Inequalities in Cancer Distribution in Tehran; A Disaggregated Estimation of 2007 Incidence by 22 Districts

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ABSTRACT

Background: Cancer is the third cause of death in Iran, with an increasing incidence projected for the next decade. This study aimed to provide a disaggregated viewpoint on cancer incidence in all 22 districts of Tehran, using the Geographic Information System (GIS). Identifying clusters of cancers may assist in recognizing the cause of the disease, visualizing patterns of cancer distribution, the potential disparities, and help in the provision of early detection programs and equitable, curative, and palliative services.

Methods: According to the 2007 – 2008 Cancer Registry Data published by the Ministry of Health, there were 7948 new cancer cases diagnosed in Tehran. Data were collected from all pathology centers and hospitals, either public or private facilities, in Tehran. These were classified into 31 main categories according to the expert panels and available resources. The population of the districts and neighborhoods were obtained from the Iran Statistical Center and the Municipally of Tehran, respectively. Home addresses and phones were extracted from the database and imported to GIS. The Age-Standardized Rate (ASR) was calculated using both the new world standard population (2000 – 2025) and the Iran population.

Results: Overall, the cancer incidence rate and ASR were 101.8 and 94.775 per 100,000 people, respectively. The maximum cancer incidence rates in both sexes were in districts 6, 3, 1, and 2, whereas, the maximum ASRs were in districts 6, 1, 2, and 3. District 6 accommodated the highest ASRs in both the sexes. Common cancers were breast, skin, colorectal, stomach, and prostate. The ASR in men and women were 129.954 and 114.546 per 100,000 population.

Conclusion: This report provides an appropriate guide to estimate the cancer distribution within the districts of Tehran. Higher ASR in districts 6, 1, 2, and 3, warrant further research, to obtain robust population-based incidence data and also to investigate the background predisposing factors in the specified districts.

Key words: Age standardized rate, geographical information system, neighborhood cancer incidence
INTRODUCTION

Chronic diseases have come out as the most challenging problems for health systems in medium- and low-income countries. Cancer is the third cause of death in Iran, with an increasing incidence projected for the next decade, on account of aging, population growth, environmental hazards, and westernized lifestyle. Epidemiological studies on cancers are pivotal to identify incidence, type, and location of cancers. The 2008 GLOBOCAN report for Iran, estimates the ASR of new cases of cancer to be 107.3 per 100,000 population, and the most common cancers are reported to be stomach, breast, colorectal, bladder, and leukemia. Another study conducted in the Tehran Metropolis using population-based cancer registry data during 1998 – 2001, indicates the ASR as 163 in men and 141.8 per 100,000 in women. The most common reported cancers in males are stomach followed by cancers of the prostate, lung, bladder, non-Hodgkin's lymphoma, and oesophagus. In females, the most common reported cancer was breast cancer followed by cancers of stomach, lung, ovary and oesophagus. Official reports by the Iranian Ministry of Health, indicate that in Tehran, in 2007, the most common cancers in males were skin, prostate, stomach, colorectal, and bladder, and in women, they were breast, skin, colorectal, stomach, and ovary. Locations play an important role in the epidemiology of diseases. Hippocrates indicated in his memorial book, 'Airs, Waters, and Places' that: “You will find, as a general rule, that the constitutions and habits of a people follow the nature of the land where they live.” The initial disease maps were produced in Germany over two hundred years ago. Then in 1855, dot maps of a cholera epidemic by John Snow became the most famous example of spatial epidemiology. The first color cancer maps were produced in 1875. Early nineteenth century research looked to geography to identify etiological clues. In the 1970s, the use of GIS increased among epidemiologists and public health researchers when cancer clusters detected in near areas of high electromagnetic fields, where clusters of disease with unknown etiology regained popular attention in the late 1970s. Increased awareness of GIS has engendered new opportunities for policymakers to estimate the relationship between public health and the geographic characteristics of residential areas. In cancer, epidemiology helps to produce cancer maps and spatial analysis, to investigate the potential relationships between environmental risk factors and cancers. Appropriate and valid information on different cancers in special geographic areas can help specific medical programs, for high-risk groups. Many studies have been conducted on cancer and environmental factors such as exposure to pesticides, residence close to a petrochemical plant, socioeconomic factors, or geographical locations; either the distribution of gastric or esophageal cancer in the Caspian region or clusters of breast and lung cancer incidence among residents living near a river. Colorectal cancer in the United States varies geographically, while demographics, education, behavior factors, and screening use, could only partially explain the differences across geographical divisions. Residential history as well as duration of residence may play a role in breast cancer incidence.

