ETHNOGEOGRAPHICAL COINCIDENCE OF ENDEMIC KAPOSI'S SARCOMA AND AFRICAN BURKITT'S LYMPHOMA IN WESTERN KENYA

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Abstract: Geopathological studies on endemic Kaposi's sarcoma (KS) and African Burkitt's lymphoma (BL) in western Kenya were performed, and revealed that KS and BL had relatively same geographical and ethnical distribution. The western region of Kenya stands almost exactly astride the equator. It accounts for almost one third of the whole country in area and about one half in population. Western Kenya is composed of three provinces; Nyanza Province, Western Province and Rift Valley Province. Out of 25,343 surgical pathological specimens at provincial hospitals in Nyanza, Western and Rift Valley for 8 years during 1979 to 1986, 124 and 135 cases were histologically diagnosed as KS and BL respectively. Frequency in all malignant tumors was 2.92% (KS) and 3.18% (BL). The high incidence of KS was found between the age of 50 and 59, while all BL cases were found under 22 years. The male to female ratio was 8.4:1.0 in KS and 1.2:1.0 in BL. The incidence of KS and BL per 100,000 population in each province is as follows: a) 2.12 (KS) and 3.54 (BL) in Nyanza Province, b) 1.80 (KS) and 1.20 (BL) in Western Province, and c) 1.11 (KS) and 0.68 (BL) in Rift Valley Province. Nyanza Province and Western Province are tropical savannah areas, whereas Rift Valley Province is a tropical highland. The incidence of KS and BL per 100,000 population among main ethnic groups in western Kenya is as follows: the Luo, the main inhabitants of Nyanza Province around Lake Victoria, showed the highest incidence of KS (2.56) and BL (4.35), followed by the Luhya, the main inhabitants of Western Province, the Kalenjin, the inhabitants of the tropical highland in Rift Valley Province, and the Kisii, the inhabitants of highland area of Nyanza Province. The Luo are descended from the Nilotic groups and the Luhya belong to the Bantu. No case of KS and only a few cases of BL were found among the inhabitants of desert or semi-desert areas. No other tumors showed above mentioned characteristics. The geographical and ethnical coincidence of KS and BL was more clear in the child population than in the adult. These results suggest that there is a geographical coincidence of KS and BL based on same etiological cofactors including high temperature, high humidity, unknown transmissible agents, and probably genetic factors and life styles. This was mainly demonstrated in Nyanza Province around Lake Victoria in western Kenya.

INTRODUCTION

Kaposi's sarcoma (KS; initially called Idiopathisches Multiples Pigment Sarkom der

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Haut) was first described in eastern Europe (Kaposi, 1872). Up to the present day, many cases of KS have been reported from European and North American countries and a relatively high incidence of KS has appeared among the inhabitants of eastern Europe and Mediterranean countries, as well as those of Jewish origin in central Europe (Bluefarb, 1957; Oettle, 1962; Rothman, 1962). The first report of African KS from French Cameroon was made by Jojot and Laigret in 1922. Nowadays, it is well known that endemic KS is more prevalent in African continent than any other part of the world (Oettle, 1962; Maclean, 1963). When the ratio of endemic KS to all malignant tumors was considered, the highest value was found in central Africa with the incidence of endemic KS decreasing with distance away from this area (Cox and Helwig, 1959; Cook, 1962; Davies and Lothe, 1962; Keen, 1962; Oettle, 1962; Maclean, 1963; Slavin *et al.*, 1969; Taylor *et al.*, 1971a; Schmid, 1973; Toriyama *et al.*, 1987a). It has been reported that cytomegalovirus (CMV) is etiologically concerned with KS in Africa (Burkes *et al.*, 1985). Since the occurrence of the first Acquired Immunodeficiency Syndrome (AIDS) case (Centers for Disease Control, 1981a), KS has been considered one of the main complications of AIDS (Centers for Disease Control, 1981b; Friedman-Kien *et al.*, 1981). Several cases of African endemic KS contained viral inclusions, and European and American patients with KS were found to possess increased serum-levels of antibody to CMV when compared with normal controls and patients with other malignancies (Giraldo *et al.*, 1972a, 1972b, 1975; Boldogh *et al.*, 1981). However, KS in AIDS (epidemic type) is a little different from endemic KS in Africa in its manifestations (Toriyama *et al.*, 1987b). In North America, the incidence of malignant B-cell lymphoma which is also related to AIDS has been increasing (Ziegler *et al.*, 1982, 1984; Levine *et al.*, 1984, 1985).

