

## Geographic Variation of Incidence Rates of Cancer and Associated Risk Factors in Northern West Bank, Palestine, 2005-2008

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### التباين الجغرافي في معدلات الإصابة بالسرطان والعوامل المرتبطة في شمال الضفة الغربية ، فلسطين ، 2005-2008

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**الملخص - الخلفية:** يعتبر السرطان ثالث أكبر مسبب للوفيات في الضفة الغربية و غزة بنسبة 10% من مجمل الوفيات. وبالرغم من هذه الأهمية للسرطان فإن البحث العلمي لا يزال غير كاف في مجال تحديد معدلات الإصابة واختلافاتها الجغرافية. وقد هدفت هذه الدراسة إلى مقارنة معدلات الإصابة بالسرطان والعوامل المسببة له بين المحافظات وأنواع التجمع السكاني (حضر، ريف، مخيم) في شمال الضفة الغربية في الفترة من 2005-2008.

**المنهج:** تم حساب معدلات الإصابة من المعطيات التي تم جمعها من ملفات السرطان في ثلاثة مستشفيات في شمال الضفة الغربية. وقد تمت مقارنة معدلات الإصابة باستخدام تحليل Negative Binomial Regression مع الأخذ بعين الاعتبار عوامل العمر والجنس و سنة التشخيص. كما تم استخدام Fisher's exact test لفحص ارتباط العوامل.

**النتائج:** أظهرت النتائج أن أقل معدل للإصابة كان في محافظة جنين ( 45 حالة لكل 100000 شخص على مدى الأربع سنوات) بينما كان أعلى معدل إصابة في محافظة نابلس ( حوالي ثلاثة أضعاف معدل الإصابة في جنين بواقع 148.1 حالة لكل 100000 شخص). كما كان معدل الإصابة في المخيمات أعلى من الحضر والريف (169 و 103.2، و 79.3 حالة لكل 100000 شخص، على التوالي). كما أظهرت النتائج وجود اختلافات في توزيع المرضى بين المناطق الجغرافية (المحافظة و نوع التجمع) فيما يتعلق بكل من نوع التلوث البيئي، التدخين، شرب الكحول، القلق، والأمراض المزمنة، بينما لم تلاحظ فروق ذات دلالة إحصائية فيما يتعلق بالعادات الغذائية و تاريخ العائلة في الإصابة بالسرطان.

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**الخلاصة:** تبين وجود فروق بين مناطق السكن في معدلات الإصابة بالسرطان في شمال الضفة الغربية وقد يعود جزء من هذه الاختلافات إلى التباين في العوامل المسببة التي وجدت في هذه الدراسة.

**الكلمات المفتاحية:** السرطان، العوامل المسببة، التباين الجغرافي، الضفة الغربية.

**Abstract -Background:** Cancer is the third leading cause of deaths in the West Bank and Gaza accounting for about 10% of total deaths. Despite its importance, little research has been devoted to characterization of incidence rates and geographic variations. This study compared the incidence rates and some risk factors of cancer among governorates of Northern West Bank and among types of locality (urban, rural, and refugee camps) for the period 2005-2008.

**Methods:** Crude and age-adjusted incidence rates were calculated using cancer data obtained from the registry files of three hospitals in Northern West Bank. Negative binomial regression analysis was performed to compare incidence rate ratios (IRR) among governorates and types of locality while adjusting for age-group, sex and year of diagnosis. Fisher's exact test was employed to test relationships among cross tabulated variables and test homogeneity of proportions.

**Results:** The lowest overall incidence rate was found in the governorate of Jenin (age-adjusted rate of 45.0 cases per 100,000 over the 4-yr period). With Jenin taken as a reference, the governorate of Nablus had the highest IRR (3.30) with age-adjusted incidence of 148.1 cases per 100,000. Refugee camps had higher overall incidence rate than urban and rural areas (age adjusted rates of 169.0, 103.2, and 79.3 cases per 100,000 for refugee camps, urban, and rural areas, respectively). Geographical differences were found in the distribution of patients with regard to types of environmental pollution, dietary factors, smoking, alcohol consumption, types of stress, and chronic diseases but not in dietary habits and family history.

**Conclusions:** In Northern West Bank, large differences were found among areas of residence (governorates and locality types) in incidence of cancer. Geographical differences in risk factors were also found which could explain part of the geographic differences observed in incidence rates.

**Keywords:** Cancer, risk factors, geographic variation, West Bank.

## Background :

Cancer is increasingly becoming a public health concern in developing countries.<sup>1-5</sup> It is the second leading cause of deaths in developing countries,<sup>5</sup> and the third leading cause of deaths in the West Bank and Gaza accounting for about 10% of total deaths.<sup>6</sup>

The West Bank is undergoing a transition characterized by rapid urbanization,<sup>7</sup> changing lifestyle, and epidemiologic transition characterized by a persisting burden of infectious diseases and a rise in chronic diseases, including cancer.<sup>6</sup> Despite the rising importance of cancer in the West Bank, there is a lack of studies which characterize the incidence rates and their geographic distribution.

Existing studies are not recent and/or mostly focused on a single type of cancer or small group of cancers.<sup>8-11</sup> Causes of cancer are multi-factor and several factors may contribute to geographic variations in incidence rates including genetic differences, differences in lifestyle and culture, variations in screening rates and differences in exposure to some risk factors (environmental pollution, occupational, smoking, alcohol, dietary factors, etc).<sup>12-16</sup>

The objectives of this study were to estimate incidence rates of solid (non-hematology) cancers in Northern West Bank for the period from 2005 to 2008 and compare incidence rates among the six governorates of Northern West Bank and among

types of locality (urban, rural and refugee camps). We also present and discuss the geographic variations in patients' characteristics in relation to certain risk factors (environmental pollution, smoking, alcohol consumption, dietary habits, family history, stress, and chronic diseases).

