Diet and the risk for colon and breast cancers in native African populations

Alexander RP Walker DSc

Human Biochemistry Research Unit, Department of Tropical Diseases, the South African Institute for Medical Research, Johannesburg, South Africa

In view of transitional changes in life-style, dietary and non-dietary, taking place in Africans in Southern Africa, the following question arises: what changes are occurring in frequencies of cancers of the colon and breast, as affected by alterations in diet and other factors? Studies of incidence rates and other data indicate that colon cancer (and other colonic diseases) remains very uncommon even in urban dwellers. Of the influencing factors put forward, primary protection would seem due to the amount of plant foods eaten, particularly vegetables; a high level of physical activity; and undernutrition in youth. In the case of breast cancer, rare in rural areas and still of low occurrence in urban dwellers, the primary dietary protective factors would appear to be a diet high in fibre and low in fat and, reproductively, early child bearing and high parity, with a high level of physical activity and of undernutrition in youth. However, the implications of most of those factors have been variable in both Western and African populations. As to the future, for the huge masses of African populations the incidences of colon and breast cancers are likely to remain low and rise significantly only in the small prosperous moiety of urban dwellers.

Key words: colon cancer, breast cancer, Africans, epidemiology, diet, risk factors.

Introduction

Transitional changes in life-style, dietary and non-dietary, are taking place to a varying degree in numerous countries in Sub-Saharan Africa.[1,2] In African populations, cancer of the colon,[3] as with other colonic diseases, namely, diverticular disease[4] and appendicitis,[5] are relatively rare, especially in rural dwellers. In contrast, in Western populations their incidence rates are very high,[6–8] although they were much lower at the turn of the century. Regarding breast cancer, while it is very uncommon in rural African women,[9,10] and has a higher rate in urban women, especially those dwelling in big cities,[11–13] the rate remains far lower than that in women in Western populations.[6] In the USA the disease is now the leading cause of death in the 40–55 years age group.[14]

There are two particular reasons for interest in the uncommonness of colon and breast cancers in Africans. Firstly, despite a considerable measure of Westernization of environmental factors, principally occurring in urban dwellers, the incidences of the diseases in Africans still remain very low, in contrast to the huge rises which have occurred, for example, in the prevalence of obesity in women,[15] in hypertension,[16] and in diabetes.[17] A second reason for interest is the tremendously contrasting experience of African-Americans. The incidence rate for colon cancer in men reaches, indeed exceeds, that of white American men,[6] and the incidence rate of breast cancer closely approaches that of white women.

To be succinct, what are Africans in Africa doing right in their low incidences of colon and breast cancers? Conversely, what are Western populations doing wrong in their being so very prone to them? Furthermore, should a fair measure of understanding be reached on the identity of the risk factors which protect Africans, would it be possible for Western populations, including African-Americans, to take meaningful avoiding action or would the requisite changes, involving a degree of reversion in lifestyle, be near impossible to achieve?

In this contribution, the epidemiology of colon and breast cancer in African populations will be discussed, as well as the risk factors involved, particularly in relation to diet, their possible control, and the likely scenario in the future. Corresponding information for Western populations, past and present, is included in order to highlight the contrasts which prevail between the behaviours of prone and less prone populations.

Epidemiology and influencing factors for colonic diseases

In order to enhance the perspective regarding colon cancer, the epidemiological and other situations regarding diverticular disease and appendicitis in Western populations will also be discussed.

Diverticular disease

In Western populations in the past, diverticular disease was infrequent.[7,18] At present, it is the most common disorder of the colon.[7]

In African populations the disease was absent at city hospitals until the 1960s,[4,19,20] and still remains rare among rural patients admitted to hospital.[9,10] Currently at Chris Hani Baragwanath Hospital (3200 beds) in Soweto, which has a

Correspondence address: Dr Alexander RP Walker, South African Institute for Medical Research, PO Box 1038, Johannesburg 2000, South Africa.
Tel: 011 489 9380; Fax: 011 489 9001
Email: alexw@mail.saimr.wits.ac.za

population of 3–4 million Africans and is adjacent to Johannesburg, the admittance rate for local residents is 35 patients per year.

