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Geographical Variation in Cancers in Korea

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우리 나라 주요 암의 지역적 분포 현황

김 요 은*

Abstract : This study investigated geographical variations in cancer in Korea using cancer rates as percentages of total cancers by regions for 6 big cities and 8 provinces based on the Annual Report of Cancer Registry Programme(Ministry of Health and Welfare, 1996). Basic rates by regions for 7 major cancers(cancers of the stomach, the colon, the rectum, the colon and rectum, the liver, the lung and the breast) and all cancers were calculated for the analysis of geographical distribution patterns for incidence of major cancers in Korea. Such data were then combined with geographical data through ARC/INFO. The study used some of the mapping capabilities of a GIS(Geographic Information Systems). The relative risk of stomach cancer seemed to be associated with the level of health care services. Southern parts of Korea had high risk of liver cancer. There may be a relationship between cancer of the liver and liver fluke due to eating raw fish. Considering relative risk of lung cancer within each region as compared with total cancers the biggest, the second and the third biggest cities had low risk of the disease. In contrast, rural areas showed high risk of lung cancer. This might be related to cigarette smoking. Smoking rates in rural areas in Korea are higher than those in urban areas. For breast cancer Westernised urban areas showed very high risk in Korea whereas rural areas had low risk. This may imply a relationship between Westernised diet and risk of carcinoma of the breast. Risk of colo-rectal cancer in rural areas was high considering a proportion of all cancers. This may be associated with the effects of age.

Key words : Cancer, Geographical variation, GIS, Relative risk, Urban/rural areas

요약 : 본 연구는 전국 6개 광역시 및 각 도별로 우리 나라 주요 암의 지역적 분포 현황을 살펴보고 그러한 지역차의 원인을 규명해 보고자 한다. 전국 시 도별 암 등록 현황 자료를 토대로 위암, 직장·결장암, 간암, 폐암과 유방암의 전체 암에 대한 시 도별 상대적 위험도를 분석하여 지리정보체계(GIS)를 이용한 지도화를 근간으로 분석하였다. 위암의 경우 위암 발생의 상대적 위험도는 해당 지역 병원이 부담해야 하는 인구수와 관련성이 있는 것으로 보여졌다. 또한, 폐암의 경우도 대도시지역이 상대적으로 낮은 발병율을 보였으며, 농촌지역은 폐암의 고위험지역으로 나타났다. 이러한 폐암 환자의 분포 현황은 도시 지역에 비해서 농촌 지역의 흡연율이 높은 것과 밀접한 관련성이 있는 것으로 보인다. 직장·결장암의 상대적인 위험도도 도시지역보다는 농촌지역에서 높았다. 이러한 분포 패턴은 농촌지역의 노령화 현상과 관계가 있는 것으로 보인다. 그렇지만, 유방암의 경우 농촌지역보다 대도시지역에서 높은 발암율을 보였다. 이것은 유방암 발생이 식생활을 포함하는 서구화된 생활방식과 관련성이 있음을 시사해 주는 것이다. 간암은 부산, 경남 및 전남 지역에서 높은 환자 빈도를 나타냈다. 특히, 이 해안지역에서의 간암의 상대적으로 높은 위험성은 '회'의 섭취로 인한 감염성 질환과 관련이 있는 것으로 보인다.

주요어 : 암, 지리적(지역적) 차이, 지리정보체계, 상대적 위험(도), 도시/농촌 지역

1. Introduction

According to the Annual Statistical Report on the Causes of Deaths, cancers account for the highest proportion of deaths(21.3%) of all deaths in Korea(Table 1), exceeding heart disease and stroke. It is therefore important to understand why this might be the case.

Moreover, some authors(Cynn *et al.*, 1993) point out that the incidence rates of cancers in Korea are increasing, partly because of increasing average life expectancy, adoption of a more Westernised diet

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Table 1. Mortality in Korea(1994)

Ranking(total)	Disease	Ranking(males)	Ranking(females)
1	Cancers	1	2
2	Cerebral blood vessel disease	3	1
3	Accident	2	4
4	Heart disease	4	3
5	Hepatitis/Liver cirrhosis	5	5

Source: National Statistical Bureau, 1995.

and preference of a single life, late marriage and evasion of pregnancy that in particular, can increase risk of breast or colon cancer since such women with fewer children show higher risk of cancers of the breast and the colon than married women with more children(Fraumeni *et al.*, 1969; Kim and Moon, 1996; Weiss *et al.*, 1981; Yoo and Ahn, 1992).

Hence, this study aims to explore Korean cancer research using some of the mapping capabilities of a GIS(Geographic Information Systems). For this Korean-based research registered cases of all cancers and major cancers such as cancers of the stomach, the liver, the lung, the breast, the colon and the rectum are used. The present study explores the regional distribution patterns for cancers in Korea, in order to find out which factors may cause such regional variations. Furthermore, this study hopes that laying the groundwork for a fuller aetiological study can contribute o improve health in Korea. This research migh' also suggest a direction to medical geography/medical research in Korea in the future, which is a currently under-developed field.

2. Materials and methods

Registered rates of cancers and cancer rates as percentages of total cancers by regions for 6 big cities and 8 provinces were based on the Annual Report of Cancer Registry Programme in the Republic of Korea(Ministry of Health and Welfare, 1996). Population data were obtained from the Statistical Yearbook by Regions(National Statistical Bureau, 1995) and the Seoul Statistical Yearbook (Seoul Metropolitan Government, 1994). Basic frequencies and rates by regions for 7 major cancers(cancers of the stomach, the colon, the rectum, the colon and rectum, the liver, the lung and the breast) and all cancers were calculated. Such data were then combined with geographical data through ARC/INFO, a proprietary GIS(Geographic Information System). Microsoft Excel and ARC/INFO are used to compile basic statistics and for the analysis of geographical distribution patterns for incidence of major cancers in Korea.

3. Results

Registered rates of major cancers and a percentage of each cancer compared with total cancers in Korea were analysed. The results from the analysis are as follows.

1) Cancers in Korea

Seoul shows the highest percentage of all cancers(Table 2 and Figure 1). Seoul has 34 percent of the 148 registered hospitals and 24 percent of total population in Korea(Table 3). The proportion of cancer patients in Seoul is much higher in comparison with the distribution of population and that of hospitals(Tables 2 and 3). The reasons could be as follows. Firstly, Seoul has comparatively more large-scale hospitals than other cities or provinces. In addition, most people prefer to go to general hospitals in Seoul because it is believed that the best doctors, and hospitals with up-to-date medical equipment, are in Seoul. Hence, Seoul has quite a few cancer patients from other cities or provinces and shows higher incidence rates. Pusan and Daegu also belong to the second highest category. Most big cities have more large-scale hospitals with

Table 2. Registered proportions of major cancers in Korea(1994)

(unit : %)