## Methods:

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Newly diagnosed cancer cases (excluding hematology cases) during the period from January 2005 to December 2008 were identified from the registry files of the three hospitals having cancer therapy centers in Northern West Bank. These were: Al-Watani hospital in the city of Nablus which is the main oncology center and keeps the registry files of most cancer patients of Northern West Bank, Thabet-Thabet hospital in the city of Tulkarm, and Jenin hospital in the city of Jenin. All three are governmental hospitals. A total of 1075 non-hematology cancer files were initially consulted: 919 files from Al-Watani hospital, 96 files from Thabet-Thabet hospital, and 60 files from Jenin hospital. These included 20 duplicate files and 18 files (discarded) for patients from outside the study region. For duplicates, only the earlier dated file was considered.

The study relied on data obtained from the registry files of patients (medical and some personal data) as well as complementary information (types of pollution near residence, family history, dietary habits, smoking, alcohol consumption, etc) obtained via personal (face to face) or phone interviews. Whenever possible, personal interviews with patients were made during their medical visits. In case where the patient was not alive, an interview was made with very close family members. The interviews were carried out by the first author and the information was acquired via a questionnaire designed specifically for the study (the data obtained from the registry files were also filled into the questionnaire). The questionnaire was validated by a committee of experts tested on a random sample of 10 patients,

and few adjustments were consequently made to the questionnaire. The interviews covered 884 cases (85.2% of diagnosed cases). The distribution of the interviewed patients by district was as follows: 62 cases (7.0%) from Jenin, 519 cases (58.7%) from Nablus, 110 (12.4%) from Qalqiliya, 61 cases (6.9%) from Salfit, 24 cases from Tubas (2.7%), and 108 cases (12.2%) from Tulkarm. The distribution of interviewed patients by type of locality was as follows: 545 cases (61.7%) from urban areas, 243 cases (27.5%) from rural areas, and 96 cases (10.9%) from refugee camps.

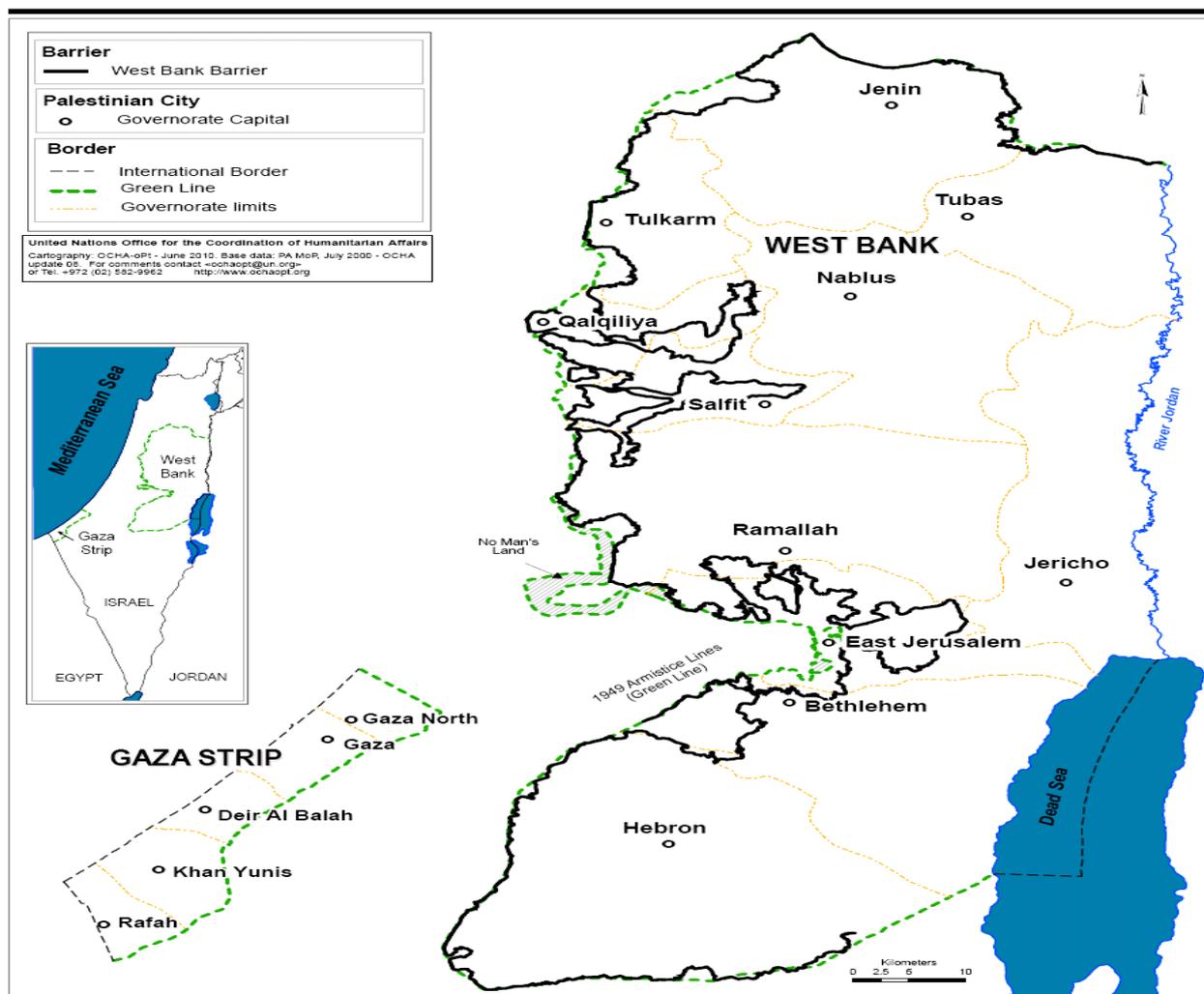
Pollution sources included electromagnetic pollution from mobile communication towers (if present within 100 m from residence), in addition to pollution from chemical factories, stone factories, garbage dumps, and uncovered sewage streams. Chemical factories included mainly local soap and detergent manufacturing plants if present within the same block of residence (within 200 to 300 m), chemical factories in settlements including plastic and fertilizers (for patients living within few hundred meters of these settlements) and Israeli industrial zones for localities near Israeli borders like Geshuri industrial zone on the border of Tulkarm specialized in the manufacture of agrochemicals. The distances referred to here are indicative as we did not make measurements of distance or exposure and these were based on declarations of patients.

