

High Incidence Rate of Lung Cancer in Oil Refinery Counties

Fares A. Masri and Amer Sheikh Yusuf

Abstract—New research shows a significant link between lung cancer and cancer-causing chemical pollution, especially from large industrial facilities such as oil refinery. The aim of the study was to compare the incidence rate of lung cancer between oil refinery counties and non oil refinery counties in Syria. All our data were collected from the Nuclear Medical Center at Beirouni hospital in Damascus, which has the only Cancer disease registry in Syria. All patients (n=2790) who were diagnosed in 2006 with any type of cancer from oil refinery counties (n=2) and non oil refinery counties (n=3) in Syria were included in this study according to their residency place and cancer type. Our results indicate that Lung cancer in oil refinery counties constituted significantly higher percentage of all cancers than non oil refineries counties [P=0.005]. Lung cancer incidence rates for 2006 in oil refinery counties was significantly higher than non oil refineries counties [refineries counties: 3.48 per 100 000 population; non refineries counties: 2.27 per 100 000 population; P=0.034]. Unexpectedly, only 53.9% of lung cancer patients in oil Refinery County were smoker. We also observed an excess rate of lung cancer occurrence in age group 30-39 years old in oil refinery counties. In conclusion, this study provides new information suggesting that oil refinery products may play an important role in lung carcinogenesis in Syria.

Index Terms—Carcinogenic exposure, lung cancer, oil refinery, pollution, syria.

I. INTRODUCTION

There are two major factors influence the incidence of cancer: hereditary factors and acquired (environmental) factors. Environmental (as opposed to hereditary) factors account for an estimated 75%-80% of cancer cases and deaths in the US [1]. Although the estimated percentage of cancer deaths caused by environmental pollutants is small compared to the cancer burden from tobacco smoking (30%) and the combination of nutrition, physical activity, and obesity (35%), the relationship between environmental carcinogens and cancer is important because a small percentage of cancers can represent large number of deaths[2]. In the Eastern Mediterranean Region (EMR) as Worldwide, lung cancer is the most commonly diagnosed cancer and causes more deaths than any other cancer [3-5]. Its high mortality rate results from both a high incidence rate and a low survival rate [6]. Changes in lifestyle have resulted in more exposure to cancer-promoting substances. This,

together with the increased prevalence of tobacco use, changes in social and dietary habits, decreased physical activity, and exposure to other environmental risk factors, contributes to the increased lung cancer morbidity. The EMR is expected to see the greatest increase in lung cancer incidence in the next 15 years, with an greatest increase in death from lung cancer [7].

There is mounting evidence that Exposure to carcinogens-chemical or biological such as the material released from oil refiners increases the risk of cancer; including lung cancer [8, 9]. Oil refineries emit about 100 chemicals everyday. These include metals like lead which makes it hard for children to learn. They also include very small dust particles called PM10, which get deep into our lungs and harm our ability to breathe. Finally, refineries emit many gases like sulphur dioxide (SO₂), nitrogen oxide (NO₂), carbon dioxide, carbon monoxide, benzene and others. Unfortunately, data related to lung cancer pattern in the region are inadequate and directed almost to treatment. However, low rates of earlier diagnosis reduce the efficacy of treatment: In the majority of Eastern Mediterranean countries, lung cancer is generally diagnosed at a relatively advanced stage. Due to the lack of information on lung cancer rates in Syria and its relation to oil refinery, we believe this study will provide an important step toward lung cancer prevention. To our knowledge; this is the first study of its kind that compared frequency rates of lung cancer between oil refinery counties and non oil refinery counties in Syria.

II. METHODS

We compared the rate of lung cancer between oil refinery counties (Homs and Tartos) with free oil refinery counties (Damascus, Latakia, and Dair Alzour). Homs and Tartos are the only counties in Syria which has oil refinery (Figure.1). Homs Refinery Company (HRC) was established in 1959 in Homs while Baniyas Refinery Company (BRC) was established in 1975 in Tartos County. HRC and BRC recently reached a total capacity of around 6 million tons / year of both Light and Heavy Crude Oil. All our data were collected from the Nuclear Medical Center at Beirouni hospital in Damascus, which has the only Cancer disease registry in Syria. Health care is free for all Syrian and is provided through a nationwide network of primary health care centers and hospitals. All Public Syrian Hospitals transfer their cancer patients to the nuclear medical center for both diagnostic and therapeutic cases. Few patients prefer to visit the private clinics for treatment but those should not account more than 5% of all cancer cases in Syria based on Beirouni Hospital information because most of the cancer patients registered their diagnoses at Beirouni hospital even if they did not get

Manuscript received June 4, 2012; revised July 13, 2012.

