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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

I 人群死因分析

锦州市卫生防疫站

张建东

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环境污染能够直接影响人体健康，这已为人所共知。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，环境污染在什么程度上能对人体健康产生影响，此种影响的人群表现是怎样，这在当前却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，环境污染的现状与规律与人群健康的关系，环境污染物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

锦州郊区围绕锦州市四周，以蔬菜种植和农业为主，兼有若干现代工厂。地处辽西走廊，濒临渤海湾，是一个平原地区。气候温和，四季多风，常年主风向为南南西。

锦州郊区设有规模较大之石油化工厂，石油六厂，有色金属冶炼——锦州铁合金厂。它们分处在郊区的西北部和西部。这两个厂都是较仿时期厂，建厂后不断扩建，三废处理措施不良。四十年来，不断向空气、土壤、水中排放大量工业废物。特别是近十多年来，随着生产规模的^重发展，生产品种的增多，由此而带来的环境污染日益严重。铁合金厂六价铬对郊区地下的污染已有报告。⁽¹⁾

(1) 其对人群健康的影响已引起当地的重视。70~74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的高发区域之一,提示了石油化工厂对环境污染促成恶性肿瘤高发的可疑线索。为进一步探讨郊区环境污染对全体城乡居民健康之影响,选用回顾性调查方法,通过多年的人群死因结合地理环境分析其流行病学特征。

本文所分析的材料为70~78年死因回顾性调查,调查是分为70—74年、73—75年、76—78年三次分别于75、76、78年完成的。其中73—74两年重复资料依死者名单校准。

调查是在事先进行细致的设计的基础上,参照全国肿瘤防办恶性肿瘤调查方法,印制统一表格,制定统一的死因判定标准。培训调查人员之后开始的。首先反复与公安机关校对所死亡人数,收集死者名单,然后通过个例走访进行回顾性流行病学调查,最后对所有的调查表格进行整理,认为符合设计要求时方进行死因分析。

二、调查结果

(一) 总死亡率

73—78年锦州郊区人群总死亡率为458.17/十万。73—75年人群总死亡率为396.61/十万,76—78年人群总死亡率为497.33/十万。由73至78平均每年递增0.5/千。

(二) 恶性肿瘤死亡率

73—78年全区恶性肿瘤死亡率为65.46/十万，调整死亡率为36.55/十万。占同时期各种死因的第三位。同时期全区非癌死亡率为385.12/十万，在其它死因中，各种心血管病死亡率670.2/十万，占各种死因第一位。脑血管病死亡率72.62/十万，占各种死因第二位。呼吸系统病死亡率63.48/十万占各种死因第四位。

73—78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29.52%，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

	全区 合计	中屯	女儿河	西郊	大薛	北郊	泉村
73—78年 总死亡率 (1/万)	407.34	518.58	530.96	355.76			
	504.42	496.87	421.95				
70—78年 恶性肿瘤死亡率 (1/十万)	51.42	59.35	47.86	42.93	57.03		

73-78年全 65.20 73.31 74.40 56.68 61.90 48.98 57.15
 区恶性肿瘤死
 亡率 (1/十万)

73-78年肿瘤 61.45 68.03 68.79 54.33 57.51 45.93 47.46
 调查死亡率
 (1/十万)

I 女儿河地区

女儿河地区 (包括郊区汤河子街道) 位于锦州郊区西部, 全地区人
 口 3.8 万。锦州铁合金厂位于该区。

73-78年该地区恶性肿瘤死亡率为 74.40/十万, 调整
 死亡率为 58.78/十万。略高于全区平均水平, 也高于辽宁省
 73-78年恶性肿瘤死亡率的平均水平(3)