Burkitt's lymphoma (BL), a malignant B-cell lymphoma, is also endemic throughout most of tropical Africa (Burkitt, 1962). Epstein-Barr virus (EBV) is now known to be the causative agent of BL (Epstein *et al.*, 1964; Old *et al.*, 1966; de Schryver *et al.*, 1969; Henle *et al.*, 1969, 1973; Gunven *et al.*, 1970; zur Hausen *et al.*, 1970; Kaschka-Dierich *et al.*, 1976). It has been suggested that EBV may initiate a lymphoid tumor of a susceptible individual whose immunological response has been altered by malaria, especially *Plasmodium falciparum* (Hutt, 1970).

Across African continent between the latitudes of approximately 15° north and south of the Equator, BL appears to be highly prevalent (lymphoma belt) (Burkitt, 1962, 1966, 1969). Although it is supposed that the lymphoma belt and the areas with the high incidence of KS are overlapping (Burkitt, 1970), no reports clarifying the geographical and ethnical coincidence of endemic KS and African BL have been published up to the present day. It is the aim of this study to discuss in more detail the geographical and ethnical distribution as well as some etiological cofactors between endemic KS and African BL in western Kenya.

MATERIALS AND METHODS

This study was based on the histopathological examinations of surgical specimens, almost all of which were performed in the Histology Departments of two hospitals, the Rift Valley Provincial General Hospital in Nakuru and the Nyanza Provincial General Hospital in Kisumu, Kenya. During the eight-year period between 1979 and 1986, a total of 25,343 surgical specimens from Nyanza, Western, and Rift Valley Provinces in western Kenya were examined histologically for KS and BL. Relevant information and clinical data were

collected as accurately as possible, with attention being paid to age, sex, ethnic group, place of residence, and macroscopic appearances. The diagnoses of KS and BL were based on clinical and histological grounds. Histological examinations were performed using H. E., periodic acid Schiff (P.A.S.), reticulum, elastic van Gieson and Azan Mallory stains. A demographic structure was obtained from the Kenya Population Census 1979 (Government of Kenya, 1979)

Table 1 Incidence of Kaposi's sarcoma (KS) and Burkitt's lymphoma (BL) amongst malignant tumors (1979-1986)

Year	No. of surg. specimen	No. of malig. tumor	No. of KS	$\frac{\text{KS}}{\text{malig. tumor}}(\%)$	No. of BL	$\frac{\text{BL}}{\text{malig. tumor}}(\%)$
1979	1,179	Male 102	2	1.96	4	3.92
		Female 76	0	—	1	1.32
		Unknown 7	0	—	0	—
		(Total) 185	2	1.08	5	2.70
1980	3,359	Male 262	12	4.58	4	1.53
		Female 318	1	0.31	0	—
		Unknown 3	0	—	0	—
		(Total) 583	13	2.23	4	0.69
1981	3,652	Male 336	22	6.55	9	2.68
		Female 368	5	1.36	9	2.54
		Unknown 5	1	20.00	0	—
		(Total) 709	28	3.95	18	2.54
1982	4,401	Male 213	24	11.27	6	1.98
		Female 315	2	1.36	7	2.22
		Unknown 25	1	4.00	0	—
		(Total) 553	27	4.88	13	2.35
1983	3,905	Male 303	8	2.64	6	1.98
		Female 253	0	—	15	5.93
		Unknown 19	0	—	0	—
		(Total) 575	8	1.39	21	3.65
1984	2,493	Male 198	8	4.04	15	7.58
		Female 216	0	—	3	1.39
		Unknown 1	0	—	1	100.00
		(Total) 415	8	1.93	19	4.58
1985	3,914	Male 323	18	5.57	17	5.26
		Female 424	3	0.70	16	3.77
		Unknown 9	0	—	0	—
		(Total) 756	21	2.65	33	4.37
1986	2,440	Male 180	15	8.33	12	6.67
		Female 271	2	0.74	10	3.69
		Unknown 16	0	—	0	—
		(Total) 467	17	3.64	22	4.71
Total	25,343	Male 1,917	109	5.69	73	3.80
		Female 2,241	13	0.58	61	2.72
		Unknown 85	2	2.35	1	1.18
		(Total) 4,243	124	2.92	135	3.18

