Study of the Effect of Environmental Pollution in JinZhou Area on Residents Health
I Mortality Analysis
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It is well known that environmental pollution can directly affect human health. The study of the relation between environmental pollution and human health is getting more and more attention. Therefore, further investigations on the appearance and the severity of pollution are necessary. The primary purpose of this study is to explore the severity issue by field investigation in the suburb of JinZhou city. The secondary purpose of this study is to offer information for treatment of the contamination so that human health can be protected. We have the following topics in our study: (1) mortality analysis (2) the study of the relation between human health and current status of this contamination (3) laboratory research of the pollutant. This paper focuses on the first topic.

Section I: Background and Investigation Plan

The near suburb of JinZhou city is the area with agriculture and vegetable products. However, there are several modern industrial plants located in this area. This area is a plain area, adjacent to the BoHai Bay. The climate is mild and windy over the seasons. Direction of the wind is southwest most time of the year.

There are several industrial plants in the suburb. They are No.6 Petroleum Corporation, a large petroleum chemical company, and JinZhou Alloy Corporation. They are located in the northwest and west of the suburb. Both companies were built before 1949, expanding after the revolution\(^{(a)}\). Due to the lack of proper handling of waste water, waste ore and waste gas\(^{(b)}\) over the past forty years, a large amount of pollutant was discharged into the air, soil and water. Especially in the last ten years, this kind of pollution is getting more and more serious because of the expansion of these plants. There are reports\(^{(1)}\) on the chromium contamination from the alloy company. The effect of this contamination on human health has drawn much attention. A malignant neoplasm epidemic study\(^{(2)}\) in 1970-1974 revealed that the location of No.6 Petroleum Corporation was a high malignant neoplasm incidence area. This fact indicated possible correlation between the pollution by the petroleum company and high malignant neoplasm incidence. In order to investigate the effect of the contamination in the suburb on residents health who are living in the JinZhou area, we conducted this retrospective study. By studying the causes of mortality over years and considering the geographical factor, we can get to know the characteristics of the contamination.

This paper is based on the materials from the mortality survey in 1970-1978. This mortality survey was conducted in three time periods: 1970-74, 1973-75, 1976-78 and completed by 1975, 1976 and 1979. Repeated material in 1973-74 has been cross-checked by names.
锦州郊区环境污染对人体健康影响之研究

一、人群死因分析

锦州市卫生防疫站 张延东 李希林

环境污染能够直接影响人体健康，这已为人们所共知。随着我国“四化”的进展，环境污染与人体健康关系的研究则更为人们所重视。但是，环境污染在什么样上能对人体健康产生影响，这种影响的人群表现又是怎样，这在当前都不无深入探讨的必要。本研究的目的在于通过对锦州郊区的现场调查，探讨环境污染对人体健康影响的程度，以便采取措施改善环境，保护人民健康。为此，本研究拟就人群死因分析，环境污染的现状及规律与人群健康的关系。环境污染的实验研究三个分题去达到这一目的。现将第一分题——人群死因分析报告如下：

一、一般情况和调查方法

锦州郊区原为锦州市东南，以薰衣种植和农业为主，今有若干现代工厂，地处辽西走廊，濒临辽湾，是一个平原地区。气候温和，四季多风。常年主导风向为东南西。

锦州郊区有规模较大之石油化工厂、石油六厂、有色金属提炼——锦州铜合金厂。它们分处在郊区的西北部和西部。这两个厂都是战时时期所建，战后不断扩建，三废处理措施不良。四十年来，不断向空气、土地、水中排放大量工业废料。特别是近十几年来，随着生产规模的发展，生产品种的增多，由此而带来的环境污染日益严重。铜合金厂六价铬对郊区地下的污染已有报告。
(1) 其对人群健康的影响已引起当地的重视。1970～1974年郊区农村
恶性肿瘤的流行病学分析(2)又发现石油化工厂所在地区为郊区恶性肿瘤
病的高发区域之一，提示了石油化工厂环境污染影响恶性肿瘤发病
的可疑线索。为进一步探讨郊区环境污染对全体城乡居民健康之影响，
采用回顾性调查方法，通过多年的人群死亡病案及环境分析其流行
病学特征。

本文所分析的材料为1970～1978年死因回顾性调查，调查分为
1978年完成的。其中1973~1974年8月基础资料依死者名单按准。

调查是在1973年进行设计的基础上，参照全国肿瘤防办恶性
肿瘤调查方法，统一表表格，制定死因判定标准，培训调查
员之后开始的。首先反复与公安机关核实死亡人数，收集死者名单，
然后通过个别走访进行回顾性流行病学调查，最后对所有的调查表
进行整理，认为符合设计要求时进行死因分析。

