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Epidemiology of intestinal and diffuse types of gastric carcinoma in the Mount Kilimanjaro area, Tanzania

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Summary

Carcinoma of the stomach is the commonest malignancy in the Mount Kilimanjaro area of Tanzania, with relative frequencies of 16.3 and 15.1% of all malignancies for males and females, respectively; and even considerably higher population based incidences than in other African registries. In this area with high risk for gastric carcinoma the ratio of intestinal to diffuse type (I:D) was significantly higher, 4.1 compared with 2.1 in the other, lower risk, regions of Northern Tanzania. Tumours of intestinal type were more often seen in young patients around Mount Kilimanjaro than in other countries, 6.0% of the patients with an I:D of 3.7 being under 35 years of age. Likewise, the proportion of females with gastric carcinoma was higher in the Mount Kilimanjaro area with an I:D ratio of 3.1, compared with 1.7 in females from the other regions. The high frequency of stomach cancer in the Mount Kilimanjaro area may be due to the influence of volcanic soils.

Résumé

Le cancer de l'estomac (carcinome) est la maladie la plus commune dans la région du Mont Kilimanjaro en Tanzanie avec une fréquence relative de 16.3 à 15.1 pour cent affectant la population male aussi bien que la population femelle. D'après les rapports disponibles, cette incidence est plus élevée comparée aux autres parties de l'Afrique. Dans cette region où les cas de carcinome gastrique sont très élevés, la population des cas intestinaux répandus (diffus) est considerablement élevé, 4.1 par rapport à 2.1 dans les autres régions de moindre risque au nord de la Tanzanie. Les tumeurs des cas intestinaux ont souvent été observés chez les jeunes patients dans la région du Mont Kilimanjaro que dans les autres pays. Presque 3.7 pour cent sur 6.0 pour cent des maladies dessous de 35 ans sont atteint des cas intestinaux du type répandu (diffus). Egalement la proportion des femelles atteint de carcinome gastrique était plus élevé dans la région du Mont Kilimanjaro avec une proportion de cas de maladie intestinale diffus de 3.1 par rapport à 1.7 de femelles se trouvant dans les autres régions. La fréquence élevée des cas de cancer d'estomac dans la région du Mont Kilimanjaro est peut-être dû à l'influence des sols volcaniques.

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Introduction

Recently, several morphological classifications of stomach carcinomas have been proposed [1–3]. Of these, the classification of Lauren [1] into diffuse and intestinal types seems to be most appropriate to be used both as a prognostic indicator and in the epidemiological study of stomach cancer. It has been shown that a high proportion of intestinal type tumours, or a high ratio of intestinal to diffuse type (I:D), is an indicator of high risk areas for stomach cancer [4–6]. The intestinal type decreases as a region experiences a decrease in the incidence of gastric cancer, while no change is seen in the incidence of the diffuse type [7–9].

In East Africa, stomach cancer has generally a low relative frequency of all malignancies. In Tanzania, previous reports have commented on the higher prevalence of stomach cancer in the area around Mount Kilimanjaro [10, 11]. In

this paper we report that the Mount Kilimanjaro area is a high incidence area, with a high I:D ratio, and that tumours of intestinal type are more often seen in females and in a younger population than in the other regions.

Patients and methods

We have studied 440 cases of stomach cancer notified by Kilimanjaro Cancer registry between March 1971 and April 1980. Of these, 279 were histologically proved. In the same study period, 4953 malignant tumours were recorded in the indigenous black population. Forty-eight per cent of the malignancies were biopsies and autopsies of patients treated at the Kilimanjaro Christian Medical Centre (KCMC), 52% were biopsies sent to the pathology department of KCMC from 46 other hospitals in Northern Tanzania.

Kilimanjaro area, or Moshi district of Kilimanjaro region (Fig. 1), provided 30% of the cancer material. It has an area of 5310 square kilometres and a population of 645,630 people

