department of the Ministry of Health (MoH). ICR has supported the Turkish Registry System with baseline training, continuing education and in-service training of staff and by performing quality checks of the

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**Table 1. Ratios for Registry Population to the Represented Population and the Total Turkish Population**

| Region | Registry | Total Population | Registry Population | Ratio | Proportion of Turkish Population (%) | Coefficient |
|---|---|---|---|---|---|---|
| Aegean | Izmir | 9,407,675 | 3,634,966 | 0.39 | 13.1 | 2.96 |
| Central Anatolia | Eskisehir | 11,915,333 | 705,823 | 0.06 | 16.5 | 3.75 |
| Eastern and Southeastern Anatolia | Erzurum | 13,720,140 | 777,468 | 0.06 | 19.0 | 4.31 |
| Marmara | Bursa | 19,740,337 | 2,294,232 | 0.12 | 27.4 | 6.21 |
| | Edirne | | 381,349 | 0.02 | | |
| Mediterranean | Antalya | 9,384,437 | 1,558,344 | 0.17 | 13.0 | 2.95 |
| Southern Black Sea | Trabzon | 3,180,941 | 721,223 | 0.23 | 4.4 | 1.00 |
| Western Black Sea | Samsun | 4,716,138 | 1,229,832 | 0.26 | 6.5 | 1.48 |


**Figure 1. Cancer Registries and Geographical Regions they Represent in Turkey**

data by evaluating, conducting site visits, and additional recase finding and reabstracting. Some of these registries failed at the very beginning (i.e., Diyarbakir, Van, Kayseri) due to local obstacles while others were successful (Antalya, Bursa, Eskisehir, Samsun, Trabzon, Edirne and Erzurum). Ankara Cancer Registry, which was established recently, was the ninth population based registry in the country.

The first robust published population based data from Turkey came from ICR (Fidaner, 2001) and Izmir and Antalya registry data were accepted for publication in the ''Cancer Incidence in Five Continents, Vol. IX''(Curado et al, 2007). More detailed information about the cancer registration system has been published (Eser, 2007).

Following the published papers and data which consist of local epidemiological cancer statistics based on the new surveillance system (Fidaner, 2001; Curado et al, 2007; Eser, 2007; Eser et al, 2009), some papers on nationwide cancer epidemiology have also recently been published such as that of Yılmaz et al (Yılmaz et al, 2010). In their recent paper, Yılmaz et al published cancer trends and cancer mortality patterns for Turkey for 2002-2005. Although a valuable contribution to national cancer epidemiology, this paper focused on relatively raw cancer morbidity statistics that need to be explained further with more processed data.

Thus this paper aims to present the estimates of cancer incidence and regional variations of cancer occurrence in Turkey in 2006 using the results of eight sentinel registries, consisting of about 16% of the population of Turkey (see map of Turkey by region, Fig. 1).

## Materials and Methods

We pooled the databases for the year 2006 of the eight registries of Turkey. We also added all 2006 diagnosed cases which are residing in these provinces and recorded in the Ankara Cancer Registry database, since Ankara is a focus for patients with good state health facilities accessible to many regions of the country.

All of the eight registries in Turkey use ICD-O3 (International Classification of Diseases for Oncology, 3rd edn.) for coding the topography and histology of the malignant tumors, use CanReg4 (http://www.iacr.com.fr/canreg4.htm) for storing, checking, processing and analyzing data, and follow IARC rules for the distinction of multiple primaries. Death certificate notified cases, benign tumors of the brain and in-situ cancers were not included in this analysis. All quality control checks and duplication control procedures were performed for the pooled database meticulously, although all those checks had already been applied for each database by each registry separately. Duplication checks and consequential corrections took time, due to interprovincial multiple registration of the same cases (for example a case would be registered both as a "Samsun resident" in Samsun Registry database and as a "Trabzon resident" in Trabzon Registry database). Duplication was a particular problem where provinces are geographically close such as Samsun-Trabzon and Eskişehir-Bursa; and between the data of Ankara and the other provinces except Izmir.

**Table 2. Basis of Diagnosis* for Turkish Cancer Cases by Site, 2006**

| Site | Microscopic | Non Microscopic |
|---|---|---|
| Oral cavity | 99.4 | 0.6 |
| Nasopharynx | 94.7 | 5.3 |
| Other pharynx | 92.9 | 7.1 |
| Esophagus | 89.7 | 10.3 |
| Stomach | 91.6 | 8.4 |
| Colorectal | 93.4 | 6.6 |
| Liver | 73.5 | 26.5 |
| Gall-bladder | 93.3 | 6.7 |
| Pancreas | 67.0 | 33.0 |
| Lung and bronchus | 85.3 | 14.7 |
| Breast | 96.9 | 3.1 |
| Cervix uteri | 96.5 | 3.5 |
| Corpus uteri | 98.2 | 1.8 |
| Ovary | 92.5 | 7.5 |
| Prostate | 96.5 | 3.5 |
| Testis | 99.5 | 0.5 |
| Bladder | 96.5 | 3.5 |
| Kidney | 95.5 | 4.5 |
| Thyroid | 98.3 | 1.7 |
| All sites | 92.3 | 7.7 |