Fares. A. Masri is with the University of Kalamoon, Faculty of Pharmacy, Deratiah, Syria (e-mail: fares_masri@yahoo.com).

Amer Sheikh Yusuf is with the Nuclear Medical Center at Beirouni hospital, Damascus, Syria. He is now with Kiwan Medical Center for Cancer Care, Damascus, Syria (e-mail: ayoussef@scs-net.org).

the treatment.

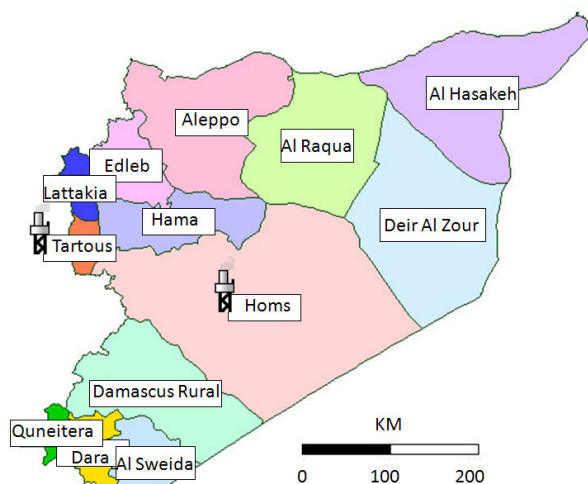


Fig. 1. Syria: By Province.

Only patients who were diagnosed in 2006 and had a confirmed pathological primary cancer diagnosis from the pathology department of Beirouni University Hospital were included in the study. A total of 2790 cancer patients from five different counties were included in this study. [Number of cancer patient in each county: Homos 615, Damascus 1043, Tartos 308, Dair Alzour 407, Latakia 417]. The incidence rate was calculated using the average of 2006 population [10]. Incidence rates of lung cancer has been expressed per 100 000 population. The study was approved by the Research Ethics Committee of Kalamoon University.

Statistical Analysis

Standard Package for Social Sciences, SPSS software was used to perform the statistical analysis. Data are presented as percentages of total \pm mean standard deviation, SD. Lung cancer patients of oil refineries counties and non oil refineries counties were compared with respect to the selected variables. For continuous variables two-sample t tests were used and for categorical variables chi-square tests are performed. For all analyses, the significance level is set as 0.05.

III. RESULTS AND DISCUSSION

To investigate the effect of oil refinery on the lung cancer occurrence in Syria, we included all the cancer patients who were diagnosed in 2006 in 5 different counties. Two of these counties have oil refiners. Table I summarized Clinical characteristics of the study subjects.

A. Lung Cancer Rate in Refineries Counties in Comparison to non Refineries' Counties

Lung cancer constituted higher percentage of all cancers in Tartos and Homs (10.06%, 9.43%) compared to Damascus, Latakia and Dair alzour (7.28%, 6.7%, 7.3%) respectively. Statically, lung cancer in oil refinery counties constituted significantly higher percentage of all cancers than non oil refineries counties [refineries counties ($n=2$): total cancer cases 923, lung cancer cases 89, % of lung cancer = 9.75 ± 0.45 ; non refineries counties ($n=3$): total cancer cases 1867, lung cancer cases 134, % of lung cancer = 7.1 ± 0.34 ;

$P=0.005$] (Table II).

Based on Al Beirouni University Hospital data, lung cancer incidence rates for 2006 in oil refinery counties was significantly higher than non oil refineries counties [refineries counties: 3.48 per 100 000 population; non refineries counties: 2.27 per 100 000 population; $P=0.034$] (Table II). This observation may indicate that Homs and Tartos counties at greater risk of lung cancer occurrence because of long term exposures to the pollutants which are released from oil refinery factories. In comparison to other studies, lung cancer incidence rates in Qatar for 2006 (4.8 per 100,000 population) and Egypt for 1999-2001 (7.7 per 100,000 population) were remarkably higher than the studied counties in Syria. The differences in rates can be attributed to several factors; Cultural disturbances associated with modernization, rich diet, physical inactivity and smoking. In addition we look at only few counties in Syria not all. for these reasons, our results might me under estimated in comparison to other countries [11], [12]