The 2007 population of the West Bank was about 2.3 million inhabitants.<sup>7</sup> The Northern region of the West Bank includes the governorates of Nablus, Tulkarm, Qalqiliya, Jenin, Tubas and Salfit (Figure 1). Each governorate includes a main city and surrounding smaller localities and each is named after the main city. The 2007 population in these governorates comprised about 40% (923 000) of the West Bank population (Table 1). A patient's area of residence was classified according to 1) the governorate, and 2) the type of locality (urban, rural,

**Table 1. The 2007 population census in Northern West Bank by governorate and type of locality. Numbers in parenthesis are the percentages within each governorate.**

Governorate	Type of locality			Total
	Urban	Rural	Refugee camp	
Jenin	148,344 (58.84)	93,287 (37.00)	10,476 (4.16)	252,107
Tubas	32,100 (66.64)	10,590 (21.99)	5,474 (11.37)	48,164
Tulkarm	105,380 (67.35)	34,092 (21.79)	16,990 (10.86)	156,462
Nablus	174,403 (55.20)	111,197 (35.19)	30,356 (9.61)	315,956
Qalqiliya	53,935 (58.15)	38,809 (41.85)	0	92,744
Salfit	20,734 (35.62)	37,467 (64.38)	0	58,201
<b>Northern West Bank</b>	<b>534,896 (57.91)</b>	<b>325,442 (35.23)</b>	<b>63,296 (6.85)</b>	<b>923,634</b>
<b>All West Bank</b>	<b>1,567,903 (68.72)</b>	<b>591,149 (25.91)</b>	<b>122,662 (5.37)</b>	<b>2,281,714</b>

(Source: PCBS, 2009)



**Figure 1. Map of the governorates in the Palestinian Territories. (Source: the United Nations Office for the Coordination of Humanitarian Affairs.)**

or refugee camp). The latter classification is important in social and epidemiological studies in Palestinian Territories as differences may exist among locations, particularly in economic status and access to education and medical services. Type of locality was assigned according to the classification of localities published by the Palestinian Central Bureau of Statistics (PCBS) which was based on the following criteria:<sup>7</sup>

**Urban:** Any locality whose population amounts to 10,000 persons or more. Besides, it refers to all localities whose populations vary from 4,000 to 9,999 persons provided they have, at least, four of the following elements: public electricity network, public water network, post office, health center with a full-time physician, and a school offering a general secondary education certificate.

**Rural:** Any locality whose population is less than 4,000 persons or whose population varies from 4,000 to 9,999 persons but lacking four of the aforementioned elements.

**Camp:** It refers to any locality administered by the United Nations Refugees and Work Agency in the Near East (U.N.R.W.A.).

Age-adjusted incidence rates were calculated by the direct adjustment method using the 2007 population census as a base reference.<sup>7</sup> Adjustment weights were calculated as the ratio of the population size in the particular age group to the total population size in the West Bank. Age groups according to the PCBS were as follows: less than one year, 1-4 yr, 5-9 yr, and so forth with the oldest group including people of 95 years or older.

### **Statistical analyses:**

The 95% confidence intervals for incidence rates were calculated based on Poisson approximation as outlined by Curtin and Klein (1995).<sup>17</sup> Fisher's exact test was performed to test for dependency (presence of relationship) between row and column classifications of variables of interest and as test of homogeneity of proportions. The test was carried out

using SPSS (Statistical Package for the Social Sciences) V16 (SPSS Inc., Chicago, IL, USA).

A negative binomial regression analysis was performed to estimate incidence rate ratios (IRR) of cancer and compare these ratios among the levels of factors in the model. The model included the following factors as class variables: age group (five groups: <40, 40-49, 50-59, 60-69, and more than 70 years), gender, year of diagnosis, governorate, and type of locality with population size used as an offset variable.

Population size was from the 2007 census of the Palestinian population.<sup>7</sup> The estimated IRR for one level of any given factor is thus adjusted for the levels of the other factors in the model. The negative binomial regression was adopted rather than Poisson regression because it accounts better for overdispersion in the data by inclusion of a dispersion parameter (the negative binomial resulted in a better fit of the data: ratio of deviance to degrees of freedom of 0.998 for the negative binomial analysis compared to 1.144 for the Poisson regression; values closer to 1.0 indicate a better fit). This analysis was carried out using SAS/STAT software V9.0 for Windows (SAS Institute Inc., Cary, NC, USA).

