

The Environmental Causes of Cancer Distribution in Syria

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Abstract: the last two decades witnessed a boost in cancer incidences in Syria, as well as high mortality ratios. The influence of the environmental factors was neglected beforehand. The study employed the geographical tools to investigate the environmental distribution of cancer disease and the environmental factor that controls this distribution. The study used the statistical, systematic, analytical descriptive, comparative and the cartographical methods, each of which were employed differently according to the data characteristics. Personal and spatial data were collected from treatment points in a questionnaire that allowed adjusting each of them on the electronic interactive map. Data was analysed statistically and cartographically depicted. Accordingly parallel descriptive and comparative data were added for reaching the final conclusions. Thematic maps were the final product of using GIS. Natural risk factors were the main focus in addition to people nutrition habits. The study showed many clusters based on the kind of cancer and the kind of risk factor and drew the attention to some risk factors that people disregard (the frequent relative marriage) and some uncommon ones like lithology. Tracing pollution in time line helped to link the earlier influences and the accumulated factor to the recent incidence. The environmental risk factors were the minor reasons for the cancer clusters (elevation height, solar radiation, rock type, polluted gases in the atmosphere and water wells), meanwhile people habitual activities were the major reason (kind of job, smoking and nutrition system). Considerably some urgent risk factor caused the small clusters up on different groups of people. Further environmental studies concerning water resources and agricultural frameworks are crucial to be carried out in this domain.

Keywords: Cancer distribution; environmental risk factors; pollution; spatial clustering.

1 INTRODUCTION

Usually the disease is treated as a pure medical issue based on the causative agent and the host without any consideration to the infectious of environmental factors unlike the epidemiologists who work on the epidemiological triangle which represents (the host, the agent, and the environment) to define the spatial relationships between them and analyze the prevalence and the spread of a disease. Snow (1855) was the first to illuminate on the influence of the environmental surrounding on the outbreak of a disease. Afterwards, Snow linked the spread of cholera in the east of London to the water pump by mapping the

incidences and linking them to the water source. Science then the approached towards health treatment has been widely developed. Hutt (1965) declared the influence of socio-cultural, nutrition, economic and environmental factors by comparing two geographically different places. To discuss the demographic factors, Muir *et al.* (1991) adjusted the age groups of Gastric cancer geographical distribution and by that they gave indications about the correlation of the geographical distribution of cancer and the age groups distributions. Similarly, Youlden *et al.* (2008) compared the geographical distribution of lung cancer over the world countries. Gatrell *et al.* (1996) analyzed the spatial point pattern in relation to epidemic phenomena and incidence clustering. Wall and Devine (2000) demonstrated the credibility and effectiveness of the georeferenced data to analyze the geographical distribution of diseases. Epidemiological atlases thoroughly illustrated the geographical distribution of disease linking the geographical data to risk elements, which helped to predict the future trends of the disease spread.

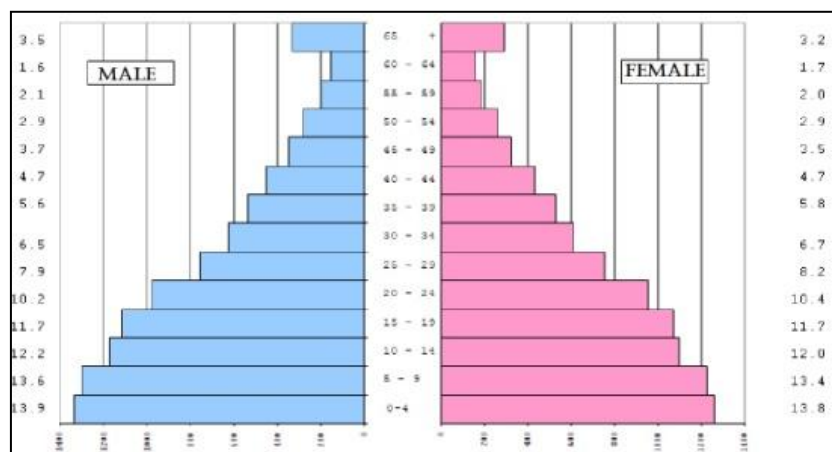
2 CANCER CLUSTERS IN SYRIA

Data were collected by the national cancer registry and grouped according to the major cancer type. Five years in a row were studied and analyzed (2002, 2003, 2004, 2005, and 2006).

