

# 山西省地方性砷中毒病區居民砷攝入水平和期望壽命的估計

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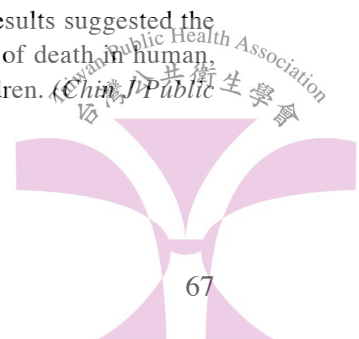
**目標：**爲了了解無機砷攝入與死亡率之相關性，作者對山西省高砷地區縣的某高砷村及與其相鄰的非高砷村進行流行病學調查。**方法：**透過標準化訪視，調查當地居民詳細的居住史、飲水史，計算死者累積砷暴露量並推估期望壽命。**結果：**調查結果發現兩個村除飲水砷含量不同外，具有類似的社會經濟狀況、生活環境、生活方式、飲食習慣和衛生服務設施。40及40歲以上的人群經年齡別調整後，生活在高砷環境中的人群死亡率爲24.9‰，非高砷環境中的人群死亡率爲12.22‰，死亡率的相對危險度(RR)爲2.04；平均壽命較非流行地區少約3-12年。無機砷攝入量，砷中毒流行率及死亡率在年齡分布上一致。**結論：**慢性砷暴露不僅可導致砷中毒，而且增加流行地區居民的死亡率，特別是從兒童時期就開始一直飲用高砷水的人群。(中華衛誌 1999；18(附冊 1)：67-72)

**關鍵詞：**砷、死亡率、期望壽命、供水。

## Estimate of life expectancy and ingested arsenic in hyperendemic area of Shan-Xi Province

**Objectives:** To examine the association between ingested inorganic arsenic and death rate, the authors studied in epidemiology methods in two near villages where one is high arsenic levels area the other is not. **Methods:** The cumulative arsenic exposure of death was calculated from the detailed history of residential addresses, drinking wells and duration of drinking artesian well water obtained through standardized interviews and the arsenic concentration in well water in order to estimate the life expectancy. **Results:** The two villages shared similar socioeconomic status, living environments, lifestyles, dietary patterns and health service facilities but arsenic contents of artesian well water. Residents who lived in hyperendemic village had death rate 24.9‰ and lived in non-endemic village had death rate 12.2‰ among the age of 40 and more than 40 after age-adjusted. The rate ratio was 2.04. The life expectancy was decreased about 3-12 years in endemic area than in no-endemic area. The levels of ingested inorganic arsenic, arseniasis prevalence and death rate were consistent in age distribution. **Conclusions:** These results suggested the chronic arsenic exposure not only lead to arseniasis but also increase the rate of death in human, especially in people who had been drinking arsenic water since they were children. (Chin J Public Health. (Taipei): 1999;18(suppl 1):67-72)

**Key words:** arsenic, death rate, life expectancy, water supply.



## INTRODUCTION

Arsenic in various compounds is distributed in nature throughout the earth's crust. In the environment, it is transported mainly by water. Generally, arsenic in rock is little. Accordingly, arsenic in deep well is microquantity. People usually ingested inorganic and organic arsenics from food little. Little arsenic in body is not only no-damage but also helpful for growth of some cell and tissue, stimulus for blood-cell's reproduction. Thus, drugs contains inorganic arsenic have been used for the treatment of leukemia, psoriasis and chronic bronchial asthma. Arsenic poisoning is mainly due to long-term arsenic exposing, such as workers in the processing of copper, gold, and lead ores, the use of arsenic in pigments and dyes, the production and use of agricultural pesticides, the manufacturing of glass and various pharmaceutical substances in addition to acute toxicity. Endemic arsenic poisoning was different with occupational exposing. Everybody who drinks high content arsenic can induce chronic poisoning.