Table 2 Age and sex distribution of 124 cases of Kaposi's sarcoma (KS)

Age Group	Sex			Total
	Male	Female	Unknown	
0—4	6	0	0	6
5—9	4	2	0	6
10—14	3	1	0	4
15—19	1	1	0	2
20—24	4	0	0	4
25—29	7	1	0	8
30—34	4	0	0	4
35—39	5	0	0	5
40—44	9	1	0	10
45—49	7	2	0	9
50—54	15	1	0	16
55—59	7	0	0	7
60 and over	17	0	0	17
"Child"*	1	0	0	1
"Adult"**	14	3	0	17
Unknown	5	1	2	8
Total	109	13	2	124

Table 3 Age and sex distribution of 135 cases of Burkitt's lymphoma (BL)

Age Group	Sex			Total
	Male	Female	Unknown	
0—4	18	2	0	20
5—9	30	29	1	60
10—14	14	17	0	31
15—19	1	6	0	7
20 and over	0	1	0	1
"Child"*	5	4	0	9
Unknown	5	2	0	7
Total	73	61	1	135

* Exact age is unknown, probably under 14 years of age.

* * Exact age is unknown, probably over 15 years of age.

RESULTS

Incidence of KS and BL amongst malignant tumors

During the eight-year period between 1979 and 1986, out of 25,343 surgical specimens, 4,243 specimens were malignant tumors. Among them 124 cases were histologically diagnosed as KS and 135 cases as BL. Table 1 shows the ratio of KS and BL to all malignant tumors during the period; 1.08% and 2.70% in 1979, 2.23% and 0.69% in 1980, 3.95% and 2.54% in 1981, 4.88% and 2.35% in 1982, 1.39% and 3.65% in 1983, 1.93% and 4.58% in 1984, 2.65% and 4.37% in 1985, and 3.64% and 4.71% in 1986 respectively. The total incidence of KS and BL amongst all malignant tumors in western Kenya for the eight-year period was 2.92% and 3.18% respectively.

Age and sex distribution of KS and BL

Tables 2 and 3 indicate the age and sex distribution of KS and BL respectively. The high incidence of KS cases was found between the age of 50 and 59, while all BL cases were found under 22 years. The male to female ratio was 8.4:1.0 in KS and 1.2:1.0 in BL. The highest incidence of BL cases was found in the 5—9-year-old age group. The analyses of sex distribution revealed that males had significantly higher rates in KS ($p < 0.001$) and BL ($p < 0.05$) than females (by the Chi-square test, using 4,243 cases of malignant tumors).

Table 4 Anatomical distribution of 124 cases of Kaposi's sarcoma (KS)

Localization	Number of cases												Total
	Adult				Child				Unknown				
	Male	Female	Unknown	Total	Male	Female	Unknown	Total	Male	Female	Unknown	Total	
Foot	34	5	0	39	1	0	0	1	1	0	1	2	42
Leg	22	0	0	22	1	0	0	1	2	0	1	3	26
Lymph node(s)	3	1	0	4	11	2	0	13	1	1	0	2	19
Hand	16	1	0	17	0	0	0	0	0	0	1	1	18
Arm	10	0	1	11	0	0	0	0	1	0	0	1	12
Thigh	6	0	0	6	0	0	0	0	1	0	0	1	7
Knee	5	0	0	5	0	0	0	0	0	0	0	0	5
Ankle	4	0	0	4	0	0	0	0	0	0	0	0	4
Trunk	3	1	0	4	0	0	0	0	0	0	0	0	4
Orbit	1	0	0	1	0	0	0	0	0	0	0	0	1
Upper lid	0	0	0	1	0	0	1	0	0	0	0	0	1
Mandible	0	0	0	0	1	0	0	1	0	0	0	0	1
Axilla	1	0	0	1	0	0	0	0	0	0	0	0	1
Pharynx	1	0	0	1	0	0	0	0	0	0	0	0	1
Tonsil	0	1	0	1	0	0	0	0	0	0	0	0	1
Unknown	3	1	0	4	0	0	0	0	0	0	0	0	4
Total	109	10	1	120	15	2	0	17	6	1	2	9	146*

* including multiple lesions.