Region	Stomach	Colon	Rectum	Colon-rectum	Liver	Lung	Breast	All
Seoul	50.26	52.75	51.86	52.27	52.64	49.17	59.48	53.09
Pusan	13.02	11.26	11.74	11.52	16.35	12.54	12.28	12.73
Daegu	9.34	8.78	8.25	8.49	8.85	10.30	8.29	9.71
Daejeon	4.54	4.03	5.60	4.87	3.56	4.08	3.18	3.60
Incheon	1.90	2.13	1.53	1.81	1.05	1.35	1.50	1.40
Gwangju	3.63	3.86	3.80	3.82	3.82	4.33	3.09	3.67
Gyunggi-do	3.17	3.55	3.15	3.33	3.32	2.79	3.15	3.08
Kangwon-do	2.48	2.22	2.45	2.34	2.57	2.66	1.53	2.56
Choongchung book-do	0.89	0.71	1.07	0.90	0.70	0.94	0.65	0.86
Choongchung nam-do	1.63	1.95	1.61	1.77	0.63	1.58	0.75	1.23
Jeollabook-do	4.10	3.55	4.45	4.03	1.55	4.65	2.87	3.65
Jeollanam-do	0.34	0.44	0.31	0.37	0.31	0.44	0.25	0.27
Gyungsang book-do	1.96	2.26	1.57	1.89	1.73	1.81	1.47	1.62
Gyungsang nam-do	2.73	2.53	2.61	2.57	2.93	3.36	1.53	2.53
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: Ministry of Health and Welfare, 1996.

better facilities than other regions. However, Incheon, one of the larger cities shows a low registered rate. The reason is in fact, Incheon is part of Seoul' s catchment area. Hence, many patients living in Incheon can easily utilise health services in Seoul, especially for serious diseases like cancers.

Table 3. Rates of registered hospitals and population and GRDP per capita in Korea(1994)

Region	No. of hospital	Hospital (%)	Population (thousand)	Population (%)	Population per hospital	GRDP per capita(won)
Seoul	50	33.78	10,727	24.42	214,540	7,160,076
Pusan	16	10.81	3,796	8.64	237,250	5,504,478
Daegu	9	6.08	2,247	5.11	249,667	5,244,209
Daejeon	4	2.70	1,153	2.62	288,250	6,004,520
Incheon	7	4.73	2,117	4.82	302,429	6,961,778
Gwangju	7	4.73	1,214	2.76	173,429	5,720,287
Gyunggi-do	12	8.11	7,280	16.57	606,667	6,854,659
Kangwon-do	8	5.41	1,449	3.30	181,125	5,635,305
Choongchung book-do	5	3.38	1,373	3.13	274,600	7,220,397
Choongchung nam-do	3	2.03	1,877	4.27	625,667	6,674,687
Jeollabook-do	5	3.38	1,917	4.36	383,400	5,811,314
Jeollanam-do	3	2.03	2,246	5.11	748,667	7,056,106
Gyungsangbook-do	8	5.41	2,750	6.26	343,750	7,590,504
Gyungsangnam-do	11	7.43	3,790	8.63	344,545	9,600,217
Total	148	100.00	43,936	100.00	296,865	6,892,914

Source: Ministry of Health and Welfare, 1996; National Statistical Bureau, 1995.
※ GRDP: Gross Regional Domestic Product

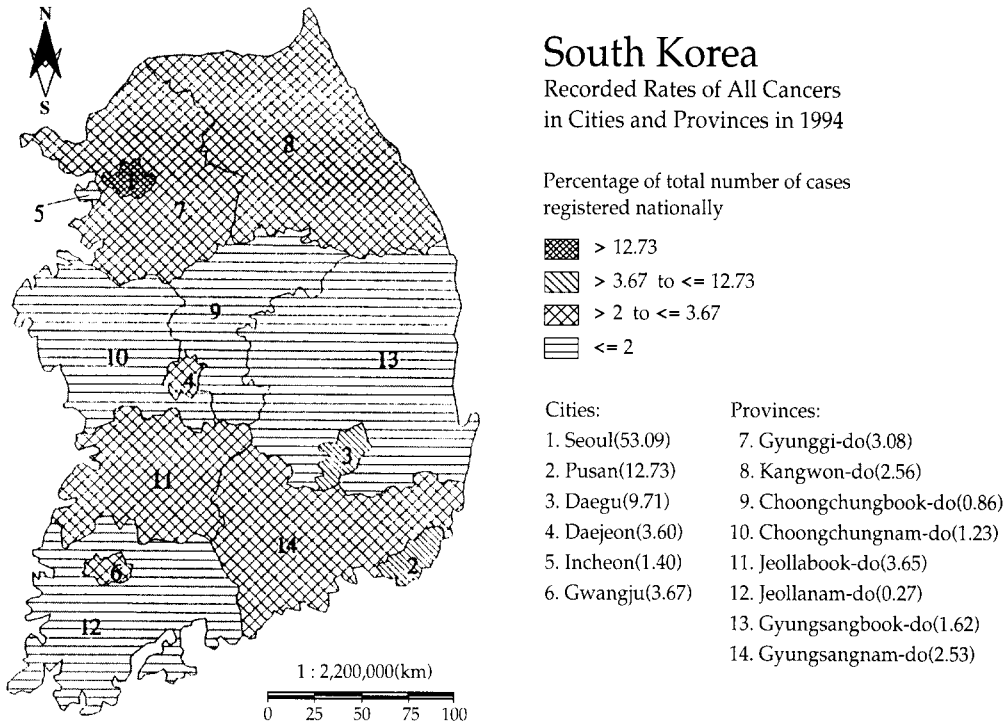


Figure 1. Recorded rates of all cancers in Korea

(1) Stomach cancer in Korea

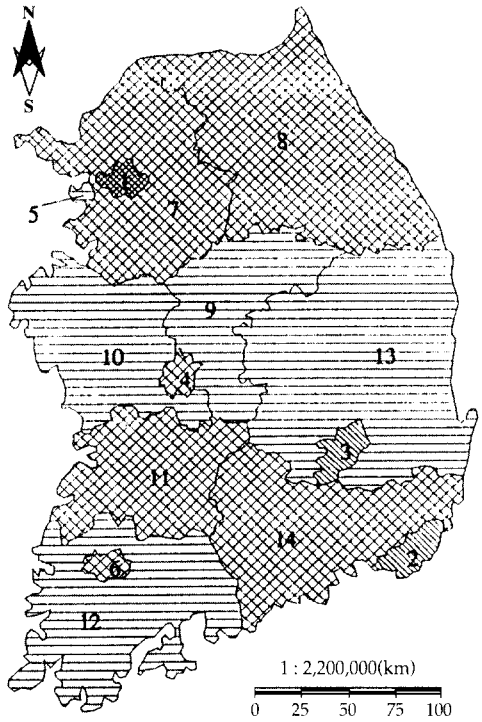
Attention now focuses on particular cancer sites. We begin with an examination of stomach cancer.

Considering recorded rates of stomach cancer, Seoul is the highest among whole regions, but the proportion of stomach cancers in Seoul is less than that for other cancers in the city(Tables 2 and 4, Figures 1, 2 and 3). This confirms that more modernised and advantaged regions have lower stomach cancer rates(Hirayama, 1986; Swerdlow and dos Santos Silva, 1993).

