

# Interim Report on Blackford County, Indiana Cancer Incidence

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## OVERVIEW

A group of concerned Hoosier citizens contacted the Indiana State Department of Health regarding a potential high rate of cancer incidence in Blackford County, a rural county in East Central Indiana. The high incidence rates were detected by using on-line statistical tools and data published by the National Cancer Institute. However, no case definition outlining a specific time period and cancer type was provided by the group. This is critical in understanding and interpreting statistics generated for rural areas.

The small population size present in rural areas can make it challenging to identify statistically significant results. A rate that is statistically significant is unlikely to have occurred by chance and can be described with confidence as *different* from an expected value. When a small population size is used to calculate a statistic, it becomes increasingly likely that the result was due to chance. As such, when the time-period for analysis is adjusted, one may observe a large change in a rate, but the change may not be statistically significant. In other words, the rates are considered similar.

With these considerations in hand, Public Health Geographics conducted a comprehensive survey of cancer incidence in Blackford County by gender for 30 time-periods between 1993 and 2007. A total of 2,160 unique variable combinations were used in performing calculations to detect statistically significant measurements of 24 primary cancer groupings. With this many calculations, one can expect to find some statistically significant results simply by chance. Thus, reviewing all 2,160 results will assist in the interpretation of statistically significant findings for expected rates, temporal change and geographic distribution.

## METHODS

### Data Source

Cancer incidence data are collected through the Indiana State Cancer Registry. This Registry was established "for the purpose of recording all cases of malignant disease and other tumors and precancerous diseases required to be reported by federal law or federal regulation or the National Program of Cancer Registries that are diagnosed or treated in Indiana, and compiling necessary and appropriate information concerning those cases, as determined by the state department, in order to conduct epidemiologic surveys of cancer and to apply appropriate preventive and control measures." (IC 16-38-2-1) The Registry continually updates records for both recent and older cancer incidences. As such, Public Health Geographics extracted data from the Registry in February, 2010 to ensure data are current and accurate. However, the collection of 2009 and 2008 data have not been completed and thus, are not available for statistical analysis. Records from 2008 are currently 75% complete.

### Cancer Type Groups

Each Registry record was grouped into 24 cancer sites based upon primary site ICD codes. Statistical measurements were generated for each distinct group as follows:

(All Sites – Aggregated)	Female Genital Organs	Nasal Cavity, Middle Ear & Larynx
Bladder	Heart & Pleura	Nerves & Connective Tissue
Blood, Bone Marrow & Spleen	Hodgkin's Lymphoma	Pancreas & Other Ill-Defined Dig Org
Bones & Joints	Lip, Oral Cavity & Pharynx	Skin
Brain, Eye & Other Cen. Nerv. Sys	Liver & Gall Bladder	Stomach & Small Intestine
Female Breast	Lung & Bronchus	Thyroid & Other Endocrine Glands
Colon, Rectum & Anus	Male Genital Organs	Urinary Tract
Esophagus	Malignant Lymphoma	Unknown Site

### Temporal Periods

In order to generate reliable statistical measurements, a sufficient number of cases and population are required. Since Blackford County is rural, these prerequisites can be difficult to obtain for a single year time-period. Thus, distinct measurements of the 24 cancer sites were generated for 3 different period lengths from 1993 to 2007 – 3 year, 5 year and 10 year. The periods analyzed are as follows:

*3-Year Periods:* 1993-1995, 1994-1996, 1995-1997, 1996-1998, 1997-1999, 1998-2000, 1999-2001, 2000-2002, 2001-2003, 2002-2004, 2003-2005, 2004-2006, 2005-2007

*5-Year Periods:* 1993-1997, 1994-1998, 1995-1999, 1996-2000, 1997-2001, 1998-2002, 1999-2003, 2000-2004, 2001-2005, 2002-2006, 2003-2007

*10-Year Periods:* 1993-2002, 1994-2003, 1995-2004, 1996-2005, 1997-2006, 1998-2007

The above time-periods do contain overlapping years in order to better understand the sensitivity of time-period selection in a comprehensive analysis. However, trend analysis was only conducted for the following distinct 3-year periods: 1993-1995, 1996-1998, 1999-2001, 2002-2004, and 2005-2007.

### Population

Age-specific measurements were not considered in this analysis. Instead, measurements are generated for the entire population by gender group (all, male, female) using an age-adjusted weight. Since cancer is more likely to occur in older populations, the population values with which measurements are taken must be adjusted or normalized. This prevents biased measurements and inaccurate representations of cancer incidence.

