

Chapter 1

Cruciferous vegetables

Botanical classification

From the botanical point of view, the term 'vegetable' broadly refers to any plant, whether edible or not (IARC, 2003). In common language, however, it applies to one of the main groups of edible plant foods apart from fruit and cereals. Specific types of vegetables, such as tubers, legumes and pulses, are often considered separately. In epidemiological studies, vegetables are further classified into subgroups, mainly on the basis of their content of nutrients or bioactive compounds. Cultural and culinary groupings are often used in household and nutritional surveys, for reporting food supply and food consumption, as well as in dietary assessments.

The botanical classification of vegetables is based on the structure, organization and physiological characteristics of plants. Cruciferous vegetables belong to the botanical family Brassicaceae, order Capparales (National Resources Conservation Services, 2003). Within this order, there are 16 families, all of which contain glucosinolates; some of these are minor vegetable crops (Mithen, 2001).

Brassicaceae is a large family, with about 3000 species in 350 genera, including several types of edible plants. It was formerly known as Cruciferae or Cruciferaceae, and is sometimes referred to as 'the cabbage family' or 'the mustard family', after the names of some of its components. The



petals of plants of this family have a distinctive cruciform arrangement, which is the origin of the terms 'Cruciferae' and 'cruciferous'. These plants can be annuals, biennials or perennials. They are well adapted to average temperatures of 16–18 °C and are thus grown during the cool season in temperate areas. Crops of Brassicaceae are distributed mainly in temperate regions of the Northern Hemisphere: in areas of Southwest Asia, China and Japan, Europe, the Mediterranean region and North America.

Despite the great diversity among the Brassicaceae, members of only a few genera are eaten. The most commonly eaten cruciferous vegetables belong to the genus *Brassica*, and many belong to several varieties of the species *B. oleracea*, including cabbage, cauliflower, broccoli and Brussels sprouts. Other edible species in the genus *Brassica* are *B. rapa* and *B. napus*, which include, respectively, Chinese cabbage and rape. Other cruciferous vegetables used in the human diet, such as radish and cress, belong to other genera of the Brassicaceae family. A list of the main cruciferous

Table 1. Main cruciferous vegetables in the human diet: Scientific and common names

Genus	Species and variety	Common name
<i>Brassica</i>	<i>B. oleracea</i> var. <i>botrytis</i>	Cauliflower
	<i>B. oleracea</i> var. <i>capitata</i>	Cabbage, white cabbage
	<i>B. oleracea</i> var. <i>costata</i>	Portuguese cabbage
	<i>B. oleracea</i> var. <i>gemmifera</i>	Brussels sprouts
	<i>B. oleracea</i> var. <i>gongyloides</i>	Kohlrabi, turnip cabbage, stem turnip
	<i>B. oleracea</i> var. <i>italica</i>	Broccoli
	<i>B. oleracea</i> var. <i>rubra</i>	Red cabbage
	<i>B. oleracea</i> var. <i>sabauda</i>	Savoy cabbage
	<i>B. oleracea</i> var. <i>sabellica</i>	Curly kale
	<i>B. oleracea</i> var. <i>viridis</i>	Kale, collards
<i>B. oleracea</i> var. <i>alboglabra</i>	<i>Kai lan</i> , Chinese kale	
<i>Brassica</i>	<i>B. rapa</i> var. <i>chinensis</i>	Chinese cabbage, <i>pak-choi</i> , <i>bok choi</i>
	<i>B. rapa</i> var. <i>oleifera</i>	Turnip rape
	<i>B. rapa</i> var. <i>pekinensis</i>	Chinese cabbage, <i>pe-tsai</i> , Napa cabbage, celery, cabbage
	<i>B. rapa</i> var. <i>rapa</i>	Turnip
	<i>B. rapa</i> var. <i>parachinensis</i>	<i>Choi sum</i>
<i>Brassica</i>	<i>B. napus</i> var. <i>napobrassica</i>	Swede, Swedish turnip, rutabaga
	<i>B. napus</i> var. <i>oleifera</i>	Rape, canola, colza
<i>Brassica</i>	<i>B. alba</i>	White mustard
	<i>B. juncea</i>	Indian mustard, brown mustard, spinach mustard
	<i>B. juncea</i> var. <i>rugosa</i>	<i>Kai choi</i>
	<i>B. nigra</i>	Black mustard
<i>Raphanus</i>	<i>R. sativus</i>	Radish
<i>Armoracia</i>	<i>A. rusticana</i>	Horseradish
<i>Nasturtium</i>	<i>N. officinalis</i>	Watercress
<i>Lepidium</i>	<i>L. sativum</i>	Cress, garden cress
<i>Eruca</i>	<i>E. vesicaria</i>	Arugula, rocket, Italian cress
<i>Wasabia</i>	<i>W. japonica</i>	Wasabi
<i>Beta</i>	<i>B. vulgaris flavescens</i>	Swiss chard
<i>Crambe</i>	<i>C. abyssinica</i>	Crambe