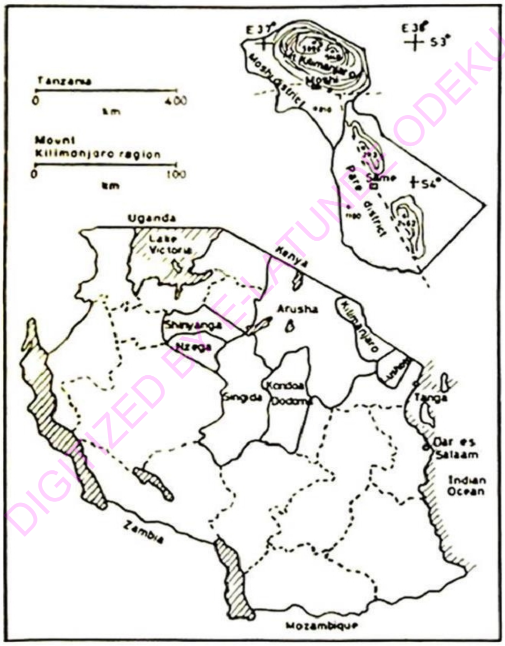

Fig. 1. Map of Tanzania with the regions of Northern Tanzania, and a special map of the Mount Kilimanjaro area.

(mean 1977 estimate). It is the most densely populated rural area in Tanzania, and medical facilities are readily available to most people [11, 12]. There is less underdiagnosis of diseases in the Mount Kilimanjaro area than in the other regions of Northern Tanzania. Most of the population lives on the slopes of the dormant volcano, Mount Kilimanjaro (5896 metres), up to an altitude of 2500 metres. The other regions served by KCMC are plains or plateaus 500–1500 metres high with a few mountain ranges, with an area of nearly 200,000 square kilometres and a population of 4.2 million.

In the Mount Kilimanjaro area, as well as in these other regions, the people are ethnically Bantu, except for the Nilo-Hamitic Masai and Iraqis in parts of the Arusha region. More than 90% of the people in all regions are peasants. There is regular rainfall in this area and the soil is fertile, so the people here have the highest income per capita in Tanzania [12]. In the other regions, the climate is dry and agriculture is not so productive. The people, therefore, belong to the low- or medium-income groups in the country. The diets are basically similar but fresh vegetables, bananas and fruits are more readily available in the Mount Kilimanjaro area than in the other regions.

One of us (P.A.L.) reviewed all the 279 cases in which histology was available. One hundred and thirty-five were of patients coming from the Kilimanjaro area, and 144 were from other regions. Another 161 cases had been diagnosed by radiology. The histological and geographical distribution of the cases is shown in Table 1. For each case, the age, sex and place of residence were obtained from the laboratory forms or from the case files of KCMC.

The histologically proven cases of gastric carcinoma were classified into: intestinal (65.9%), diffuse (23.3%) and unclassified (10.7%) types using Lauren's critieria [1].

The ratio of intestinal type to diffuse type (I:D) in the Mount Kilimanjaro area was compared with that in the other regions, stratified according to age and sex using the Mantel-Haenszel Chi-square test with Yate's correction for continuity [24]. A probability of $P = 0.05$ was used as threshold of significance, using two-tailed tests.

The population-based and age-specific incidence rates were calculated for the Mount Kilimanjaro area alone, from 1975 to 1979. The

figures of the 1976 census and the unofficial figures of the 1967 census were corrected to the mean 1977 estimate [13]. The incidence rates were adjusted for age to the 'African standard population'[14].

Results

The regions of Northern Tanzania could be divided into high, moderate and low risk areas for gastric carcinoma, according to the relative frequency of all tumours (Table 1). The highest proportional frequency, 16.3% for males and 15.1% for females was seen in the Mount Kilimanjaro area, with the two neighbouring regions of Pare and Arusha showing the next highest frequencies. For the Mount Kilimanjaro area, the crude population-based incidence rate per 10^5 was 4.7 for males and 3.9 for females; and the incidences age adjusted to the African standard population were 7.3 and 6.0, respectively.

In the Mount Kilimanjaro area, 95 out of 130 (73%) of the histologically diagnosed tumours were of intestinal type, while in the other regions 83 out of 140 (59%) were of this type (Table 2). There was a higher I:D ratio for both sexes and age groups in this area than in the other regions. Overall, the I:D ratio in the Mount Kilimanjaro area of 4.1, compared with 2.1 in the other regions, was significantly higher (χ^2 (MH) = 4.779, $P < 0.05$). The relative risk of having intestinal type carcinoma was 2.03 times greater for patients who live in the Mount Kilimanjaro area than those who live in the other regions of Northern Tanzania (Table 2).

The preponderance of male patients with stomach carcinoma was less, giving a sex ratio of 1.3 : 1 in the Mount Kilimanjaro area versus 1.9 : 1 in other regions. This was caused by the higher number of intestinal type tumours in females. In this area the I:D ratio in females was 3.1 and in the other regions it was 1.7.