The yearly population counts used in this analysis are interpolated from the 1990 Census, 2000 Census and 2005 population estimates. The release of the 2010 Census in 2011 will provide a more accurate interpolation of yearly population counts. However, the new values should not greatly affect the results of this analysis.

### Geography

Measurements of sub-county cancer incidence are difficult in rural areas due to small population samples. Thus, this analysis focuses on county-level measurements. Additionally, measurements for selected cancer types and periods were performed for all Indiana counties. If counties adjacent to Blackford County have similar incidence, then it may be concluded that the distribution of cancer incidence could be regional in nature, or clustered. An elevated incidence of cancer isolated to Blackford County may indicate a cause (e.g. occupational hazards or better cancer screenings) specific to the county.

### Statistical Measurement of Elevated Rate

An age-adjusted standard incidence ratio (SIR) was calculated for each cancer site, gender and period. The SIR describes how Blackford County compares to the state of Indiana as a whole – if the rate is higher or lower than expected. For instance, based upon total cases and the age-adjusted population in the state of Indiana, the *expected* number of cases for a specific area (e.g. county) can be determined. When this is compared to the *actual* number of cases for the area, a ratio is calculated – the standard incidence ratio (SIR). A SIR value of 1 indicates that the number of cases for the area is the same as what is expected in the state. A value greater than 1 indicates that the area has more cases than expected, as compared to the state. A value of 2 indicates the area is 2 times higher than the state. If the lower confidence interval (LCI) of the SIR value is greater than 1, then the SIR value is considered statistically significant. Thus, the area can be considered higher than the state value with 95% confidence. It is only considered higher if the SIR LCI is above 1. If the SIR LCI is less than 1 then the number of cases in the area is similar to what is expected in the state.

In addition to the LCI requirement, an area must have at least 20 cases to consider the statistical measurement as stable. Thus, SIR values for cancer types with less than 20 cases per area are not considered significant even if the SIR LCI is above 1. These instances are denoted as unstable and statistical measurements such as the SIR are not reliable.

### Statistical Measurement of Temporal Change

An age-adjusted county rate (AAR) was also calculated for each cancer site, gender and 3-year period. The rates for each of the following periods were then compared using a Z-Test: 1993-1995, 1996-1998, 1999-2001, 2002-2004, and 2005-2007. A rate is considered statistically distinguishable, or statistically significant, from the rate of a previous period when at least 20 cases exist and the Z-value is 1.96 or higher (95% confidence). If these conditions are not met, then the rates for two periods are considered similar and the differences in values are likely to occur by chance.

### Statistical Measurement of Regional Clustering

Statistical spatial measurements of county rates indicate how cancer incidence is distributed within the state – randomly or clustered. For each statistically significant elevated SIR detected (by cancer, gender and period) in Blackford County, a spatial algorithm was used to determine if

the age-adjusted incidence rate is: 1. randomly elevated throughout the state (no cluster), 2. elevated only in Blackford County (isolated county cluster), or 3. elevated in multiple adjacent counties (regional cluster). The calculations were performed through SatScan analytical software using a Poisson purely spatial, single time-period model. Results must have a p value less than 0.05 to be considered a statistically significant spatial cluster.

## RESULTS

### Significant Elevated Rates

The standard incidence ratio (SIR) was used to identify Blackford County cancer incidence rates (by cancer group, sex, and time period) that are distinguishable, statistically, from the state rate (SIR LCI  $\geq$  1.0 and cases  $\geq$  20). The significant rates detected were found in 6 different cancer types for various time periods and genders including: “all cancer sites”, “colon, rectum & anus”, “lung & bronchus”, “malignant lymphoma”, and “thyroid & other endocrine glands”.

The following table lists the statistics for each significant rate detected. The results of all statistical measurements for Blackford County are available in Attachment A.