vegetables with their botanical classification is given in Table 1 (National Resources Conservation Services, 2003).

Estimated intake by region and country

Methods used

Consumption of cruciferous vegetables in several countries and world regions was assessed from published data. To ensure that the information was up-to-date and took into account

any time trends in intake, only papers published in 1993 or later were included; when two or more papers reported data on the same population or study, the most recent one was used. A review based on data that were originally published before 1993 was therefore also used. The two main criteria for including a paper were that intake of cruciferous vegetables was explicitly reported or could be easily estimated from the data, and that the population to which the consumption applied was clearly identified. Furthermore, the search was restricted to

adult populations. The results and the main features of the studies included are summarized in Table 2.

Various methods are used for estimating food intake, as reviewed in the *Handbooks of Cancer Prevention* on fruit and vegetables (IARC, 2003). Usually, data on dietary intake are derived from dietary surveys of representative populations. In most of these studies, however, data on energy and nutrient intake and on the consumption of main food groups are reported, while individual food consumption or the intake of specific subgroups is not.

Table 2. Estimated intakes of cruciferous vegetables by control subjects in epidemiological studies

Reference	Country	Sex	Age (years)	Type of study and no. of controls	Diet information method	Cruciferous vegetables included	Mean or median	Intake (g/day)	Proportion of all vegetable intake (%)
Asia									
Bosetti <i>et al.</i> (2002)	Japan	M, W	NR	CC, 365	FFQ	Broccoli, cabbage, radish, turnip, mustard greens	Mean	83.5	21.2
Memon <i>et al.</i> (2002)	Kuwait	M, W	≤ 70	CC, 311	FFQ, 13 items	Broccoli, Brussels sprouts, cabbage, cauliflower	Median	59.8	NR
National Institute of Health & Nutrition (2002)	Japan	M, W	30–70	Survey, no. not given	Household food intake	Cabbage, Chinese cabbage, Japanese radish	Mean	59.8	8.1
Seow <i>et al.</i> (2002a)	Singapore	M, W	45–74	CC, 1194	Semi-quantitative FFQ, 165 items	Chinese white cabbage, Chinese mustard, Chinese flowering cabbage, watercress, Chinese kale, head cabbage, celery cabbage, broccoli, cauliflower	Mean	W: 43.4 M: 42.1	NR
Shannon <i>et al.</i> (2002)	Thailand	W	30–60	CC, 509	FFQ, 80 items	Cruciferous, unspecified	Median	46.3	NR
Chiu <i>et al.</i> (2003)	Shanghai, China	M, W	30–74	CC, 1552	FFQ, 86 items	<i>Bok choy</i> , cabbage, Chinese cabbage, cauliflower	Median	W: 102.4 M: 101.8	W: 24.4 M: 24.2
Rajkumar <i>et al.</i> (2003)	Southern India	M, W	18–80	CC, 582	FFQ, 21 items	Cruciferous, unspecified	Median	17.1	15
North America									
Lin <i>et al.</i> (1998)	Southern California, USA	M, W	50–74	CC, 507	Semi-quantitative FFQ, 126 items	Broccoli, Brussels sprouts, cabbage, kale, coleslaw, cauliflower, mustard, chard greens	Mean	40	11.7
Yuan <i>et al.</i> (1998)	Los Angeles, USA	M, W	25–75	CC, 1204	FFQ, 90 items	Broccoli, cabbage, coleslaw, Brussels sprouts, collard, kale, mustard, turnip greens	Median	29.7	NR