2.1 Demographic distribution

At the age group of (0-14) bones and soft tissue cancer, lymphoma and leukaemia form the majority of incidences. For the age group of (20-39) breast cancer, lymphoma and digestive system are the most frequent. For the age group of (40-59) breast cancer, digestive system cancer, and women fertility system forms great proportion of the incidence. For the last age group (+60) digestive system cancers, lung cancer, and men fertility system are the highest of incidences.

The gender differences do not show a significant difference at the scale of the whole country apart from (45-49), (50-54) and (60-64) age groups. Figure 1 shows the gender differences for both population and cancer incidences.



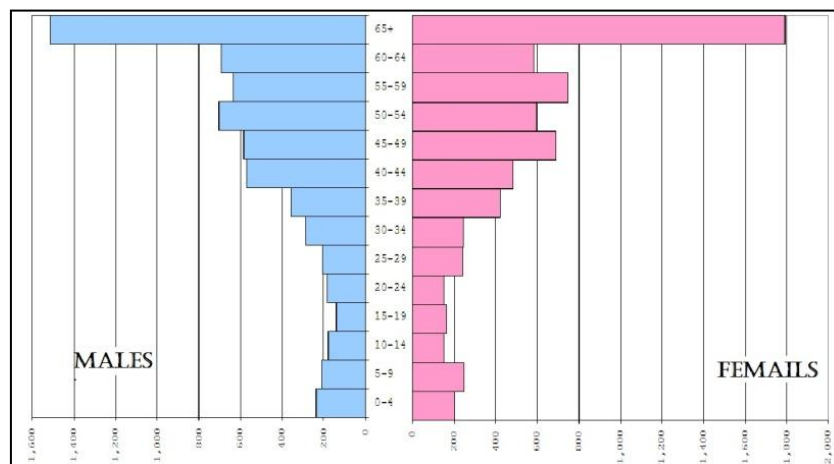


Figure 1. Age Pyramids: population (up) and cancer incidences (down).

Figure 2 illustrates the gender distribution of the overall incidences in 2006, showing a considerable rise of male incidences over females'. This ratio is about 55% males to 45 % females. It also illustrates the number of incidences which is compatible with the population distribution.

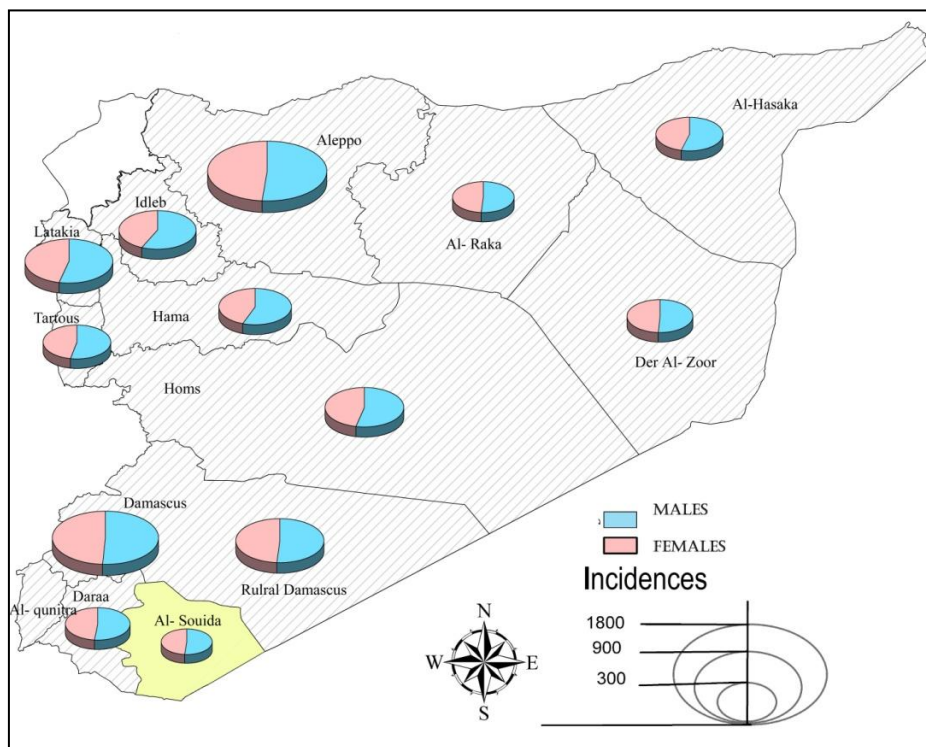


Figure 2. Incidences distribution over the Syrian district 2006 (males vs. females).