CANCER TYPE	SEX	PERIOD	START YEAR	END YEAR	CASES	EXP CASES	SIR x 100	LOWER SIR CI	UPPER SIR CI	AA RATE	AA Z SCORE	AA SE
All Sites	All	5	2000	2004	436	395.8	<b>110.2</b>	100.1	121.0	<b>516.2</b>	1.94	24.7
All Sites	All	5	2001	2005	442	400.4	<b>110.4</b>	100.3	121.2	<b>520.3</b>	1.94	24.7
All Sites	Male	5	2001	2005	239	202.8	<b>117.9</b>	103.4	133.8	<b>643.2</b>	2.27	41.6
All Sites	All	3	2001	2003	271	238.5	<b>113.6</b>	100.5	128.0	<b>538.2</b>	2.07	32.7
All Sites	All	5	2002	2006	456	403.4	<b>113.0</b>	102.9	123.9	<b>538.2</b>	2.54	25.2
All Sites	Male	5	2002	2006	247	204.1	<b>121.0</b>	106.4	137.1	<b>667.1</b>	2.77	42.4
All Sites	All	3	2002	2004	277	240.4	<b>115.2</b>	102.1	129.6	<b>544.5</b>	2.21	32.7
All Sites	Male	3	2002	2004	146	121.6	<b>120.1</b>	101.4	141.2	<b>660.2</b>	2.05	54.6
All Sites	All	3	2003	2005	282	241.7	<b>116.7</b>	103.5	131.1	<b>548.1</b>	2.30	32.6
All Sites	Male	3	2003	2005	153	122.8	<b>124.6</b>	105.7	146.0	<b>689.6</b>	2.49	55.7
Bladder	All	10	1996	2005	51	35.4	<b>144.2</b>	107.4	189.6	<b>30.9</b>	2.16	4.3
Bladder	Male	10	1996	2005	38	25.8	<b>147.3</b>	104.2	202.2	<b>57.4</b>	2.03	9.3
Bladder	All	10	1997	2006	48	35.1	<b>136.8</b>	100.9	181.4	<b>28.3</b>	1.91	4.1
Bladder	All	10	1998	2007	49	35.2	<b>139.3</b>	103.1	184.2	<b>28.9</b>	2.04	4.1
Bladder	All	5	2000	2004	29	17.7	<b>163.4</b>	109.4	234.7	<b>34.2</b>	2.13	6.4
Bladder	Male	5	2000	2004	21	12.9	<b>162.7</b>	100.7	248.7	<b>58.6</b>	1.77	12.8
Bladder	All	5	2001	2005	32	18.1	<b>176.9</b>	121.0	249.7	<b>36.8</b>	2.42	6.5
Bladder	Male	5	2001	2005	23	13.3	<b>173.2</b>	109.8	259.9	<b>62.6</b>	1.98	13.1
Bladder	All	3	2003	2005	20	11.3	<b>177.0</b>	108.1	273.4	<b>38.1</b>	1.91	8.5
Colon, Rectum, & Anus	Female	5	1994	1998	35	24.0	<b>145.7</b>	101.5	202.7	<b>75.4</b>	2.03	12.7
Colon, Rectum, & Anus	Female	3	1994	1996	22	13.7	<b>160.2</b>	100.4	242.6	<b>78.1</b>	1.84	16.7
Colon, Rectum, & Anus	Male	5	2003	2007	35	22.6	<b>155.0</b>	107.9	215.6	<b>90.7</b>	1.93	15.3
Colon, Rectum, & Anus	All	3	2003	2005	40	28.5	<b>140.5</b>	100.4	191.3	<b>77.3</b>	1.88	12.2
Colon, Rectum, & Anus	Male	3	2003	2005	24	13.9	<b>173.1</b>	110.9	257.5	<b>103.6</b>	1.93	21.1
Lung & Bronchus	All	5	2000	2004	86	67.5	<b>127.5</b>	102.0	157.4	<b>100.8</b>	2.09	10.9
Lung & Bronchus	Male	5	2000	2004	55	37.6	<b>146.1</b>	110.1	190.2	<b>152.3</b>	2.44	20.5
Lung & Bronchus	Male	5	2001	2005	56	37.9	<b>147.6</b>	111.5	191.7	<b>154.5</b>	2.52	20.6