Various studies have investigated the cancer incidence in Tehran, either by using pathology or the population-based registry; however, the present study was designed to provide a disaggregated viewpoint on cancer incidence within the 22 districts of Tehran, using GIS. Identifying clusters of cancers may assist in identifying the cause of disease and visualizing patterns of cancer distribution and potential disparities, to provide early detection programs for populations at risk, as also equitable, curative, and palliative services.

METHODS

Cancer registry in Iran

There are two main cancer registry systems in the country; pathology-based, which has been endorsed by law since 1984, and population-based cancer registry, which is defined as using multiple sources (including hospital records, diagnostic facilities, and death certificates) to collect cancer data. Cancer registration in developing countries suffers from instability of the population, due to emigrations and mobility, lack of expert personnel, inequitable healthcare infrastructure, limited hospital facilities, and inappropriate and unreliable death certificates. The pathology-based cancer
registry includes cases diagnosed histologically or cytologically, which are reported regularly to the health system, then compiled, and refined to make an annual report by the Ministry of Health; this registry covered more than 81% of the incident cases in 2005, while the quality and coverage of the reported cancers by laboratories and pathology centers have been improved significantly so far.\textsuperscript{[1,32,35]}

The study area
The Tehran metropolitan area is situated on the southern slopes of the Alborz Mountains at a latitude of 35°45'N and a longitude of 51°25'E, consisting of 22 municipal districts, with a total population of 7803883 (according to 2006 census), living in 374 neighborhoods with a mean population of 20865.

Data collection
According to the 2007 – 2008 Cancer Registry Data published by the Ministry of Health, there were 7948 new cancer cases diagnosed in Tehran. Data were collected from all pathology centers and hospitals, either public or private facilities, in Tehran. The data on cancer cases had to include the patient’s age, sex, address, and cancer type, with topology. A total of 70 different topographic reports on malignancies were reported for all cases, while these were classified into 31 main categories according to expert panels and the available resources,\textsuperscript{[6,8]} which are shown in Table 1. The population of the districts and neighborhoods was extracted from the IRAN statistical center and the municipality, respectively.

Districts and neighborhood maps in the GIS were identified by giving attention to municipal data, to convert paper maps and data into a digital format. After providing the neighborhood map, the location of cancer cases could be shown on the map that was produced.

Home addresses and phones were extracted from the database and the neighborhoods were verified by the research team. Case data that did not have sufficient information on addresses and phone numbers were eliminated.

Data analysis
In the initial step, the frequency of the 31 topographic categories was reported in 22 districts. Second, the crude incidence rate of the cancers was calculated in 14 age groups and both sexes, in a population of 100.000. The world standardized rate (ASR) per 100 000 people was calculated using the direct method of standardization to the 1966 and new (2000)\textsuperscript{[36]} World Health Organization (WHO) World Standards. Third, the neighborhood cancer incidence per 1000 people was calculated in each district. Data analysis was done by Stata v.11 and SPSS software (version 17).

Age standardized rate calculation
Most rates, such as incidence and prevalence, are strongly age-dependent, therefore age-specific comparisons are useful, but comparisons of crude age-specific rates may be misleading, because of different age structures in populations, hence, age standardization or age adjustment are recommended. The age-adjusted rates are rates that would have existed if the population under study had the same age distribution as the ‘standard’ population. Direct standardization yields a standardized rate, which is a weighted average of the age-specific rates for each of the populations, based on the age-independent index (standard population) to be compared. The age-adjusted rate is calculated by multiplying each crude rate by the appropriate weight (the standard), which is summed up at the end.