2.1 Geographical distribution

The geographical distribution was studied in two steps. The first step is studying the distribution of cancer incidences within each district and comparing this distribution between the districts. Figure 3 illustrates how cancer is distributed over districts and the most common cancer in each district. This visual representation allows comparing the cancer types within and between districts showing either

compatibility or disagreements. Compatibility indicates similar risk factors whereas disagreement points out to distinct associated risk factor(s).

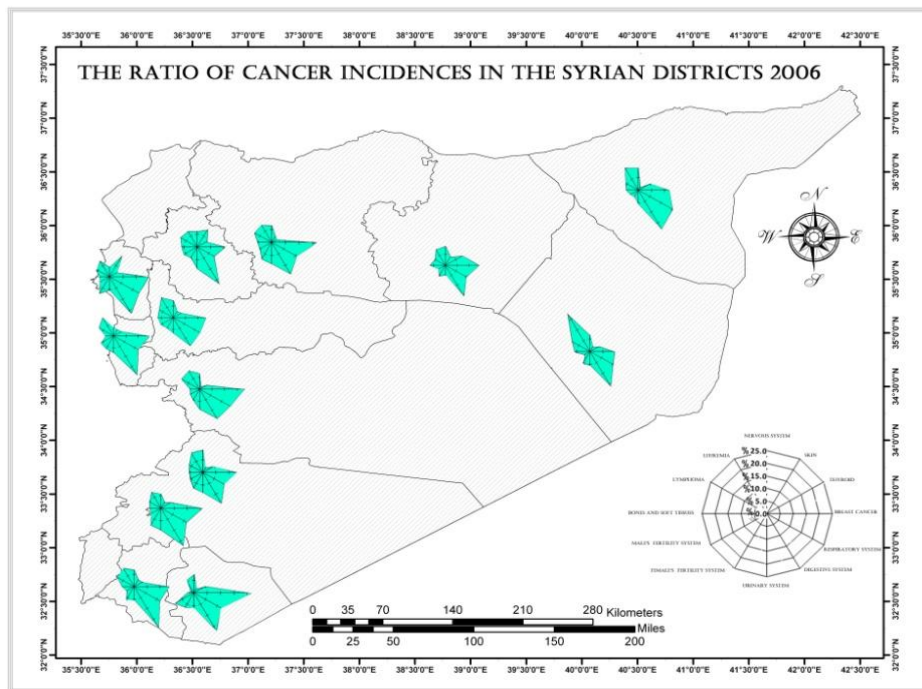


Figure 3. The distribution of cancer incidences over Syrian districts.

The second step is studying the geographical distribution of the incidences ratios to population number. Visualization of these ratios allows effective comparisons of the disease trend in time line and analytical comparisons between cancer types. Examples of two comparisons are depicted in Figure 4 and Figure 5. Having one scale of incidences ratios of all maps allows constant comparisons between cancer types over districts; showing critical clusters and constant ratio for other types.