*Basis of diagnosis was unknown in 2.7% overall

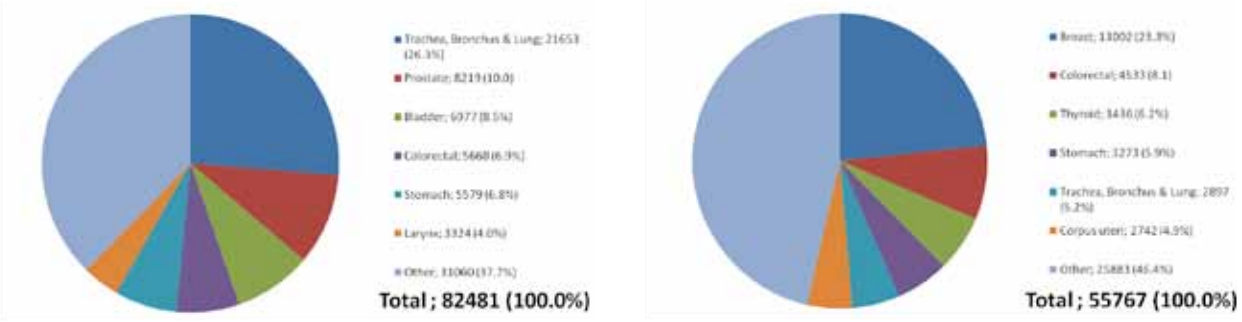


**Figure 2. Estimated New Cancer Cases (all ages), Males (left) and Females (right), 2006**

We calculated crude, age specific and age adjusted incidence rates (AAIR, world standard population) for each of the eight registries separately. We used 2006 mid-year population estimates supplied by Provincial Health Directorates as denominators.

For national estimates, we assigned a weighting coefficient to each registry according to their population size, gender and age structure. Since the population of the East Black sea region, represented by Trabzon registry is the smallest, the coefficient for this region was set to 1 and the coefficients for the other regions were assigned proportionally (Table 1). Edirne and Bursa results were combined to represent Marmara region. Erzurum registry was used to represent for both the east and the southeastern areas of the country.

## Results

The eight cancer registries represent seven regions of Turkey and a total population of over 10 million, 15.6% of the population of Turkey. Table 2 shows the proportion of the cases with morphological verification which have been diagnosed on the basis of histology, hematology or cytology. 92.3% of cancers in Turkey were diagnosed microscopically. Histological confirmation ranged by site from 67.0% of pancreatic cancers to 99.5% of cancers of the testes. The cancers with the highest percentage of histological verification were those located in readily accessible sites (e.g. cervix and oral cavity). Sites more difficult to access (e.g. liver and pancreas) had the lowest proportion of histological verification. The proportion of histological diagnosed cases decreased with age from 94.4% in the age group <35 years to 89.7% at ≥65 years. The proportions of the microscopically confirmed cases for all sites were 95.5% in Izmir, 85.5% in Eskisehir, 82.1% in Erzurum, 91.9% in Bursa, 82.2% in Edirne, 93.3% in Antalya, 93.5 in Trabzon and 88.4% in Samsun.

A total of 24,428 cancer cases (14,581 male and 9,847 female) were reported by the eight registries combined. We estimate that 82481 in males and 55767 in females new cancer cases arise in a year in Turkey (see Fig.2). The estimated AAIRs for all cancers excluding non-melanoma skin cancer in Turkey are 210.1 per 100 000 among males and 129.4 among females (Tables 3 and 4). In men, lung cancer was by far the most frequent malignancy (see Figure 2) comprising 26.3% with 60.3 per 100 000 AAIR; followed by prostate (10%), bladder (8.5%), stomach (6.8%) and colo-rectal (6.9%) cancer.