把该地区70年以来各年人群死亡资料按生产队和自然村屯为
 单位进行统计, 然后归纳整理可以看出 (见表2图1)。

表2 70-78年女儿河、西郊 (部分) 公社恶性肿瘤死亡率

地段	恶性肿瘤		肺癌死 亡率 (1/十万)	胃癌死 亡率 (1/十万)	食管癌 死亡率 (1/十万)	30岁 以上非 患癌平 均死亡 率 (岁)
	死亡率 (1/十万)	调整 死亡率 (1/十万)				
I	83.28	71.32	21.37	18.07	58.43	65.57
II	96.87	81.78	8.80	23.41	62.90	68.45
III	88.68	71.81	7.62	30.48	64.84	68.36
IV	68.42	61.27	18.97	28.62	58.59	68.32
V	68.38	63.62	13.17	35.71	63.78	72.51
VI	73.42	71.89	14.99	NA	52.62	64.72
VII	89.30	82.06	NA	55.17	67.55	75.00

Ⅲ 81, 27 76, 80 21, 30 36, 50 60, 33 71, 77

Ⅳ 86, 87 91, 12 20, 78 27, 68 59, 69 69, 74

〔※地段 I, 汤河子街道, I, 北汤河子大队, 前、西、后汤河子大队, II, 大洼、姜屯、华山、陈家沟、王胡台、王胡沟大队, IV, 腰汤河子大队, V, 金厂堡大队, VI 女儿河大队, VII, 十里台, VIII, 杨兴, IX, 温家屯。(地理位置参见图1)〕

(1). 恶性肿瘤死亡率以铁合金厂所在地的汤河子街道为中心, 形成一个高癌死亡率地区。汤河子街道略低于外围。然后向北部过渡, 死亡率逐步下降。汤河子街道恶性肿瘤死亡率在70—79/十万之间, 其外围达80/十万以上, 然后逐降至70/十万以下。

(2). 中心点(汤河子街道)肺癌死亡专率最高, 超过20/十万, (全郊区肺癌死亡专率仅为11.21/十万); 然后随着向北部过渡, 肺癌死亡专率逐步下降。胃癌死亡专率又以中心点最低, 然后向北部及周围逐步上升。

(3). 总癌人口平均死亡年龄, 以中心部份为最低(58岁)。在向周围过渡过程中又逐步上升。尤以向北部地区过渡最为明显, 分别相差5—7年。

(4). 以汤河子街道为中心, 向东经过女儿河大队引伸至西郊公社的三个大队(十里台、杨兴、温屯) 出现一个狭长的低死亡率地区。

2. 中屯地区

中屯地区(公社)位于锦州郊区北部。北部靠山, 南部小沙河。全地区人口1.5万。石油六厂位于该区东南端。70—72年以来恶性肿瘤死亡率有逐年上升之势, 70—72年为52.03/十万, 而73—78年为73.31/十万。