Table 5 Anatomical distribution of 135 cases of Burkitt's lymphoma (BL)

Localization	Number of cases			
	Male	Female	Unknown	Total
Oral cavity (includ. Nasal cavity)	17	12	0	29
Maxilla and Mandibula (includ. Cheek, Orbit and Eye)	19	9	1	29
Abdominal mass	8	7	0	15
Unknown lymph node	9	6	0	15
Ovary	0	14	0	14
Neck (includ. Cervical lymph node and Thyroid)	8	5	0	13
Inguinal lymph node and Groin	3	1	0	4
Kidney	1	2	0	3
Axillary lymph node	0	2	0	2
Mediastinum	0	1	0	1
Spleen	1	0	0	1
Head	1	0	0	1
Shoulder	0	1	0	1
Hand	1	0	0	1
Hip	1	0	0	1
Mesenteric lymph node	1	0	0	1
Unknown	4	0	0	4
Total	73	61	1	135

Table 6 Geographical and sex distribution of Kaposi's sarcoma (KS) and Burkitt's lymphoma (BL)

Province	District	Number of KS				Number of BL			
		Male	Female	Unknown	Total	Male	Female	Unknown	Total
Western	Bungoma	9	1	0	10	0	0	0	0
	Busia	5	0	0	5	1	0	0	1
	Kakamega	14	3	1	18	9	12	0	21
	(Total)	28	4	1	33	10	12	0	22
Nyanza	Siaya	8	2	0	10	3	2	0	5
	Kisumu	24	0	0	24	32	31	1	64
	South Nyanza	11	1	0	12	11	4	0	15
	Kisii	7	1	0	8	1	5	0	6
	(Total)	50	4	0	54	47	42	1	90
Rift Valley	Turkana	0	0	0	0	0	1	0	1
	West Pokot	3	0	0	3	0	1	0	1
	Trans Nzoia	2	0	0	2	2	1	0	3
	Uasin Gishu	4	0	0	4	0	0	0	0
	Elgeyo Marakwet	1	0	0	1	0	0	0	0
	Baringo	1	0	0	1	1	0	0	1
	Nandi	3	0	0	3	2	0	0	2
	Nakuru	13	2	1	16	6	3	0	9
	Kericho	3	1	0	4	4	1	0	5
	Narok	1	1	0	2	0	0	0	0
	Others	0	0	0	0	0	0	0	0
	(Total)	31	4	1	36	15	7	0	22
Unknown		0	1	0	1	1	0	0	1
Total		109	13	2	124	73	61	1	135

Anatomical distribution of KS and BL

The anatomical distribution of KS and BL are shown in Tables 4 and 5 respectively. The most common sites of primary lesion of KS in adults were the foot, followed by the leg, hand and arm. In children, the primary lesion of KS was predominantly of lymph node(s) origin. The most common sites of primary lesion of BL were the oral cavity, followed by the maxilla, mandibula, abdominal cavity, lymph nodes and ovary.

Geographical distribution of KS and BL

Tables 6 and 7 show the geographical distribution of KS and BL. Out of 124 collected cases of KS, 54 were from Nyanza Province, 36 from Rift Valley Province and 33 from Western Province (Table 6). The estimated incidence of KS per 100,000 population in each province and district for the eight-year period was as follows: Nyanza Province showed the highest incidence of 2.12, followed by 1.80 in Western Province and 1.11 in Rift Valley Province (Table 7). Kisumu District in Nyanza Province showed the highest incidence of 4.98, followed by Nakuru District of Rift Valley Province with 3.06 and Siaya District of Nyanza Province with 2.11 (Table 7).