Table 2 (contd)

Reference	Country	Sex	Age (years)	Type of study and no. of controls	Diet information method	Cruciferous vegetables included	Mean or median	Intake (g/day)	Proportion of all vegetable intake (%)
Cohen <i>et al.</i> (2000)	Seattle, USA	M	40–64	CC, 602	FFQ, 99 items	Broccoli, coleslaw, cabbage, sauerkraut, Brussels sprouts, cauliflower	Geometric mean	20.5	9.6
Feskanich <i>et al.</i> (2000)	Boston, USA	M, W	W: 30–55 M: 40–75	Prospective: W: 77 283 M: 47 778	Semi-quantitative FFQ, 116 items (W), 131 items (M)	Broccoli, cabbage coleslaw, sauerkraut, cauliflower, Brussels sprouts, kale, mustard, chard greens	Median	32.0	14.3
Johnston <i>et al.</i> (2000)	USA	M, W	25–75	Survey, 4806	Two non-consecutive 24-h recalls	Broccoli, cauliflower, kale Brussels sprouts	Mean	16	5.6
Kolonel <i>et al.</i> (2000)	Canada & USA	M	65–84	CC, 1618	Diet history	Broccoli, Brussels sprouts, green mustard cabbage, head cabbage, mustard greens, <i>pak-choi</i> , red cabbage, turnip greens, watercress, <i>won bok</i>	Median	29	15.4
Slattery <i>et al.</i> (2000)	USA, several areas	M, W	> 55	CC, 1989	Diet history	Broccoli, Brussels sprouts, cauliflower, cabbage, coleslaw, greens, turnip, rutabaga	Mean	30.8	
Smith-Warner <i>et al.</i> (2000)	Minnesota, USA	M, W	30–74	Randomized controlled trial, 101	Diet records	Cruciferous, unspecified	Mean	26.4	8.9
Spitz <i>et al.</i> (2000)	Texas, USA	M, W	60.9 (mean)	CC, 465	Semi-quantitative FFQ, 135 items	Broccoli, cauliflower, Brussels sprouts, coleslaw, cabbage, sauerkraut, mustard greens, turnip greens, collard greens, kale	Mean	29.1	NR
Lanza <i>et al.</i> (2001)	USA	M, W	35–89	Intervention, 1042	FFQ & 4-day food records	Cruciferous, unspecified	Mean	23.6	8.9

Table 2 (contd)

Reference	Country	Sex	Age (years)	Type of study and no. of controls	Diet information method	Cruciferous vegetables included	Mean or median	Intake (g/day)	Proportion of all vegetable intake (%)
Bosetti <i>et al.</i> (2002)	Hawaii, USA	M, W	NR	CC, 441	FFQ	Broccoli, cabbage, Chinese cabbage, cauliflower, Brussels sprouts, turnip, rutabaga, mustard cabbage, Swiss chard	Mean	33.2	14.8
	Connecticut, USA	M, W	NR	CC, 184	FFQ	Brussels sprouts, broccoli, cabbage	Mean	28.5	NR
Smith-Warner <i>et al.</i> (2002)	Minnesota, USA	M, W	30–74	CC, 1237	Semi-quantitative FFQ, 153 items	Broccoli, cabbage, cauliflower	Mean	W: 38.8 M: 27.5	W: 12.6 M: 10.3
Cerhan <i>et al.</i> (2003)	Iowa, USA	W	55–69	Prospective, 29 368	Semi-quantitative FFQ, 127 items	Cabbage, cauliflower, broccoli	Median	27.5	12.1
South America									
Pacin <i>et al.</i> (1999)	Argentina	M, W	18–50	Survey, 449 W, 378 M	24-h recall	Broccoli	Mean	W: 2.43	NR
Atalah <i>et al.</i> (2001)	Chile	M, W	> 20	CC, 1066 W, 547 M	FFQ, 58 items	Cabbage, cauliflower, broccoli, Brussels sprouts	Median	W: 11.1 M: 14.3	W: 5.0 M: 6.6
Australia									
Nagle <i>et al.</i> (2003)	Australia	W	18–79	CC, 609 cases	Semi-quantitative FFQ, 119 items	Broccoli, cauliflower, cabbage coleslaw, Brussels sprouts	Median	49.6	13.1
Europe									
Bosetti <i>et al.</i> (2002)	Sweden	M, W	NR	CC, 252	FFQ	Cabbage, broccoli, Brussels sprouts, cauliflower	Mean	11.5	14.7
	Norway	M, W	NR	CC, 173	FFQ	Cabbage, broccoli, Brussels sprouts, cauliflower	Mean	17.2	23.1
	Italy	M, W	NR	CC, 617	FFQ	Cruciferous, unspecified	Mean	11.5	6.9
	Switzerland	M, W	NR	CC, 412	FFQ	Cruciferous, unspecified	Mean	11.5	6.7
	Greece	M, W	NR	CC, 140	NR	Broccoli, cauliflower	Mean	5.7	7.8