**Table 3. Principal Cancer sites and AAIRs* in 2006 by the World Standard Population by Registry, Males**

| Site | Izmir | Eskisehir | Erzurum | Bursa | Edirne | Antalya | Trabzon | Samsun | Total |
|---|---|---|---|---|---|---|---|---|---|
| Trachea, Bronchus & Lung | 85.2 | 58.5 | 48.2 | 62.1 | 75.0 | 49.7 | 51.8 | 59.4 | 60.3 |
| Prostate | 38.2 | 23.3 | 10.4 | 17.6 | 9.3 | 34.2 | 29.4 | 27.2 | 22.8 |
| Bladder | 24.8 | 24.8 | 18.5 | 15.3 | 18.8 | 17.2 | 24.1 | 16.8 | 19.6 |
| Stomach | 12.8 | .0 | 30.5 | 14.1 | 12.0 | 11.7 | 22.0 | 14.7 | 16.3 |
| Colorectal | 22.0 | 16.2 | 10.5 | 14.1 | 10.3 | 16.6 | 20.7 | 17.0 | 15.4 |
| Larynx | 9.9 | 8.2 | 11.0 | 10.2 | 9.6 | 6.3 | 9.6 | 10.2 | 9.4 |
| Non-Hodgkin Lymphoma | 8.1 | 6.3 | 7.8 | 4.4 | 2.8 | 7.2 | 8.5 | 7.2 | 6.5 |
| Brain, Nervous System | 5.8 | 6.1 | 5.3 | 3.7 | 4.7 | 5.8 | 3.9 | 6.0 | 5.2 |
| Pancreas | 5.5 | 6.2 | 5.0 | 4.8 | 2.8 | 5.8 | 5.6 | 3.0 | 5.1 |
| Esophagus | 2.5 | 2.9 | 14.1 | 2.4 | 1.6 | 1.5 | 2.8 | 3.3 | 4.7 |
| Kidney | 6.9 | 2.9 | 3.7 | 5.5 | 2.7 | 4.7 | 4.8 | 4.7 | 4.6 |
| Liver | 4.6 | 2.9 | 2.7 | 2.7 | 3.4 | 5.0 | 4.6 | 2.2 | 3.4 |
| Lymphoid Leukemia | 4.0 | 3.6 | 3.2 | 0.7 | 2.4 | 4.7 | 4.3 | 3.4 | 3.0 |
| Myeloid Leukemia | 3.4 | 3.0 | 2.5 | 1.3 | 4.5 | 4.0 | 1.7 | 3.6 | 2.7 |
| Testis | 3.5 | 2.1 | 1.5 | 3.0 | 3.3 | 3.8 | 2.5 | 2.2 | 2.7 |
| Connective Tissue | 2.2 | 1.8 | 2.9 | 1.9 | 0.4 | 2.3 | 2.8 | 2.2 | 2.2 |
| Thyroid | 3.3 | 1.7 | 1.7 | 1.9 | 0.8 | 2.0 | 3.4 | 2.7 | 2.1 |
| Multiple Myeloma | 2.1 | 3.1 | 2.5 | 0.9 | 0.0 | 2.2 | 1.4 | 2.9 | 2.0 |
| Hodgkin's Disease | 2.4 | 1.4 | 2.9 | 1.5 | 0.4 | 1.8 | 3.1 | 2.2 | 2.0 |
| Melanoma of the Skin | 2.3 | 0.7 | 1.1 | 1.1 | 1.2 | 2.5 | 2.1 | 1.4 | 1.4 |
| All sites | 306.2 | 227.6 | 218.2 | 199.4 | 215.9 | 231.1 | 253.9 | 228.6 | 230.8 |
| All sites but skin | 274.4 | 209.7 | 197.8 | 185.8 | 188.5 | 209.5 | 228.0 | 207.7 | 210.1 |

* Per 100 000

**Table 4. Principal Cancer sites and AAIRs* in 2006 by the World Standard Population by Registry, Females**

| Site | Izmir | Eskisehir | Erzurum | Bursa | Edirne | Antalya | Trabzon | Samsun | Total |
|---|---|---|---|---|---|---|---|---|---|
| Breast | 45.6 | 35.3 | 30.7 | 30.5 | 21.4 | 34.7 | 34.6 | 31.1 | 33.7 |
| Colorectal | 13.4 | 10.6 | 9.5 | 12.0 | 9.6 | 14.1 | 11.2 | 10.7 | 11.5 |
| Stomach | 6.7 | 6.6 | 18.0 | 6.0 | 4.5 | 5.3 | 13.9 | 7.6 | 8.8 |
| Thyroid | 16.7 | 7.6 | 8.8 | 6.1 | 3.0 | 9.0 | 11.5 | 6.2 | 8.8 |
| Trachea, Bronchus & Lung | 9.2 | 8.7 | 10.6 | 4.9 | 3.4 | 8.3 | 4.2 | 7.3 | 7.7 |
| Corpus uteri | 10.5 | 8.4 | 4.2 | 7.0 | 6.7 | 8.5 | 5.7 | 5.8 | 7.2 |
| Ovary | 5.4 | 4.4 | 3.6 | 6.9 | 4.0 | 7.9 | 4.3 | 5.2 | 5.4 |
| Brain, Nervous System | 5.0 | 5.4 | 5.1 | 3.8 | 4.0 | 4.5 | 4.8 | 4.1 | 4.6 |
| Non-Hodgkin Lymphoma | 6.1 | 3.0 | 5.3 | 3.7 | 1.2 | 5.3 | 5.3 | 4.1 | 4.4 |
| Cervix uteri | 5.8 | 3..9 | 3.0 | 4.7 | 3.5 | 5.4 | 2.4 | 2.8 | 4.2 |
| Esophagus | 1.3 | 0.8 | 11.3 | 1.4 | 0.7 | 1.3 | 1.3 | 1.4 | 3.1 |
| Pancreas | 2.7 | 4.1 | 2.4 | 2.7 | 1.1 | 3.8 | 2.0 | 3.5 | 3.0 |
| Bladder | 2.5 | 2.7 | 2.4 | 2.4 | 2.1 | 3.3 | 2.0 | 1.7 | 2.5 |
| Kidney | 3.0 | 2.0 | 2.0 | 1.4 | 2.8 | 3.1 | 1.1 | 1.6 | 2.1 |
| Myeloid Leukemia | 2.3 | 1.1 | 3.0 | 1.2 | 1.2 | 2.1 | 2.0 | 2.7 | 1.9 |
| Lymphoid Leukemia | 2.6 | 2.2 | 1.1 | 0.5 | 2.2 | 2.2 | 2.6 | 3.1 | 1.7 |
| Liver | 1.6 | 1.9 | 1.2 | 1.1 | 0.9 | 2.4 | 0.5 | 1.4 | 1.5 |
| Multiple Myeloma | 2.1 | 2.4 | 0.3 | 0.6 | 1.2 | 1.3 | 1.5 | 1.9 | 1.3 |
| Connective Tissue | 1.9 | 0.7 | 0.5 | 1.3 | 1.2 | 1.4 | 1.9 | 2.5 | 1.2 |
| Hodgkin's Disease | 1.7 | 2.0 | 1.0 | 0.4 | 0.6 | 1.7 | 0.8 | 1.6 | 1.2 |
| All sites | 185.7 | 145.7 | 144.5 | 122.1 | 105.2 | 163.0 | 148.1 | 129.4 | 144.7 |
| All sites but skin | 163.8 | 129.8 | 133.7 | 110.5 | 87.1 | 142,3 | 128.7 | 118.3 | 129.4 |