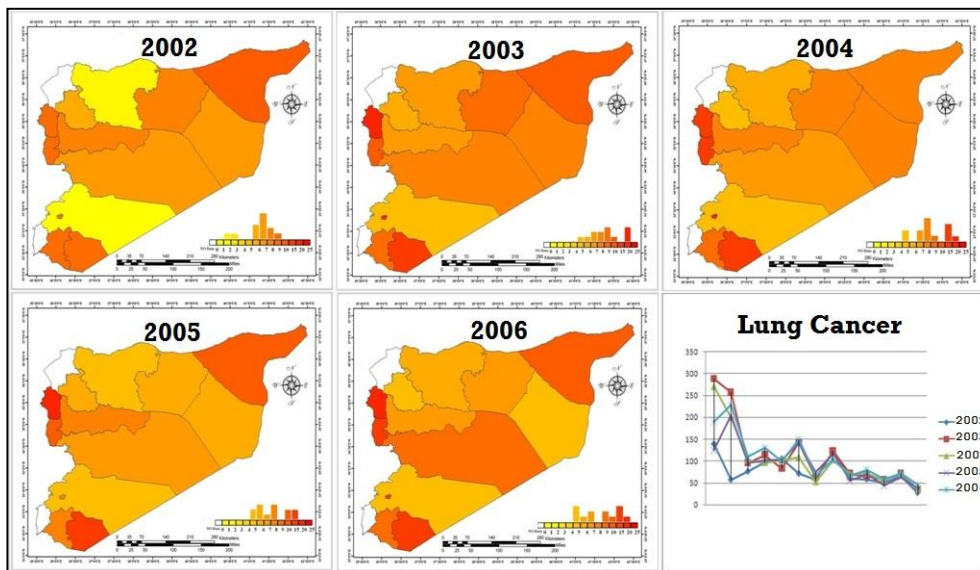


Figure 4. The trend of Lung cancer incidences ratios.

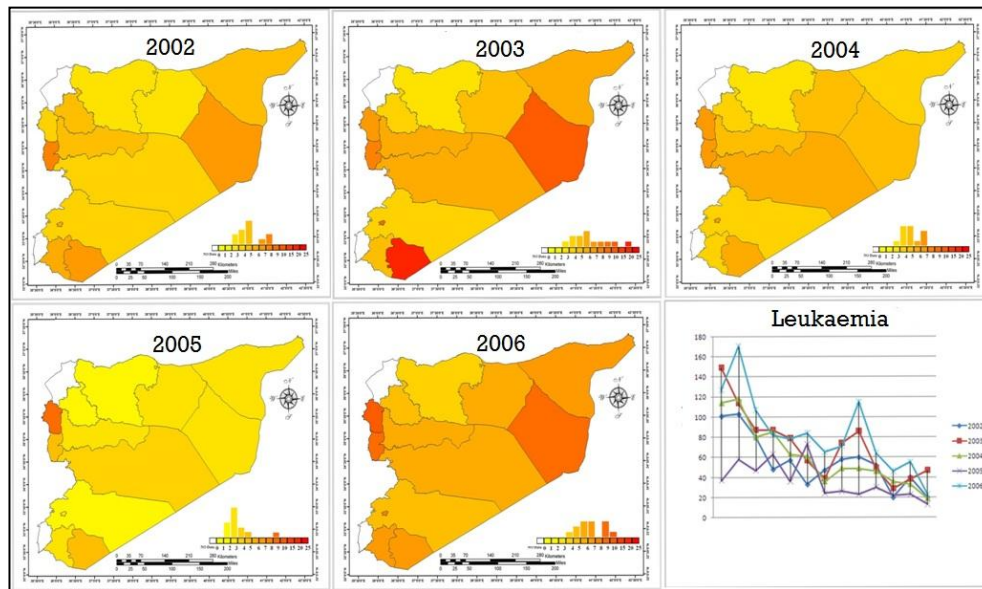


Figure 5. The trend of Leukaemia incidences ratios.

3 CASE STUDY

To get an insight details about the environmental cancer causes, the study moved to larger scale maps. Al-Souida district was chosen as a case study due to the fact that it forms only 3% of the overall area of Syria and has the highest ratio of incidence. In addition to that, Al-Souida has distinct geographical components and structures.

3.1 Environmental Risk Factors

The district is covered with an exceptional volcanic lithology (acidic, neutral and alkali). The Basalt cover forms the majority of the rocks in the area, which has the lowest radiation intensity 15-8 $\mu\text{t/h}$ (see Table 1). These rocks are covered with three soil types (red and dark red, yellow brown and desert soil). The lowest height is 700m and the highest peak is at 1809m height with average height of 1000. the elevation factors makes the area situated on three sun radiation intensity circles; the first is 17.5-18.5 mj/m^2 , the second is 18.5-19.5 mj/m^2 and the last is 19.5-20.5 mj/m^2 . There is no permanent water flow and most of the flows are temporal which end at the beginning of the hot season. Drinking water is collected by 17 dams and 180 storage stations. Knowing that the district is poor of sewage system, it was important to study the geological layers and faults to trace the sewage water leaks.