Appendicitis

In the past, appendicitis, as with diverticular disease, was very uncommon in Western populations.[5] Frequency of the disease rose rapidly from just before the turn of the century until approximately 1940–50. Since that time it has fallen to about half of its peak level for reasons not wholly clear. At first the disease caused high mortality, up to 22% for acute appendicitis. Subsequently, however, mortality declined considerably to approximately 0.1% for uncomplicated cases.[21] The disease remains the most common abdominal emergency. In the USA, individuals carry a 7% lifetime risk of developing the disease.[22] Each year there is one admission to hospital per 1000 of population.[23]

Among rural dwellers in African populations the disease is near absent as a cause of admission of patients to hospital.[9,10,24] However, in referral hospitals the numbers of admissions are increasing. At Chris Hani Baragwanath Hospital in 1992 there were 196 admissions for the disease. At Ga-Rankuwa Medical Complex (1600 beds), a major referral hospital near Pretoria which serves a very large area, during 1993–95 there was an average annual admission of 139 patients.[25] In a study on the prevalence of appendicectomy in school pupils of 16–18 years of age, the proportions reported were 1.0% for urban Africans and 13.4% for whites.[26]

Colon cancer

Incidence rates in a variety of populations differing in proneness to colon cancer are given in Table 1. Colon cancer was an uncommon malignancy in Western populations in the past.[27,28] In the USA, although the incidence rate was low early this century,[29] it has risen considerably; at present 6% of the population are likely to develop colon cancer and 3% are likely to die from the disease.[30]

Table 1. Colon cancer: Age standardized incidence rate per 100 000

Population	Men	Women	Reference
Africans			
South Africa colon-rectal*	2.3	2.1	3
Zimbabwe, Harare	6.6	3.0	12
Uganda, Kyadondo	4.2	2.2	11
The Gambia	0.7	0.6	6
USA, Alameda	35.8	29.5	6
Eastern populations			
India, Madras	1.8	1.3	6
China, Shanghai	12.2	10.7	6
Japan, Nagasaki	25.7	15.7	6
Whites			
South Africa colon-rectal	21.0	16.5	3
Zimbabwe, Harare	17.8	14.1	12
USA, Alameda	32.1	22.6	6
UK, Oxford	20.6	17.0	6
Italy, Latina	15.9	12.8	6
Spain, Zaragoza	12.9	10.2	6
Poland, Warsaw	16.0	9.9	6

*The term 'colon-rectal' is used because the South African Cancer Registry does not separate values for colon and rectum cancers. The Registry does not provide data for any of Africa's major cities.

In Africa, the colon-rectal cancer incidence in the African population, generally, is very low.[3,11,12,31,32] However, in the city of Harare, Zimbabwe, which has a population of 1.5 million, the colon cancer rate is slightly higher, although still far lower than those in Western populations.[12] The same situation prevails in Kampala, Uganda.[11]

The low rate of colon cancer in the African populations cited stands in tremendous contrast to the very high incidence rate of African-Americans whose rate, apparently, is the highest extant. In Asian populations there are very low rates of colon cancer among Indians,[31,32] as in those living in Madras, but high rates among Japanese, as in those living in Nagasaki. The incidence rates of colon cancer in some Mediterranean populations are much lower than those in the USA.

Influencing factors

From both descriptive and case-control studies it has been judged that in Western populations the primary protective factor in colon cancer is a high intake of fibre-containing foods. Diets high in vegetables and whole grain products, and with a low polyunsaturated/saturated fat ratio, have been shown to be protective.[33–35] Other dietary factors reported as protective are high intakes of dairy produce,[36] calcium and vitamin D.[37] Physical activity has been found to be protective in some studies,[38] although not in others.[39] A slower rate of growth in youth with lesser height attainment is believed to be protective.[35] Smoking and a high consumption of alcohol appear promotive.[40]

In Africa, no large scale case-control study has been undertaken. In an unpublished initial enquiry of this nature, based on a series of urban patients, no significant differences were found in the parameters mentioned between patients and controls. However, the number studied, 20, was small. Dietetically, a primary characteristic of African populations until very recently has been a very high intake of plant foods and a relatively low intake of animal foodstuffs (Table 2).[41,42] Mean intakes of calcium, dairy produce and vitamin D were, and still are, low. Until recently, levels of smoking and alcohol consumption were low, especially among women. The

Table 2. Breast cancer: Age standardized incidence rate per 100 000

Population	Rates per 100 000	Reference
Africans		
South Africa	12.8	3
Zimbabwe, Harare	20.4	12
Uganda, Kyadondo	16.4	11
The Gambia	3.4	6
USA, Alameda	83.8	6
Eastern populations		
India, Madras	23.5	6
China, Shanghai	26.4	6
Japan, Nagasaki	27.1	6
Whites		
South Africa	63.6	3
USA, Alameda	99.2	6
UK, Oxford	80.9	6
Italy, Latina	50.3	6
Spain, Zaragoza	40.4	6

level of physical activity remains high, particularly among rural dwellers.