二、调查结果

(一) 总死亡率

1973~1978年年间郊区人群总死亡率为45.8/10万人，1973~1975年
人群总死亡率为39.6/10万人、1976~1978年人群
总死亡率为43.7/10万人，由1973至1978平均每年递增0.5
/1千。

(二) 恶性肿瘤死亡率
73—74年各区恶性肿瘤死亡率为6.61/10万，全死
亡率为3.85/10万，占同期各种死因的第二位。同期
全区非癌死亡率为3.85、1.2/10万，在其它死因中，各种心血
管病死亡率为6.762/10万，占各种死因第一位。脑血管病死亡率
7.52/10万占各种死因第二位，呼吸系统病死亡率6.8、
6.2/10万占各种死因第四位。

73—76年全区恶性肿瘤死者中，胃癌占首位，为全部恶性
肿瘤死者的20.52%，肺癌次之，占21.03%以下为肝癌
(13.28%) 食管癌 (7.75%)。

（三）地区死亡率

锦州郊区按行政区划分为六个公社（农场）。73—78年以
各公社（农场）为单位的总死亡率、恶性肿瘤死亡率均有效大差别
（见表1）在女儿河、中屯两地上述两项指标均较其它地区为高。
地区死亡率的差异提示了死因的差异，为此，我们把女儿河、中屯
两地70～78年各人群死亡资料进行各大队及村屯为单位的统计分
析。

70—78年锦州郊区各公社农场死亡率统计 表一

<table>
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<tr>
<th></th>
<th>全区</th>
<th>中屯</th>
<th>女儿河</th>
<th>西郊</th>
<th>大营</th>
<th>北郊</th>
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TY-0271
78-78年

<table>
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I 女儿河地区

女儿河地区（包括郊区河子街等）位于锦州郊区西南。年地区人口3.8万。锦州铁合金厂位于该区。

78-80年地区恶性肿瘤死亡率为7.4、4.0/十万，调查
死亡率为3.0、3.8/十万，略高于全区平均水平，也高于辽宁省
78-75年恶性肿瘤死亡率的平均水平(3)

表2  7.0-7.6年女儿河、西郊（部分）公社恶性肿瘤死亡率

| 年份 | 地点 | 男 | 女 | 总数 | 0-14 | 15-29 | 30-49 | 50-69 | 70以上 | 非
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<td>67.55</td>
<td>78.00</td>
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</table>
（四）地区

1. 淇河子街道
2. 北淇河子大队
3. 南岸、西岸、东岸、中段
4. 大洼、姜屯、华山、陈家沟
5. 王营大队、王营子大队
6. 淇河子
7. 金厂堡大队
8. 女儿河大队
9. 十里台
10. 杨兴
11. 温家庄

（地理位置参见图）

1. 恶性肿瘤死亡率以铁合金厂所在地的淇河子街道为中心，形成一个高癌死亡率地区。淇河子街道略低于外围。然后向北部过渡，死亡率逐级下降。淇河子街道恶性肿瘤死亡率在7.3~7.9/十万之间，其他地区略高，然后逐渐降至7.3/十万以下。

2. 中心点（淇河子街道）恶性肿瘤死亡率最高，烟达2.0/十万，（全郊区恶性肿瘤死亡率仅为1.1~2.1/十万），然后随转向北部过渡，恶性肿瘤死亡率逐级下降。胃癌死亡率又以中心点最低，然后向北部及周围逐级上升。

3. 恶性人口平均闭死年龄，以中心点为最高（58岁）。在向周围过渡过程中逐级上升。尤以向北部地区过渡最为明显，分别相差5~7年。

4. 以淇河子街道为中心，向东经过女河大队延伸至淇河公社的三个大队（十里台、杨兴、温家庄）出现一个狭长的高死亡率地区。

二、中屯地区

中屯地区（公社）位于鹤州郊区北部。北部靠山，东南临水。

全地区人口1.6万。油田六厂位于该区东南端。70~72年恶性肿瘤死亡率有逐年上升之势。70~72年为9.2,1.3/十万，而73~74年为7.3，3.1/十万。
把该地区70年以来各年人群死亡资料按生年队和自然村屯为单位统计整理之后，可以看到（见表3，图1）：