The age distribution of the patients calculated as below or above 40 years is shown in Table 2. The mean age of the patients with intestinal type carcinoma was 2.3 years lower in the Mount Kilimanjaro area than in the other regions, but the mean age of the patients with diffuse type carcinoma was 6.2 years higher in this area than in the other regions. The I:D ratio increased with age, except in females from the Mount Kilimanjaro area who showed a decrease as in those above 40 years. The highest ratio of 6.1 was seen in males above 40 years from the Mount Kilimanjaro area, and the lowest ratios of 0.6 for males and 0.8 for females were seen in those under 40 years from the other regions of Northern Tanzania (Table 2).

In the youngest age groups, below 35 years, 11 out of 14 cancer patients from the Mount Kilimanjaro area had intestinal type tumours, and from the other regions, four out of 13 had this tumour type. In these very young groups, the intestinal type was more common in the Mount Kilimanjaro area than the diffuse type, I:D 3.7 for both sexes, but in the other regions the diffuse type was predominant, I:D 0.4 for both sexes (Table 2).

Discussion

Lauren's classification of stomach carcinomas has been used by several authors in the epidemiological study of these tumours. It has been shown that high incidence areas have a higher proportion of the intestinal type of stomach carcinoma (high I:D ratios), while low incidence areas have a small proportion of such tumours. The intestinal type has, therefore, been called the epidemic type of stomach carcinoma [4, 6, 15]. Indirect methods like this for the estimation of incidences of malignancies are most valuable in developing countries. For many reasons [16] there is a varying amount of underdiagnosis of malignancies in African countries, and this is reflected in the population-based incidence rates of all malignancies registered in these countries (Table 3). In Africa a high proportion of intestinal type stomach carcinoma in high risk regions or population groups is reported from South Africa [17] and Uganda [16].

In the Mount Kilimanjaro area we found that the I:D ratio of 4.1, compared with 2.1 in the other regions of Northern Tanzania, was statistically significant. That the Mount Kilimanjaro area is a high risk area for stomach carcinoma is further supported by the finding that the population-based incidence rates, as well as the relative frequency of stomach carcinoma for this area, are some of the highest recorded in Africa (Table 3).

The lower ratios of I:D in the other regions of

Table 1. Geographical and histological distribution of stomach cancer in Northern Tanzania

Category	Area	Gastric carcinomas			Other malignancies*	No histology	Total	Relative frequency
		Intestinal	Diffuse	Uncertain				(%)
High frequency	Mount Kilimanjaro area	95	23	12	5	104	239	15.8
Moderate frequency	Pare	15	10	3	—	27	55	13.1
	Arusha	20	10	3	—	17	50	6.8
	Lushoto	17	6	3	1	3	30	7.4
	Dodoma	10	8	5	—	7	30	6.9
Low frequency	Singida	6	3	2	2	2	15	3.5
	Shinyanga	2	2	—	—	—	4	1.5
	Others	13	1	1	1	1	17	3.5
Total		178	63	29	9	161	440	8.7

*Carcinoid 2, myosarcoma 4, lymphoma 3.

Table 2. Age and sex distribution of histological types of stomach carcinomas in the Mount Kilimanjaro area and other regions of Northern Tanzania

	Males							Females						
	Total	Mean age	Age distribution					Total	Mean age	Age distribution				
			20–	25–	30–	35–	40+			20–	25–	30–	35–	40+
Mount Kilimanjaro area														
Intestinal[1]	50	52.7	1	1	4	3	49	37	49.7	1	2	2	4	28
Diffuse[3]	11	48.6		1	1	1	8	12	50.0			1	1	10
Unclassified	6					2	4	6			1			5
No histology	56				3	2	51	48				1	1	46
Total	131	53.6	1	2	8	8	112	103	54.2	1	3	4	6	89
I:D ratio	5.3				3.0		6.1	3.1				4.5		2.8
Other regions														
Intestinal[2]	52	54.2		1	2	2	47	31	52.7			1	2	28
Diffuse[4]	22	41.1	1	1	4	3	13	18	45.0	1		2	1	14
Unclassified	11			1	1	2	7	6				1		5
No histology	43			1		3	38	14				2		12
Total	128	49.3	1	4	7	10	105	69	49.1	1		6	3	59
I:D ratio	2.4				0.6		3.6	1.7				0.8		2.0

Distribution of intestinal and diffuse types in the Mount Kilimanjaro area are compared with that in other regions, Mantel-Haenszel χ^2 test analysis stratified by age and sex; χ^2 (MH) = 4.779, $P < 0.05$, d.f. 1.