Epidemiology and influencing factors for breast cancer

Epidemiology

Breast cancer incidence rates for a number of populations are given in Table 2. While less common in the past, in Western populations breast cancer has increased such that in the USA it is now the leading cause of death of women aged 40–55 years.[14] The disease is less common in the United Kingdom, even less in Mediterranean populations, and still less again in Asian populations.

In all Sub-Saharan African populations breast cancer uniformly is of low occurrence. In South Africa in rural hospitals, annual admissions of patients are reckoned to be approximately 2–3 per 100 000 population served.[9,10] In a rural study in Eastern Cape, the incidence rate was reported to be five per 100 000 of 'world' population.[43] As will be noted, the rate is much higher in city areas, as in Harare[12] and Kampala.[11]

Influencing factors

In Western populations a diet high in fibre and non-polysaccharides and low in fat has been reported to be protective for breast cancer.[35,44–46] Regarding reproduction, protective features are considered to be late menarche, an early age at birth of first child, high parity, long breast feeding practice, early menopause,[47] and not being overweight, at least postmenopausally. These protective factors also apply to African-American women.[48] A high alcohol intake is a risk factor.[49] One favourable feature has been reported to be slower growth in youth and lesser attainment of height.[35] Regarding non-dietary risk factors, there is evidence that physical activity reduces proneness to the disease.[50]

In Western populations there must be recognition that while findings in a number of investigations have supported the importance of the roles of the various risk factors mentioned, the results in others have been conflicting. Thus, regarding lactation, while found to be protective in some studies,[51] in the long term USA nurses study it was concluded that breast feeding and the duration of lactation provided no protective effect against breast cancer.[52] Further, dietetically, although a number of studies have strongly supported the protective role of plant foods,[53] in others no correlation has been found with levels of intakes of nutrients.[54]

In Soweto, South Africa, in a case-control study,[55] some characteristics of a series of 59 African patients were compared with those of 93 controls. Although positive associations were found with nulliparity, body mass index ≥ 30, a genetic component and levels of dietary fat, the association at the 5% level reached significance only in the case of 10 or more years of domestic service in white households.

In Dar-es-Salaam, Tanzania, in a breast cancer case-referent study,[13] in contrast to the reports of others, it was found that breast cancer risk increased with parity; additionally, lactation did not show a significantly protective effect against the disease. Other factors investigated included age at menarche, age at birth of first baby, marital status, age at menopause, and duration of menstruation. However, statistical analysis revealed that none of these factors were significantly associated with breast cancer in the series of women studied.

In fairness, in both of the studies described the numbers of patients and controls investigated were small. As a consequence of the findings, it was urged that a joint inter-African enquiry be conducted to clarify the relationship between different known risk factors, and, simultaneously, to investigate the influence of other variables including socio-economic disparity and changing lifestyles, which may confer risk or protection against this cancer.[13] The authors hoped that the knowledge gained would lead to a better understanding of the disease process. It was also emphasized that the inconsistencies in findings which have been reported between different studies regarding known risk factors and breast cancer make planning for intervention difficult.

Dietary and other practices of Africans

In the Report of the World Cancer Research Fund Committee and the American Institute for Cancer Research, derived from a comprehensive study of research reports, it was concluded that there is 'convincing' evidence regarding the roles of vegetables in preventing colon cancer, and the 'probable' roles of vegetables and fruits in preventing breast cancer.[35] With regard to colorectal cancer, a major review concluded that the potential for its prevention by diet is very great.[56] Attributable population risk estimates from case-control studies suggest that 25–35% of such cancers might be prevented by high intakes of vegetables and fruit, and that 15–25% of colorectal cancers could be attributed to a high fat intake. If followed, recommendations to increase starch and non-starch polysaccharide consumption in the UK by 33%, from 12 to 18 g/day, is likely to increase stool weight by 25% and reduce large bowel cancer incidence on a population level by 15%. Yet, responses to appeals to adopt a 'prudent' diet have been minimal.[57,58]