* Per 100,000

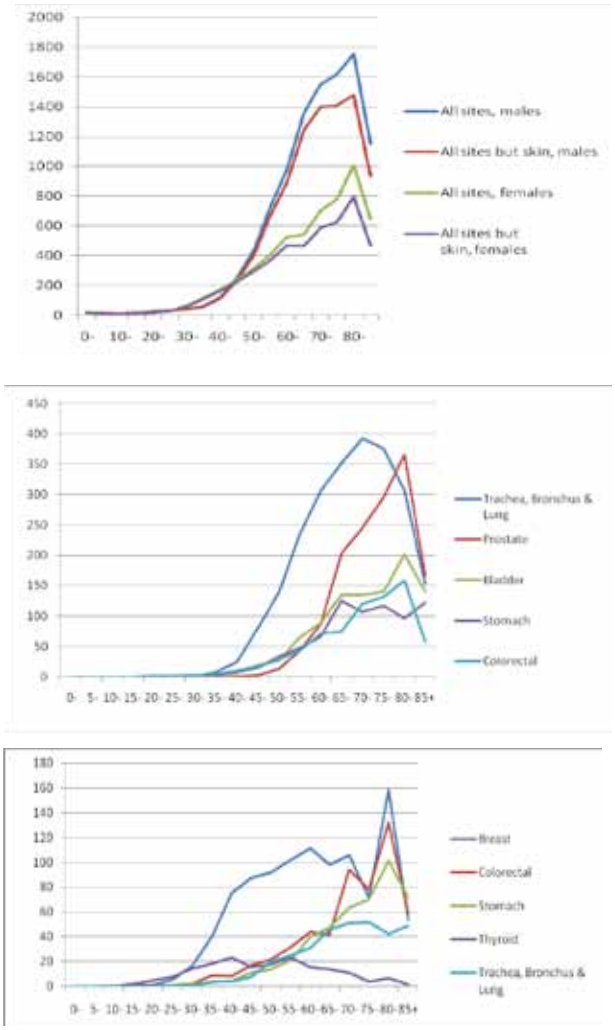


**Figure 3. Age-specific Incidence Rates for Turkey, 2006**. a) by sex; b) for principal cancers in males; c) for principal cancers in females

In women, breast was the most common site (23.3%), followed by colo-rectal (8.1%), thyroid (6.2%), stomach (5.9%) and lung (5.2%) (Tables 3 and 4). Although lung cancer was one of the top five cancers for both sexes, the AAIR for men (60.3) is over sevenfold higher than that for women (7.7). Another smoking-related cancer; bladder, was over sevenfold higher for men than women. Rates of digestive cancers colorectal and stomach were also higher for men (15.4 and 16.3 respectively) than for women (11.5 and 8.8).

Age specific rates for principle cancers can be seen in Figure 3 for men and women. The most interesting pattern of the age specific curves is declining rates in the elderly as seen in the data of most developing countries (Curado et al, 2007).

Tables 3 and 4 also show the principal cancer sites and age adjusted incidence rate (AAIR) for males and females respectively by registries. Both for males and females, the highest AAIRs for all sites were calculated in Izmir (respectively 306.2 and 185.7 per 100,000) whilst the lowest were calculated in Bursa among males and Edirne among females (199.4 and 105.2 per 100 000 respectively).

Although rates of male lung cancer vary from 48.2 in Erzurum to 85.5 in Izmir, per 100,000, it is the most frequent cancer in all registries. With a few exceptions, prostate cancer was second followed by bladder cancer. In Trabzon prostate cancer was second followed by bladder and stomach cancer. In Edirne bladder cancer is second followed by stomach and colorectal cancers In Erzurum, the cancer pattern showed a striking but not unexpected difference from the other registries: stomach cancer was second with 30.5 per 100 000 AAIR which was close to the rate of lung cancer followed by bladder cancer. Just after bladder cancer, we see esophageal cancer at the fourth row (Table 3). The dominance of stomach and esophageal cancers appears in this region.

For females, breast cancer was the most frequent in all

registries with the AAIRs ranging from 21.4 in Edirne to 45.6 in Izmir, per 100 000. Colorectal cancer was ranked second or third in most registries. In Izmir, colorectal cancer was third after thyroid cancer. Thyroid cancer was among the most common five cancers in all registries. Lung cancer was fifth in Izmir and Antalya, third in Eskişehir, and fourth in Samsun and Erzurum. In other registries, lung cancer was not among the most frequent five cancers in women. Stomach cancer was second in Erzurum and Trabzon, third in Samsun and fourth in Edirne but it was not among the five most common cancers in other registries. In Erzurum, the pattern was quite similar, to that seen in men; the AAIR of stomach cancer was quite high (18 per 100 000), as was esophageal cancer (11.3 per 100 000).