Stomach cancer is the most prevalent cancer in Korea and the age-standardised annual incidence of stomach cancer shows the highest rate in the world; 57.9 per 100,000 people for males and 25.1 per 100,000 people for females over the period 1986-87(Ahn *et al.*, 1991). The likely explanation is that consumption of salty food (Correa *et al.*, 1983; Haenszel *et al.*, 1972; Hirayama, 1986; Smans *et al.*, 1992) is a risk factor in Korea(Ahn, 1992; Maeng, 1993). In addition, cooking methods(especially broiling) are related to increased risk of stomach cancer(Ahn and Shin, 1995).

However, the mortality/incidence rate of gastric cancer has decreased since 1984 (Cynn *et al.*, 1993). This may be due to change of diet. In other words, whereas the intake of starch has decreased gradually, the intakes of animal protein and fat from animal have conspicuously increased recently(Cynn *et al.*, 1993). In contrast, however, change to a Westernised diet increases the risk of colo-rectal cancer. Furthermore, the growth in popularity of refrigerators has diminished the need for salt as a preservative. As a result, the risk of stomach cancer has reduced.

For stomach cancer as a percentage of total cancers(Figure 3), regions 10 and 12, relatively rural



South Korea

Recorded Rates of Stomach Cancer
in Cities and Provinces in 1994

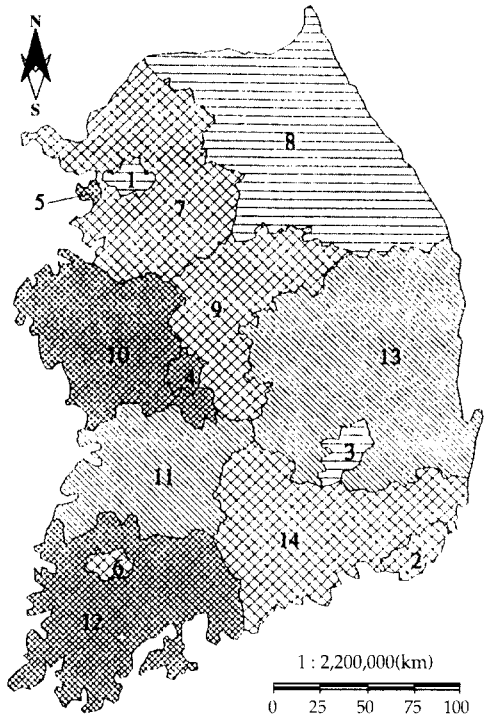
Percentage of total number of cases
registered nationally

- > 13.02
- > 4.54 to <= 13.02
- > 2 to <= 4.54
- <= 2

Cities:
1. Seoul(50.26)
2. Pusan(13.02)
3. Daegu(9.34)
4. Daejeon(4.54)
5. Incheon(1.90)
6. Gwangju(3.63)

Provinces:
7. Gyunggi-do(3.17)
8. Kangwon-do(2.48)
9. Choongchungbook-do(0.89)
10. Choongchungnam-do(1.63)
11. Jeollabook-do(4.10)
12. Jeollanamdo(0.34)
13. Gyungsangbook-do(1.96)
14. Gyungsangnam-do(2.73)

Figure 2. Recorded rates of stomach cancer in Korea



South Korea

Stomach Cancer as a Percentage of Total Cancers
Registered Within Each City/Provinces

Classes set manually

- < 20.69
- 20.69 - 23.73
- 23.74 - 26.78
- >= 26.79

(Mean=23.74%)

Cities:
1. Seoul(20.20)
2. Pusan(21.82)
3. Daegu(20.53)
4. Daejeon(26.93)
5. Incheon(29.02)
6. Gwangju(21.09)

Provinces:
7. Gyunggi-do(22.00)
8. Kangwon-do(20.68)
9. Choongchungbook-do(22.29)
10. Choongchungnam-do(28.21)
11. Jeollabook-do(23.93)
12. Jeollanam-do(26.99)
13. Gyungsangbook-do(25.73)
14. Gyungsangnam-do(22.97)

Figure 3. Stomach cancer as a percentage of total cancers in Korea

Table 4. Cancer rates as percentages of total cancers crelative risk in Korea(1994)

(unit : %)

Region	Stomach /total	Colon /total	Rectum /total	Colon-rectum /total	Liver /total	Lung /total	Breast /total
Seoul	20.20	3.66	4.15	7.81	10.83	10.62	5.86
Pusan	21.82	3.25	3.92	7.17	14.01	11.29	5.05
Daegu	20.53	3.33	3.61	6.94	9.95	12.16	4.47
Daejeon	26.93	4.13	6.62	10.74	10.79	13.01	4.62
Incheon	29.02	5.59	4.66	10.26	8.16	11.07	5.59
Gwangju	21.09	3.86	4.40	8.26	11.37	13.50	4.40
Gyunggi-do	22.00	4.24	4.35	8.59	11.77	10.39	5.36
Kangwon-do	20.68	3.19	4.08	7.28	10.98	11.93	3.13
Choongchungbook-do	22.29	3.05	5.33	8.38	8.95	12.57	4.00
Choongchungnam-do	28.21	5.83	5.56	11.39	5.56	14.70	3.18
Jeollabook-do	23.93	3.57	5.18	8.75	4.64	14.60	4.11
Jeollanam-do	26.99	6.13	4.91	11.04	12.88	19.02	4.91
Gyungsangbook-do	25.73	5.13	4.12	9.25	11.66	12.76	4.72
Gyungsangnam-do	22.97	3.67	4.38	8.04	12.61	15.19	3.15
Mean	23.74	4.19	4.37	8.85	10.30	13.06	4.47

Source: Ministry of Health and Welfare, 1996.

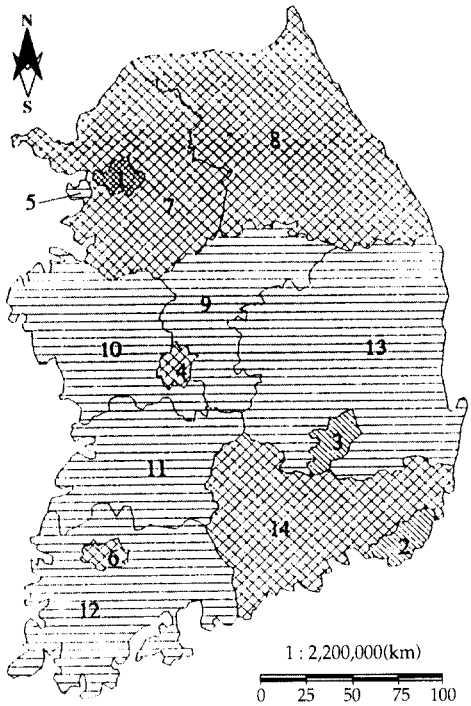
areas, show very high percentages. Region 4 is also in the highest category(Figure 3). It might be presumed that many patients with gastric cancer living in neighbouring areas go to hospitals in Daejeon(region 4). High percentages of total cancers for stomach cancer in regions 4, 5, 10 and 12 seem to be more related to population per hospital than the level of income (GRDP per capita; Table 3). Regions 4 and 5 showing high percentages for gastric cancer have a larger population per hospital than any other big cities. Low percentages for the disease in regions 6 and 8 are strongly associated with the level of health care services. In particular, the regional distribution of recorded rates of stomach cancer is similar to that of lung cancer(Figures 2 and 6). This may suggest that cigarette smoking is an important risk factor of stomach cancer as well as lung cancer(Lee *et al.*, 1995). Non-smokers in Japan also show a low risk of stomach cancer(Hirayama, 1975).