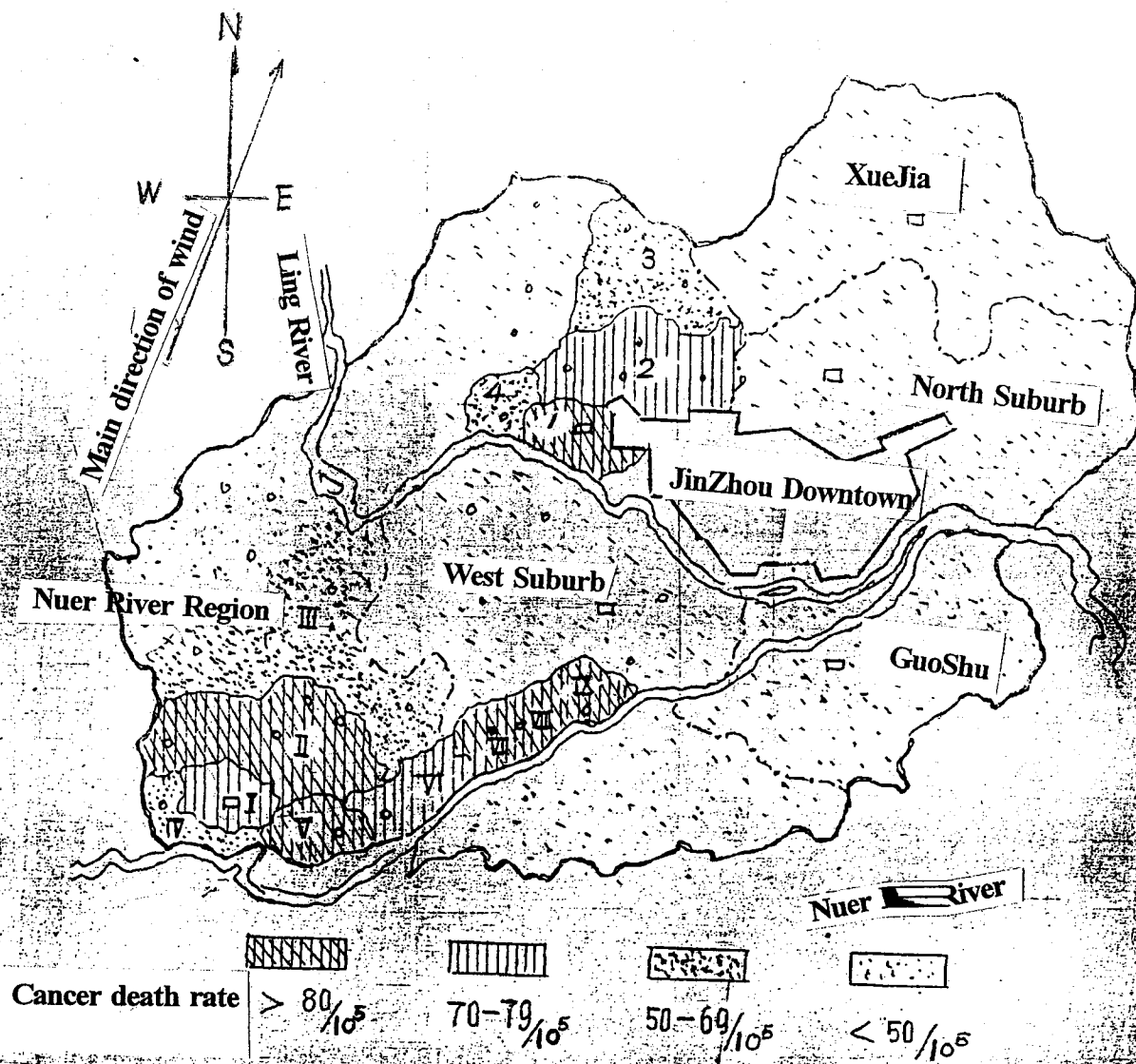


Figure 1: Distribution of death rate due to malignant neoplasm

把该地区70年以来各年人群死亡资料按生产队和自然村屯为単位统计整理之后, 可以看到(见表3、图1),

(1)、与石油六厂最近的中屯大队恶性肿瘤死亡率为最高, 达96.46/十万。成为该地区高死亡率的中心。然后向北部地区逐步过渡, 死亡率逐步降。该地区的西、西北部恶性肿瘤死亡率最低。

表3 70—78年中屯地区人群死亡率比较

地段	恶性肿瘤死亡率(1/十万)	肺癌死亡率(1/十万)	胃癌死亡率(1/十万)	非癌死亡率(1/十万)	呼吸系统疾病死亡率(1/十万)	总死亡率(1/十万)
1.	96.46	21.87	21.87	467.76	73.71	57.17
2.	73.28	3.01	24.09	349.98	92.17	62.03
3.	59.63	16.32	16.32	203.16	70.14	60.33
4.	46.26	17.35	5.78	581.59	142.55	52.29
5.	35.82	4.48	17.91	260.42	72.76	55.75

(※地段, 1中屯大队, 2幸福胜利, 士英、五姓大队, 3何屯、帽山大队, 4、罗台子大队, 5、二郎洞、四方台、沙河堡、侯屯大队。

(地理位置参见图1)]

(2)、肺癌死亡专率由中心点向周围地段逐步下降。胃癌死亡率也有外围地段高于中心的趋势。

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

三、讨论

(一)、从锦州郊区70—78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5.07、5.4/十万, 恶性肿瘤死亡率66.46/十万, 肺癌死亡率66.35/十万。这在省内并非为最高。