Table 1. Comparison of the rocks' radiation intensity.

Rock Type	Potassium ppm	Thorium ppm	Uranium ppm	Radiation intensity
Granite rich in Ca	25000	8.5	3.0	25-10
Granite poor in Ca	42000	17.0	3.0	25-10
Basalt	8300	4	1	15-8
Impulsive alkaline rocks	40	0.004	0.001	60-10
Cyanate	48000	13.0	3.0	40-30
Clays	26000	12.0	3.7	15-8

All these geographically distinct elements were implemented in the Geographic information system (illustrated in Figure 6). Considering pollution caused by mining, industry...etc, it shall be mentioned that the district is considered one of the environment friendly regions according to the world sanders (2008) science most of the human activity is linked to the service sector and agriculture. But it worth noting that construction industry is growing in the region.

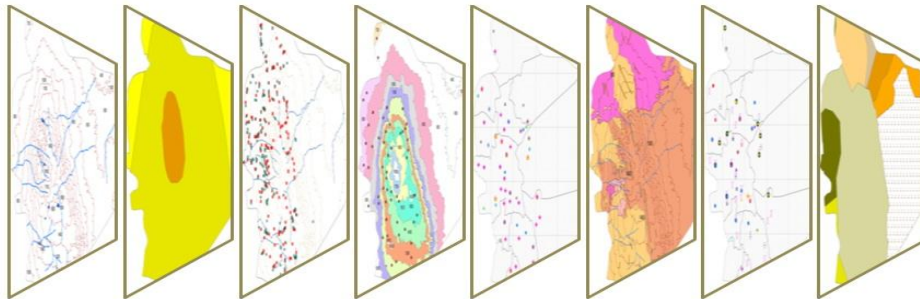


Figure 6. The transformation of the georeferenced data to GIS layers.

3.2 Demographic Risk Factors

Some demographic indicators are considered exceptional such as the population growth rate 1.4%, interior emergency 1.4% and the ratio of urban to rural population which show that people of the district are closely related to the environment. The gender ratio is 98.9 males to 100 females. The indicators presented in Table 2 are the highest in the country although it has witnessed some development between 1995-2004.

The Cancer incidences rate is the highest over the Syrian districts; it is 120 incidences for each 100,000 people which means that each year the district records 382 new incidence.

Table 2. Life needs Indicators.

Indicators	1995	2004
Percentage of people who use safe water	%15.3	%3
Percentage of children who have weight lose	%9.3	%8.4
Index of deprivation of adequate standard of	%12.3	%5.7
Percentage of people who are not expected	%7.6	%6
Percentage of adult illiteracy	%18.9	%13.9
Poverty indicator	%14.4	%10.1

Figure 7 Shows the Gender variation of the incidence according to the cancer type showing great differences between male and females spatially for respirator system, digestive system. This issue indicates the influence of occupation and genetic as risk factors.