CANCER TYPE	SEX	PERIOD	START YEAR	END YEAR	CASES	EXP CASES	SIR x 100	LOWER SIR CI	UPPER SIR CI	AA RATE	AA Z SCORE	AA SE
Lung & Bronchus	All	3	2001	2003	55	41.2	<b>133.6</b>	100.7	173.9	<b>109.3</b>	2.03	14.7
Lung & Bronchus	Male	3	2001	2003	39	23.0	<b>169.7</b>	120.6	232.0	<b>179.2</b>	2.62	28.7
Lung & Bronchus	Male	5	2002	2006	55	37.8	<b>145.7</b>	109.7	189.6	<b>151.7</b>	2.45	20.5
Lung & Bronchus	All	3	2002	2004	58	41.2	<b>140.9</b>	107.0	182.2	<b>114.0</b>	2.34	15.0
Lung & Bronchus	Male	3	2002	2004	38	22.5	<b>168.6</b>	119.3	231.5	<b>175.2</b>	2.59	28.4
Malignant Lymphoma	All	10	1997	2006	44	30.5	<b>144.1</b>	104.7	193.5	<b>26.3</b>	2.04	4.0
Malignant Lymphoma	All	5	1997	2001	24	14.9	<b>160.7</b>	102.9	239.1	<b>30.6</b>	1.94	6.2
Thyroid & Other Endocrine Glands	All	10	1997	2006	23	12.4	<b>185.2</b>	117.4	277.9	<b>16.4</b>	2.30	3.4
Thyroid & Other Endocrine Glands	All	10	1998	2007	25	13.6	<b>184.3</b>	119.2	272.1	<b>18.2</b>	2.43	3.6
Thyroid & Other Endocrine Glands	Female	10	1998	2007	20	9.4	<b>211.9</b>	129.4	327.3	<b>29.3</b>	2.51	6.6

### Significant Temporal Change

A Z-Test was used to identify age-adjusted cancer incidence rates (by cancer group, sex, and time period) in Blackford County that have had a statistically significant change over time. In other words, conduct a test to determine if rates in two distinct periods are statistically distinguishable. Such changes in rates were detected in 3 different cancer types by gender for various period comparisons including: “all sites”, “colon, rectum & anus”, and “lung and bronchus”. The following table lists the statistics for each significant change detected.

CANCER TYPE	SEX	START YEAR	END YEAR	CASES	AAR RATE	AAR SE	% CHANGE	Z SCORE	START YEAR	END YEAR	CASES	AAR RATE	AAR SE
All Sites	All	2002	2004	277	544.5	32.7	20.0%	2.04	1999	2001	224	453.7	30.3
All Sites	All	2002	2004	277	544.5	32.7	28.3%	2.72	1996	1998	205	424.5	29.6
All Sites	All	2002	2004	277	544.5	32.7	33.8%	3.13	1993	1995	193	407.1	29.3
All Sites	All	2005	2007	255	503.3	31.5	23.6%	2.24	1993	1995	193	407.1	29.3
All Sites	Female	2002	2004	131	479.4	41.9	30.0%	1.96	1993	1995	95	368.7	37.8
All Sites	Male	2002	2004	146	660.2	54.6	38.4%	2.51	1996	1998	98	477.1	48.2
All Sites	Male	2002	2004	146	660.2	54.6	36.5%	2.41	1993	1995	98	483.7	48.9
Colon, Rectum, & Anus	Male	2002	2004	21	91.9	20.0	256.6%	2.92	1996	1998	6	25.8*	10.5
Lung & Bronchus	All	2002	2004	58	114.0	15.0	72.9%	2.55	1999	2001	33	65.9	11.5
Lung & Bronchus	All	2002	2004	58	114.0	15.0	95.2%	3.01	1996	1998	29	58.4	10.9
Lung & Bronchus	All	2002	2004	58	114.0	15.0	75.3%	2.61	1993	1995	33	65.1	11.3
Lung & Bronchus	Male	1999	2001	20	112.9	25.2	110.2%	2.00	1996	1998	12	53.7*	15.5
Lung & Bronchus	Male	2002	2004	38	175.2	28.4	226.2%	3.75	1996	1998	13	53.7*	16.5
Lung & Bronchus	Male	2002	2004	38	175.2	28.4	91.7%	2.39	1993	1995	20	91.4	20.4

\* Rate is considered unstable and affects the stability of the percentage change

### Significant Regional Clusters

A Poisson purely spatial single time-period algorithm was used to detect statistically significant clustering of high age-adjusted cancer incidence rates for those cancer types in Blackford

County that are distinguishable from the state. The regional clustering of high county incidence rates was detected in each of the 6 cancer types for various time periods and genders found to be elevated in Blackford County including: “all cancer sites”, “colon, rectum & anus”, “lung & bronchus”, “malignant lymphoma”, and “thyroid & other endocrine glands”. No isolated cluster, an elevated rate specific to Blackford County, was detected. The following table lists the statistically significant cluster detected for each significant rate.