均在73—75年辽宁省恶性肿瘤年平均死亡率水平以下⁽¹⁾。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—75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之内,又明显地存在着各自的恶性肿瘤的高发点。高发点与其附近的地区又保持一个具有特点的变动过程。高发点的出现,又与其固有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镇(汤河子街道)。全镇人口1.5万。虽然恶性肿瘤死亡率并非为全地区的最高点,但肺癌死亡率却为该地区的最高地点。总恶性肿瘤死者的平均死亡年令也是全地区的最低点。由此往北,被一个恶性肿瘤死亡率为80/十万左右的地段包围。这一地段恶性肿瘤死亡率虽然较汤河子街道为高,但肺癌死亡专率又明显地低于汤河子街道。总癌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专率则更加降低,总癌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,明显的存在着较强的致癌因素,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推迟。但是,在两者之间的中间地段的恶性肿瘤死亡率的提高,以及肺癌死亡专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与锦州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、杨兴到温家屯的整个地段里，恶性肿瘤死亡率却处在该地区的较低水平上。肺癌死亡专率也都分别处在同地区的高水平上。看不到明显的地区转移与死亡率之间的变化。已经知道这一狭长地段是锦州铁合金厂三工段废水对地下水的污染地区，主要污染物是六价铬。⁽¹⁾ 虽然在七十年代初期在这一地段相继为全体居民安装了自来水，但已经查明这一地段种植的蔬菜中总铬含量都超过对照地区5—10倍。⁽²⁾ 说明该地居民每日餐时都在接触大量的金属盐类。因此该地区恶性肿瘤死亡率升高的真正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农业地区，居民以农业为主。总死亡率和恶性肿瘤死亡率的地区分布也同样存在着地段间的过渡变化。以石油六厂所在地段——中屯为中心，形成了一个恶性肿瘤的高发区，死亡率达92、40/十万，肺癌死亡专率达29、37/十万。以后恶性肿瘤死亡率，肺癌死亡专率也是向北偏东方向逐步降低。平均死亡年龄则也以中心地段为最低，并随肿瘤死亡率的降低而逐渐升高。

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环境污染，那么也存在着与锦州常年主风向相一致的死亡率逐步扩散和下降的过程。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，已经有大量的研究证实为相关，指出恶性肿瘤病人中的80%，为环境污染所致。我们从锦州郊区20—78年的人群死因分析中似乎也看到在女儿河、中屯两地区恶性肿瘤的死亡率变化，在地理位置上与环境污染似有联系。

锦州铁合金厂位于汤河子的东南角。在该区内除铁合金厂外，
还有造纸、纺织及一些小型社队工业，这些工厂目前尚未发现有明显
的致癌物质排出。而铁合金厂则是以钒、铬、钛、锆等有色金属
冶炼为主，长期以来通过废气、废水、废渣向外扩散多种污染物。
其中钒的污染能够引起癌症，已有报导^(5,6)。其它物质的致癌作用尚有待研究。锦州石油六厂是生产燃料油和其它石油化工产品的工厂，
废气、废水中的污染物不论在种类、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
染是毋庸置疑的。上述两厂环境污染的种类、数量、污染范围和污
染物对人群死亡，特别是恶性肿瘤死亡的影响，以及污染物的致癌
作用，有待在本文第二、三分题中进一步探讨。

(三)、死因回顾性调查在探讨环境污染对人体健康影响时，
确是一项极为重要的方法，和必要的前提。但是在做人群死亡率分
析时，似应以最小的人群为单位进行长时期的观察，结合地理环境
特点探讨环境因素的作用。同时也应注意选用适当的指标，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因的影
响。

四、小结

本文报告了锦州郊区70—78年人群死亡资料，并结合局部
地理环境对人群死因提出分析。认为在锦州郊区九年来的人群死因
中，环境因素的作用是值得重视的；它在人群总死亡率和恶性肿瘤
死亡率以及癌症者的平均死亡年龄方面都有着值得进一步探讨的连
系。

(16)

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。认为小单位的长时期的死亡率统计并结合局部地区环境的分析，对探讨环境对人体健康的影响是有益的。

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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^(c). 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

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

* All rate is in $1/10^5$.