Both new world standard population (2000 – 2025),\textsuperscript{[36]} which reflects the average age structure of the world’s population expected from the year 2000 to 2025, and also the national standard population were used for this purpose. Implementation of the new world standard population facilitates comparative analysis globally.\textsuperscript{[8,36]}

RESULTS
A total of 8246 new cancer cases were identified in 2007, in Tehran, within the mandatory pathology registry of cancers. Of these, 298 cases were excluded from our study, as their location was out of the Tehran metropolitan official borders. Out of 7948 remaining cases, 576 were unknown or with no recorded address, to identify their district of residential area, but they were included in the study to calculate the cancer incidence rates.
The overall cancer incidence rate was 101.8 per 100,000 people. The mean age in males was 74, which was more than in females (70.47). The maximum cancer incidence rates between districts in both sexes were seen in districts 6, 3, 1, and 2, whereas, the maximum ASRs were in districts 6, 1, 2, and 3. The highest ASR in women was in districts 6, 22, 1, and 2, and in men it was in districts 6, 3, 1, and 2 [Table 2 and Figures 1 and 2]. Figure 3 demonstrates the distribution of incidence according to all 374 neighborhoods across Tehran, where the incidence varied between zero and 13.81 per 1000.

| Cancer types                      | Frequency (%) | Incidence | ASR, Iran | ASR, World 1966 | ASR, World 2000 |
|----------------------------------|---------------|-----------|-----------|-----------------|-----------------|
| Bladder                          | 446 (5.6)     | 5.715     | 4.465     | 6.557           | 7.378           |
| Bone                             | 108 (3.3)     | 3.406     | 1.327     | 1.394           | 1.342           |
| Bone marrow                      | 266 (3.3)     | 3.409     | 2.795     | 3.687           | 3.177           |
| Brain and CNS                    | 218 (2.7)     | 2.793     | 2.365     | 2.811           | 2.730           |
| Breast                           | 1347 (17)     | 17.261    | 12.140    | 17.624          | 17.122          |
| Cervix and vagina*               | 102 (1.3)     | 2.671     | 2.156     | 2.831           | 3.084           |
| Colorectal                       | 762 (9.6)     | 9.764     | 7.356     | 10.904          | 9.054           |
| Liver and gallbladder            | 55 (0.7)      | 0.705     | 0.551     | 0.810           | 0.619           |
| Kidney                           | 90 (1.1)      | 1.153     | 0.862     | 1.274           | 1.175           |
| Larynx                           | 132 (1.7)     | 1.691     | 1.169     | 1.910           | 1.685           |
| Lung                             | 247 (3.1)     | 3.165     | 2.440     | 3.587           | 2.911           |
| Lymph node                       | 197 (2.5)     | 2.524     | 2.155     | 2.466           | 2.334           |
| Mediastinum, heart, and pleura   | 37 (0.5)      | 0.474     | 0.395     | 0.484           | 0.443           |
| Nasal and paranasal              | 19 (0.2)      | 0.243     | 0.173     | 0.254           | 0.218           |
| Lip, oral cavity, tonsils, and mouth | 118 (1.5) | 1.512     | 1.210     | 1.651           | 1.306           |
| Ovary*                           | 146 (1.8)     | 3.824     | 3.175     | 4.09            | 4.404           |
| Pancreas                         | 72 (0.9)      | 0.923     | 0.678     | 1.051           | 0.930           |
| Peritoneum and retro-peritoneum  | 23 (0.3)      | 0.295     | 0.247     | 0.356           | 0.305           |
| Pharynx                          | 38 (0.5)      | 0.487     | 0.348     | 0.546           | 0.471           |
| Prostate**                       | 543 (6.8)     | 13.621    | 11.33     | 16.236          | 18.226          |
| Parotid and salivary glands      | 29 (0.4)      | 0.372     | 0.309     | 0.384           | 0.336           |
| Skin, external ear, and labia major | 1293 (16.3) | 16.569     | 12.427    | 19.006          | 15.428          |
| Small intestine                  | 10 (0.1)      | 0.128     | 0.096     | 0.145           | 0.127           |
| Soft tissue                      | 123 (1.5)     | 1.576     | 1.427     | 1.557           | 1.392           |
| Stomach                          | 591 (7.4)     | 7.573     | 5.903     | 8.525           | 6.608           |
| Testis**                         | 58 (0.7)      | 1.454     | 1.27      | 1.197           | 1.283           |
| Thyroid                          | 167 (2.1)     | 2.140     | 1.681     | 1.956           | 1.950           |
| Eye and eyelid                   | 144 (1.8)     | 1.847     | 1.395     | 2.1334          | 1.769           |
| Uterus*                          | 132 (1.7)     | 3.431     | 2.695     | 3.808           | 4.096           |
| Esophagus                        | 164 (2.1)     | 2.102     | 1.643     | 2.388           | 1.715           |
| Unknown                          | 268 (3.4)     | 3.434     | 2.607     | 3.876           | 3.301           |
| Total                            | 7945          | 101.808   | 78.037    | 111.591         | 94.775          |