### **Results:**

#### **Geographic variation in incidence rates of cancer:**

A total of 1037 new cancer cases were diagnosed between 2005 and 2008 in the six governorates of the northern West Bank (Figure 1 and Table 2). The data showed an increase in the number of new cancer cases from 2005 to 2008 (200 cases in 2005, 229 cases in 2006, 293 cases in 2007 and 315 cases in 2008). The increase was mainly in urban and rural areas but the trend was not consistent among governorates (Table 2). In refugee camps, the incidence was nearly stable. Over the whole period, about 50% of the subjects (519 cases) were diagnosed in the governorate of Nablus, and

the lowest number of cases was observed in Tubas (27 cases, 2.6%). About 63% of diagnosed patients lived in urban areas, 27% lived in rural areas and 10% lived in refugee camps. There were no differences ( $P > 0.05$ ) among governorates and types of locality in the distribution of number of cancer cases by gender.

Age-adjusted incidence rates by year are in Tables 3. Incidence rate increased from 20.0 cases per 100 000 people in 2005 to 31.3 cases per 100 000 people in 2008 with an average of 25.8 cases per 100,000 people per year. Table 4 shows the incidence rates by governorate and by type of

locality. Age-adjusted rate over the 4-year period ranged from 45.0 cases per 100,000 for the governorate of Jenin to 148.1 cases per 100,000 for the governorate of Nablus. Refugee camps had higher incidence rates (age-adjusted rate of 169.0 cases per 100,000) than urban areas (age-adjusted rate of 110.4 cases per 100,000 per year) and rural areas (age-adjusted rate of 79.3 cases per 100,000).

Estimates of IRR (incidence rate ratios) and 95% CI from the negative binomial regression are in

Table 5.

**Table 2. Number of new cancer cases in the Northern West Bank by governorate and type of locality for the period of 2005-2008.**

Governorate	Type Of Locality												Total
	Camp				Rural				Urban				
	2005	2006	2007	2008	2005	2006	2007	2008	2005	2006	2007	2008	
<b><u>Males</u></b>													
Jenin	0	0	0	2	2	5	4	9	4	4	15	15	<b>60</b>
Nablus	11	13	7	10	14	25	18	18	30	32	45	46	<b>269</b>
Qalqiliya	-	-	-	-	5	1	5	3	9	5	12	9	<b>49</b>
Salfit	-	-	-	-	5	7	3	5	2	1	0	2	<b>25</b>
Tubas	0	0	1	0	0	0	1	0	1	0	5	5	<b>13</b>
Tulkarm	5	2	1	2	1	3	7	7	10	10	18	19	<b>85</b>
All governorates	16	15	9	14	27	41	38	42	56	52	95	96	<b>501</b>
<b><u>Females</u></b>													
Jenin	0	0	1	1	0	3	7	3	6	13	7	18	<b>59</b>
Nablus	8	13	7	10	8	12	24	14	28	37	45	44	<b>250</b>
Qalqiliya	-	-	-	-	4	0	4	4	15	11	10	14	<b>62</b>
Salfit	-	-	-	-	4	4	10	6	4	4	1	3	<b>36</b>
Tubas	0	0	0	0	0	0	0	0	7	2	3	2	<b>14</b>
Tulkarm	5	2	1	6	2	7	5	9	10	13	26	29	<b>115</b>
All governorates	13	15	9	17	18	26	50	36	70	80	92	110	<b>536</b>
<b>Total</b>	<b>29</b>	<b>30</b>	<b>18</b>	<b>31</b>	<b>45</b>	<b>67</b>	<b>88</b>	<b>78</b>	<b>126</b>	<b>132</b>	<b>187</b>	<b>206</b>	<b>1037</b>

**Table 3. Age-adjusted incidence rates of cancer in the Northern West Bank for the years 2005-2008.**

Age-adjusted incidence rates per 100 000 (95% CI)			
Year	Males	Femals	All
2005	21.1 (16.9-25.3)	22.3 (18.3-26.2)	20.0 (17.3-22.8)
2006	23.3 (18.9-27.7)	23.3 (19.2-27.5)	22.7 (19.7-25.6)
2007	30.7 (25.6, 35.8)	28.8 (24.2-33.5)	29.1 (25.8-32.5)
2008	32.5 (27.3, 37.7)	31.7 (26.8-36.5)	31.3 (27.8-34.8)
All years	107.6 (98.2-117.1)	104.0 (95.1-112.8)	103.2 (98.0-110.7)
Average over years	26.9	26.0	25.8

As expected, people in age groups of 40 years and older had much higher risk of cancer ( $P < 0.0001$ ) compared to the age group of less than 40 years

(IRR of 9.66 for age group 40-49 yr, 21.78 for age group 50-59 yr, 36.69 for age group 60-69 yr, and 45.98 for age group  $\geq 70$  yr).

**Table 4. Age-adjusted incidence rates (95% CI) of non-haematology cancer in Northern West Bank for the period 2005-2008, by governorate and type of locality.**

	Males	Females	Both genders combined	Rate per year (both genders)
<b>Governorate</b>				
Jenin	49.3 (36.81-61.86)	42.6 (31.67-53.56)	45.0 (36.87-53.04)	11.24
Nablus	166.7 (146.70-186.70)	137.7 (120.49-154.84)	148.1 (135.30-160.81)	37.02
Qalqiliya	109.5 (77.67-141.34)	139.4 (104.60-174.12)	121.4 (98.31-144.50)	30.30
Salfit	88.8 (53.57-123.98)	112.5 (75.38-149.57)	98.5 (73.63-123.34)	24.63
Tubas	54.9 (24.97-84.83)	59.8 (28.39-91.15)	55.9 (34.79-77.06)	13.98
Tulkarm	108.0 (84.88-131.06)	119.9 (97.79-142.05)	111.5 (95.98-126.96)	27.71
<b>Type of locality</b>				
Rural	90.4 (75.58-105.23)	75.2 (62.19-88.27)	79.3 (69.88-88.66)	19.8
Urban	109.7 (97.19-122.20)	115.3 (103.20-127.43)	110.4 (101.88-118.86)	27.6
Refugee camps	184.5 (134.94-234.14)	158.1 (115.60-200.68)	169.0 (136.93-201.04)	42.3
<b>Type of locality</b>				