（1）区石油市厅地区的中心死亡率最高，达2.3/万，成为该地区高死亡率的中心，然后向北部地区逐步过渡，死亡率逐渐降低。该地区的西、西部死亡率最低。

表3 1961—1969年中屯地区人群死亡率比较

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<th>地段</th>
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（**地段**：1.中屯大队，2.幸福胜利，3.五四大队，4.河屯，5.峰山大队，6.罗合子大队）

（地理位置参见图1）

（2）肺癌死亡率先由中心点偏离的地段逐步下降。胃癌死亡率也有外来城市高于中心的趋势。

（3）恶性肿瘤人群的平均死亡年龄，也有以中心点最低，在向周围过渡中逐步提高的趋势。高低之间相差约五年左右。

三、讨论

（一）从锦州郊区1961—1969年的人口死亡资料中可以看出，从全区范围来看，人群总死亡率0.75/万，恶性肿瘤死亡率为0.36/万，调查死亡率0.87/万。这在省内并非最低。
均在73—75年辽宁省恶性肿瘤年平均死亡率水平以下。只是在以公社（农场）为单位的统计时，才发现女儿河中屯两地恶性肿瘤死亡率略高于73—76年辽宁省的平均水平。但没有显示出更大的差异。然而，当我们再进一步结合地理环境特点进行更小一级单位的分析对比时，人群的死亡分布才比较真实的显示出来。因此在锦州郊区70—78年的人群死亡率分布中看到，在两个恶性肿瘤高发区范围内，又明显地存在着各自的恶性肿瘤的高发点。高发点与某附近地区的地区又保持一个具有特点的变动过程。高发点的出现，又与当地的环境条件存在着值得深入探讨的联系。

女儿河地区是一个农业地区，属于锦州市的远郊地区。由于铁合金厂设立，在工厂的周围形成了一个小城（汤河子街道）。全年人口1．5万，虽然恶性肿瘤死亡率并不是远地区的最高点，但肺癌死亡率却为该地区的最高点。恶性肿瘤死者的平均死亡年令也是远地区的最低点。由此往北，被一个恶性肿瘤死亡率为8．0／十万左右的地带包围。这一地段恶性肿瘤死亡率虽然较汤河子街道为高，但肺癌死亡率却明显地低于汤河子街道。癌症的平均死亡年令也有所提高。再往北偏东方向，恶性肿瘤死亡率和肺癌死亡率则更加降低，癌症平均死亡年令也更提高。这似乎说明在汤河子街道这一点上，明显的存在着较短的致癌因素，所以使人群患癌的年令提前。随着地段的北移，这种较强的致癌因素逐步降低。人群患癌的平均年令也逐渐相等。但是，在二者之间的中间地段的恶性肿瘤死亡率的提高，以及肺癌死亡率由中心向北部地段逐步升高的现象，似乎说明了由中心点到阜新市常年主风向相一致方向的广大地区中，各个地段存在着不同的致癌条件。
由汤河子街道向东，经金厂堡、女儿河、十里台、杨家村，再经三家屯的整个地段里，恶性肿瘤死亡率都处在该地区的较高水平上。肝癌死亡率也分别处在同地区的高水平上。看不到明显的地点分布与死亡率之间的变化。已经知道这一结果是由哈尔滨肿瘤研究所（工业化副产品对地下水的污染地区，主要污染物是六价铬）在这一地区相隔为全体居民提供了自来水，但是查出这一段的水质的某些指标明显超过了对照地区5—10倍。说明该地区居民经常受污染源及污染水的污染加剧。因此该地区恶性肿瘤死亡率升高与真善原因确有深入研究的必要。