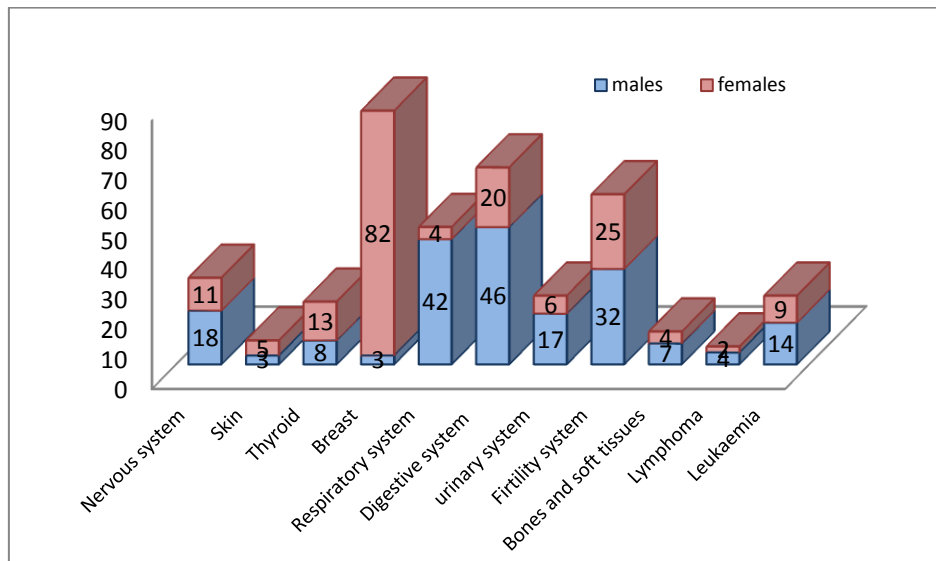


Figure 7. Percentage of incidences according to infected system, Gender Comparison 2006.

3.3 Data analysis

Both environmental and demographic factors were employed in the database, which was geographically referenced. In addition to that, the incidence data in the time line of 2001-2006 were added to the data base. Layers depicting each factor were made. Personal and spatial data were collected from treatment points using a questionnaire that allowed adjusting all details on the interactive map. Using GIS as analytical tool helped to link between the risk factors and the incidences showing crucial correlation between the incidences and the water source. Having closer look reveals that fertilizers and pesticides are used extensively in the mountain where apple trees are grown. Consequently, the drinking water, which is collected behind dams, is polluted when rains washes these poisonous materials and gathered later on in leaks behind dams. Moreover, there is a link between the wells layer and the geological layer. More specifically, the sewages leaks to water wells. Proof of that was found by chemical analyses of the wells' water in the region, where high level of nitrate was found in ten of them (10 out of 128).

CONCLUSION

Studying the distribution of cancer over Syria and using the geographical tools and methods, the research found out the following:

- The disease has a drastic growth since 2002 as the incidences recorded 9978 cases and reached 13149 new cases in 2006 with the average ratio of 58.6 cases for 100.000 citizens.
- The recorded incidences show that the largest part of incidences belongs to the older age groups. The fact that illuminate on hormone factors as well as the accumulated factors of pollution.
- Unexpected records of incidence at a very young age for breast cancer.
- Breast cancer, respiratory system and digestive system cancers are the most common ones excluding the eastern part of (Dier al-Zor) where the leukemia is the most common one and in the northern western part of (Edlib) where the urinary system cancer is the most common.

- The incidence ratio in the eastern part is considerably high because of the effects of Iraqi war 2003. People were affected by the uranium and phosphor bombs which were used extensively during the Iraqi war. In addition to that the markets were flooded with cheap nuclear polluted products.
- At the far east of the country of (al-Hasaka) district the respiratory system cancer form 15.2% of the total incidences which is the highest ratio in the country. This was caused by the accumulated factor of profession in addition to the great pollution in the low and middle atmosphere layers caused by the remains of burning oil wells of the second world war 1991.
- The occupation factor is one of the direct causes of the disease because of the direct interaction with the risk factor on a daily base especially for the construction workers, farmers and miners.
- Cancer clusters obviously appear in Daraa, Edleb and Tartous districts because of the extensive use of chemical fertilizers.
- The geographical factors (lithology, sun radiation, soil type) in Al-Souida do not act as risk factors, but in the contrary they are the least cancer causing factors.
- Studying the case of Al-Souida, water pollution was found as the direct cause of the cancer outbreak of cancer in Al-Souida. In addition to that, the genetic factor seems to be the main cause of the breast cancer.
- Using fertilizers extensively in Al-Souida was reflected to the high leukaemia and lymphoma incidence forming 12% of the incidence. This percentage is considered one of the highest in the country.
- Incidences of lung cancer are remarkably distinct. The ratio of females' to males' lung cancer incidences is 1:6.

FUTURE PERSPECTIVES

Environmental factors can be considered the basic element for diseases' outbreaks. Obtaining more information about cancer incidence and mortality will allow us to control the causing factors and model the development of the disease. The next step of the research will be helping the decision makers to choose the best location for treatment points for the best of patients needs. However, it would be interesting to extend this study to analyze and model the causes of epidemiological disease such as tuberculosis (TB). Further study need to be conducted to clarify the reasons of variant incidences ratios of male to female over the Syrian districts.

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