Endemic arsenic area in Shan-Xi located in northern and central part. The area which arsenic concentration is over 0.05 mg/L (the standard for arsenic in drinking water set by the US Environmental Protection Agency is 0.05ppm) [1] covered 1,500 kilometer square, the people in the area has been estimated about 150,000. The people who drink arsenic water directly have been estimated about 20,000. Arsenic has been well-documented as one of the major risk factors for blackfoot disease, occurred on the southwest coast of Taiwan, a peripheral artery disease characterized by systematic atherosclerosis as well as by dry gangrene and spontaneous amputations of affected extremities [2,3]. It was observed significant dose-response relationships between the ingested arsenic level and mortality from between cancer of the liver, lung, bladder and kidney [4]. The chronic arsenic exposure

may induce diabetes mellitus in human [5].

In Chinese continent, the plaque of colored or discolored on the trunk, armpits and inguen, palms and soles over-keratinization and rhagades were major symptoms.

People's mortality rate from cancer was not only significant, but the mortality rate from other disease among the arsenic drinking villagers is getting higher and higher than that among the non-arsenic drinking villagers recently. The purpose of the present study was to elucidate the effect of arsenic on people life of the heaviest prevalence area in Shan-Xi Province.

## MATERIALS AND METHODS

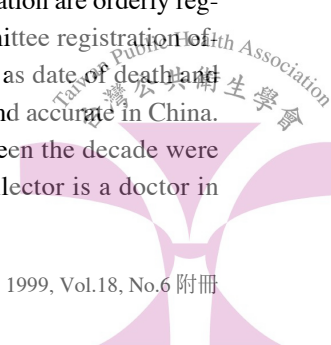
### Study area and subjects

The study area included two villages, one is Da Ying in the Shan Ying County, which located on the north of Shan Xi, the other is Li Jia Yao, in the same county with the DaYing. Residents in the two villages have drunk water from artesian wells as deep as 20-80 meter since the 1960's. They shared similar socio-economic status, living environments lifestyles, dietary patterns and health service facilities. The major difference in environmental exposure among residents was arsenic concentration of the artesian well water. In Da Ying village, the level of arsenic in water ranged from 0.05-4.435 mg/L, the arithmetic mean was 0.553 mg/L. Li Jia Yao only has one artesian well without detectable arsenic.

Study subjects included each death resident between 1986.1.1-1997.1.1 in the two villages.

### Date collection

In China county, any events of birth, death, marriage, divorce and migration are orderly registered in the village committee registration office. Date for records such as date of death and birth are quite completed and accurate in China. The names of deaths between the decade were listed one by one. One collector is a doctor in



the Second People Hospital of Shan-Xi Province since graduated from Shan-Xi medical university in 1957 and the other is a public health doctor in anti-epidemic station of Shan-Xi province since graduated from Shan-Xi medical university in 1986. The information on the socio-demographic characteristics, occupational exposure to arsenic, history of residential villages and water consumption lifestyles, including cigarette smoking and alcohol drinking habits, history of dietary consumption frequency, and personal and familial history of diseases were obtained through each study subject's friends or relations.

### Accumulate of arsenic in death

In prevalence area, the shallow water tastes bit and salt but non-detectable arsenic content. Water is supplied to dry field mainly depending on raining, the soil contains more salt and alkali than common does. The arsenic content in soil is 8.0 mg/L (the arithmetic mean in Shan-Xi is 8.4 mg/L, rang from 4.0-15.6 mg/L [6] and major agriculture production such as corn contain arsenic 0.37 mg/kg. So arsenic in subjects mainly come from water. Supposing an adult drinks 2L everyday, the total arsenic ingested can accumulate as following:

$$A=2 \times 365 \times \sum C_i D_j$$

The total elimination from urine was about:

$$B=2 \times 365 \times \sum C_i D_j$$

A: the total arsenic ingested (mg)

C: arsenic content of drinking water (mg/L)

D: the time of drinking the water (year)

n: average urine arsenic content of Da-Ying villagers (0.492 mg/L, according to our previous studies in 1994) [7]

w: average water arsenic content of Da-Ying villagers (0.552 mg/L, according to our previous studies in 1994) [7]

### Date analysis and statistical method

The expectancy life of Shan-Ying county

calculated according to the date of population-detection survey in 1990. The average population of Da-Ying and Li Jia Yao during the decade based on the date of 1991's. The total numbers of all age-periods were accumulated by person year.