中屯地区是一个靠近石油六厂的工业地区，居民以农业为主。死亡率和恶性肿瘤死亡率的地区分布也同样存在着段间的过渡分布。

以石油六厂所在地段——中屯为中心，形成了一恶性肿瘤的高发区。

死亡率超过500/十万，肺癌死亡率达29，37/十万，肝癌死亡率的高发区。

后恶性肿瘤死亡率，肝癌死亡率也明显高于对照地区向北偏东方向逐步降低，平均死亡率也以中心地区为最低。随着肺癌死亡率的逐渐升高。

如果说在中屯地区是以石油六厂所造成的大气污染为主要的污染源，那么也存在着与锦州市区相同的风向相同的死亡率逐步扩大的下降过程。这确实是值得探讨的特点。

（二）当然，环境污染与恶性肿瘤的关系，已经有人指出心脏病死亡率，恶性肿瘤死亡率的80％，为环境污染所造成。中屯地区的人口死亡率中，恶性肿瘤死亡率又接近该地区的人口死亡率。恶性肿瘤的死亡率变化，在地理位置上与环境污染似乎没有直接关系。
徐州铁合金厂位于新河子的东南角。在该区内除铁合金厂外，还有炼油、染织及一些小型规模工业。这些工厂目前尚未发现有明显的污染物质排出。而铁合金厂则是以铬、镍、钛等有色金属作为原料，长期以来造成废气、废水、废渣向外扩散多种污染物。其中铬的污染能够引起癌症，已有报道。其它物质的致癌作用尚有待研究。徐州石油六厂是生产燃料油和其它石油化工产品的工厂。厂内又有尾气、废水中污染物不论在种类或数量上，都是复杂而大量的。以BaP为代表的多环芳烃这类强致癌物质，对石油六厂周围的污染是毫无疑问的。上述两厂环境污染的种类、数量、污染范围和污染剂对人群死亡，特别是恶性肿瘤死亡的影响，以及污染物的致癌作用，有待在第四、五章中进一步探讨。

(三)。病因回顾性调查在探讨环境污染对人体健康损害中，确是一项极为重要的方法。和必须的前提。但是在做人群死亡率分析时，必应以最小的人群为单位进行长时期地观察。结合地理环境特点探讨环境因素的作用，同时也要注意应用适当的指标，使之能够真实的反映人群死亡状况，进一步说明局部环境对人群死亡的影响。

四。小 结

本文报告了徐州郊区70-78年人群死亡资料，并结合局部地理环境对人群死亡的分析。认为在徐州郊区九年来的人群死亡中，环境因素的作用是值得注意的，它在人群总死亡率和恶性肿瘤死亡率以及其它主要平均死亡率牵引方面都有着值得进一步探讨的联系。
同时对进行环境与人体健康关系的研究中使用的流行病学方法提出了探索性意见。认为小单位的长期的死亡率统计应结合与各地理环境的分析。探讨环境对人体健康的影响是难的。

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2. 张延东：银州郊区农村恶性肿瘤流行病学分析。《78年内部资料
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4. 银州市卫生防疫站。银州西郊蔬菜种植污染情况的初步调查小结。1976年。内部资料。
5. 河本。代谢（日文）13（6，7）1972
The study was carefully planned. The survey form and mortality reasons are standardized according to the National Malignant Neoplasm Survey. Survey persons were trained before conducting this survey. The first step of this survey is to check the death record with the police department. After collecting a name list of people dead in the study time, we conduct personal interviews (surrogate). Finally we gather and check all the survey forms. Only when the survey goes well as its planned, a mortality analysis can be done.

Section II: Survey Result

(1) Overall Death Rate:

Overall death rate of the population of suburb of JinZhou was 453.13/10^5 in 1973-78. It was 396.61/10^5 in 1973-75; and it was 497.33/10^5 in 1976-78. The average increase was 0.5/10^3 per year.

(2) Malignant Neoplasm Death Rate:

The whole area's malignant neoplasm death rate was 65.40/10^5 between the years 1973-78; adjusted death rate was 66.35/10^5. Malignant neoplasm was the third cause of death. At that time, death caused by other reasons was 385.12/10^5. Among them cardiac vascular disease was number one, and the death rate was 87.62/10^5. The second cause was cerebral disease, death rate was 72.62/10^5. Respiratory disease was the forth reason with death rate 63.48/10^5.

Among the deaths caused by malignant neoplasm, stomach cancer was the number one reason, which acclaimed 29.52%. The second was lung cancer which acclaimed 21.03%. The following two were liver cancer (13.28%) and esophagus cancer (7.75%).

Section III: Death Rates by Region

The suburb of JinZhou is divided into six administrative regions (farms). There were significant variations in both the total death rate and malignant neoplasm death rate among these six farms in 1973-1978 (Table I). The Nuer River region and ZhongTun were the highest both in total death rate and malignant neoplasm death rate. The regional pattern of the death rate revealed the reason of death. Therefore, we did the following statistical analysis using the population mortality data from 1970-78.
Table I