In support of our finding, there is a study in Spain shows that toxic substances released into the environment by many types of industries might be associated with some malignant tumors, specifically lung cancers. Spanish data looked at geographical mortality patterns in association with industrial pollution. The geographic patterns studies in Spain suggest that there are environmental factors which may play an important role in tumor etiology and lung cancer in Spain [13]. In contrast, Hearey et al. found no relationship between cancer incidence and residential exposure to petroleum and chemical emissions in Contra Costa County[14]

B. Comparison of Lung Cancer Frequency Rates between Refineries Counties and non Refineries Counties according to Their Age Groups, Sex Distribution and Smoking Habits

Our results show that frequency rate of lung cancer rises sharply with age in all counties as already known in other studies that lung cancer is a disease of aging [15]. According to the American Cancer Society, the average age of people with lung cancer is 60. Lung cancer is unusual among people under 40 years of age. We also observed an excess rate of lung cancer in aged group 30-39 and low rate above 70 years old group in oil refinery counties in comparison to non refinery counties (Table II). This observation indicates that oil refineries may increase the risk of lung cancer occurrence at the younger age groups.

There was no significant different between refinery counties and non refinery counties in both male and female. Around 75% of lung cancer patients were males in both refinery counties and non refinery counties (Table II).

The high frequency rate of lung cancer among males than females in both refinery counties and non refinery counties may due primarily to the lower prevalence of smoking among females in Syria [16]. Several studies indicate that smoking is related to all the major types of lung cancer.

TABLE I: CLINICAL CHARACTERISTICS OF THE STUDY SUBJECTS

Counties Names	<u>Refineries Counties</u>		<u>Non Refineries' Counties</u>		
	HOMS n (%)	TARTOS n (%)	DAMASCUS n (%)	LATAKIA n (%)	DAIR ALZOUR n (%)
• Total cases of cancer	615	308	1043	417	407
• Total cases of lung cancer	58	31	76	28	30
• % of lung cancer according to total cancer cases	9.43 %	10.06 %	7.28 %	6.7 %	7.3 %
• Average population for 2006	1745500	806500	3649500	1024500	1224000
• Incidence rate of lung cancer per 100,000 population	3.32	2.84	2.08	2.73	2.45
<u>Lung cancer Pattern</u>					
Mean Age \pm SD	58.9 \pm 11.8	50.9 \pm 16.3	59.5 \pm 13.6	56.3 \pm 18.7	62.7 \pm 11
<u>Rate by Age group</u>					
< 30	2 (3.45 %)	2 (6.45%)	2 (2.63%)	3 (10.71%)	0 (0.00%)
30-39	1 (1.72 %)	8 (25.81%)	4 (5.26%)	1 (3.57%)	1 (3.33%)
40- 49	7 (12.07%)	6 (19.35%)	10 (13.16%)	3 (10.71%)	3 (10.00%)
50-59	19 (32.76%)	6 (19.35%)	20 (26.32%)	9 (32.14%)	9 (30.00%)
60-69	20 (34.48%)	4 (12.90%)	23 (30.26%)	7 (25.00%)	9 (30.00%)
70+	9 (15.52%)	5 (16.13%)	17 (22.37%)	5 (17.86%)	8 (26.67%)
<u>Rate by Sex</u>					
Male	42 (72.4%)	23 (74.2%)	65 (85.5%)	21 (75%)	20 (66.7%)
Female	16 (27.6%)	8 (25.8%)	11 (14.5%)	7 (25%)	10 (33.3%)
<u>Smoking</u>					
Yes	31 (53.4%)	17 (54.8%)	56 (73.7%)	19 (67.9%)	19 (63.3%)
No	27 (46.6%)	14 (45.2%)	20 (26.3%)	9 (32.1%)	11 (36.7%)