(2) Liver cancer in Korea

Even though region 1(Seoul) has the highest recorded rate of liver carcinoma(Table 2 and Figure 4) regions 2(Pusan), 12(Jeollanam-do) and 14(Gyungsangnam-do) also show very high risk of the disease according to the percentage of total cancers registered within each region(Table 4 and Figure 5). This regional pattern is likely to show an association between liver cancer and liver fluke infection. In particular, many people living in regions 2, 12 and 14 may like to consume raw freshwater-(non-salt water) fish at the junction of a river and the sea. Those who eat raw freshwater-fish are liable to be infested with liver fluke(Stitnimankarn, 1976, cited in Armstrong, 1986). Approximately 50 percent of patients with cancer of the liver in Thailand owe their disease to infection with liver fluke(Stitnimankarn, 1976, cited in Armstrong, 1986).

Over 70 percent of cases, hepatitis - mainly B virus - or cirrhosis of the liver (Polednak, 1989) leads to liver cancer in Korea(Jung and Lee, 1992; Maeng, 1993; Shin, 1995). In addition, frequent alcohol drinking, a past history of liver fluke infection, residence in rural areas and low socio-economic class are also important risk factors for liver cancer(Maeng, 1993).

In the future, however, the mortality from liver cancer may decrease because recently the result



South Korea

Recorded Rates of Liver Cancer
in Cities and Provinces in 1994

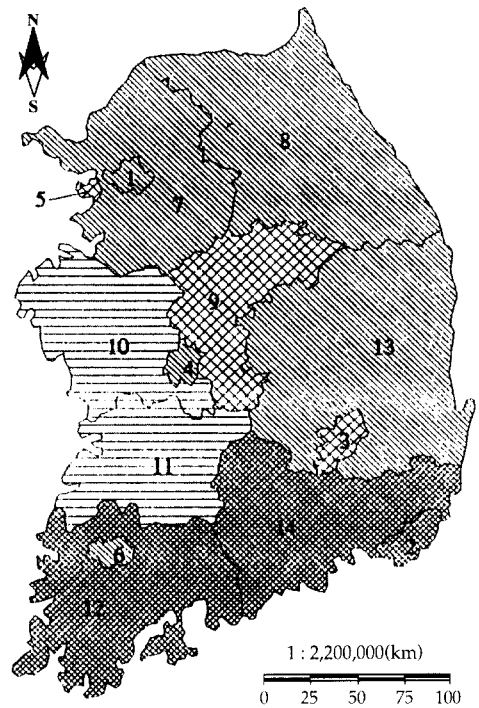
Percentage of total number of cases
registered nationally

- > 16.35
- > 3.82 to <= 16.35
- > 2 to <= 3.82
- <= 2

Cities:
1. Seoul(52.64)
2. Pusan(16.35)
3. Daegu(8.85)
4. Daejeon(3.56)
5. Incheon(1.05)
6. Gwangju(3.82)

Provinces:
7. Gyunggi-do(3.32)
8. Kangwon-do(2.57)
9. Choongchungbook-do(0.70)
10. Choongchungnam-do(0.63)
11. Jeollabook-do(1.55)
12. Jeollanam-do(0.31)
13. Gyungsangbook-do(1.73)
14. Gyungsangnam-do(2.93)

Figure 4. Recorded rates of liver cancer in Korea



South Korea

Liver Cancer as a Percentage of Total Cancers
Registered Within Each City/Provinces

Classes set manually

- < 8.16
- 8.16 - 10.29
- 10.30 - 12.60
- >= 12.61

(Mean=10.30%)

Cities:
1. Seoul(10.83)
2. Pusan(14.01)
3. Daegu(9.95)
4. Daejeon(10.79)
5. Incheon(8.16)
6. Gwangju(11.37)

Provinces:
7. Gyunggi-do(11.77)
8. Kangwon-do(10.98)
9. Choongchungbook-do(8.95)
10. Choongchungnam-do(5.56)
11. Jeollabook-do(4.64)
12. Jeollanam-do(12.88)
13. Gyungsangbook-do(11.66)
14. Gyungsangnam-do(12.61)