1970-1978 Death Rates By Region of Suburb of JinZhou

<table>
<thead>
<tr>
<th></th>
<th>Total Suburb Area</th>
<th>Zhong Tun</th>
<th>Nuer River</th>
<th>West Suburb</th>
<th>Xue Jia</th>
<th>North Suburb</th>
<th>GuoShu</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973-75 total death rate</td>
<td>407.34</td>
<td>504.42</td>
<td>518.58</td>
<td>496.87</td>
<td>530.96</td>
<td>421.95</td>
<td>355.76</td>
</tr>
<tr>
<td>1970-74 malignant neoplasm</td>
<td>51.42</td>
<td>58.35</td>
<td>47.86</td>
<td></td>
<td></td>
<td>42.93</td>
<td>57.03</td>
</tr>
<tr>
<td>1973-78 malignant neoplasm</td>
<td>65.40</td>
<td>73.31</td>
<td>74.40</td>
<td>56.68</td>
<td>61.90</td>
<td>48.98</td>
<td>59.15</td>
</tr>
<tr>
<td>1973-78 Adjusted malignant neoplasm</td>
<td>66.35</td>
<td>68.43</td>
<td>68.79</td>
<td>54.33</td>
<td>57.51</td>
<td>45.93</td>
<td>64.66</td>
</tr>
</tbody>
</table>

* All rate is in 1/10⁵.

1. The region around Nuer River:

The region of Nuer River is located to the west of JinZhou city. Total population was 38,000. The alloy company was located in this region. The malignant neoplasm death rate in 1973-78 was 74.40/10⁵, adjusted death rate was 68.79/10⁵. This figure was a little higher than the average level of JinZhou suburb; also higher than average level of LiaoNing province.

Table II shows the yearly death rate by villages in the Nuer River region.
Table II  
1970-78 Malignant Neoplasm Death Rate in the Nuer river Area and West Suburb

<table>
<thead>
<tr>
<th>Area</th>
<th>Malignant Neoplasm Death rate(1/10^5)</th>
<th>Adjusted Malignant Neoplasm Death rate(1/10^5)</th>
<th>Lung Cancer (1/10^5)</th>
<th>Stomach Cancer (1/10^5)</th>
<th>Average age of cancer incidents</th>
<th>Average age of death due to cancer (&gt;30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>83.23</td>
<td>71.32</td>
<td>21.37</td>
<td>16.87</td>
<td>58.48</td>
<td>65.57</td>
</tr>
<tr>
<td>II</td>
<td>96.84</td>
<td>81.76</td>
<td>8.80</td>
<td>26.41</td>
<td>62.90</td>
<td>68.45</td>
</tr>
<tr>
<td>III</td>
<td>68.66</td>
<td>71.84</td>
<td>7.62</td>
<td>30.48</td>
<td>64.84</td>
<td>68.36</td>
</tr>
<tr>
<td>IV</td>
<td>68.42</td>
<td>61.27</td>
<td>19.97</td>
<td>26.62</td>
<td>58.53</td>
<td>68.32</td>
</tr>
<tr>
<td>V</td>
<td>86.38</td>
<td>83.62</td>
<td>13.17</td>
<td>36.71</td>
<td>63.78</td>
<td>72.51</td>
</tr>
<tr>
<td>VI</td>
<td>73.42</td>
<td>71.89</td>
<td>14.99</td>
<td></td>
<td>52.62</td>
<td>64.72</td>
</tr>
<tr>
<td>VII</td>
<td>99.30</td>
<td>92.96</td>
<td></td>
<td>55.17</td>
<td>67.66</td>
<td>75.00</td>
</tr>
<tr>
<td>VIII</td>
<td>81.27</td>
<td>76.80</td>
<td>21.39</td>
<td>36.50</td>
<td>60.33</td>
<td>71.77</td>
</tr>
<tr>
<td>IX</td>
<td>96.87</td>
<td>91.12</td>
<td>20.76</td>
<td>27.68</td>
<td>59.66</td>
<td>69.74</td>
</tr>
</tbody>
</table>

(I: TangHezi St; II: North TangHeZi; III: Dawa, JianTun, HuaShan, ChenJiaGou, WangHuTai, WangHuGou; IV: YaoTangHeZi; V: JinChangBao; VI: Nuer Village; VII: ShiLiTai; VIII: YangXing; IX: WenJiaTun) (see Figure I for locations)

From the above table, we observed the following:
(1) The high malignant neoplasm death rate region had its center at TangHeZi Street, which was the location of the alloy company. However, the malignant neoplasm death rate of TangHeZi street was a little lower than the immediate adjacent region. The malignant neoplasm death rate gradually decreased towards the north. The malignant neoplasm death rate on TangHezi Street was 70-79/10^5. It reached more than 80/10^5 in the immediate adjacent region; gradually decreased to less than 70/10^5 north to TangHezi.