## RESULT

There were 74 men and 60 women 40 and more than 40 year-old residents participated in Da-Ying, and 101 men and 90 women in Li Jia Yao. The age groups of 40 to 49, 50 to 59, 60 to 69, and more than 70 years were 41, 39, 36, 18 in Da-Ying and 56, 53, 45, 37 in Li Jia Yao, respectively. Most residents had lived in study areas for 30 years. They were mainly employed in the farming.

The age-specific death rate is shown in Fig. 1. The death rate increased with age both in Da-Ying and Li Jia Yao, but significantly higher in Da-Ying (24.9, 95% confidence interval 24.6-25.4) than in Li Jia Yao (12.2, 95 % confidence interval 11.2-13.2). The RR for 40-, 50-, 60-, 70- was 4.86, 4.10, 1.88, 1.10 respectively. The people below 40 have no one death in both villages, so we supposed the death rate below 40 was consistent with the age of county's. The number belong to the lower ages was not big enough to have one death. In this study, only the death rates in the age groups 40-49, 50-59, 60-69 and +70 were compared.

The age-specific prevalence of arseniasis is shown in Fig. 2. We can see the highest age range of death rate was behind that of the arseniasis prevalence about one age group.

The expectancy life of the people below 40 was expressed with point in Fig. 3. As Fig. 3. shows, the average expectancy life of Da-Ying was 12 years less than Li Jia Yao, and 5 years less than Shan-Ying. The difference of life expectancy between the arseniasis hyperendemic and non-endemic area was decreasing gradually