What is the dietary situation in low risk populations, as among Africans in South Africa? In rural areas the diet varies.[41,42] The very early dietary studies,[59] although limited, indicated that dietary fibre intake was high, 30–35 g daily, and that fat supplied 15–20% of energy. Until relatively recently, the traditional diet with local modifications was and still is followed to a large extent. Broadly, maize, although mainly very refined, is still the staple; it is supplemented in parts with African corn (*Sorghum vulgare)* and wheat products (increasingly white bread). Additional foods include dried peas and beans, groundnuts, pumpkin, African melon, tomatoes, onions, and other vegetables, fruits, and wild greens (e.g. *m'fino, morogo)*. Consumption of fermented cereal products (e.g. *marewu*, 'native' beer) varies greatly. Meat is consumed irregularly, once to twice a week but sometimes more, and milk is usually consumed in small quantities. Rural Africans buy varying, although increasing, amounts of sugar, tea, coffee, soft drinks, condensed milk, margarine, and tinned fish.

In towns, house servants, previously a large but now a very diminishing population, eat much the same foods as their employers. Maize-meal porridge remains popular. Some groups of workers, for example gold and coal miners, are catered for in part by industrial concerns. However, most Africans buy their own food and many eat a partially westernized diet. Bread and maize products are their major

sources of energy. Intakes of sugar, also milk and condensed milk, are increasing. Meat is eaten fairly regularly, two or more times per week. Municipally prepared 'native' beer' (3% alcohol), made from maize and African corn, is popular with men, and to a lesser extent with women. Unfortunately, the consumption of alcohol-containing drinks, home-made or purchased and from both legal and illegal sources, formerly low, is increasing.

Recent characteristics of the diets of present-day rural and urban Africans in Southern Africa are given in Table 3.[41,42]

It will be apparent that, compared with the past, the proportion of energy supplied by fat has risen in both urban and rural populations, and that the converse applies regarding the intake of fibre. A recent but unpublished study carried out on 50 urban adults living in relatively comfortable circumstances (i.e. with one or more members in regular employment) indicated that fat now supplies 30–35% energy, and that fibre intake has fallen to 10–12 g daily, intakes which are comparable to those in many Western countries.

Discussion

While it is disappointing that there is not more unanimity among researchers over the individual responsibility of the risk factors involved, particularly in the case of breast cancer, two points must be kept in mind. On the one hand, there must be recognition that in respect of the most researched of diseases, coronary heart disease (CHD), known risk factors explain only half of the variance in the occurrence of the disease.[60] The same uncertainty applies with regard to most cancers, including breast cancer.[61] Because of this continuing incompleteness of knowledge, there could be unexpected and unexplained rises or even falls in the incidences of the diseases under review. An example in this regard is the 'conundrum' now occurring in Japan, where the incidences of both colon and prostate cancers are falling despite rises in energy and fat intakes.[62] On the other hand, it must be appreciated that despite insufficiencies of information, there is adequate evidence that populations and subpopulations who broadly follow the life-style characteristics recommended have rewarding health experiences. Thus, in Western populations the life-style practices of many Mediterranean populations,[63] especially regarding dietary fibre intake, are consistent with lower incidence rates for several cancers, including those of the colon and breast, compared with the rates prevailing in northern European populations.[6] Furthermore, the favourable cancer statistics of vegetarians[64] and of Seventh Day Adventists[65] are well known.

From what has been described and discussed it would seem reasonable to consider that in the African setting protection from colon and breast cancers is attributable to high fibre/low fat diets, to high levels of physical activity, and in African women to early child bearing and other reproduction practices.

A major protective factor, probably insufficiently taken into account, could well be a degree of undernutrition in childhood.[35] In Africa at present, although more so in the past, a quarter or more of children fall under the 5th percentile of US National Centre for Health Statistics Reference Standards for height and weight for age.[66–68] In a recent review on energy intake and adult mortality from cancer that used the findings in the Boyd Orr Cohort study, it was concluded that animal evidence linking energy restriction with reduced incidence of cancer is in agreement with the association between height, weight and human cancer.[69] In another review it was advanced that energy restriction 'but only early in life' protects against the development of colorectal and breast cancers.[70] Others have emphasized the roles of under- and of overnutrition in relation to their influence on carcinogenesis and other degenerative changes.[71,72] It is interesting to note that at a particular period of dietary change and restriction, as occurred in Norway during World War II, the subsequent incidence of breast cancer was found to be lower than expected among women who had experienced puberty during that period.[73]