## Discussion

It is important to review the quality of data in terms of completeness and validity. The 1998-2002 series of Izmir and Antalya Registries were evaluated as being of high quality and accepted for publication in the Cancer Incidence in Five Continents Vol IX (Curado et al, 2007). However the quality does vary across the registries. Nevertheless, all the registries follow international standard registration practices (Parkin et al, 1995) and data collection is regularly supervised and carefully scrutinized. Use of Canreg-4 software for data management further enhances the validity of data reported because there are built-in quality checks.

One of the most important indicators of the completeness of cancer data is the reasonable (not very high) proportions of the microscopically verified (MV) cases (Parkin et al, 1995). The proportion of the of microscopical verification all sites except skin cancers of Turkey data is 92.2% which is not very high. This is consistent with other registries such as 94.4% for SEER 14 registries, 97.1% for Germany Saarland, 85.4% for Israel, and 86.0% for Spain Granada (Curado et al, 2007). The 92.2% MV cases of Turkey and the acceptable variation of the proportion among registries (from 82.1% in Erzurum to 95.5% in Izmir) may be regarded as a satisfactory enough level to refer to the high validity of the data (Parkin et al, 1995).

For our estimations about Turkey, the incidence rates for all cancer sites that we report are consistent with the expected figures for Turkey related with the socio-demographic features and risk factors (Bray, 2004 and 2010). Incidence rates were lower in females than in males, which are in part, a consequence of the much lower incidence of tobacco-related cancers. The consistency of these results from Turkey (Fidaner, 2001; Eser, 2007; Yılmaz et al, 2010; Fırat, 1998), may reflect truly lower levels of exposure to risk factors rather than selective under-registration or under-diagnosis in females.

One of the strengths of this paper is its results that stand on the high quality processed data with reasonable completeness and high validity. Data processing (checking duplications, doing necessary editing etc.) and use of internationally accepted classifications in this study gave quite different results from a recently published paper (Yılmaz et al, 2010). Yılmaz et al. used unprocessed pooled data for 2002-2005 from the registries and reported crude incidence rates of 202.7 in men and 144.5 in women per 100 000 for 2005 while our rates are somewhat higher (233.2 in men and 158.4 in women) for all sites. We see other differences in site specific rates. For instance the most frequent cancers in females was breast, thyroid, lung and stomach cancer while we found the order of breast, colorectal, stomach and then thyroid cancer. Inconsistencies might arise due to the differences in the quality of the data used by the two studies and also some other methodological aspects such as registry selection. Yılmaz et al. used the data from Ankara Cancer Registry while we preferred not to use it since we did not find the data quality high enough in the terms of completeness and validity. Furthermore, the data of Ankara Cancer Registry suffered from a substantial amount of the duplicate cases which were registered as Ankara residents instead of their accurate addresses were outside of Ankara.

In our study, we obtained the highest AAIRs for all sites and for the most of the cancer sites in Izmir and the rates of Trabzon and Antalya follow Izmir in general. The lowest rates were calculated for Edirne and Bursa as presented in tables 3 and 4. Differences in incidence rates were already expected and could be explained by the substantial differences in the level of exposure to a variety of risk factors among provinces. A small amount of diversity can also be attributed to the differences of data quality among provinces.

In Tables 5 and 6, the AAIRs for the major cancer

**Table 5. Age-adjusted* Incidence Rates in Various Registries in the Region, Males**

| Site | Esophagus | Stomach | Colorectal | Liver | Larynx | Lung | Prostate | Bladder | Hodgkin's Disease | NHL | Leukemia |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Turkey (2006) | 4.7 | 16.3 | 15.4 | 3.4 | 9.4 | 60.3 | 22.8 | 19.6 | 2,0 | 6.5 | 6.0 |
| Iran, Ardabil (2004-2006) | 19.5 | 51.8 | 9.6 | 3.7 | 1.8 | 10.8 | 5.7 | 13.1 | 1,1 | 4.0 | 5.8 |
| Bulgaria (1998-2002) | 2.2 | 17.2 | 29.9 | 5.9 | 9.0 | 49.6 | 17.1 | 12.9 | 2,5 | 4.0 | 6.0 |
| Egypt, Gharbiah (1999-2002) | 1.7 | 3.3 | 6.3 | 21.9 | 4.2 | 14.0 | 8.5 | 27.9 | 2,5 | 16.9 | 6.5 |
| Germany, Saarland (1998-2002) | 6.8 | 13.6 | 50.5 | 6.9 | 5.9 | 59.6 | 65.3 | 12.8 | 2.0 | 10.7 | 9.0 |
| Israel: all Jews (1998-2002) | 2.1 | 12.0 | 42.5 | 3.1 | 4.6 | 30.5 | 49.2 | 28.1 | 3,7 | 17.5 | 10.5 |
| Israel: non-Jews (1998-2002) | 1.1 | 6.7 | 18.9 | 2.6 | 6.1 | 40.4 | 20.0 | 18.1 | 3,2 | 10.0 | 7.5 |
| Italy, Ragusa (1998-2002) | 0.9 | 10.8 | 30.6 | 14.5 | 4.7 | 45.1 | 28.1 | 33.1 | 3,1 | 7.9 | 9.5 |
| Malta (1998-2002) | 2.8 | 10.9 | 27.0 | 2.5 | 5.2 | 38.8 | 35.1 | 26.8 | 3,4 | 10.5 | 10.3 |
| Spain, Granada (1998-2002) | 3.6 | 10.9 | 29.3 | 7.8 | 11.2 | 43.0 | 29.0 | 30.2 | 2,1 | 8.9 | 8.4 |
| USA SEER 14 (1998-2002) | 5.1 | 7.2 | 37.7 | 6.2 | 4.9 | 52.8 | 113.7 | 20.9 | 2,6 | 15.4 | 11.1 |