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 $74.40/10^5$, adjusted death rate was $68.79/10^5$. 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

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

(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^(d)) 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

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

(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

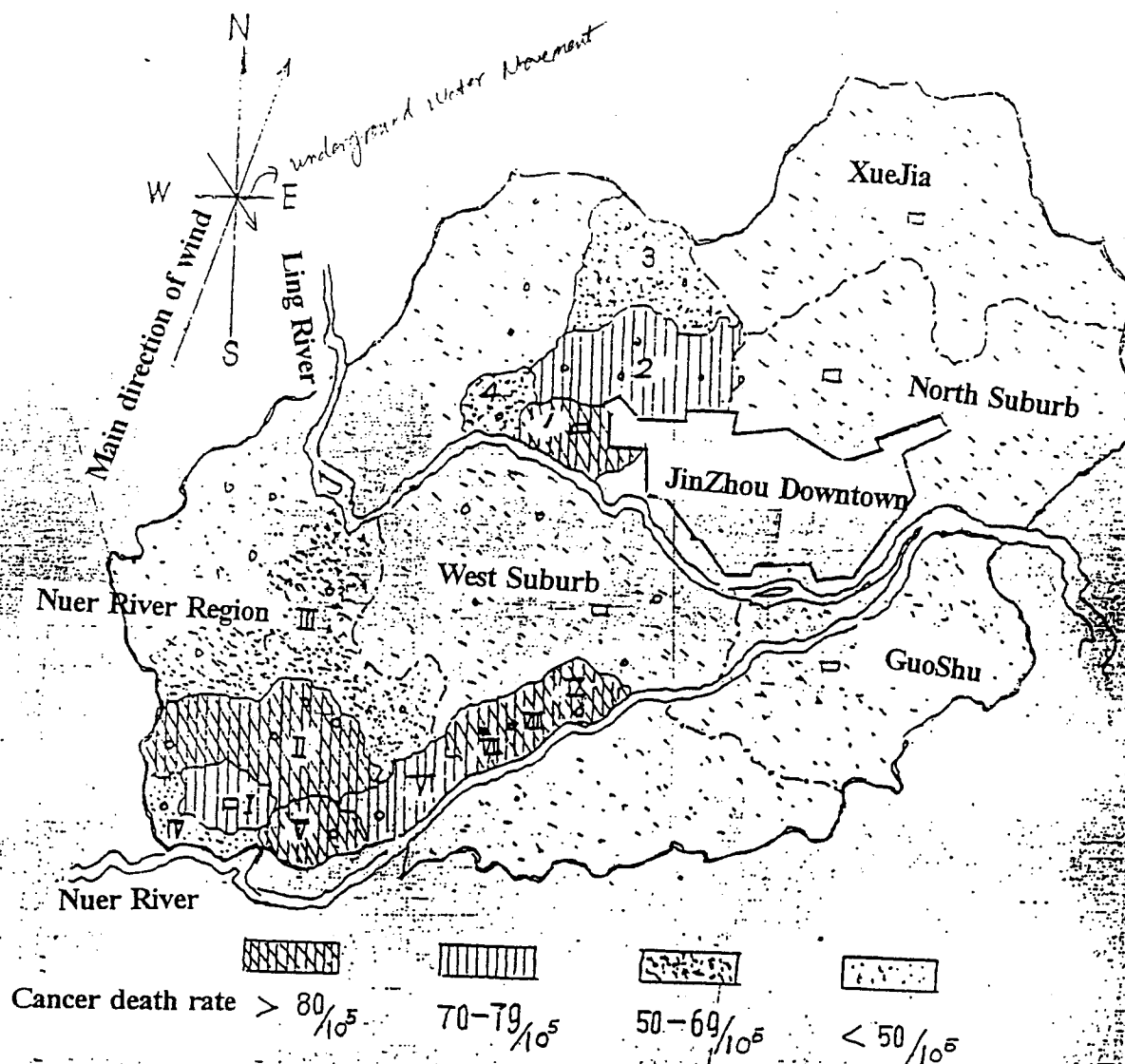


Figure 1: Distribution of death rate due to malignant neoplasm

(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)

(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 shortened. 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 water 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.

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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 $4.95/10^5$. For the Nuer village, the population was 15,000, the standard deviation was $7.87/10^5$. 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 10^5 '. 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 north east.

(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.