Figure 5. Liver cancer as a percentage of total cancers in Korea

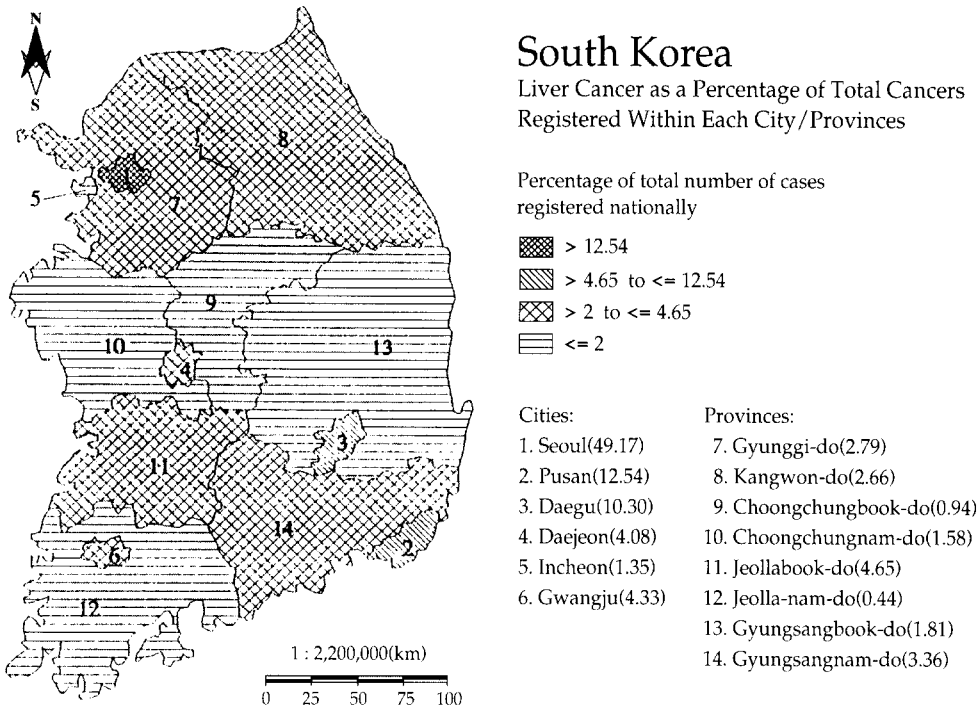


Figure 6. Recorded rates of lung cancer in Korea

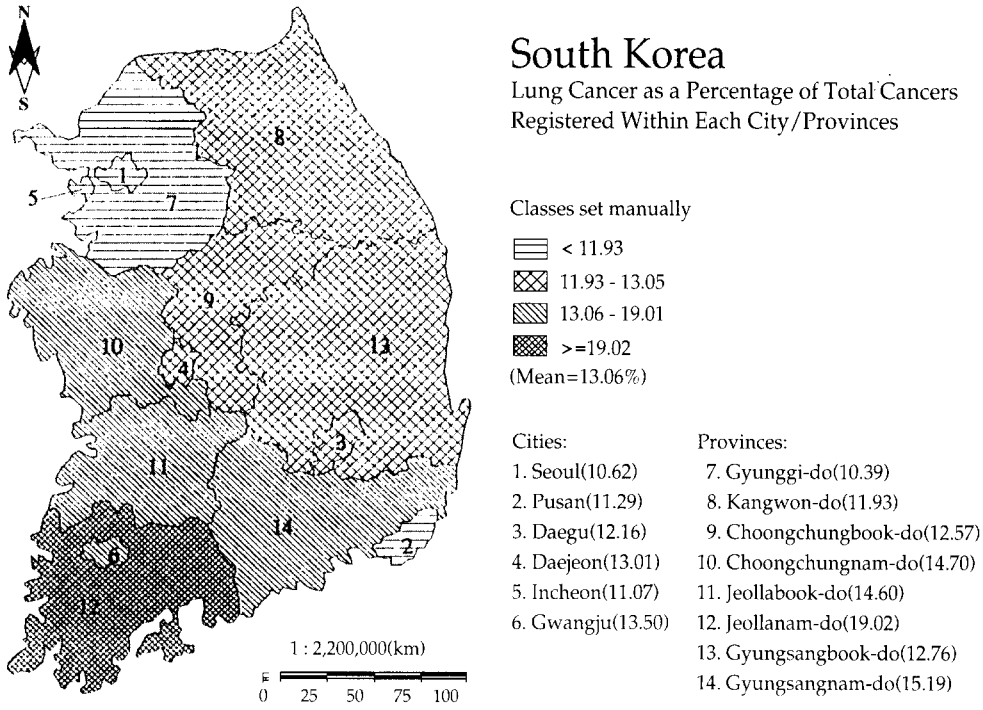


Figure 7. Lung cancer as a percentage of total cancers in Korea

from hepatitis B virus test for elementary, junior and senior high school students shows a low infection rate, under one percent(Seoul School Health Institute, 1996).

(3) Lung cancer in Korea

Regions 1(Seoul), 2(Pusan) and 3(Daegu) have very high registered rates for lung cancer(Table 2 and Figure 6), whereas those three biggest cities show a low risk considering lung cancer as a percentage of all cancers(Table 4 and Figure 7). In particular, however, region 12(Jeollanam-do), a comparatively traditional rural area, belongs to the highest risk group(Table 4 and Figure 7). Such a regional pattern can be explained as follows. For lung cancer, cigarette smoking is the most important risk factor(Maeng, 1993). Smoking rates in urban areas are lower than those in rural areas in Korea(Maeng, 1992). Furthermore, those who have been brought up in urban regions also have 25% reduced risk rate than those in rural regions for lung cancer in Korea(Maeng, 1993). Regretfully, however, this study can not make a direct connection between smoking rates by regions (6 big cities and 8 provinces) and the incidence rates of lung cancer by the regions since there are no data for smoking rates by the regions in Korea.

In particular, the mortality rates from lung cancer in Korea have risen dramatically since the middle of 1980s(Maeng, 1992; Oh, 1995) and this may be related to a very high rate of smoking, especially in men in Korea(smoking rate of 70 percent for adult men, Korean Association for Prevention of Tuberculosis, 1990, cited in Maeng, 1992). As a result, the rate of lung cancer shows the second highest of all cancers. Ultimately, lung cancer may show the highest cancer rate in the near future(Kim, J.P., 1995).