Returning to Africans, regarding future hopes for a major rise in the intake of fibre containing foods, the chances are nil. Urban dwellers have no desire whatever to revert to diets of lesser variety and palatability, which were consumed one to two generations ago.[41,42,46] As already indicated, the present fibre intake of both rural and urban dwellers is now only approximately one half of what it was previously. However, it could be added that even with most Western populations no recent significant rises in fibre intake have occurred[57,58] despite the strong recommendations that have been made, initially by the US Senate's 'Dietary Goals for the United States' a generation ago.[74] In the United Kingdom, the current consumption of bread is approximately 120 g per day[75] although double that amount is being recommended.[76] The

Table 3. Dietary intakes of African adults: Mean ± SD

Variable	Rural Vendaland		Urban Cape Town	
	Men	Women	Men	Women
	36.6 ± 10.0*	33.0 ± 6.9*	19–44*	19–44*
Total energy (kcal)	2071 ± 790	1744 ± 725	2020 ± 874	534 ± 667
Total protein (g)	67.5 ± 28.6	66.1 ± 26.3	77 ± 44	56 ± 33
% energy	13.2 ± 3.7	13.2 ± 2.7	15.1	14.5
Total fat (g)	35.8 ± 20.4	49.7 ± 31.6	60 ± 43	49 ± 33
% energy	16.0 ± 8.7	23.3 ± 0.0	25.9	27.0
Total carbohydrate (g)	303.6 ± 141.0	265.3 ± 801	282 ± 128	214 ± 95
% energy	60.8 ± 9.7	55.5 ± 8.8	61.3	62.0
Added sucrose (g)	21.7 ± 34.8	25.6 ± 22.7	50 ± 44	47 ± 34
% energy	4.3 ± 6.5	5.6 ± 4.3	11.0	13.6
Total dietary fibre (g)	21.6 ± 11.2	24.3 ± 9.9	21 ± 15	16 ± 11

*Age (years).

consumption of this foodstuff a century ago[77] was far higher at 500–700 g per day. Moreover, while double the consumption of vegetables and fruit have been advocated,[76] the increases have only been slight.[57,58,78] Furthermore, on an economic level a 'prudent' diet costs more than a usual everyday diet, whether that of Africans or Western populations, and hence is almost precluded for the indigent.[79]

Among the huge African populations, where lesser growth with age is prevalent and likely to continue and with dietary practices and physical activity changing little, the incidences of colon and breast cancer almost certainly will remain low.[80]

Acknowledgements. Gratitude is expressed for financial assistance from the National Cancer Association, Anglo American De Beers Chairman's Fund, and the South African Institute for Medical Research Foundation. Thanks are also due to Mrs BF Walker, Mrs J Halse and Mrs F Adam for library work.