The IRR for year of diagnosis showed an increase of risk in 2007 (IRR of 1.43,  $P < 0.001$ ) and 2008 (IRR of 1.58,  $P < 0.0001$ ) compared to the reference year 2005 but the increase was not significant for 2006 (IRR of 1.13,  $P > 0.05$ ). All governorates had higher incidence rates of cancer than Jenin ( $P < 0.0001$ ) except for Tubas (IRR = 1.13,  $P > 0.05$ ). Nablus had the highest rate ratio (IRR = 3.30),

followed by Qualqiliya (IRR = 2.59), then Salfit (IRR = 2.46) and Tulkarm (IRR = 2.34). Urban and rural localities had significantly less incidence rates than refugee camps (IRR = 0.74,  $P < 0.01$  for urban; IRR = 0.51,  $P < 0.0001$  for rural areas). No difference was found in overall cancer incidence rates between males and females (IRR = 1.01 for males relative to females,  $P > 0.05$ ).

<b>Table 5. Cancer incidence rate ratios (IRR) from the negative binomial regression analysis</b>			
	<b>IRR (95%CI)</b>	<b>Wald's <math>\chi^2</math></b>	<b>P value</b>
<b><u>Age Group</u></b>			
<40	<b>Ref</b>		
40-49	9.66 (7.6 - 12.27)	343.04	<b>&lt; 0.0001</b>
50-59	21.78 (17.3 - 27.4)	689.38	<b>&lt; 0.0001</b>
60-69	36.69 (29.13 - 46.21)	937.12	<b>&lt; 0.0001</b>
>70	45.98 (36.65 - 57.69)	1094.64	<b>&lt; 0.0001</b>
<b><u>Gender</u></b>			
Females	<b>Ref</b>		
Males	1.01 (0.87 - 1.16)	0.01	<b>0.92</b>
<b><u>Year</u></b>			
2005	<b>Ref</b>		
2006	1.13 (0.91 - 1.46)	1.17	<b>0.2791</b>
2007	1.43 (1.17 - 1.76)	11.7	<b>0.0006</b>
2008	1.58 (1.28 - 1.93)	19.07	<b>&lt; 0.0001</b>
<b><u>Governorate</u></b>			
Jenin	<b>Ref</b>		
Nablus	3.30 (2.64 - 4.13)	109.8	<b>&lt; 0.0001</b>
Qalqiliya	2.59 (1.95 - 3.43)	43.65	<b>&lt; 0.0001</b>
Selfit	2.46 (1.77 - 3.42)	28.93	<b>&lt; 0.0001</b>
Tubas	1.13 (0.73 - 1.74)	0.29	<b>0.5903</b>
Tulkarm	2.34 (1.82 - 3.01)	44.51	<b>&lt; 0.0001</b>
<b><u>Type of locality</u></b>			
Camp	<b>Ref</b>		
Urban	0.74 (0.59 - 0.92)	7	<b>0.0082</b>
Rural	0.51 (0.4 - 0.66)	27.77	<b>&lt; 0.0001</b>

Number of new cases and crude incidence rates for the cancer types are in Table 6. Breast cancer accounted for 38.1% of all female cancers, followed by gastrointestinal cancers (25.2%) and cancers of the genital system (14%). In males, gastrointestinal cancers were the most common (28.3%) followed by cancers of the lung and larynx (16%), bladder and kidney cancers (14.6%), and cancers of the genital system (14%).

Incidence of cancers of the bladder and kidney, lung and larynx, oral cavity, and skin were about four times higher in males than in females.

Age-adjusted estimates based on small numbers of cases (less than 25 cases) exhibit large amount of random variation<sup>17</sup> therefore, these were not calculated for types of cancers. Instead, crude rates

are reported herein and for both sexes combined. Table 7 shows the crude incidence rates of cancer types by governorate and those for type of locality are in Table 8. The pattern of variation reflects the pattern found for all cancers combined (Nablus had the highest rates and Jenin had the lowest rates for most cancer types; refugee camps had the highest rates for most types).

### **Variations among geographical regions in patients' exposure to certain risk factors**

#### **Environmental pollution:**

Figure 2 shows the percentage of cancer patients in each governorate exposed to different types of pollution. All governorates had high percentages of patients exposed to electromagnetic sources (67.6% in Qalqiliya, 63% in Nablus and Jenin, 62.3% in Salfit, 56.3% in Jenin, and 53% in Tulkarm). There

were significant differences ( $P < 0.001$ ) among governorates in the percentages of patients exposed

to pollution from chemical factories, uncovered sewage streams, garbage dumps, and stone

**Table 6. Number of new diagnosed cases and crude incidence rates of cancer types in the Northern West Bank for the period 2005-2008**