(4) Breast cancer in Korea

Breast cancer shows a typical high-risk pattern in

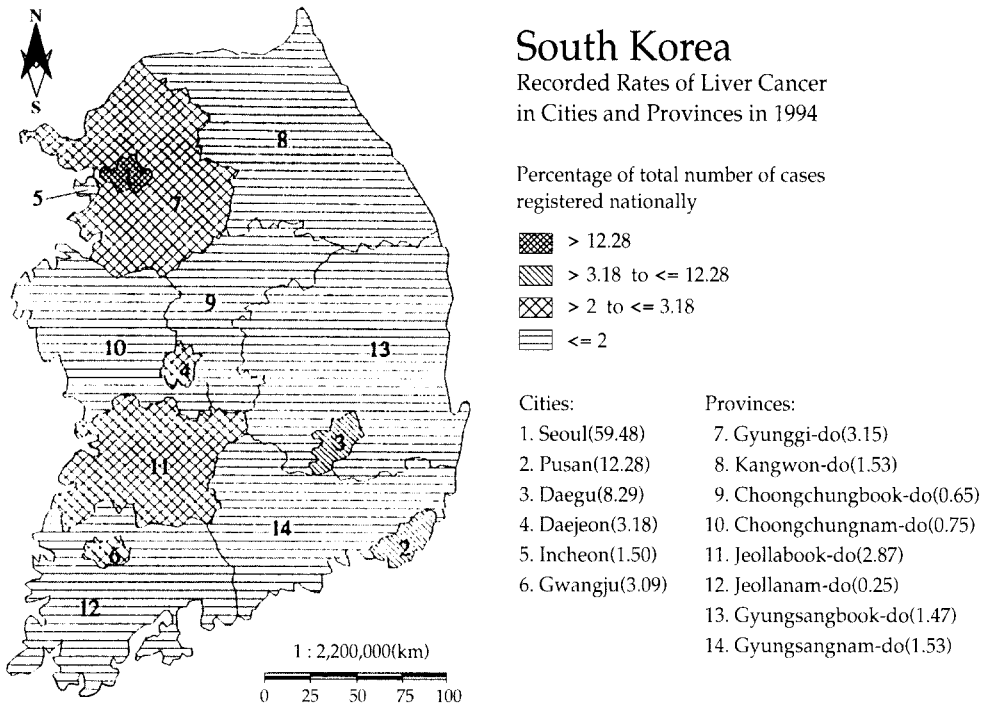


Figure 8. Recorded rates of breast cancer in Korea

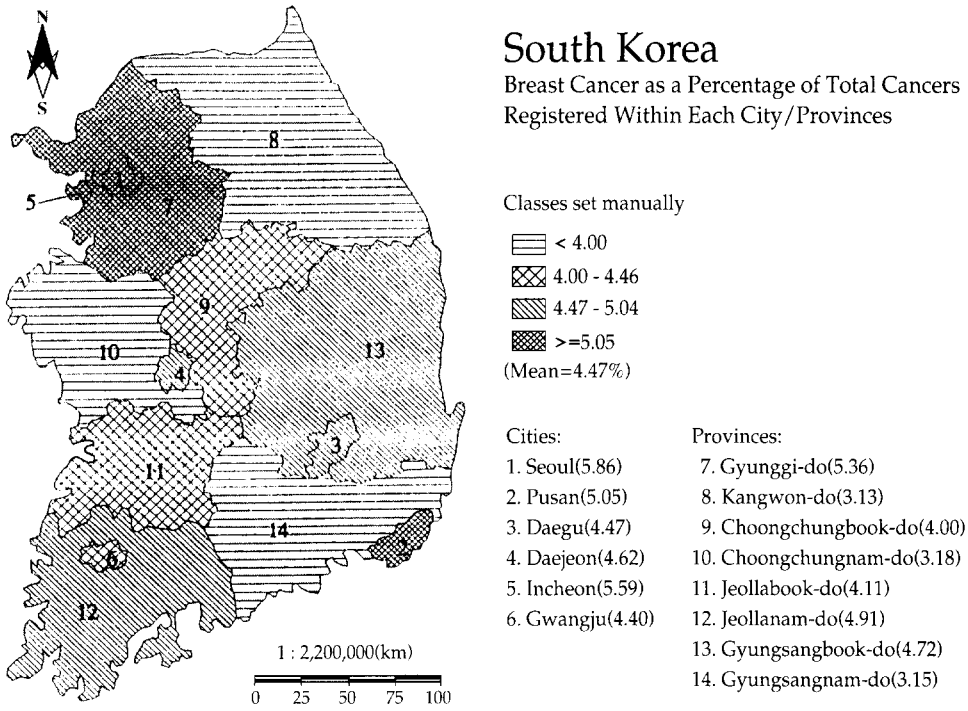


Figure 9. Breast cancer as a percentage of total cancers in Korea

Westernised urban areas. Seoul (region 1) and Seoul Metropolitan Areas(region 7) and Pusan (region 2) show very high recorded rates in regions and in terms of a percentage of total cancers within each region(Tables 2, 4 and Figures 8, 9). As a rule, rural areas show a lower risk for breast cancer. That is to say, less Westernised regions have lower incidence rates of breast cancer in Korea(Kim and Moon, 1996).

The incidence rate of breast cancer in Korea has increased since the 1980s because of high fat diet, increased smoking in females, late marriage, evasion of pregnancy and tendency to remain single(Yoo *et al.*, 1995). A history of benign breast disease and high fat diet are strongly associated with breast cancer(Maeng, 1993). However, a vegetable-oriented diet is protective of breast cancer(Maeng, 1993). In addition, those in higher socio-economic classes have higher risk of breast cancer than those from lower classes, and people in urban areas belong to higher risk group of breast cancer than people in rural areas(Yoo and Ahn, 1992).

(5) Colo-rectal cancer in Korea

Recorded rates of colon cancer have a similar pattern to those of rectal cancer and colo-rectal cancer combined(Table 2 and Figures 10, 12 and 14). In particular, registered rates of rectal cancer show the same regional distribution to those of colo-rectal cancer(Figures 12 and 14). This is due to a comparatively higher proportion of rectal cancer than colon cancer within each region, although there are exceptions(Table 4). Considering recorded rates of cancers of the colon, rectum and colon-rectum, Seoul has the highest rate(Table 2). However, the distribution of those three cancers as percentages of total cancers gives a relatively low rate for Seoul (Table 4 and Figures 11, 13 and 15). Pusan(region 2) and Daegu(region 3) too show low rate considering a percentage of total cancers for

cancers of the colon, rectum and colon-rectum(Table 4 and Figures 11, 13 and 15). This might suggest that characteristics of cancers of the colon, rectum and colon-rectum in Korea are different from those of Western countries. On the whole, the regional distribution of gastric cancer differs from that of colo-rectal cancer(Howe, 1986; McConnell, 1976; Miller, 1983; Wynder, 1975). However, the regional pattern of colo-rectal cancer in Korea is similar to that of stomach cancer since urban areas show a low risk of colo-rectal cancer considering a percentage of total cancers. This may be related to the different age distributions between urban areas and rural areas in Korea. Since 1970s, when industrialisation started in Korea, many young people in rural areas have left their home areas for big cities. As a result, most residents in rural areas are the elderly people. According to many authors(Department of Health, 1997; Sandler, 1996; Smans *et al.*, 1992; Whittemore, 1989; Young and Pollack, 1982) most patients with colo-rectal cancer are aged mainly over 65. For that reason, rural areas in Korea may show higher risk of colo-rectal cancer than urban areas.

According to Kim(1995) colo-rectal cancer shows the fourth incidence rate in Korea. Furthermore, the incidence rate of colo-rectal cancer will be the second or the third one in the future because its rate is increasing gradually. Mortality from colo-rectal cancer(1981 - 1990) is also rising continuously. In particular, for females, mortality from colo-rectal cancer has more than doubled in recent years(Cynn *et al.*, 1993).

In general, for colo-rectal cancer, fat from animals(Correa, 1975; Faivre *et al.*, 1997; Graham *et al.*, 1988; Hill *et al.*, 1971; Jain *et al.*, 1980; King, 1996; Sandler, 1996; Schottenfeld and Winawer, 1982; Wynder, 1975; Ziegler *et al.*, 1986) and animal protein(Armstrong and Doll, 1975; Cruse *et al.*, 1979; Giovannucci *et al.*, 1994; Hill *et al.*, 1971; Knox, 1977;

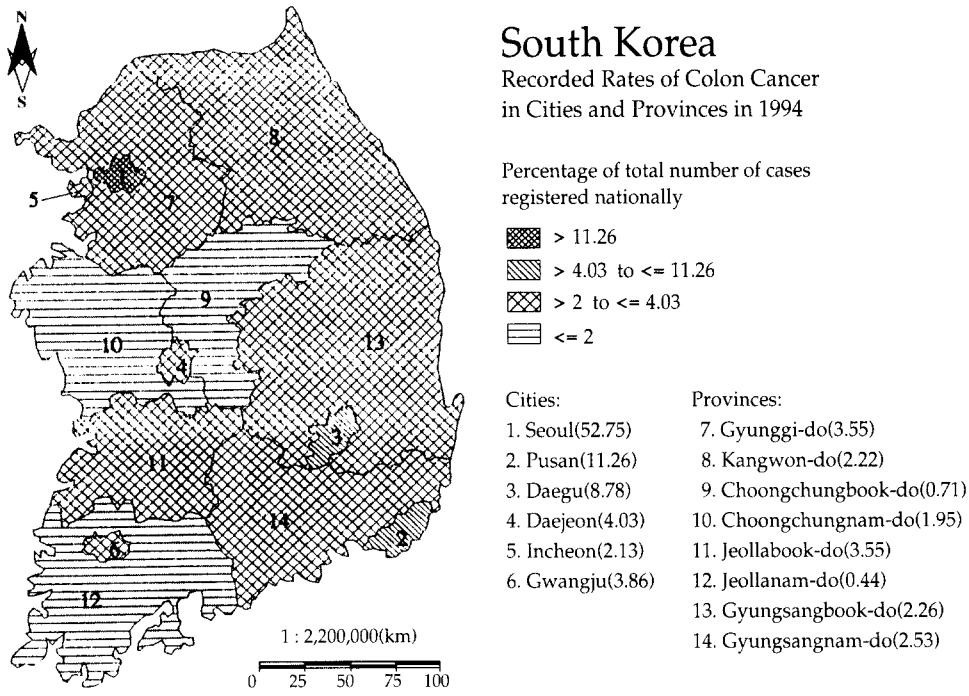
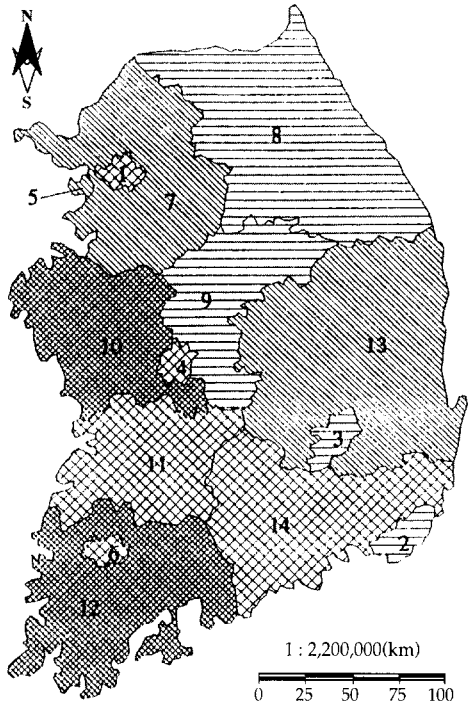