TABLE II: COMPARISON OF LUNG CANCER PATTERN BETWEEN REFINERIES COUNTIES AND NON REFINERIES' COUNTIES IN SYRIA

	<u>Refineries Counties</u>	<u>Non Refineries' Counties</u>	<u>P- Value</u>
	n (%)	n (%)	
• Total cases of cancer	923	1867	
• Total cases of lung cancer	89	134	
• % of lung cancer according to total cancer cases	9.64 %	7.17 %	0.005*
• Average population for 2006	2,552,000	5,898,000	
• Incidence rate of lung cancer per 100,000 population	3.48	2.27	0.034*
<u>Lung cancer Pattern</u>			
Mean Age \pm SD	56.28 \pm 13.84	59.12 \pm 14.54	0.14
<u>Rate by Age group</u>			0.587
< 30	4 (4.49%)	5 (3.73%)	
30-39	9 (10.11%)	6 (4.47%)	
40- 49	13 (14.08%)	16 (11.94%)	
50-59	25 (28.08%)	38 (28.35%)	
60-69	24 (26.96%)	39 (29.10%)	
70+	14 (15.73%)	30 (22.38%)	
<u>Rate by Sex</u>			0.245
Male	65 (73.03%)	106 (79.10%)	
Female	24 (26.96%)	28 (20.89%)	
<u>Smoking</u>			0.014*
Yes	48 (53.9%)	94 (70.1%)	
No	41 (46.1%)	40 (29.9%)	

Unpredictably, our results showed that the percentage of smokers among lung cancer patients was significantly lower in refineries counties than non oil refineries counties [refineries counties: total lung cancer cases 89, % of smokers= 53.9%; non refineries counties: total lung cancer cases 134, % of smokers= 70.1%; P=0.014], (Table II). These results were unexpectedly surprising to us since it is already known that more than 80% of lung cancer patients are smokers. For example; in the United States, smoking is

estimated to account for 87% of lung cancer cases (90% in men and 85% in women)[17]. Our findings point to potential other causes for lung cancer in the estimated 46.1% of lung cancer patients who never smoked and live in refinery counties. This study raises concern (or supports our theory) that other environmental carcinogens influencing the current trends for lung cancer in these counties, or possibly interacting with cigarette smoking changing incidence and mortality [18].There are many carcinogenic substances

which are increased in workplace (oil refinery), as well as in the general environment: Volatile Organic compounds (Methane, Ethane and benzene), nitrogenated composites, and derivatives of sulphur [18]. There is some evidence to suggest an association between cancer incidence (including lung cancer) and employment at petrochemical facilities or even living close to that area [9, 19-21].

Some limitations of our analysis are worth noting. One of these limitations is that we only included registered cases at Beirouni Hospital (government cancer center) which account for high percentage of all cancer cases in Syria based on Beirouni Hospital information (not published). For this reason, our results might be under estimated. Despite these limitations, our data provide a good indication of current patterns of lung cancer in Syria. Such estimates may serve as a baseline for investigating future trends of lung cancer incidence and planning for better lung cancer control activities in the next millennium.

IV. CONCLUSION

To our knowledge, this is the first study of its kind that compared lung cancer incidence rate between refineries counties and non refineries counties. Our data showed that lung cancer incidence rate was higher in oil refinery counties. Although the study is not conclusive, it provides new information suggesting that oil refinery products may play an important role in lung carcinogenesis." it will be important for future studies to determine the exact cause- effect relationship between exposure to oil refinery products and lung cancer. We would recommend planning for well designed future prospective studies looking at workers of oil refineries and future cancer risk in relation to known risk factors such as smoking and other molecular genetics markers.

ACKNOWLEDGMENT

The authors are indebted to Beirouni hospital for clinical information. We thank Dr. Mona Satli for statistic information regarding cancer pattern in Middle East.

REFERENCES

[1] American Cancer Society. Cancer Facts and Figures 2010. Atlanta: American Cancer Society; 2010.
 [2] The national Toxicology Program: 11th Report on Carcinogens. *US Department of Health and Human Services*, 2005.
 [3] S. B. Devesa, A. P. Vizcaino, and D. M. Parkin, "International lung cancer trends by histologic type: male:female differences diminishing and adenocarcinoma rates rising," *Int J Cancer* vol. 117, pp. 294-299, 2005.
 [4] D. B. Parkin, J. Ferlay, and P. Pisani, "Global cancer statistics, 2002," *CA Cancer J Clin* vol. 55, pp. 74-108, 2005.
 [5] D. B. Parkin, J. Ferlay, and P. Pisani, "Estimating the world cancer burden: Globocan 2000," *International Journal of Cancer* vol. 94, pp. 153-156, 2001.