Relative risk $R = \frac{\Sigma (1 \times 4)/T}{\Sigma (2 \times 3)/T} = 2.03$.

1–4 = Rows and columns used in calculating relative risk in a 2 × 2 table in the Mantel-Haenszel analysis.

Table 3. Incidence of carcinoma of the stomach in some African regions and in American blacks

Region	Age adjusted incidence* rate per 10^5		Relative frequency % of all malignancies		All malignancies: crude incidence rate	
	Male	Female	Male	Female	Male	Female
Mount Kilimanjaro area, Tanzania	7.3	6.0	16.3	15.1	35.2	26.2
Uganda, Kyadondo [14]	2.0	0.8	4.1	1.0	39.4	48.1
Nigeria, Ibadan [23]	4.2	3.7	7.1	4.7	33.7	45.1
Zimbabwe, Bulawayo [23]	5.8	4.3	3.8	4.0	102.1	44.9
South Africa, Natal Africans [22]	6.6	3.6	5.2	3.5	126.8	101.7
California, Blacks [23]	12.0	3.3	6.3	2.6	263.5	204.6
Whites [23]	5.9	3.2	4.0	2.5	355.6	378.4

*Incidences of carcinoma of stomach are adjusted for age to the 'African Standard Population'.

Northern Tanzania indicate that they are either moderate or low risk areas for gastric carcinoma, as could be anticipated from the lower relative frequency of this tumour in these regions. As one moves away from the high risk Mount Kilimanjaro area, there seems to be a gradual decline in the incidence of stomach cancer, such that immediately adjacent areas show a moderate risk, while those farther away are low risk areas (Fig. 1).

The intestinal type of carcinoma is characteristically more prevalent in males and in older age groups, compared with the diffuse type [1]. For example, in Finland with a declining incidence of gastric cancer, the intestinal type has totally disappeared from age groups under 35 years, and the mean age of the patients with intestinal type carcinoma is 8 years higher in males and 8.3 years in females than that of patients with diffuse carcinoma [9]. In the Mount Kilimanjaro area the mean age of the patients with intestinal type carcinoma was only slightly higher than that of patients with diffuse type carcinoma, 51.2 *v.* 49.3 years. In the other regions of Northern Tanzania, corresponding figures show a 10-year difference, 53.5 *v.* 43.1 years.

A much younger population of both sexes with intestinal type carcinoma was present in the high risk area where an excess of young patients, 11 of 14 *v.* 4 of 13 in the other regions, were below 35 years of age. This is a striking characteristic of the disease in this area, which has not been seen in other countries. The high I:D ratio implies that the increase of young patients with cancer not only reflects the youthfulness of an African population [14] but also probably means that a factor, or factors, responsible for this high frequency are operative from early childhood or adolescence.

Several environmental factors have been implicated in the pathogenesis of stomach cancer. Many of the areas with high rates of stomach cancer are geologically young volcanic regions such as Iceland, Japan and Chile [18], and the mountainous areas of Colombia [4]. Mount Kilimanjaro is a dormant volcano, and it is therefore possible that a factor that predisposes to the development of intestinal type stomach cancer is present in the soil of this area but is missing in the lower risk non-volcanic areas around it [6, 19].

Alcohol consumption has been implicated in the pathogenesis of intestinal type carcinoma of stomach in Afro-americans [15]. There are no detailed studies on the pattern of alcohol consumption in Northern Tanzania but generally alcohol made from bananas is more commonly used in the Mount Kilimanjaro area, Arusha and Lushoto. Alcohol intake usually starts from early childhood in these areas. In the low risk areas of Northern Tanzania, alcohol made from cereals is the predominant type and its consumption starts later in adolescence or early adulthood.

Diet is also supposed to have an influence on rates of carcinoma of the stomach. A protective effect of vegetables and fruits has been demonstrated [20] while salty and dried foods seem to have the opposite effect [21]. In the Mount Kilimanjaro area fresh vegetables and fruits are readily available throughout the year, whereas

they are not in most of the lower risk areas. Probably the protective effect by these is offset by other factors present in the Mount Kilimanjaro area.

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