CANCER TYPE	SEX	PRD	START YEAR	END YEAR	OBV/EXP RATIO (x100)	P VAL	# OF CNTY	COUNTIES INCLUDED IN CLUSTER OF SIMILAR INCIDENCE
All Sites	All	5	2000	2004	122	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
All Sites	All	5	2001	2005	122	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
All Sites	M	5	2001	2005	125	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
All Sites	All	3	2001	2003	122	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
All Sites	All	5	2002	2006	121	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
All Sites	M	5	2002	2006	123	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
All Sites	All	3	2002	2004	123	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
All Sites	M	3	2002	2004	125	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
All Sites	All	3	2003	2005	123	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
All Sites	M	3	2003	2005	125	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
Bladder	All	10	1996	2005	123	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
Bladder	M	10	1996	2005	122	.001	10	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn, Han, Tip
Bladder	All	10	1997	2006	128	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
Bladder	All	10	1998	2007	128	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
Bladder	All	5	2000	2004	132	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
Bladder	M	5	2000	2004	133	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
Bladder	All	5	2001	2005	139	.001	6	Blk, Del, Grnt, Jay, Mad, Hen
Bladder	M	5	2001	2005			0	None
Bladder	All	3	2003	2005	131	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
Col, Rec, Anus	F	5	1994	1998	119	.001	12	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Hunt, Wells, Adm, Tip, Wab
Col, Rec, Anus	F	3	1994	1996	123	.002	11	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn, Hunt, Wel, Adm
Col, Rec, Anus	M	5	2003	2007	110	.001	35	Northern Indiana
Col, Rec, Anus	All	3	2003	2005	130	.001	10	Blk, Del, Grnt, Jay, Ran, Hen, Hunt, Wel, Adm, Wyn
Col, Rec, Anus	M	3	2003	2005	128	.001	10	Blk, Del, Grnt, Jay, Ran, Hen, Hunt, Wel, Adm, Wyn
Lung & Brnch	All	5	2000	2004	131	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
Lung & Brnch	M	5	2000	2004	135	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
Lung & Brnch	M	5	2001	2005	136	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
Lung & Brnch	All	3	2001	2003	132	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
Lung & Brnch	M	3	2001	2003	131	.001	8	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn
Lung & Brnch	M	5	2002	2006	133	.001	10	Blk, Del, Grnt, Jay, Mad, Ran, Hen, Wyn, Tip, Han
Lung & Brnch	All	3	2002	2004	124	.001	17	Eastern Indiana
Lung & Brnch	M	3	2002	2004	129	.001	17	Eastern Indiana
Malig Lymph	All	10	1997	2006	126	.001	13	Blk, Del, Mad, Grnt, Jay, Ran, Hen, Hunt, Tip, How, Wab, Wel, Adm
Malig Lymph	All	5	1997	2001	130	.001	10	Blk, Del, Grnt, Jay, Ran, Hen, Hunt, Wyn, Tip, Han
Thyr, Endo Gland	All	10	1997	2006	148	.001	7	Del, Grnt, Blk, Ran, Jay, Wel, Adm
Thyr, Endo Gland	All	10	1998	2007	158	.001	4	Del, Grnt, Blk, Jay
Thyr, Endo Gland	F	10	1998	2007	181	.001	3	Del, Blk, Jay

## **CONCLUSION**

There is evidence to suggest that the incidence of cancer over the past 10 years in Blackford County may be slightly higher than expected. Elevated incidence rates were detected in cancers of the bladder, colon & rectum & anus, lung & bronchus, thyroid & endocrine glands, and malignant lymphoma. Moreover, elevated incidence rates in most of these cancers appeared to be partly due to slightly higher rates present in males. The one exception is thyroid cancer where incidence is greater in females. There is also evidence that suggests recent cancer incidence, as a whole, has increased from periods in the 1990's. Cancer of the lung & bronchus is the only specific cancer site where significant increases were detected during the 1993-2007 time period.

However, there is sufficient evidence that suggests elevated rates are not isolated to Blackford County, but similar rates are present in much of the East Central Indiana region. This generally includes the adjacent counties of Blackford, Delaware, Grant, Jay, Madison, Randolph, Henry and Wayne. Thus, the presence of any elevated incidence rates in Blackford County is expected given the higher incidence rates observed in the region, primarily Public Health Preparedness District 6.

The cause of any elevated cancer incidence in the region may not necessarily be due to behavioral or environmental characteristics, but medical factors unique to the region. For instance, incidence may be elevated because of improved cancer screenings and early detection procedures. From a public health perspective, one may also want to investigate cancer mortality to help determine if health care accessibility is appropriate. High rates of cancer mortality, years of potential life lost (YPLL), or late-stage diagnosis may indicate shortcomings in primary care or patient behaviors toward primary care.