Cancer Type	Number of cases (%)			Crude Incidence rates (95% CI)		
	Males	Females	All	Males	Females	All
<b>Bladder &amp; kidney</b>	73 (14.6%)	24 (4.5%)	97 (9.4%)	15.5 (11.96-19.08)	5.3 (3.18-7.41)	10.5 (8.41-12.59)
<b>Bones &amp; neck</b>	11 (2.2%)	9 (1.7%)	20 (1.9%)	2.3 (0.96-3.72)	2.0 (0.69-3.28)	2.2 (1.22-3.11)
<b>Brain &amp; other NS</b>	54 (10.8%)	30 (5.6%)	84 (8.1%)	11.5 (8.42-14.55)	6.6 (4.25-8.98)	9.1 (7.15-11.04)
<b>Breast</b>	2 (0.4%)	204 (38.1%)	206 (19.9%)	0.4 (-0.16-1.01)	45.0 (38.82-51.17)	22.3 (19.26-25.35)
<b>Female genital system</b>	0	75 (14%)	75 (7.2%)	0	16.5 (12.80-20.29)	8.1 (6.28-9.96)
<b>Gastrointestinal</b>	142 (28.3%)	135 (25.2%)	277 (26.7%)	30.2 (25.23-35.16)	29.8 (24.75-34.80)	30.0 (26.46-33.52)
<b>Lung &amp; larynx</b>	80 (16%)	20 (3.7%)	100 (9.6%)	17.0 (13.28-20.74)	4.4 (2.48-6.34)	10.8 (8.70-12.95)
<b>Male genital system</b>	70 (14%)	0	70 (6.8%)	14.9 (11.40-18.37)	0	7.6 (5.80-9.35)
<b>Oral cavity</b>	20 (4%)	4 (0.7%)	24 (2.3%)	4.3 (2.39-6.12)	0.9 (0.02-1.75)	2.6 (1.56-3.64)
<b>Skin</b>	21 (4.2%)	5 (0.9%)	26 (2.5%)	4.5 (2.56-6.38)	1.1 (0.14-2.07)	2.8 (1.73-3.90)
<b>Thyroid</b>	13 (2.6%)	14 (2.6%)	27 (2.6%)	2.8 (1.26-4.27)	3.1 (1.47-4.71)	2.9 (1.82-4.03)
<b>Other types</b>	15 (3%)	16 (3%)	31 (3%)	3.2 (1.58-4.80)	3.5 (1.80-5.26)	3.4 (2.17-4.54)

factories. Tulkarm had high percentage of patients living close to chemical factories (50.5%) compared to the other governorates (20.7% in Qalqiliya, 9.8% in Salfit, 4% in Nablus, 3.7% in Tubas, and 2.5% in Jenin). Tulkarm and Qalqiliya had high percentages of patients exposed to uncovered sewage water (48.6 and 46%, respectively), Qalqiliya and Salfit had high percentages of patients living close to garbage dumps (48.6%, and 47.5%, respectively), while Tubas and Jenin had high percentages of patients living close to stone factories (48.1%, and 33.6%, respectively). Significant differences ( $P < 0.001$ ) in the number of sources of pollution to which a patient was exposed were found among governorates. Cancer patients in Qalqiliya and

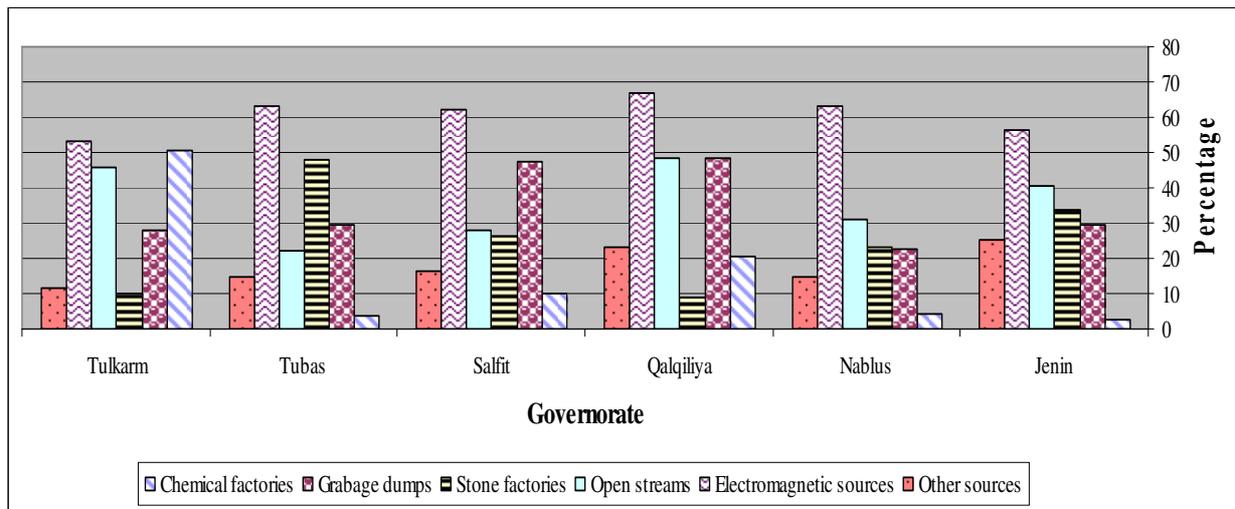
Tulkarm had been exposed, on average, to a larger number of sources of pollution than the other governorates (1.95 for Qalqiliya, and 1.87 for Tulkarm compared to 1.74 for Salfit, 1.67 for Tubas, 1.62 for Jenin, and 1.44 for Nablus).