References

1. Walker ARP, Segal I. Health/ill-health transition in less privileged populations: what does the future hold? J R Coll Physicians Lond 1997; 31: 392–395.
2. Walker ARP, Segal I. Effects of transition on bowel diseases in sub-Saharan Africans. Eur J Gastroenterol Hepatol 1997; 9: 207–210.
3. Sitas F, Blaauw D, Terblanche M, Madhoo J, Carrara H. Cancer in South Africa, 1992. Johannesburg: National Cancer Registry, South African Institute for Medical Research, 1997.
4. Segal I, Walker ARP. Diverticular disease in urban Africans in South Africa. Digestion 1982; 24: 42–44.
5. Walker ARP, Segal I. Appendicitis: an African perspective. J R Soc Med 1995; 88: 616–619.
6. Parkin DM, Whelan SL, Ferlay J, Raymond L, Young J. eds. Cancer incidence in five continents, Vol. VII (IARC Scientific Publication no. 143). Lyons: International Agency for Research on Cancer, 1997.
7. Mortensen NJ, Kettlewell MGW. Colonic diverticular disease. In: Weatherall DJ, Ledingham JGG, Warrell DA, eds. Oxford text book of medicine, 3rd edn, Vol. 2. Oxford: Oxford University Press, 1996; 1969–1972.
8. Irving M. The peritonium, omentum, and appendix. In: Weatherall DJ, Ledingham JGG, Warrell DA, eds. Oxford text book of medicine, 3rd edn, Vol. 2. Oxford: Oxford University Press, 1996; 2007–2011.
9. Walker ARP, Dunn MJ, Dunn SE, Walker BF. Causes of admissions of rural African patients to Murchison Hospital, Natal, South Africa. J R Soc Health 1994; 114: 33–38.
10. Kakembo ASL, Walker BF, Walker ARP. Causes of admission of African patients in 1994 to Gelukspan Hospital, North West Province, South Africa. East Afr Med J 1996; 73: 744–749.
11. Wabinga HR, Parkin DM, Wabwire-Mangen F, Mugerwa W. Cancer in Kampala, Uganda, in 1989–91: changes in incidence in the era of AIDS. Int J Cancer 1993; 54: 26– 36.
12. Bassett MT, Chokunonga E, Mauchaza B, Levy L, Ferlay J, Parkin DM. Cancer in the African population of Harare, Zimbabwe, 1990–1992. Int J Cancer 1995; 63: 29–36.
13. Amir H, Makwaya CK, Aziz MR, Jessani S. Breast cancer and risk factors in an African population: a case referent study. East Afr Med J 1998; 75: 268–270.
14. Lerner BH. Fighting the war on breast cancer: debates over early detection, 1945 to the present. Ann Intern Med 1998; 129: 74–77.
15. Walker ARP. Epidemiology and health implications of obesity, with special reference to African populations. Ecol Food Nutr 1998; 37: 21–55.
16. Seedat YK, Seedat MA. An inter-racial study of the prevalence of hypertension in an urban South African population. Trans R Soc Trop Med Hyg 1982; 76: 62–71.
17. Omar MAK, Seedat MA, Motala AA, Dyer RB, Becker P. The prevalence of diabetes mellitus and impaired glucose tolerance in a group of urban South African blacks. S Afr Med J 1993; 83: 641–643.
18. Painter NS, Burkitt DP. Diverticular disease of the colon, a 20th century problem. Baillieres Clin Gastroenterol 1975; 4: 3–7.
19. Segal I, Leibowitz B. The distributional pattern of diverticular disease. Dis Colon Rectum 1989; 32: 227–230.
20. Segal I, Walker ARP, Parekh D. Gastroenterology. In: Huddle K, Dubb A, eds. Baragwanath Hospital: 50 years – A Medical Miscellany. Department of Medicine: Baragwanath Hospital, South Africa, 1994; 17–32.
21. Leading article. A sound approach to diagnosis of acute appendicitis. Lancet 1987; i: 198–200.