Table 7 Geographical distribution of Kaposi's sarcoma (KS) and Burkitt's lymphoma (BL) in western Kenya (per 100,000 population)

Province	District	Population in '000s*	KS	KS	BL	BL
				100,000 population		100,000 population
Western	Bungoma	503.9	10	1.98	0	0.00
	Busia	297.8	5	1.68	1	0.34
	Kakamega	1,030.9	18	1.75	21	2.04
	(Total)	1,832.7	33	1.80	22	1.20
Nyanza	Siaya	474.5	10	2.11	5	1.05
	Kisumu	482.3	24	4.98	64	13.27
	South Nyanza	817.6	12	1.47	15	1.83
	Kisii	869.5	8	0.92	6	0.69
	(Total)	2,544.0	54	2.12	90	3.54
Rift Valley	Turkana	142.7	0	0.00	1	0.70
	West Pokot	158.7	3	1.89	1	0.63
	Trans Nzoia	259.5	2	0.77	3	1.16
	Uasin Gishu	300.8	4	1.33	0	0.00
	Elgeyo Marakwet	148.9	1	0.67	0	0.00
	Baringo	203.8	1	0.49	1	0.49
	Nandi	299.3	3	1.00	2	0.67
	Nakuru	522.7	16	3.06	9	1.72
	Kericho	633.3	4	0.63	5	0.79
	Narok	210.3	2	0.96	0	0.00
	Others	211.4	0	0.00	0	0.00
	(Total)	3,240.4	36	1.11	22	0.68
Unknown		—	1	—	1	—
Total		7,617.0	124	1.63	135	1.77

* A demographic structure was obtained from the Kenya Population Census 1979 (Government of Kenya, 1979).

Table 8 Ethnical distribution of Kaposi's sarcoma (KS) and Burkitt's lymphoma (BL) (per 100,000 population)

Ethnic Group	Population in '000s (1979, estimated)	KS	KS	BL	BL
			100,000 population		100,000 population
Luo	1,955.9	50	2.56	85	4.35
Luhya	2,119.7	35	1.65	22	1.04
Kalenjin	1,652.2	17	1.03	13	0.79
Kisii	944.1	9	0.95	11	1.17
Teso	132.7	1	0.75	0	—
Kikuyu	3,202.8*	11	0.34	0	—
Turkana	207.2	0	—	1	0.48
Arab	—	0	—	1	—
Unknown	—	1	—	2	—

* Exact number of their population in western Kenya is unclear.

Table 9 Ethnic incidence of Kaposi's sarcoma (KS) and Burkitt's lymphoma (BL) amongst malignant tumors

Ethnic Group	No. of malig. tumor	KS	KS		BL	BL	
			malig. tumor	(%)		malig. tumor	(%)
Luo	Male	625	46	7.36	48	7.68	
	Female	765	4	0.52	36	4.70	
	Unknown	6	0	—	1	16.67	
	(Total)	1,396	50	3.58	85	6.09	
Luhya	Male	347	30	8.65	10	2.88	
	Female	391	1	0.26	12	3.07	
	Unknown	9	4	44.44	0	—	
	(Total)	747	35	4.69	22	2.95	
Kalenjin	Male	402	15	3.73	8	1.99	
	Female	472	2	0.42	5	1.06	
	Unknown	22	0	—	0	—	
	(Total)	896	17	1.90	13	1.45	
Kisii	Male	165	8	4.85	5	3.03	
	Female	153	1	0.65	6	3.92	
	Unknown	1	0	—	0	—	
	(Total)	319	9	2.82	11	3.45	
Teso	Male	8	1	12.50	0	—	
	Female	9	0	—	0	—	
	Unknown	1	0	—	0	—	
	(Total)	18	1	5.56	0	—	
Kikuyu	Male	181	9	4.97	0	—	
	Female	303	2	0.66	0	—	
	Unknown	18	0	—	0	—	
	(Total)	502	11	2.19	0	—	
Others	(Total)	365	1	0.27	4	1.10	
Total		4,243	124	2.92	135	3.18	