**Table 7. Crude incidence rates (and 95% CI) of cancer types by governorate**

<b>Governorate</b>						
<b>Bladder &amp; kidney</b>	4.4 (1.78-6.94)	14.6 (10.35-18.77)	15.1 (7.19-23.00)	10.3 (2.06-18.56)	4.2 (-1.60-9.91)	11.5 (6.19-16.82)
<b>Bones &amp; neck</b>	0	4.1 (1.88-6.35)	2.2 (-0.83-5.15)	1.7 (-1.65-5.09)	0	2.6 (0.05-5.06)
<b>Brain &amp; other NS</b>	2.4 (0.48-4.28)	12.3 (8.47-16.22)	12.9 (5.62-20.26)	6.9 (0.14-13.61)	6.2 (-0.82-13.28)	12.8 (7.18-18.38)
<b>Breast</b>	5.9 (2.94-8.96)	33.9 (27.45-40.28)	18.3 (9.62-27.04)	29.2 (15.32-43.09)	14.5 (3.77-25.30)	27.5 (19.27-35.70)
<b>Female genital system</b>	5.6 (2.64-8.46)	8.6 (5.32-11.77)	10.8 (4.10-17.47)	6.9 (0.14-13.61)	2.1 (-1.99-6.15)	12.1 (6.68-17.60)
<b>Gastrointestinal</b>	16.7 (11.62-21.70)	42.7 (35.52-49.94)	33.4 (21.66-5.19)	29.2 (15.32-43.09)	12.5 (2.49-22.43)	29.4 (20.90-37.90)
<b>Lung &amp; larynx</b>	4.8 (2.07-7.45)	18.4 (13.63-23.08)	9.7 (3.36-16.04)	5.2 (-0.68-10.99)	2.1 (-1.99-6.15)	10.9 (5.70-16.03)
<b>Male genital system</b>	3.9 (1.51-6.43)	14.2 (10.08-18.40)	1.1 (-1.04-3.19)	3.4 (-1.33-8.20)	4.2 (-1.60-9.91)	6.4 (2.43-10.35)
<b>Oral cavity</b>	1.2 (-0.16-2.54)	3.2 (1.20-5.13)	1.1 (-1.04-3.19)	3.4 (-1.33-8.20)	0	5.1 (1.57-8.66)
<b>Skin</b>	1.2 (-0.16-2.54)	4.4 (2.11-6.75)	3.2 (-0.43-6.90)	5.2 (-0.68-10.99)	0	1.9 (-0.25-4.09)
<b>Thyroid</b>	0.4 (-0.38-1.17)	3.2 (1.20-5.13)	6.5 (1.29-11.65)	0	4.2 (-1.60-9.91)	5.1 (1.57-8.66)
<b>Other types</b>	0.8 (-0.31-1.89)	4.8 (2.34-7.15)	5.4 (0.67-10.12)	3.4 (-1.33-8.20)	6.2 (-0.82-13.28)	2.6 (0.05-5.06)
<b>Bladder &amp; kidney</b>	4.4 (1.78-6.94)	14.6 (10.35-18.77)	15.1 (7.19-23.00)	10.3 (2.06-18.56)	4.2 (-1.60-9.91)	11.5 (6.19-16.82)

**Table 8. Crude incidence rates (95%CI) of cancer types by type of locality for the period 2005-2008**

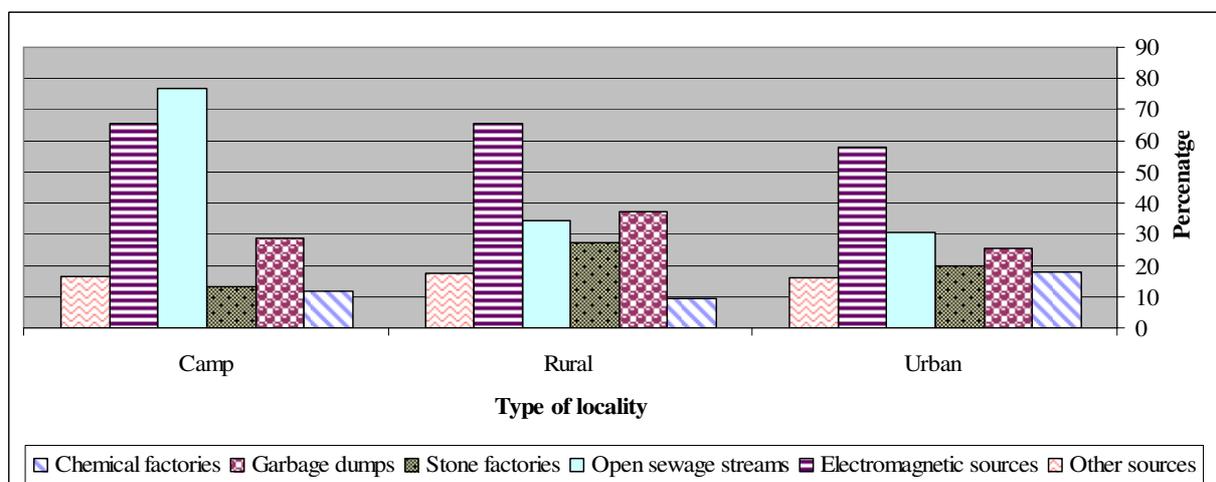
<b>Cancer Type</b>	<b>Type of Locality</b>		
	<b>Urban</b>	<b>Rural</b>	<b>Camp</b>
<b>Bladder &amp; kidney</b>	10.8 (8.05-13.63)	8.9 (5.67-12.15)	<b>15.8 (6.01-25.59)</b>
<b>Bones and neck</b>	2.2 (0.97-3.51)	1.8 (0.37-3.32)	<b>3.2 (-1.22-7.54)</b>
<b>Brain and other NS</b>	9.7 (7.08-12.36)	6.5 (3.69-9.21)	<b>17.4 (7.11-27.65)</b>
<b>Breast</b>	24.5 (20.30-28.68)	16.6 (12.17-21.02)	<b>33.2 (18.99-47.37)</b>
<b>Female genital system</b>	10.1 (7.40-12.79)	4.0 (1.82-6.17)	<b>12.6 (3.88-21.40)</b>
<b>Gastrointestinal</b>	33.3 (28.39-38.17)	20.6 (15.66-25.52)	<b>50.6 (33.04-68.07)</b>
<b>Lung &amp; larynx</b>	10.3 (7.56-13.00)	10.8 (7.19-14.32)	<b>15.8 (6.01-25.59)</b>
<b>Male genital system</b>	8.6 (6.11-11.09)	4.9 (2.51-7.33)	<b>12.6 (3.88-21.40)</b>
<b>Oral cavity</b>	3.2 (1.67-4.69)	1.5 (0.19-2.88)	<b>3.2 (-1.22-7.54)</b>
<b>Skin</b>	2.4 (1.11-3.75)	3.4 (1.38-5.38)	<b>3.2 (-1.22-7.54)</b>
<b>Thyroid</b>	3.4 (1.81-4.92)	2.8 (0.96-4.57)	<b>0</b>
<b>Other types</b>	3.2 (1.67-4.69)	3.7 (1.60-5.77)	<b>3.2 (-1.22-7.54)</b>