*Only for women. **Only for men

The incidence rate and ASR in both sexes of a total of 7948 cases were 101.8 and 94.775 per 100,000, respectively. Common cancers were breast, skin, colorectal, stomach, and prostate cancers [Table 1]. The incidence rate and ASR in 4193 men were 105.182 and 129.954 and in 3755 women they were 98.363 and 114.546 [Table 3].

Higher cancer incidence of breast, colorectal, ovary, and bone marrow cancer in females was observed in district 3, and skin and stomach cancers in districts 6 and 10, respectively. The highest rate of bladder, colorectal, prostate, and stomach cancers in males was seen in district 6.
For further analysis, the cancer types were limited to five most common cancers [Table 3], which were significantly different within districts; found by using the Fisher exact test ($P < 0.001$).

Age-specific rates of the five common malignancies among men are presented in Figure 4; the prostate cancer rate starts in the fourth and increases sharply in the sixth decade of life. In women, the breast cancer rate presents a different age-specific pattern [Figure 5], which increases between the ages of 30 and 65, and then it comes to recess.
Rasaf, et al.: Inequalities in cancer distribution in Tehran

**DISCUSSION**

This is the first report of district-based cancer incidence in Tehran, which demonstrates differences in cancer incidence in all 22 districts of Tehran. The previous report indicated the overall cancer incidence in the metropolitan area, although it was a population-based report, which included all data sources.\(^7\) The overall cancer ASR in Tehran was 94.775, with a breakdown to prostate (18.22), stomach (13.09), colorectal (13.04), and bladder (11.83) in men, and breast (38.62), colorectal (11.04), stomach (5.76), and ovary (4.4) in women. The highest cancer ASR in women was seen in districts 6, 22, 1, and 2, and in men it was seen in districts 6, 3, 1, and 2. The higher ASR in district 22 compared to the other districts was due to the higher age-specific rate of total cancer after age 65. The mean age of cancer in men was greater than in women.

A study on childhood cancer in the inner city of the Tehran metropolitan indicated that cancer incidence in youngsters (less than 15 years) were seen in districts 6, 12, 7, 4, and 18, and the lowest incidence among both sexes was observed in district 21.\(^{31}\) In this study, the higher incidence in...
less than 15-year patients was seen in districts 7, 8, 6, 12, and 19, and the lowest incidence was in district 22.

Cancer incidence rate in women and men was 98.363 and 105.182. It was adjusted by the standard world population (1966) to compare with other studies. In this study, the total cancer ASR in women and men was 104.902 and 117.535, respectively, while the Iranian Ministry of Health had reported the overall ASR in Tehran, in 2007, as being 99.89 and 99.05 for women and men, which was less than the figures reported for 2006.[8]

During 1998 – 2001, in Tehran, stomach, lung, and esophageal cancers were the most common malignancies in women and men, while those in this study and in report 2007 of the Ministry of Health has decreased dramatically. Indeed all cancers have diminished, except breast in women, since 1998 – 2007.[7,8] In a retrospective study, in the breast cancer cases in five provinces covered by the cancer registry, during the five-year period, 1996 – 2000, breast cancer ASR was 16.2 while during 1998 – 2001 the ASR in Tehran was 31.4. Breast cancer ASR in this study (adjusted by 1966 population) was 35.47, thus, it could be concluded that the incidence of breast cancer has increased in Tehran.[37] The ASR of breast cancer in Iran was lower than in the developed countries, but it had the highest cancer incidence in Iranian women.[8] The 2008 GLOBOCAN report estimated the ASR of breast cancer to be 29.3 for EMRO and 18.4 for Iran.[6]