Table 2 (contd)

Reference	Country	Sex	Age (years)	Type of study and no. of controls	Diet information method	Cruciferous vegetables included	Mean or median	Intake (g/day)	Proportion of all vegetable intake (%)
Terry <i>et al.</i> (2002)	Sweden	W	50–74	CC, 2887	FFQ	Cabbage, Chinese cabbage, broccoli, cauliflower	Median	28.5	NR
Michaud <i>et al.</i> (2002)	Finland	M	50–69	Prospective, 27 111	FFQ, 276 items	Broccoli, cauliflower, cabbage, Brussels sprouts, rutabaga	Median	9.7	9.8
Voorrips <i>et al.</i> (2000a)	Netherlands	M, W	55–69	Prospective, 1497 W, 1456 M	Semi-quantitative FFQ, 150 items	Brussels sprouts, kale, cauliflower	Mean	W: 31.6 M: 32.7	W: 16.5 M: 17.5
Africa Steyn <i>et al.</i> (2003)	South Africa	M, W	≥ 10	National food survey, no. not given	FFQ, 24-h recall	<i>Brassica</i>	Mean	15.0	16.5

M, men; W, women; CC, case-control study; FFQ, food frequency questionnaire; NR, not reported

Most of the data in this Handbook come from analytical studies of the effects of intake of cruciferous vegetables on several disease outcomes; these are mainly case-control studies, with some intervention studies. From these studies, data for the controls or the reference group were used. In prospective or intervention studies, estimates are made from information collected at baseline. It should be borne in mind that the results are for specific populations and are not necessarily representative of the country in which the study was conducted.

In this Handbook, intake of cruciferous vegetables is always expressed in grams per day, as the mean or the median of consumption, depending on how it was reported in the original work or on the data available. Intake of cruciferous vegetables was estimated directly in grams in a

few cases, but usually it was reported in servings per day or per week. Except when the authors explicitly stated the portion size assigned to a serving, it was assumed that a standard serving of vegetables corresponds to 80 g (Williams, 1995; Department of Health and Human Services, 2000). Usually, consumption of cruciferous vegetables was reported for both sexes together; when the data were available, separate estimates are given for men and women. In addition to the absolute amount, the consumption of cruciferous vegetables is given as the proportion of total vegetable intake, when the information was available for such a calculation.

In order to improve the interpretability of the results, the following data were reported: place, sex and age of the population studied, type

and size of study, method used to assess intake of cruciferous vegetables and the individual foods considered within the group 'cruciferous vegetables'.

Various countries and regions

In the studies that were reviewed (Table 2), the highest intake of cruciferous vegetables was reported to be that of people in Shanghai, China, who consumed more than 100 g/day, representing about one-fourth of their total vegetable intake (Chiu *et al.*, 2003). Other Asian and some Middle Eastern populations (in Japan, Singapore and Thailand and Kuwait) had relatively high intakes of cruciferous vegetables, ranging from 40 to 80 g per day (Bosetti *et al.*, 2002; Memon *et al.*, 2002; National Institute of Health and Nutrition, 2002; Seow *et al.*, 2002a; Shannon *et al.*, 2002); the only study

carried out in India (Rajkumar *et al.*, 2003) showed a lower daily intake, of about 17 g. Studies in China (Chiu *et al.*, 2003) and Singapore (Seow *et al.*, 2002a) that gave separate estimates for men and women, showed similar intake by sex.