Out of a total of 135 collected BL cases, 90 were from Nyanza Province, and 22 each from both Western Province and Rift Valley Province (Table 6). The estimated incidence of BL per 100,000 population in each province and district for the eight-year period was as follows: Nyanza Province showed the highest incidence of 3.54, followed by 1.20 in Western Province and 0.68 in Rift Valley Province (Table 7). Kisumu District in Nyanza Province showed the highest incidence of 13.27, followed by Kakamega District of Western Province with 2.04, South Nyanza District of Nyanza Province with 1.83, Nakuru District of Rift Valley Province with 1.72, Trans Nzoia District of Rift Valley Province with 1.16 and Siaya District of Nyanza Province with 1.05 (Table 7). High incidence rates of both diseases appeared in Kisumu, Siaya and South Nyanza Districts of Nyanza Province, in the tropical savannah around Lake Victoria, Nakuru District of Rift Valley Province, in the tropical highland, and Kakamega District of Western Province, in the tropical savannah. When the numbers of cases of KS and BL were compared by region, there was a significant positive

correlation ($r=0.819$, $p<0.001$), i. e., a high incidence of KS (BL) cases were found in regions which exhibited a high incidence of BL (KS) cases.

Figures 2, 3 and 4 are adapted from figures in Health and Disease in Kenya (Vogel *et al.*, 1974) showing these factors for references. The occurrence of KS and BL was analysed in relation to the altitude, mean annual temperature and mean annual rainfall in western Kenya. Among the factors the annual rainfall correlated with the occurrence of KS, but it was not significant statistically. As for BL, the temperature gave the highest correlation value, but again without significance.

Ethnical distribution

Table 8 shows the ethnical distribution of KS and BL per 100,000 population for the eight-year period between 1979 to 1986. In the case of KS, the Luo, the main inhabitants of Nyanza Province, around Lake Victoria showed the highest incidence with 2.56, followed by the Luhya, the main inhabitants of Western Province, with 1.65, the Kalenjin, the inhabitants of the tropical highland in Rift Valley Province, with 1.03, and the Kisii, the inhabitants of highland area of Nyanza Province, with 0.95. On the other hand, the highest incidence of BL was seen among the Luo with 4.35, followed by the Kisii with 1.17, the Luhya with 1.04, and the Kalenjin with 0.79. Table 9 shows the ethnical incidence of KS and BL amongst malignant tumors. The Luhya had a higher rate of KS than the Kisii ($p<0.05$), Kikuyu ($p<0.05$) and Kalenjin ($p<0.01$). There was no significant difference between the Luhya and the Luo (by the Chi-square test, using 4,243 cases of malignant tumors). The number of cases of Teso was so small that could not be analysed. The highest incidence of both KS and BL appeared in the Luo, Luhya and Kisii. The analysed results showed a clear association between the ethnic group and the occurrence rate of KS ($p<0.025$) or BL ($p<0.001$).

Table 10 Child type Kaposi's sarcoma (KS) in western Kenya

Case	Age	Sex	Site of lesion	Ethnic group	District	Province
1	1	M	Inguinal lymph node	Luhya	Busia	Western
2	1y6m	M	Generalized lymph nodes	Luo	South Nyanza	Nyanza
3	1y8m	M	Generalized lymph nodes	Luo	Kisumu	Nyanza
4	1y9m	M	Generalized lymph nodes	Luhya	Kakamega	Western
5	1y9m	M	Generalized lymph nodes	Luo	Siaya	Nyanza
6	2y6m	M	Unknown lymph node	Luhya	Kisumu	Nyanza
7	5	F	Generalized lymph nodes	Luo	South Nyanza	Nyanza
8	6	M	Unknown lymph node	Luo	Kisumu	Nyanza
9	7	M	Generalized lymph nodes	Luo	Kakamega	Western
10	7	F	Mandibula	Luo	Siaya	Nyanza
11	8	M	Elbow lymph node	Kisii	Kisii	Nyanza
12	9	M	Foot	Luo	South Nyanza	Nyanza
13	10	F	Unknown lymph node	Luhya	Kakamega	Western
14	11	M	Leg	Luo	Kisumu	Nyanza
15	12	M	Upper lid	Luo	Busia	Western
16	12	M	Cervical lymph node	Luo	Kisumu	Nyanza
17	Child*	M	Generalized lymph nodes	Luo	Kisumu	Nyanza

*Exact age in unknown.