(2) The lung cancer death rate reached its highest at TangHeZi street which was more than 20/10^5 (it is only 11.21/10^5 in the whole JinZhou suburb). The lung cancer death rate gradually decreased in the region on the north of TangHeZi. In comparison, the stomach cancer death rate had its minimum value at TangHeZi and gradually increased in the regions on the north of TangHeZi.

(3) The average age of death due to cancer was 58 in the center area, which was the lowest. This average age gradually increased with the distance from the center. This phenomenon was more significant in the northern direction. The difference of the average age of death due to cancer was 5-7 years.

(4) The high death rate region (Nuer Village, ShiLiTai, YangXing and WenTun) forms a long and narrow region and surrounds the center of TangHeZi street.

2. ZhongTun Region:

ZhongTun region was located north to JinZhou city. On the north of ZhongTun is mountains; south is the Ling River and total population 15,000. The No.6 Petroleum Corporation was located at southeast of this region. The malignant neoplasm death rate in ZhongTun had an increasing trend during 1973-78. The malignant neoplasm death rate in 1970-72 was 52.35/10^5 and it reached 73.31/10^5 in 1973-78.

Tabulating the death rate after 1970 by villages revealed the following:

(1) ZhongTun, which was the nearest village to No.6 Petroleum Corporation, had the highest malignant neoplasm death rate (death rate was 98.40/10^5). In fact, ZhongTun was the center of the high malignant neoplasm death rate region, which covered several villages which were located north to ZhongTun. The death rate gradually decreased towards the northern direction. The malignant neoplasm death rate reached its lowest at the west and northwest.
Table III
1970-78 Death Rate in the ZhongTun Area

<table>
<thead>
<tr>
<th>Area</th>
<th>Malignant Neoplasm</th>
<th>Lung Cancer</th>
<th>Stomach Cancer</th>
<th>Non-cancer</th>
<th>Respiratory</th>
<th>Average Age of Death due to cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>98.40</td>
<td>21.87</td>
<td>21.87</td>
<td>467.78</td>
<td>73.71</td>
<td>57.17</td>
</tr>
<tr>
<td>2</td>
<td>73.28</td>
<td>3.01</td>
<td>24.00</td>
<td>349.98</td>
<td>92.17</td>
<td>62.03</td>
</tr>
<tr>
<td>3</td>
<td>59.33</td>
<td>16.32</td>
<td>16.32</td>
<td>203.16</td>
<td>78.14</td>
<td>60.33</td>
</tr>
<tr>
<td>4</td>
<td>46.26</td>
<td>17.35</td>
<td>5.70</td>
<td>581.59</td>
<td>149.55</td>
<td>59.29</td>
</tr>
<tr>
<td>5</td>
<td>35.82</td>
<td>4.48</td>
<td>17.91</td>
<td>260.42</td>
<td>72.76</td>
<td>55.75</td>
</tr>
</tbody>
</table>

(1: ZhongTun; 2: XingFu, ShengLi, ShiYing, WuXing; 3: HeTun, MaoShan; 4: LuoTaiZi; 5: ErLangDong, SiFangTai, ShaHeBao, HoTun)

(2) Similar to the Nuer River region, death rate of lung cancer had its highest value at the center (ZhongTun) and gradually decreased with the distance from the center. However, for the stomach cancer death rate, the immediate adjacent region had higher value than the center.

(3) The average age of death due to cancer reached its lowest at the center and gradually increased with the distance from the center. The difference between the maximum and minimum was about 5 years.

3. Discussion:

(1) The total death rate of JinZhou suburb in 1970-78 was 497.34/10^5. The malignant neoplasm death rate was 65.40/10^5, adjusted death rate was 66.35/10^5. These rates were not the highest in the province. In fact these death rates were lower than the province average in 1973-1975(3). Only the malignant neoplasm death rate in Nuer Village and ZhongTun between 1973-75 were a little higher than the province average. However, when we studied and compared the death rates of each village, the distribution of the death rate became noticeable. From the death rate distribution in JinZhou suburb between 1970-1978 we can see the following:

(1) There were two high death rate regions
(2) Both regions had centers
(3) The death rate regional distribution in each region satisfied a similar pattern. The relation
Figure 1: Distribution of death rate due to malignant neoplasm

(1: TangHezi St; II: North TangHeZi; III: Dawa, JianTun, HuaShan, ChenJiaGou, WangHuTai, WangHuGou; IV: YaoTangHeZi; V: JinChangBao; VI: Nuer Village; VII: ShiLiTai; VIII: YangXing; IX: WenJiaTun) (see Figure I for locations)

(1: ZhongTun; 2: XingFu, ShengLi, ShiYing, WuXing; 3: HeTun, MaoShan; 4: LuoTaiZi; 5: ErLangDong, SiFangTai, ShaHeBao, HoTun)
between the appearance of the centers and the environmental condition needs more investigation.