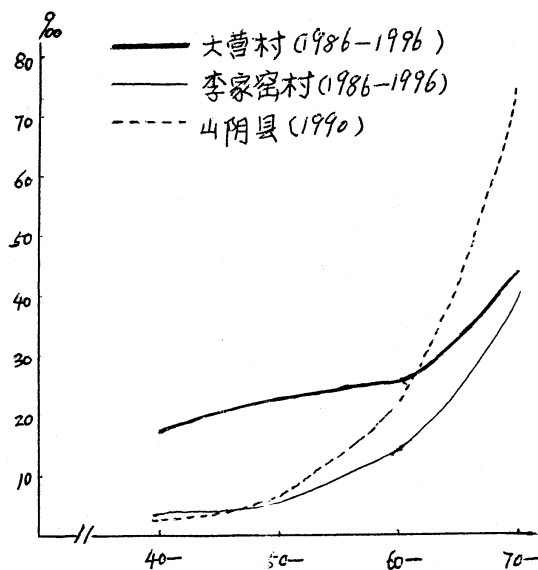


Fig. 1. The age-specific death rate

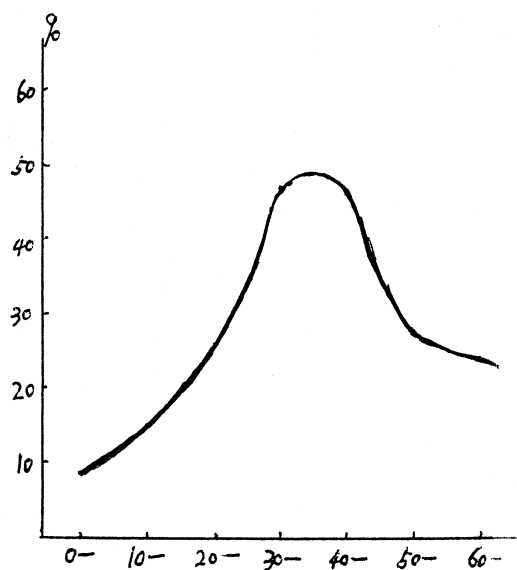


Fig. 2. The age-specific prevalence of arseniasis

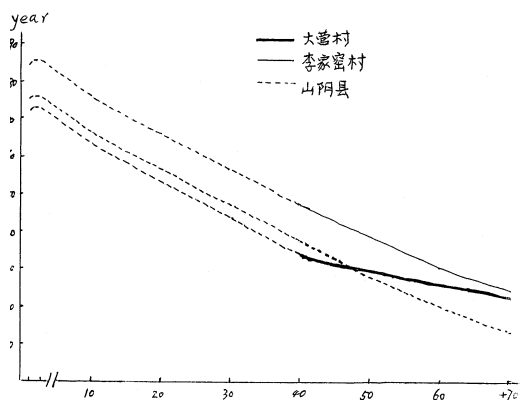


Fig. 3. Show the expect life of different age-period residents in study villages

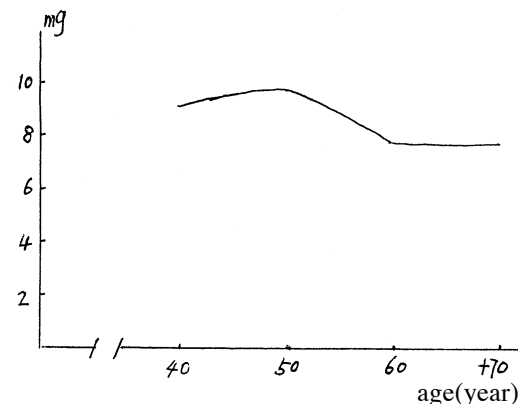


Fig. 4.

after 50 and more than 50 age ranges.

The beginning of drinking arsenic water was in 1960. The death who lived in hyperendemic area had been drunk arsenic water various from 24-34 years. The arithmetic mean was 29 years. The total of ingested arsenic was 3.54-11.10 g,  $q_{50}=8.68$  g. The remainder in the death body was estimated about 2.52-7.90 g. The relation between the age and ingested quantity shows as Fig. 4.

The distribution of various reasons of death

was shown in Table 2.

## DISCUSSION

In the study, residents who lived in hyperendemic village had  $RR=2.04$  among the age of 40 and more than 40 after age-adjusted death rate compared with residents in non-detectable arsenic village. The death rate of the age and more than age of 70 in endemic area was getting lower than all county's, and similar to non-endemic

Table 1. Age-specific and death rate distribution among the residents more than 40 years old in study areas during 1986-1996.

Age Y	Da-Ying			Li Jia Yao			RR
	person-year No.	death No.	rate of death ‰	person-year No.	death No.	rate of death ‰	
40-49	410	7	17.00	560	2	3.5	4.86
50-59	390	9	23.00	530	3	5.6	4.10
60-69	360	9	25.00	450	6	13.3	1.88
≥70	180	8	44.44	370	15	40.5	1.10
Age-adjusted death*			24.90			12.2	2.04
95% confidence interval			24.60-25.4			11.2-13.2	

\*age-adjusted to 1990 Shan-Ying county

Table 2. Proportion dying of a specific cause.

Specific cause	Da Ying		Li Jia Yao	
	proportion(%)	order	proportion(%)	order
Respiratory system	9.38	4	23.08	1
Urinary system	12.50	3	0	0
Digestive system	3.13	6	3.85	4
Cerebrovascular	15.63	2	11.54	2
Cardiovascular	6.25	5	3.85	4
Cancer	37.50	1	7.69	3
Unclear	15.63		50.00	

area's. The reason may be due to the different metabolism level while they drank arsenic water, and/or the age when they began drinking it. The level of ingested inorganic arsenic and death rate showed as Fig. 1. and Fig. 4. were consistent in age distribution and the arseniasis prevalence was one age group before them.

These results suggest the chronic arsenic exposure not only lead to arseniasis prevalence but also increase the rate of death in human, especially in people who had been drinking arsenic water since they were children.

The life expectancy was decrease about 3 years compared with all county's and about 12 years compared with Da-Ying village's as the death rate increased. Soluble forms of arsenic are eliminated about 89 percent from urine.

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