22. Wagner JM, McKinney P, Carpenter JL. Does this patient have appendicitis? JAMA 1996; 276: 1589–1594.
23. Rao PM, Rhea JT, Novelline RA, Mostafavi AA, McCabe CJ. Effect of computed tomography of the appendix on treatment of patients and use of hospital resources. N Engl J Med 1998; 338: 141–146.
24. Levy RD, Degiannis E, Kantarovsky A, Maberti PM, Wells M, Hatzitheofilou C. Audit of acute appendicitis in a black South African population. S Afr J Surg 1997; 35: 198– 202.
25. Muthuphei MN, Morwamoche P. The surgical pathology of the appendix in South African blacks. Centr Afr J Med 1998; 44: 9–11.
26. Walker ARP, Walker BF. Appendectomy in South African interethnic school pupils. Am J Gastroenterol 1987; 82: 219–222.
27. Walker ARP, Burkitt DP. Colon cancer: epidemiology. Semin Oncol 1976; 3: 341–350.
28. Colorectal cancer. In: Weatherall DJ, Ledingham JGG, Warrell DA, eds. Oxford text book of medicine, 3rd edn, Vol. 2. Oxford: Oxford University Press, 1996; 1990–94.
29. King WW. Incidence of cancer in America. Lancet 1926; ii: 1020–1024.
30. Simon JB. Should all people over the age of 50 have regular fecal occult-blood tests? N Eng J Med 1998; 338: 1151–1152.
31. Patil P, Elem B, Zumla A. Pattern of adult malignancies in Zambia (1980–1989) in light of the human immunodeficiency virus Type 1 epidemic. J Trop Med Hyg 1995; 98: 281–284.
32. Koulibaly M, Kabba IS, Cisse A. Cancer incidence in Conakry, Guinea: first results from the cancer registry 1992–95. Int J Cancer 1997; 70: 39–45.
33. Ghadirian P, Lacroix A, Maisonneuve P, Perret C, Potvin C, Gravel D, Bernard D, Boyle P. Nutritional factors and colon carcinoma. Cancer 1997; 80: 858–864.
34. Slattery ML, Potter JD, Coates A, Ma K-N, Berry D, Duncan DM, Caan BJ. Plant foods and colon cancer: an assessment of specific foods and their related nutrients (United States). Cancer Causes Control 1997; 8: 575–590.
35. Food, Nutrition and the Prevention of Cancer: a Global Perspective. Washington DC: World Cancer Research Fund/American Institute for Cancer Research, 1997.
36. Lupton JR. Dairy products and colon cancer: mechanisms of the protective effect. Am J Clin Nutr 1997; 66: 1065–1066.
37. Garland C, Shekelle RB, Barrett-Connor E, Criqui MH, Rossof AH, Paul O. Dietary vitamin D and calcium and risk of colorectal cancer: a 19 year prospective study in men. Lancet 1985; i: 307–309.
38. Lee I-M, Manson JE, Ajani U, Paffenbarger RS, Hennekens CH, Buring JE. Physical activity and risk of colon cancer: the Physicians' Health Study (United States). Cancer Causes Control 1997; 8: 568–574.
39. Colditz GA, Cannuscio CC, Frazier AL. Physical activity and reduced risk of colon cancer: implications for prevention. Cancer Causes Control 1997; 8: 649–667.
40. Yamada K, Araki S, Tamura M, Sakai I, Takahashi Y, Kashihara H, Kono S. Case-control study of colorectal carcinoma in situ and cancer in relation to cigarette smoking and alcohol use (Japan). Cancer Causes Control 1997; 8: 780–785.
41. Vorster HH, Venter CS, Menssink E, van Staden DA, Labadarios D, Strydom AJC, Silvis N, Gericke GJ, Walker ARP. Adequate nutritional status despite restricted dietary variety in adult rural Vendas. S Afr J Clin Nutr 1994; 7 (2): 3–16.
42. Bourne LT, Langenhoven ML, Steyn K, Jooste PL, Laubscher JA, Van der Vyver E. Nutrient intakes in the African population of the