Figure 10. Recorded rates of colon cancer in Korea



South Korea

Colon Cancer as a Percentage of Total Cancers Registered Within Each City/Provinces

Classes set manually

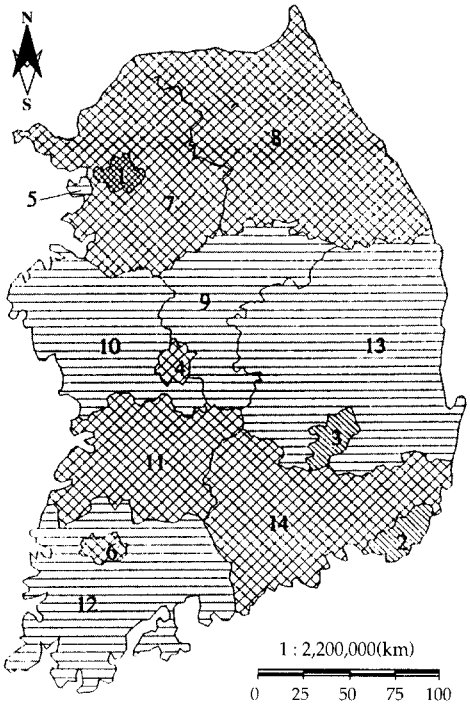
- < 3.57
- 3.57 - 4.18
- 4.19 - 5.82
- >=5.83

(Mean=4.19%)

Cities:
1. Seoul(3.66)
2. Pusan(3.25)
3. Daegu(3.33)
4. Daejeon(4.13)
5. Incheon(5.59)
6. Gwangju(3.86)

Provinces:
7. Gyunggi-do(4.24)
8. Kangwon-do(3.19)
9. Choongchungbook-do(3.05)
10. Choongchungnam-do(5.83)
11. Jeollabook-do(3.57)
12. Jeollanam-do(6.13)
13. Gyungsangbook-do(5.13)
14. Gyungsangnam-do(3.67)

Figure 11. Colon cancer as a percentage of total cancers in Korea



South Korea

Recorded Rates of Rectum Cancer in Cities and Provinces in 1994

Percentage of total number of cases registered nationally

- > 11.74
- > 5.60 to <= 11.74
- > 2 to <= 5.60
- <= 2

Cities:
1. Seoul(51.86)
2. Pusan(11.74)
3. Daegu(8.25)
4. Daejeon(5.60)
5. Incheon(1.53)
6. Gwangju(3.80)

Provinces:
7. Gyunggi-do(3.15)
8. Kangwon-do(2.45)
9. Choongchungbook-do(1.07)
10. Choongchungnam-do(1.61)
11. Jeollabook-do(4.45)
12. Jeollanam-do(0.31)
13. Gyungsangbook-do(1.57)
14. Gyungsangnam-do(2.61)