Figure 1 Map of western Kenya showing districts. (Adapted from figures in Vogel *et al.*: Health and Disease in Kenya. East African Literature Bureau, 1974)

Figure 2 Map of western Kenya showing altitudes above sea level.
(Adapted from figures in Vogel *et al.*: Health and Disease in Kenya. East African Literature Bureau, 1974)

Figure 3 Map of western Kenya showing mean annual temperature.
(Adapted from figures in Vogel *et al.*: Health and Disease in Kenya. East African Literature Bureau, 1974)

Figure 4 Map of western Kenya showing mean annual rain fall.
(Adapted from figures in Vogel *et al.*: Health and Disease in Kenya. East African Literature Bureau, 1974)

KS in children and BL

Table 10 shows the 17 cases of KS found in children (under 14 years old) between 1979 and 1986. Twelve cases in all appeared in Nyanza Province, followed by 5 cases in Western Province, while no case was reported from Rift Valley Province. Kisumu District had the largest number with 6 cases, followed by South Nyanza District and Kakamega District with 3 cases each, Busia District and Siaya District with 2 cases each, and Kisii District with one case. Significantly more cases were found in Kisumu District than Busia District ($p < 0.05$) or Kisii District ($p < 0.01$). As for ethnic group, 12 cases of KS in children were from the Luo, with 4 cases of the Luhya and one case of the Kisii. KS in children were more prevalent in the Luo than in the Luhya ($p < 0.05$) or the Kisii ($p < 0.05$). There was a significant level of association of KS in children with region ($p < 0.05$) and ethnic group ($p < 0.05$). Majority of BL cases were found in children under 14 years old (Table 3). Ethnically, the Luo had a higher rate of BL than the Kisii, Luhya, and Kalenjin ($p < 0.01$) (Table 8). Geographically, Kisumu District had a higher rate of BL than Kakamega, South Nyanza, Siaya and Kisii Districts ($p < 0.01$) (Table 7) (by the Chi-square test, using the number of KS in children and BL against the total populations in each ethnic group and region). The occurrence rate of BL in ethnic groups and regions showed a clear association of BL with ethnic group and with region. The geographical and ethnical distributions of KS and BL coincided far more in children than in the adult population.

DISCUSSION

The Republic of Kenya stands almost exactly astride the equator; its area is 569,137 km² and its population is 15,327,000 (Bhushan, 1982). Western Kenya (Western, Nyanza and Rift Valley Provinces) accounts for one third of the whole country, 189,578 km², in area and about one half, 7,617,000, in population (Bhushan, 1982). It is bounded by Sudan and Ethiopia on the north, Uganda on the west and Tanzania on the south, and consists of three provinces, namely, Western, Nyanza and Rift Valley Provinces. These provinces are divided into three, four and thirteen districts respectively (Figure 1). These areas experience a wide variation of climatic conditions (Figure 2, 3 and 4). The most northern part, Turkana District, and the most southern part, Kajiado District, are dry desert or dry tropical savannah and have mean annual rainfalls of 100 to 200 mm and 300 to 700 mm respectively, and mean annual temperatures of 33 to 36°C and 22 to 33°C respectively. The altitudes of these areas are 650 m and 650 to 1,000 m respectively. On the contrary, the central part of Rift Valley Province is tropical highland with an altitude of 1,500 to 2,000 m, a mean annual rainfall of 1,200 to 2,000 mm and a mean annual temperature of 18 to 22°C. Western Province is tropical savannah with an altitude of 1,200 to 2,000 m, a mean annual rainfall of 1,250 to 1,750 mm and a mean annual temperature of 26 to 30°C. Nyanza Province is tropical savannah situated around Lake Victoria with altitude of 1,100 to 1,800 m, a mean annual rainfall of 1,000 to 1,750 mm and a mean annual temperature of 26 to 34°C.

When the geographical distribution of endemic KS and African BL per 100,000 population and the incidence of both diseases amongst malignant tumors in western Kenya were considered, coincidences of both diseases were observed in Kisumu District around Lake Victoria in Nyanza Province, Kakamega District in Western Province, Siaya District in Nyanza Province and Nakuru District in Rift Valley Province. Kisumu and Siaya Districts around Lake Victoria and Kakamega District consist of relatively moist tropical savannah whereas Nakuru District is situated in tropical highland which has relatively moist climatic conditions. Although the author could not detect any apparent statistical significances, it is likely that some environmental factors, such as high temperature (mean annual temperature over 26°C) and humidity (annual rainfall over 1,000 mm), influence the causation of KS and BL in western Kenya. And ethnically, a high incidence of KS and BL appeared among the Luhya, descended from the Bantu, and the Luo, descended from the Nilotic groups. These ethnic groups are from different origins (Fedders and Salvadori, 1979), but are living in moist and high temperature areas. These findings suggest that some environmental factors and some transmissible agents influence more the causation of endemic KS and African BL rather than genetic factors.