* World Standard Population, Per 100 000

**Table 6.Age-adjusted* Incidence Rates in Various Registries in the Region, Females**

| | Esophagus | Stomach | Colo-rectal | Liver | Lung | Breast | Cervix uteri | Corpus uteri | Ovary | Thyroid | Hodgkin's Disease | NHL | Leukemia |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Turkey (2006) | 3.1 | 8.8 | 11.5 | 1.5 | 7.7 | 33.7 | 4.2 | 7.2 | 5.4 | 8.8 | 1.2 | 4.4 | 3.8 |
| Iran. Ardabil (2004-2006) | 19.7 | 24.9 | 7.4 | 2.6 | 4.8 | 12.0 | 1.4 | 1.3 | 3.9 | 3.3 | 0.8 | 1.9 | 3.3 |
| Bulgaria (1998-2002) | 0.5 | 8.3 | 19.3 | 2.5 | 7.0 | 47.9 | 18 | 15.3 | 11.3 | 2.8 | 1.6 | 2.7 | 4.4 |
| Egypt. Gharbiah (1999-2002) | 0.9 | 2 | 4.3 | 4.5 | 3.6 | 42.5 | 2.1 | 2.6 | 5.1 | 2.6 | 2.1 | 9.9 | 4.8 |
| Germany. Saarland (1998-2002) | 1.5 | 6.9 | 31.7 | 2.1 | 17.3 | 76.6 | 9.8 | 13.3 | 10.1 | 5.3 | 1.5 | 7.9 | 4.8 |
| Israel: all Jews (1998-2002) | 0.9 | 6.3 | 34.2 | 1.4 | 12.4 | 96.8 | 5.8 | 13.2 | 9.9 | 12 | 3.5 | 14 | 6.7 |
| Israel: non-Jews (1998-2002) | 0.4 | 3.5 | 15.6 | 0.7 | 5.1 | 38.5 | 2.4 | 9 | 3.7 | 7 | 2.8 | 9.1 | 4.5 |
| Italy. Ragusa (1998-2002) | 0.2 | 5.1 | 22.3 | 5 | 5.4 | 61.6 | 5.7 | 12.3 | 9.5 | 10 | 2.1 | 7 | 7.4 |
| Malta (1998-2002) | 0.6 | 4.6 | 22.3 | 1.1 | 6.1 | 67.7 | 3.9 | 16.5 | 10.8 | 9.4 | 1.3 | 7.6 | 5.8 |
| Spain. Granada (1998-2002) | 0.4 | 5.6 | 19.3 | 2.5 | 3.3 | 55.9 | 6 | 13.6 | 8.3 | 7.4 | 1.8 | 6 | 5.4 |
| USA SEER 14 (1998-2002) | 1.3 | 3.4 | 27.2 | 2.2 | 34.3 | 90.9 | 7.4 | 16.8 | 10 | 9.1 | 2.2 | 10.7 | 7.0 |

* World Standard Population, Per 100 000

sites in males and females in Turkey are summarized and compared with the results from cancer registries in South-western Asia (Iran) (Ardabil Cancer Registry, 2004-2006), in Western Asia (Israel), in the Mediterranean region (Egypt, Spain, Italy, Malta), in south-eastern Europe (Bulgaria), in Germany (Saarland) and US (14 SEER registries) (Curado et al, 2007). The most remarkable feature of the cancer profile in Turkey is the quite high incidence of tobacco-related cancers (lung, larynx and bladder) in men. The incidence of lung cancer in males is the highest of all populations at the table. Lung cancer has previously been identified as the most frequent male cancer in Turkey (Curado et al, 2007; Fırat, 1998). Laryngeal cancer rate is also higher than the rates in all populations except Spain and Bulgaria. Conversely, incidence of these cancers in females is low (AAIR of lung cancer is 7.7 per 100 000). Bladder cancer rate is also quite high, higher than in Iran and Bulgaria but lower than in Egypt and developed countries like Italy and Spain. In Egypt schistosomiasis is responsible for the high rates while in developed countries occupational and tobacco exposures are discussed.