[6] L. E. Ries, C. Kosary, B. Hankey, B. Miller, and L. Clegg, et al. SEER cancer statistics review, 1975-2002. [Online]. Available: http://seercancer.gov/csr/1975_2000/, 2003.
 [7] S. Omar NHMA and O. M. N. Khatib, "Cancer magnitude, challenges and control in the Eastern Mediterranean Region," *Eastern Mediterranean Health Journal* vol. 13, 2007.
 [8] G. N. Berry and P. Antonis, "Combined effect of asbestos and smoking on mortality from lung cancer and mesothelioma in factory workers," *Br J Ind Med* vol. 42, pp. 12-18, 1985.
 [9] A. C. P. Pier Alberto Bertazzi, C. Zocchetti, and R. Latocca, "Mortality study of cancer risk among oil refinery workers," *Int Arch Occup Environ Health* vol. 61, pp. 261-270, 1989.
 [10] Office of Prime Minister CBoS. *Statistical Abstract*. Damascus: Central Bureau of Statistics, 2006.
 [11] U. S. National Institutes of Health . National Cancer Institute: SEER Cancer Statistics Review.
 [12] H. A. Abdulbari Bener, R. Kakil, W. Ibrahim, "Patterns of Cancer Incidence Among the Population of Qatar: A Worldwide Comparative Study," *Asian Pacific Journal of Cancer Prevention* vol. 8, 2007.
 [13] E. B. Javier Garcia-Pérez, R. Ramis, M. Pollan, B. Pérez-Gomez, N. Aragonés, and G. Lopez-Abente, "Description of industrial pollution in Spain," *BMC Public Health* 7:40doi:10.1186/1471-2458-7-40, 2007.
 [14] C. D. Hearey, A. Siegelau, M. K. P. Ho, H. Salmon, and R. L. Cella, "Lack of association between cancer incidence and residence near petrochemical industry in San Francisco Bay Area," *J Natl Cancer Inst*: pp.1295-1299, 1980.
 [15] H. J. Cohen, "Biology of aging as related to cancer," *Cancer* vol. 74, pp. 2092 - 2100, 2006.
 [16] W. M. Smoking in Syria: profile of a developing Arab country, *Int J Tuberc Lung Dis* Mar; vol. 6, pp. 183-191, 2002.
 [17] R. McKinnies, "Effects of environment and genetics on lung cancer," *Radiation Therapist: The Journal of the Radiation Oncology Sciences*, 2007.
 [18] EOv. Ravenswaay, "Pollution Prevention Case Study on Petroleum Refining," 1995.
 [19] O. R. Wong, "A critical review of cancer epidemiology in the petroleum industry, with a meta-analysis of a combined database of more than 350,000 workers," *Regul Toxicol Pharmacol* vol. 32, pp. 78-98, 2000.
 [20] S. C. T sai, E. E. Fox, J. K. Wendt, C W. X. heng, D. E. Foster, and A. E. Fraser, "Cancer incidence among refinery and petrochemical employees in Louisiana, 1983-1999," *Ann Epidemiol* vol. 14, pp. 722-730, 2004 Oct.
 [21] M. T. Madkour MSEB, H. I. Awad Allah, A. A. Awad, and H. F. Mahmoud, "Environmental exposure to asbestos and the exposure-response relationship with mesothelioma," vol. 15, 2009.



Fares A. Masri was born in Damascus, Syria in 1975. He obtained his Ph.D. in Clinical Chemistry and Bioanalytical Chemistry, Cleveland State University and Cleveland Clinic Foundation, Ohio, May /2005. And he got his M.Sc. in Chemistry, Cleveland State University, Ohio, Dec/2002. He got his B.Sc. in Molecular Biology and Biochemistry, Damascus University, Syria, Sep/1999. From 2007 to present, he is the Chairman of Biochemistry and Microbiology Department, Faculty of Pharmacy, University of Kalamoon, Syria. From 2011 to present, he is the director of Privet Medical laboratory specialized in clinical chemistry, Syria. From 2005 to 2006, he was the Post Doctoral Research Fellowship/Clinical Chemistry, Pathobiology Department, Cleveland Clinic Foundation, U.S.A. His current research focuses in the epidemiology of the common diseases in Syria such as Cancer and Diabetes. I think the research in epidemiology of human diseases in Syria is very essential to improve detection, treatment, and ultimately the quality of life for persons facing these diseases.