**Figure 2. Percentage of cancer patients exposed to different sources of pollution by governorate**

The patterns of exposure to pollution by type of locality are in Figure 3. Significant differences were found among types of locality in the percentages of patients exposed to pollution from chemical factories ( $P = 0.003$ ), uncovered sewage water ( $P < 0.001$ ), garbage dumps ( $P = 0.001$ ), and stone factories ( $P = 0.003$ ) but not electromagnetic sources ( $P = 0.055$ ). The majority of patients living in refugee camps were exposed to uncovered sewage water (76.9%, 34.5%, and 30.6%, for refugee camps, rural, and urban areas, respectively). Higher percentage of patients in rural areas lived close to garbage dumps and stone factories (37.4% and 27.3%, respectively) compared to patients in urban (25.3% and 19.8%)

and refugee camps (28.7% and 13%). The percentages of patients exposed to pollution from chemical factories were 17.8% in urban areas, 12% in refugee camps and 9.4% in rural areas. Significant differences ( $P < 0.001$ ) were also found among types of locality in the number of sources of pollution to which a patient was exposed: patients in refugee camps were exposed on average to 1.95 sources of pollution compared to 1.74 sources for patients in rural areas and 1.51 sources in urban areas (57.7% of patients in urban areas were exposed to two or more sources of pollution compared to 59.8% in rural areas and 72.3% in refugee camps).



**Figure 3. Percentage of cancer patients exposed to different sources of pollution by type of locality.**

### **Limitations of the study:**

The study has some limitations that should be taken into consideration when interpreting the results. First, the study considered cancer patients in governmental hospitals and did not take into consideration the patients who may have been referred abroad (Israel and Jordan) by private hospitals and clinics and did not have files in the governmental hospitals. It was not possible for us to quantify these referrals, although few of those referred abroad did visit governmental hospitals particularly those seeking to be medically covered and financed by the Ministry of Health and these were interviewed in this study. Second, the incidence rates were calculated based on population census of 2007 and compared among years, districts and types of locality. The present study did not take into consideration the shift in population across years, districts or types of locality (for example migration from camps and rural areas to urban areas). The projections of the increase in the population from 2007 to 2008 were 2.63%, 3.45%, 2.65%, 2.35%, 1.95%, and 2.35% for Jenin, Tubas, Tulkarm, Qalqiliya, Salfit, and Nablus, respectively.<sup>7</sup> No data is available on migration among types of locality, but a recent study by the Palestinian Central Bureau of Statistics gave some insights on migration trends in the West Bank and Gaza.<sup>23</sup> It showed that more than 95% of the Palestinians in the West Bank and Gaza had the same place of residence as it was when they were born (97% in Jenin, 92.9% in Tubas, 95% in Tulkarm, 94.9% in Nablus, 96.7% in Qalqiliya, and 95.8% in Salfit). It also showed, that a large proportion of migrants remained within the same governorate (Jenin: 84.7%, Tubas: 65.1%, Tulkarm: 67.2%, Nablus: 63.9%, Qalqiliya: 46.5%, Salfit: 39.6%).

Third, risk factors for cancer are numerous and interact together which makes it difficult to discern the effects of individual factors. In this study, we investigated risk factors among patients and no

comparisons were made between cancer patients and non patients. Case-control studies may be more appropriate to further clarify the effects of differences in exposure to individual risk factors.

### **Conclusions and recommendations:**

In Northern West Bank, large differences were found among areas of residence (governorates and locality types) in incidence of cancer. Geographical Differences observed in incidence rates.

The results of this study should have important implications on health programs and cancer prevention measures to be adopted as the variations in incidence rates and exposure to known risk factors suggest that different and adapted measures may be required for different geographical regions (governorates and types of locality). For example, in Qalqiliya and Tulkarm it is urgent to reduce the effects of pollution of chemical factories and sewage water while educational programs against smoking are needed in Nablus, Tubas, and Jenin. Programs to alleviate the economical burden are more urgent in refugee camps than rural and urban areas. Cancer screening and treatment centers should be established in areas which lack these facilities, particularly rural areas. Part of the problem (pollution and restriction of movement) is related to the Israeli occupation and settlements which makes the task even harder.

More research (case-control or cohort studies) is needed to further elucidate the differences in exposure to risk factors across geographical locations.

### **Ethical Considerations:**

This study was approved by the graduate committee of the Master Program in Public Health at the Faculty of Graduate Studies of An-najah National University, Nablus, Palestine. It was also approved by the Ministry of Health of the Palestinian Authority upon official correspondence by the university administration. A statement was included in the questionnaire (and verbally communicated to each

interviewed patient) concerning the ethical issues of the study and the confidentiality of information provided by patients.

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