The geographical and temporal variation in lung cancer is to a large extent determined by tobacco use (smoking accounts for 85% or more of lung cancers). An increase in tobacco use is generally followed 20-30 years later by an increase in the incidence of lung cancer lung cancer; similarly, a decrease in consumption is followed by a decrease in incidence (Lo, 2005). During 1970-2000, cigarette consumption in Turkey increased by 207% (www1.worldbank.org), and according to a 1993 survey, smoking prevalence among males was 58% and was 13% among females (PIAR Research Company, 1988). Tobacco smoking is also likely to be responsible for the relatively high incidence of bladder cancer among men, also reported by a study from the Aegean region (Gümüş 1999). Eser and Pisani estimated that 88.3% of lung, 40% of larynx, 41.8% of bladder cancers and 44.7% of all sites but skin were attributable to smoking in males in Turkey (Eser, 2006). Since the relatively high prevalence of smoking in females is a comparatively recent phenomenon (over the last 10-15 years) we might expect much higher rates of tobacco related cancers among females in the future.

While smoking is common in Turkey (www1. worldbank.org; PIAR Research Company, 1988; Gümüş 1999; Eser, 2006; Turkish Statistical Institute, 2008-2009; World Health Organization, 2008), alcohol drinking is not (IARC, 1988). This may account for the rather low rates for other cancer sites associated with the combination of tobacco plus alcohol, e.g. pharynx and esophagus. Cancers of the oral cavity were not frequent either; chewing tobacco is not commonly practiced in Turkey, by either sex.

The second most frequent cancer among men was prostate cancer although the AAIR was modest. The incidence of prostate cancer varies widely between countries and ethnic groups. The etiology of prostate cancer is unclear; but lifestyle, diet, environmental agents, and heredity causes are believed to be etiological factors. It is also a well known phenomenon that incidence is increased by the widespread usage of prostate-specific antigen testing. The AAIRs of prostate cancer has had a striking increasing trend in Izmir: (3.1% at 1993-1994, 13.7 % at 98-2002 and 27.9 % at 2003-2005 per 100,000 (Fidaner, 2001; Curado et al, 2007; Eser et al, 2009; Barchana et al, 2009). Despite a lack of systemized PSA screening programs, opportunistic PSA testing is increasing very rapidly in recent years in Turkey generally, but especially in the big cities as Izmir. This sharp increasing trend in prostate cancer incidence rate in Izmir might explain easily with the increasing of opportunistic PSA screening.

Breast cancer was the most frequent cancer for women in Turkey, accounting for approximately a quarter of female cancers. The age adjusted rate was, however, relatively modest and similar to that in other countries of Western Asia (except Israel), and considerably less than in European countries. McCredie et al. found that the incidence in Turkish women in Australia is considerably

higher which might be the consequence of the life style changes in immigrants (McCredie, 1994). Previous data from Izmir and Antalya are consistent with ours (Curado et al, 2007). The major influences on breast cancer risk are reproductive factors. Among Turkish women, fertility has declined in recent years, with total fertility rates declining from 4.3 in 1978, to 3.0 in 1988, to 2.6 in 1993 and in 1998, to 2.2 in 2003 and to 2.1 in 2008 (Hacettepe University Institute of Population Studies, 2009). This might be expected to be associated with an increasing incidence of breast cancer in the future. Furthermore, the data from the ICR show an increasing trend of breast cancer incidences with 26.7% at 93-94, 34.8 at 98-2002, 41.1% at 2003-2005 per 100 000 AAIRs (Fidaner, 2001; Curado et al, 2007; Barchana et al, 2009). Systemized mass mammography screening programs are not available, but the opportunistic screening is performed especially in the big cities. Thus, a part of this increase also might be related with the escalation in diagnosis.

The incidence of stomach cancer in Turkey was much higher than elsewhere in the Mediterranean, Egypt, Israel and US. Infection with Helicobacter pylori is considered to be an important carcinogen, and the prevalence of infection has been found to be high, with 85% of adults testing as antibody positive (Ozden, 1995). We see that the results of Erzurum and Trabzon registries are responsible for high rates of stomach cancer both for males and females in Turkey; contrary to the lower rates in the western and southern part of the country (Tables 5 and 6). Although there is not any other population based information from the east and south east region of Turkey, several hospitals based or clinical studies showed the predominance of stomach and esophageal cancers in the region. In Van (in the East of Turkey), the most frequently occurring cancer in males is stomach cancer and the second most frequent is esophageal cancer. In women, the second most common cancer is esophageal cancer, followed by stomach cancer in third place. In that study, the total endoscopic prevalence of esophagus and stomach cancer in Van was found to be 13.5% (6% and 7.5% respectively) and 1 out of every 7 upper endoscopy was diagnosed as one of either esophagus or stomach cancer. These findings are the highest values of Turkey and leads to the estimation that the prevalence of esophageal and stomach cancer in Van is 40 and 50 per 100 000 respectively. Cases of esophageal and stomach cancer in the Eastern Anatolian region, is 5-6 times higher than in other regions of Turkey (Türkdoğan, 2007). In 2001, stomach cancer was reported as the most frequent cancer (35.8%) in males and it is third after breast and esophageal cancer in females in Van (Van Provincial Directorate of Health, 2001). Throughout Iran and all of Central Asia, esophageal cancer is of major importance and has attracted a great deal of research interest, with setting up a cohort in Golestan (Pourshams et al, 2010). Drinking of hot tea 'kitlama' and low fruit diet are the most common risk factors for esophageal cancer in high risk areas such as in Eastern Turkey (Onuk, 2002). Consumption of smoked, salted, hot, fatty foods, and well water, cigarette smoking, poor intake of fresh fruits and vegetables and poor hygienic conditions are also probable culprit factors and a traditional diet rich in nitrate and nitrite is significant in the development of endemic upper gastrointestinal (esophageal and gastric) cancers in the Van region of Turkey (Türkdoğan et al, 2005; Türkdoğan, 2003). Our study releases the first reliable data for that expected pattern of cancer incidence with dominance of stomach and esophageal cancers in the east and southeast of Turkey as in the other populations in the region, outside of Turkey (Sadjadi, et al 2003; Mousavi, et al 2009).