Cape Peninsula, South Africa: The BRISK Study. Centr Afr J Med 1993; 39: 238–247.
43. Makaula AN, Marasas WF, Venter FS, Badenhorst CJ, Bradshaw D, Swanevelder S. Oesophageal and other cancer patterns in four selected districts of Transkei, Southern Africa: 1985–90. Afr J Health Sci 1996; 3: 11–15.
44. Marchand LL, Wilkens LR, Hankin JH, Kolonel LN, Lyu L-C. A case-control study of diet and colorectal cancer in a multiethnic population in Hawaii (United States): lipids and foods of animal origin. Cancer Causes Control 1997; 8: 637–648.
45. Rohan TE, Howe GR, Friedenreich CM, Jain M, Miller AB. Dietary fiber, vitamins A, C and E, and risk of breast cancer: a cohort study. Cancer Causes Control 1993; 4: 29–37.
46. Willett WC, Stampfer MJ, Colditz GA, Rosner BA, Hennekens CH, Speizer FE. Relation of meat, fat, and fiber intake to the risk of colon cancer in a prospective study among women. N Engl J Med 1990; 323: 1664–1672.
47. Kampert JB, Whittemore AS, Paffenbarger RSJ. Combined effect of childbearing, menstrual events and body size on age-specific breast cancer risk. Am J Epidemiol 1988; 128: 962–979.
48. Moormeier J. Breast cancer in black women. Ann Intern Med 1996; 124: 897–905.
49. Freudenheim JL, Marshall JR, Graham S, Laughlin R, Vena JE, Swanson M, Ambrosone C, Nemoto T. Lifetime alcohol consumption and risk of breast cancer. Nutr Cancer 1995; 23: 1–11.
50. Brinton LA, Bernstein L, Colditz GA. Summary of the Workshop on Physical Activity and Breast Cancer, November 13–14, 1997. Cancer 1998; 83: 595–599.
51. Byers T, Grahams S, Rzepka T, Marshal J. Lactation and breast cancer: evidence for a negative association in premenopausal women. Am J Epidemiol 1985; 121: 664–674.
52. Michels KB, Willet WC, Rosner BA, Manson JE, Hunter DJ, Colditz GA, Hankinson SE, Speizer FE. Prospective assessment of breast feeding and breast cancer incidence among 89,887 women. Lancet 1996; 347: 431–436.
53. Freudenheim JL, Marshall JR, Vena JE, Laughlin R, Brasure JR, Swanson MK, Nemeto T, Graham S. Premenopausal breast cancer risk and intake of vegetable, fruits, and related nutrients. J Natl Cancer Inst 1996; 88: 340–348.
54. Verhoeven DTH, Assen N, Goldbohm RA, Dorant E, Veer P, Sturmans F, Hermus RJJ, Brandt PAA. Vitamins C and E, retinol, beta-carotene and dietary fibre in relation to breast cancer risk: a prospective cohort study. Br J Cancer 1997; 75: 149–155.
55. Walker ARP, Walker BF, Funani S, Walker AJ. Characteristics of black women with breast cancer in Soweto, South Africa. The Cancer J 1989; 2: 316–319.
56. Bingham SA. Epidemiology and mechanisms relating diet to risk of colorectal cancer. Nutr Res Rev 1996; 9: 197–239.
57. Popkin BM, Siega-Riz AM, Haines PS. A comparison of dietary trends among racial and economic groups in the United States. N Engl J Med 1997; 335: 716–720.
58. Kearney M, Kearney JM, Gibney MJ. Perceived barriers to healthy eating among nationally representative samples of European adults. Proc Nutr Soc 1998; 57: 10A.
59. Labadarios D, Walker ARP, Blaauw R, Walker BF. Traditional diets and meal patterns in South Africa. World Rev Nutr Diet 1996; 79: 70–108.
60. Leeder S, Gliksman M. Prospects for preventing disease. Br Med J 1990; 301: 1004–1005.
61. Marshall E. Search for a killer: focus shifts from fat to hormones. Science 1993; 259: 618–621.
62. Boyle L, Kevi R, Lucchuni F, La Vecchia C. Trends in diet related cancers in Japan: a conundrum? Lancet 1993; 342: 725.
63. Berrino F, Muti P. The Mediterranean diet and cancer. Eur J Clin Nutr 1989; 43 (Suppl. 2): 49–55.
64. Knutsen SF. Lifestyle and the use of health services. Am J Clin Nutr 1994; 59 (Suppl. 5): 1171S–1175S.
65. Snowdon DA. Animal product consumption and mortality because of all causes combined, coronary heart disease, stroke, diabetes, and cancer in Seventh Day Adventists. Am J Clin Nutr 1988; 48: 739–748.
66. Cameron N, Kgamphe JS. The growth of South African rural black children. S Afr Med J 1993; 83: 184–190.
67. Walker ARP, Walker BF. Rises in schoolchildrens' anthropometry: what do they signify in developed and developing populations? J R Soc Health 1998; 118: 159–164.
68. Hamill PVV, Drizd TA, Johnson CL, Reed RB, Roche AF, Moore WM. Physical growth: National Center for Health statistics percentiles. Am J Clin Nutr 1979; 17: 200– 210.
69. Frankel S, Gunnell DJ, Peters TJ, Maynard M, Davey Smith G. Childhood energy intake and adult mortality from cancer: the Boyd Orr study. BMJ 1998; 316: 499–504.
70. Caygill CPJ, Charlett A, Hill MJ. Relationship between the intake of high fibre foods and energy and the risk of cancer of the large bowel and breast. Eur J Cancer Prev 1998; 7 (Suppl. 2): S11–S17.
71. Masoro EJ. Retarding aging process by food restriction: an experimental tool. Am J Clin Nutr 1992; 55 (Suppl.): 1250S–1252S.
72. Kritchevsky D. The effect of over- and undernutrition on cancer. Eur J Cancer Prev 1995; 4: 445–451.
73. Tretli S, Gaard M. Lifestyle changes during adolescence and risk of breast cancer: an ecologic study of the effect of World War II in Norway. Cancer Causes Control 1996; 7: 507–512.
74. US Senate. Dietary Goals for the United States. Washington DC: Select Committee on Nutrition and Human Needs, US Senate, 1977.
75. National Food Survey. Ministry of Agriculture Fisheries and Food. London: Her Majesty's Stationery Office, 1996.
76. Bingham S. Dietary aspects of a health strategy for England. Br Med J 1991; 303: 353– 355.
77. Editorial. Brown versus white bread. Br Med J 1937; 2: 752–753.
78. Krebs-Smith SM. Progress in improving diet to reduce cancer risk. Cancer 1998; 83: 1425–1432.
79. Cade J, Booth S. What can people eat to meet dietary goals: and how much does it cost? J Hum Nutr Dietet 1990; 3: 199–207.
80. Walker ARP. The nutritional challenges in the New South Africa. Nutr Res Rev 1996; 9: 33–65.