Figure 12. Recorded rates of rectal cancer in Korea

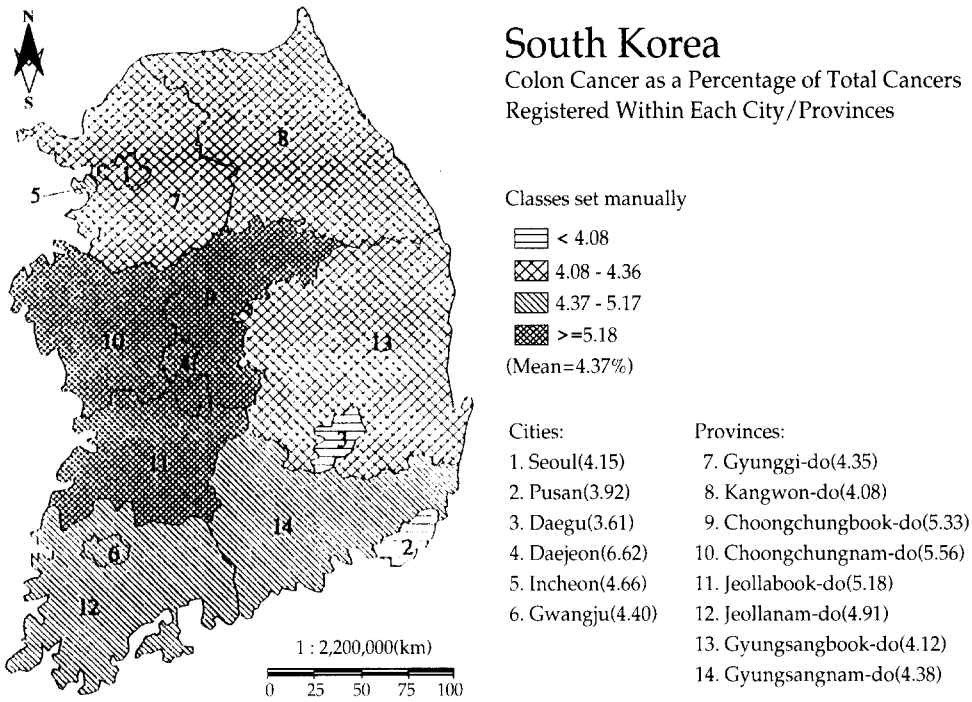


Figure 13. Rectal cancer as a percentage of total cancers in Korea

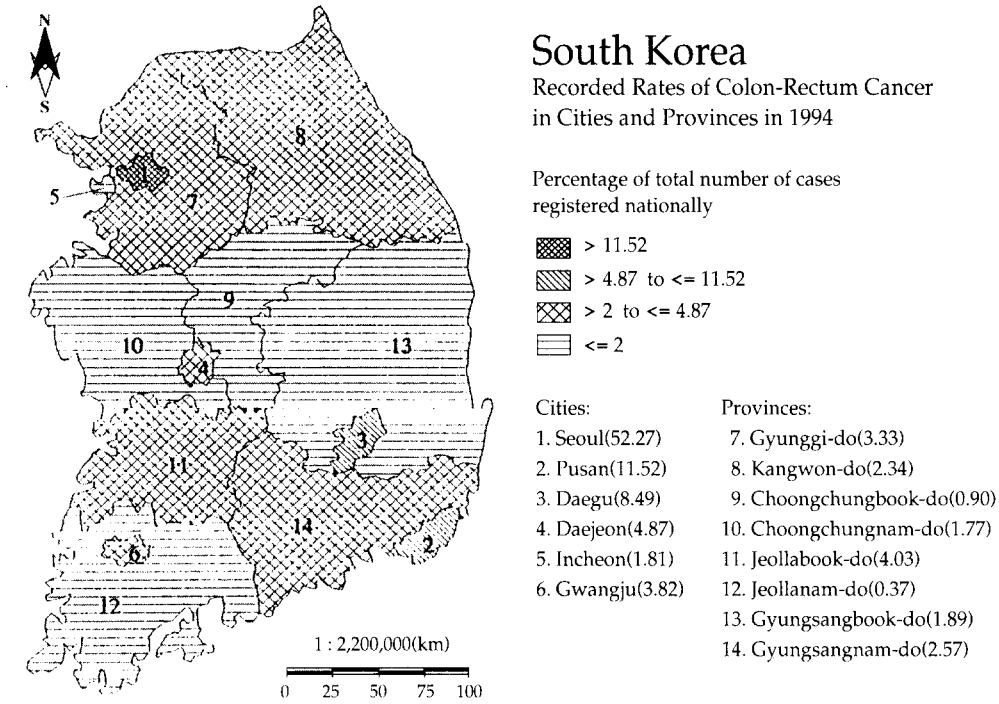


Figure 14. Recorded rates of colo-rectal cancer in Korea

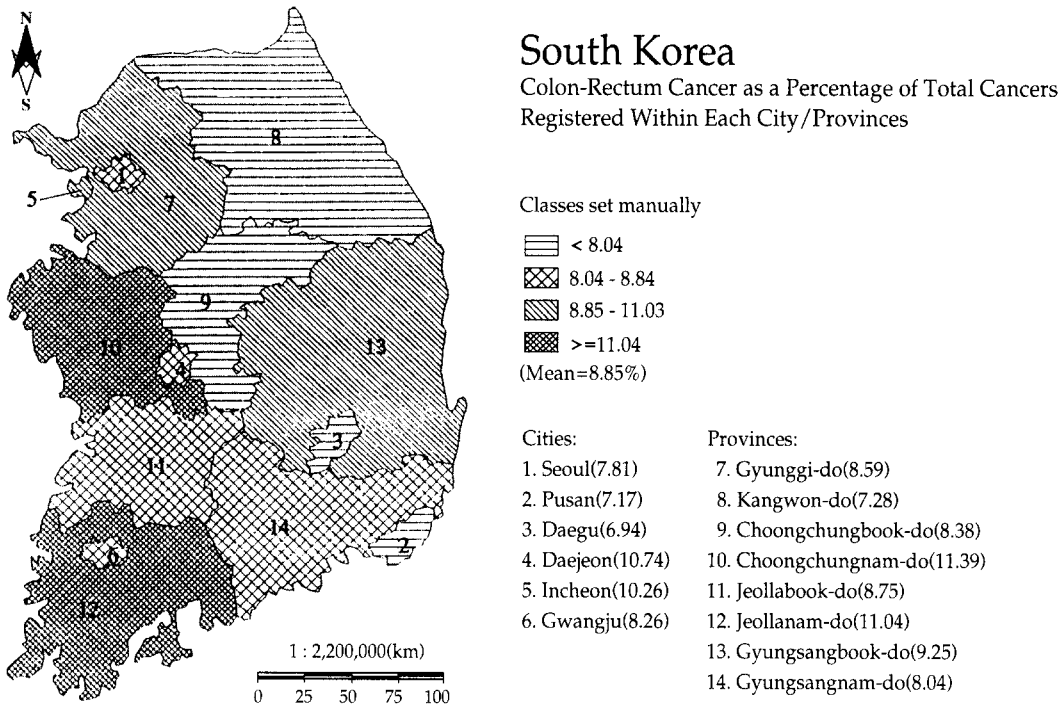


Figure 15. Colo-rectal cancer as a percentage of total cancers in Korea

Potter and McMichael, 1986; Smans *et al.*, 1992) are risk factors and cereals and vegetables(Bingham *et al.*, 1979; Faivre *et al.*, 1997; Franceschi *et al.*, 1997; Graham *et al.*, 1978; Hill, 1997; Kampman *et al.*, 1995; Le Marchand and Hankin *et al.*, 1997; Malhotra, 1977; Modan *et al.*, 1975; Steinmetz *et al.*, 1994) are protective factors(Cynn *et al.*, 1993). Recently, Koreans' common diet is moving from cereal-oriented food to meat-oriented food. In addition, such change is taking place rapidly, especially among children in Korea. For instance, the younger generations favourite food is not traditional Korean food but Westernised food such as pizza or hamburgers. Several authors(Cynn *et al.*, 1993; Lee and Woo, 1992) suggest that such Westernised food has increased the risk of colo-rectal cancer in Korea. Hirayama(1975) also mentions that an increase in colo-rectal cancer is associated with an increasingly Westernised diet in Japan.

4. Conclusions

In this study Seoul shows the highest proportion of all cancers. This may result from a high proportion of hospitals and population; the absence of good, age-standardised rates means that it is difficult to assess whether the high rates in Seoul simply reflect the fact that the capital has many large hospitals and most patients prefer to go to big hospitals in Seoul.

The relative risk of stomach cancer seems to be related to the level of health care services by regions. Southern parts of Korea have high risk of liver cancer. There may be a relationship between cancer of the liver and liver fluke due to eating raw fish. A high proportion (over 70 percent) of liver cancer stems from hepatitis B virus or cirrhosis of the liver in Korea. Considering relative risk of lung cancer within each region as compared with total cancers the biggest, the second and the third biggest

cities have low risk of the disease. In contrast, rural areas show high risk of lung cancer. This might be related to cigarette smoking. Smoking rates in rural areas in Korea are higher than those in urban areas. For breast cancer Westernised urban areas show very high risk in Korea whereas rural areas have low risk. This may imply a relationship between Westernised diet and risk of carcinoma of the breast. Risk of colo-rectal cancer in rural areas is high considering a proportion of all cancers. This may be associated with the effects of age. As a rule, however, in Korea the incidence or mortality rates of colo-rectal cancer increase whereas the rates of cancer of the stomach decrease due to change to Westernised diet.

Regretfully, the present study has some limitations as follows: This study simply used only aggregate data; no individual data were available. In addition, the study could not use the incidence rates of cancers by smaller regions (than 6 big cities and 8 provinces) because of inaccessibility of the data. Life style including diet by regions could not be associated with the incidence rates of cancers since there had been very few life-style-related studies by regions in Korea. Fortunately, however, life-style (or individual health behaviour)-related data by regions will be available in 2000 through the results from '1998 Korean Health and Nutrition Survey' (organised by the Ministry of Health and Welfare). More detailed analysis and explanation will only be possible if patients' individual data or socio-economic data of small areas within each city or province in Korea are accessible in the future. But, nonetheless this is the first attempt to explore the geography of cancer incidence in Korea.

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