Colorectal cancers are the second most common cancer (8.1%) in females and the fifth most common (6.9%) cancer in males. Although the rates are not as high as in developed countries (Barchana et al, 2009), they are considerably higher than other countries in the region (Barchana et al, 2009: Sadjadi, et al 2003), which may be due to the increasingly westernized life style including fast food, physical inactivity, and obesity which are risks for colorectal cancers.

Thyroid cancer was ranked third in females with 8.8 per 100 000 AAIR. During the past several decades, an increasing incidence of thyroid cancer has been reported in many parts of the world (Smailyte, 2006; Andry, et al 2009; Chen, 2009; Enewold, et al 2009; Hall, 2009; Kilfoy, et al 2009) one possible explanation for this trend is increased detection through more widespread and aggressive use of ultrasound and image-guided biopsy (Chen, 2009). But most of the other studies suggested that increased diagnostic scrutiny is not the sole explanation and other explanations, including environmental influences and molecular pathways, should be investigated.

The low incidence of cervical cancer, a cancer that is associated with sexual and reproductive factors and the oncogenic subtypes of the human papilloma virus is the pattern observed in Muslim countries in Western Asia. The AAIR in this study was similar to that in Malta, non-Jews in Israel, and in Egypt. Muslims in Bombay have a lower incidence than the other major religious groups (Jusawala, 1985). Nonetheless, the lack of population based HPV prevalence studies in Turkey, show that the findings from some hospital based studies, which reported very low HPV prevalence (2%-6%) among the low risk women are consistent with the low cervical cancer AAIRs we estimated (Dursun, 2009).

The incidence of liver cancer in Turkey was rather low. The previous data from Izmir and Antalya registries were consistent with our findings with low liver incidence rates (Fidaner, 2001; Curado et al, 2007; Eser, 2007). In addition, liver cancer is not one of the most frequent cancers among hospital cases for Turkey (Fırat, 1998). Hepatitis viruses B and C, and aflatoxins are major risk factors for hepatocellular carcinoma and the international incidence pattern of liver cancer correlates well with the prevalence of hepatitis B viral infection. In Turkey, the WHO reported the prevalence of chronic carriers of hepatitis B virus who test positive for hepatitis B surface antigen (HBsAg) as approximately 4% (Sobeslavsky, 1980) and a survey of pregnant women in Ankara instituted a prevalence of 4.3% (Erdem et al, 1994). In Izmir the percentage of hepatitis surface antigen positivity was found 9.2%.(Sobeslavsky, 1980). In a rural region in Ankara the prevalence for HBsAg is 10.6% and of all anti-HBC positive individuals, 25% (83 of 337) was HBsAg positive

(Tuzgol, 1993). The prevalence of markers of infection with hepatitis C virus has been investigated in a community survey in five districts-it was 1.5% overall, similar to that in other countries of Southern Europe (Thomas, 1994). Moderate prevalence of infections such as these might have been expected to give a rather higher risk of liver cancer. We find scarce information on the aflotoxin levels in foods in Turkey. In a survey on the presence of aflotoxin in nuts sampled in three distinct regions of Turkey 14.28% of the samples were found to have low levels of aflotoxin, below the Turkish National regulatory limits of 5 $\mu$g/kg for AFB1 and 10 $\mu$g/kg for total aflatoxins, 1.84% of the samples showed a level of contamination that exceeded the maximum tolerated levels set in the Turkish regulations (Basaran, 2009). In a survey conducted in Van with the flaked red pepper, they found the levels of aflotoxin B1 were 1.10-5.00, 5.01-10.00, 10.01-20.00, 20.01-44.00 ppb of the 42.5%, 40%, 12.5%, 5% of the samples respectively (Agaoglu, 1999).

The incidence of lymphomas and leukemias was relatively low, as in several Asian populations. Among leukemia, myeloid leukemia was seen in excess of lymphoid leukemia in men, as observed in other cancer registries in West Asia.

A major limitation of this study is the lack of adequate death certificates information due to inadequate death registration procedures in the country, since the ratio of the cases notified by death certificates is crucial for completeness.

In conclusion, the findings of this study present the most reliable and recent estimates for cancer incidence in Turkey. It is obvious that cancer has become one of the major public health problems in the country in the last decades, especially tobacco related cancers (lung, bladder, larynx, etc) which give us an important opportunity for intervention via tobacco control. Other cancers which have primary prevention (i.e. colorectal) and secondary prevention strategies (breast, colorectal) constitute the greater part of cancer burden which gives us the opportunity for establishing effective cancer control programs in Turkey. Also variations in the cancer patterns among provinces should be evaluated carefully supporting with further analytic studies in the name of cancer control in the country.

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