Nuer River region is an agricultural region. Because of the establishment of the alloy company plant, a small town (TangHeZi) was developed around the plant. Total population of this town was 15,000. Although the malignant neoplasm death rate of TangHeZi was not the highest, the lung cancer death rate was the highest in the whole Nuer River region. It also had the lowest average age of death due to malignant neoplasm in the Nuer River region.

The northern area of Nuer River was a high malignant neoplasm rate area. The malignant neoplasm death rate was $80/10^5$. Although the malignant neoplasm death rate in this area was higher than TangHeZi, the lung cancer death rate was lower than TangHeZi. It also had a higher average age of cancer incidents than the center. The region which was located northeast to this area had an even lower malignant neoplasm death rate and a higher average age of cancer incidents. This fact revealed that there was some toxicant at TangHeZi, which are carcinogen. Therefore the average age of cancer incidents was shorten. The average age of cancer incidents was prolonged with less toxicant concentration in the northern direction. However the fact that the highest malignant neoplasm rate appeared in the middle area (not in the center) and the fact that stomach cancer death rate increased from the center towards the northern direction revealed that each region located north to the center (down the wind direction) had its specific geographical condition.

In the regions located east to TangHeZi (JinChangBao, NuerRiver, ShiLiTai, YangXing and WenJiaTun), malignant neoplasm death rate maintained a relatively high level in the whole region and lung cancer death rate was also high. There was no significant difference of death rates among those locations. It was known that this long and narrow region was the contaminated area whose underground water was heavily contaminated with Cr$_6^+$ from the alloy company.$^{(1)}$ Although the residents began using tap water in the 1970's, they contacted a large amount of metal chemicals daily. The vegetables grown in this area had chromium concentration as high as 5-19 times as standard. It is necessary to conduct further study to investigate the reason of the high malignant neoplasm death rate.

ZhongTun, which was located near No.6 Petroleum Corporation, was an agricultural region. Most residents were farmers. Both total death rate and malignant neoplasm death rate showed a gradual changing pattern. The pattern was: the high malignant neoplasm death rate region had its center at ZhongTun (malignant neoplasm death rate was $98.40/10^5$ and lung cancer death rate was $21.87/10^5$), gradually decreasing toward the northern direction. At the same time, the average age of cancer incidents had its lowest value at the center (ZhongTun). Along with lower malignant neoplasm death rate, the average age of cancer incidents increased. If one can say that the main pollution of ZhongTun was air pollution by No.6 Petroleum Corporation, then the air pollution must be diluted and expanded with the direction of the wind towards the north east in JinZhou area.
(2) The relation between environmental pollution and malignant neoplasm has been confirmed by many studies. Nearly 80% of malignant neoplasm is attributable to environmental pollution. From this mortality study in 1970-1978, we can see the malignant neoplasm pattern in Nuer River and Zhong Tun. This pattern geologically indicated the possible relation between environmental pollution and malignant neoplasm death rate. JinZhou Alloy Corporation was located in the southeast corner of TangHeZi. Besides the alloy company, there were several other small plants in this area. It is not confirmed that carcinogen has been discharged from those small plants. The alloy company, on the other hand, had main products with vanadium, chromium, titanium and zirconium. It discharged a large amount of waste water, waste ore and waste gas in a large variety. Chromium is carcinogen\(^5\)\(^6\) while carcinogenesis of the other substances needs more study. No.6 Petroleum Corporation's main product was gasoline and other petroleum chemical products. There is a large amount of pollutants in a broad variety in its waste gas and waste water. Carcinogens like BaP and other polycyclic hydrocarbon certainly contaminated the adjacent area. The effect of the pollution (from the two plants we mentioned above) on human health, especially malignant neoplasm, will be discussed in the second and third parts of this study.

(3) Retrospective mortality study is a very useful and necessary tool in analyzing the effect of pollution on human health. When we do mortality analysis, it is suggested that we should use small study units, and consider the geographical factor at the same time. Measurement should be selected carefully in order to reflect the true effect of environmental pollution on human health.

Section IV: Summary

This paper summarizes the mortality analysis of residents living in JinZhou suburb in 1970-1978. Considering the geographical factor, we come to the conclusion that more attention should be paid to the environmental pollution as a factor of the deaths over the studied years. More study is needed to investigate the relation between the environmental pollution and human health, especially malignant neoplasm.