Although EBV is now known as the causative agent of BL (Epstein *et al.*, 1964; Old *et al.*, 1966; Henle *et al.*, 1969, 1973; de Schryver *et al.*, 1969; Gunven *et al.*, 1970; Kaschka-Dierich *et al.*, 1976), most studies of American cases have failed to demonstrate an association between high titers of anti-EBV and BL, and it was suggested that, even if EBV is etiologic for BL, it is only one of several factors (Linder and Purtilo, 1984). Also it has been suggested that EBV may initiate a lymphoid tumor if it infects a susceptible individual whose immunological response has been altered by malaria, especially *P. falciparum* (Hutt, 1970). As a result of similar etiological conditions, CMV has been linked with endemic KS in Africa (Burkes *et al.*, 1985).

With special reference to KS in children, it has been suggested that preceding persistent infection with malaria, especially *P. falciparum* before CMV infection may play a role as one of the etiological factors of KS (Safai *et al.*, 1980). It was recognized that continuous stimulation with foreign antigens might cause a relative immunodeficiency in Africa (Oettle, 1962; Master *et al.*, 1970; Taylor *et al.*, 1971b). Although the tropical savannah around Lake Victoria in western Kenya is a holoendemic area of *P. falciparum* (Vogel *et al.*, 1974), it is not known whether malaria infections could be an etiological cofactor of endemic KS and African BL or not. However, some environmental cofactors, including climatic conditions, life styles of the inhabitants and other unknown causative agents, might play a role in the causation of endemic KS and African BL. Furthermore, unknown transmissible agents might be one of the etiological cofactors of the both diseases, in a similar way to the relationship between epidemic KS and malignant B-cell lymphoma in AIDS.

According to this statistical study on the geographical distribution of endemic KS and African BL, a relatively high temperature and moist climatic conditions were considered to be related to the high incidence of endemic KS and African BL in western Kenya. No case of KS and only a few cases of BL were found among the inhabitants of desert or semi-desert areas. No other tumors showed above mentioned tendencies. The geographical and ethnical coincidence of KS and BL was more clear in the child population than in the adult. These results suggest that there is a geographical coincidence of KS and BL based on same etiological cofactors including high temperature, high humidity, unknown transmissible agents, and probably genetic factors and life styles. This was mainly demonstrated in Nyanza Province around Lake Victoria in western Kenya.

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西ケニアにおける地方病型カポシ肉腫とアフリカ型バーキット リンパ腫の部族および地理的分布の一致性

鳥山 寛

アフリカ型（地方病型）カポシ肉腫（KS）はアフリカ中央部に多発地帯があり，その地域から東西南北に地理的に遠ざかるにつれてその頻度は減少すると言われており，今までに我々が西ケニアで行った調査結果もそれを裏付けている。これとは別に赤道をはさんで東アフリカから西アフリカへ帯状のリンパ腫の多発地帯（Lymphoma Belt）が存在する。1979年から1986年の8年間にわたって，ケニア西部においてカポシ肉腫とB細胞型悪性リンパ腫の一つであるアフリカ型バーキットリンパ腫（BL）の，病理組織学的診断を基礎とした疫学的調査を行い，それらの地理的および部族的分布を検討した。その結果，KSとBLの相関性および自然環境や人的環境との関連性はつぎのようであった。1）KS，BLともに高温で比較的湿潤な地域に多く見られた。2）部族的にはKS，BLともに主として熱帯サバンナに居住するルオー族およびルヒア族に多く見られた。3）乾燥した地域での発生頻度は非常に低かった。4）他の腫瘍では，このような地理的，部族的，および自然環境的な特徴は著明ではなかった。5）特にBLと小児型KSでは地理的，部族的の一致性が強く認められた。これらの結果より，両疾患の発生には遺伝的あるいは先天的要因というよりも，何らかの共通した環境因子の存在や生活様式のより強い関与があるものと思われる。