In a study based on the population cancer registry in the five provinces of Iran, the ASR of colorectal cancer (CRC) in males and females was 8.2 and 7,[38] which was less than our findings in Tehran, which were, 11.7 and 10, respectively. The CRC ASR sex ratio was 1.4 : 1 in the world,[6] compared to 1.17 in both Ansari et al.’s study[38] and the present study. In the previous report of CRC epidemiology in Iran, 17.[38] and 42.9%.[39] of the cases were under 40 and 50 years, respectively, while in this study 6.5 and 19.68% of the CRC were under 40 and 50 years, and then steeply increased to over 65-year-old men. According to these findings, CRC presents in older age in Tehran, which warrants further studies, such as, age-period cohort, to investigate the grounded reasons for this age distribution. This age proportion was similar to proportions seen in many other Middle-Eastern countries,[38] but much higher than in Western countries, for example, 8.7% of the total CRC patients were under 50 years old in the United States.[40] This is probably due to the younger age-structure of our country and relatively low rates of CRC in older individuals. Having said that, when age-adjusted rates were calculated, these figures were almost the same in both Iran and the western countries,[38] which could be a clear reason against the early onset of CRC in Iran. Genetic factors have claimed to play a role in the development of CRC at a younger age,[38,39] however, there is insufficient evidence to prove the early onset of CRC in Iran, due to the fact that age-adjusted rates are close to their western counterparts. The ASR of male CRCs in Tehran was higher than in Pakistan and Turkey, the neighboring countries,[41,42] and was higher than in females, which was probably due to more prevalence of inflammatory bowel disease (IBD) in males.[43]

The ASR of cervix cancer in Tehran was 2.83, which was lower than in Pakistan (6.5) and Turkey (5.4), the neighboring countries.[41,42] Ovarian cancer ASR rate in this study was 4.09, which was similar to the national figure (4.25)[8] and less than the previous report in Tehran during 1998 – 2001 (6.5).[7] and much less than in the US, which was asserted to be attributable to the vast use of oral contraceptives, higher parity, reduced energy intake, and also shortages in the cancer registry in Iran.[44]

Thyroid cancer had a total ASR of 1.95, and was much greater in females (2.88) than in males (1.07), which was almost similar to other reports where the female to male ratio has been reported to be 3.[45,46]

There are some limitations in this study. Although the quality of pathological data in Tehran is fairly acceptable, one may claim otherwise.[47] This is mainly because the Pathology Department must rely upon such data that are filled in, almost invariably rather poorly, by busy clinicians, who are reluctant to supply data, which may not be at hand (e.g., in the Operating Room), and which they feel is unnecessary or irrelevant.[33]

Therefore, the population-based cancer registries are widely recommended,[1] which may prevail pathology-based registry, particularly in stomach and lung cancers that are usually diagnosed in
advanced stages and with high-case fatality rates, and therefore, may underestimate the true cancer rates. However, the quality of the pathology-based registry has improved constantly and significantly from 27% in 1973 to a so-claimed 86.7% in 2007; the validity of national reports should be approved by the third party, although the figures of most incidences — highly fatal cancers like lung, liver, and stomach — are close to what GLOBOCAN had predicted for Iran.

The second limitation refers to the incomplete and missing addresses, which pushed the research team to either investigate the surrogates such as telephone codes or path finding through maps or even discard them from the study if no address was found. This may have some implications in the proper estimation of cancer incidence. Nevertheless, the purpose of this study was to show inequalities in cancer incidence within the districts of Tehran, where all limitations probably occur similarly. Despite these limitations, this is the first report of cancer incidence within the districts of Tehran that provides a useful guide to evaluate the cancer control program. Higher incidence rate in defined districts warrants further investigations for possible risk factors.

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