This paper also discusses epidemic study methodology. The conclusion is: long time small unit study, with consideration of geographical condition, is helpful in studying the relation between the environment and human health.
References:


(5) 和田政: 代謝 13 (6,7) 1972

Original Paper in Chinese was received on June 21, 1995.
Translation was finished on June 24, 1995, by Tony Ye
Electronic File is: a:trans.624
Translator's Note:

(a) Revolution: In 1949 the communist party took control of the mainland of China.

(b) Direct translation would be "three waste". As the translator knows, this is the abbreviation of "waste gas, waste water and waste ore" in Chinese.

(c) Unlike U.S.A., the death records (for any reasons) are maintained by the police department in P.R.China.

(d) The author used WenTun here. It might be the abbreviation of WenJiaTun.

(e) This reference is in Japanese, which is a language that the translator does not understand.

(f) The author mentioned in the first paragraph of Section I that the main direction of wind was southwest. This information is contrary to his figure and the rest of his paper. The translator thinks the meaning of the author is "most time, wind come from southwest". Wind direction, in Chinese, is a little confusing. Sometimes it means the direction that the wind comes from; sometimes it means the direction that the wind goes to. In the rest of this translation, wind direction means the direction that wind goes to.

(g) In order to understand this paper, background information of JinZhou City and LiaoNing Province is necessary.

LiaoNing Province is one of 30 provinces in China. Located north to BeiJing, LiaoNing is a well-developed heavy industry province. Heavy industry, such as petroleum chemical industry, steel, auto, alloy etc., acclaims 73% of total industrial revenue of the province. There are more than 20 heavy industry corporations with revenue more than 0.4 billion Yen. Total population of LiaoNing province is 40.42 million. Jinzhou is a city of LiaoNing. Total population is 2.968 million.

(The above information comes from "Liao Ning Year Book 1992")

In this paper, the author mentioned that the malignant neoplasm death rate of Nuer River region was only slightly higher than the province average. Given the background of LiaoNing province, it is understandable that other cities in LiaoNing may have suffered by other contamination so that malignant neoplasm death rate in general was high. This argument supports Dr.Zhang's conclusion of the methodology, which is 'Long time small units study with consideration of geographical factor', is recommended.

(h) Although small units study may reveal the geographical relation between contamination and location, it may sacrifice statistical significance, for example the standard deviation. The author did not give any estimate of the standard deviation of those death rates mentioned in this paper. However, we can approximately estimate the standard deviation. For example, for the Nuer River region, total population was 38000. The malignant neoplasm death rate was 74.40/10^5 per year. The study covered 8 years. The estimator of the malignant neoplasm death
rate for the whole Nuer River region has standard deviation of \(4.95 \times 10^5\). For the Nuer village, the population was 15,000, the standard deviation was \(7.87 \times 10^5\). Although the author's method is small units study combining with geographical consideration, a standard deviation for each death rate is still helpful.

(i) The 'death rate' in this paper should be 'death per year per \(10^6\)'. The author did not mention 'per year'. It seems 'per year' is indicated.

(j) This paper covered two different contaminations. One was the chromium contamination in the Nuer river area. The other one was petroleum related material contamination in ZhongTun area. Although the chromium contamination is the one related to the PG&E project, the other contamination should not be neglected. In fact, the similarity of the pattern of these two contaminations is the key factor that the author's conclusion was based on. In general the conclusion is: because the wind direction is towards northeast, those areas located northeast to the plants (the alloy company and the petroleum company) have a gradually decreasing pollutant concentration. In the mortality study, the author found that the lung cancer death rate was gradually decreasing and average age of death due to cancer was gradually increasing on the direction of northeast.

(k) As the translator can see, the chromium contamination in JinZhou, China in 1970's offers relevant information in evaluating the PG&E contamination. The question now is how much chromium concentration is necessary to cause health problems of humans instead of whether chromium can affect human health. Dr.Zhang's studies (both laboratory study and epidemic study) have showed evidence that chromium may cause lung cancer. A study of the relation between the level of chromium contamination and malignant neoplasm death rate seems necessary. Dr.Zhang may have done the similar study. If so, his study on this topic will be very helpful. If he has not done any studies like this, we may cooperate with him on this study. In fact, a very simple study will be: if Dr.Zhang can provide us the chromium concentration in underground water and in air for those villages he mentioned in this paper, we can do some statistical analysis of the relation between malignant neoplasm death rate and chromium concentration. Again, it is recommended that Dr.Zhang would be questioned about this issue.