Studies of cruciferous vegetable intake in North America covered a variety of populations (Table 2). Overall, the daily estimated consumption was about 25–30 g, with a range of 16–40 g, representing 5–15% of total vegetable intake. Although most of the studies included both men and women, only one gave separate results, showing higher consumption by women (38.8 g per day) than by men (27.5 g per day). Two studies in South America showed low consumption of cruciferous vegetables, with 2.4 g per day for women in Argentina (Pacin *et al.*, 1999) and 14 g per day for men and 11 g per day for women in Chile (Atalah *et al.*, 2001).

The only study with data for Australia was a case–control study of women with ovarian cancer (Nagle *et al.*, 2003), who were reported to have a consumption of 49.6 g per day, comparable to the intake observed in most Asian countries.

In Europe, the lowest intake of cruciferous vegetables was reported for Greece, at 5.7 g per day (Bosetti *et al.*, 2002), whereas the estimates for Finland, Italy, Norway, Sweden and Switzerland were between 10 and 30 g per day (Bosetti *et al.*, 2002; Terry *et al.*, 2002). The results of two prospective studies in which information on diet was based on answers to extensive, detailed questionnaires showed an estimated intake of 9.7 g per day in Finland (Michaud *et al.*, 2002) and a daily consumption of 32.7 g by men and 31.6 g by women in The Netherlands (Voorrips *et al.*, 2000a).

In one study performed in South Africa, the combined results of several surveys among adults showed a mean

consumption of *Brassica* vegetables of 15 g per day (Steyn *et al.*, 2003).

European countries

The European Prospective Investigation into Cancer and Nutrition (the EPIC study) is a multicentre prospective study being carried out in 27 centres in 10 countries of Europe (Riboli *et al.*, 2002). Information on intake of cruciferous vegetables, obtained from a 24-h dietary recall interview, is available for a subset of 35 644 persons, about one-third of whom were men (36%) and two-thirds women (64%) with mean ages of 57 and 55 years, respectively. The participants were interviewed during 1 year between 1995 and 2000, on any day of the week. The quality of the instrument and the logistics of the study resulted in valid, reliable and comparable data on dietary consumption across countries. Further details about the study and the participants have been given elsewhere (Slimani *et al.*, 2002). The results presented below were derived from an extension of analyses previously reported for all vegetables (Agudo *et al.*, 2002). Although most of the participants represented the general population, the estimates given below cannot be considered to reflect intake in a particular country.

Geographical pattern

The average daily consumption of cruciferous vegetables by the participants in each country is shown in Table 3. Overall, intake was about 21 g per day. Consumption by country varied markedly: intake in the United Kingdom was reported to be about three times that in Spain, which had the lowest intake. Three groups of countries can be distinguished: participants in Germany, Norway and the United Kingdom ate more than 30 g per day; those in France and The Netherlands ate between 20 and 30 g daily; and those in Denmark, Greece, Italy, Spain

and Sweden ate between 10 and 20 g per day. The pattern was consistent for individual centres and countries as a whole (results not shown).

This geographical pattern is quite different from that of consumption of all vegetables, which shows a clear south–north gradient (Agudo *et al.*, 2002): consumption of cruciferous vegetables is high in countries of central Europe and Great Britain, while the lowest intake is seen in countries of southern Europe, with intermediate intake in France. The Scandinavian countries show differences in consumption, with a high intake in Norway and an intake in Sweden similar to that in southern countries. The discrepancy between intake of cruciferous and of all vegetables is even clearer when expressed as a proportion: about 13% of all vegetables eaten are of the cruciferous type, but cruciferous vegetables constitute more than 20% of total vegetable intake in countries with high consumption and account for only 5–10% in countries with low consumption.

Overall, about 80% of all cruciferous vegetables are eaten cooked by both men and women. Raw preparations represent 30–40% of cruciferous vegetable intake in Greece, Norway and Sweden and less than 10% in other countries (Figure 1). This pattern does not, however, appear to be related to the amount consumed but to the way all vegetables are eaten, and thus to the eating habits in each country.

Cruciferous vegetables eaten

Table 4 shows the contributions of individual cruciferous vegetables to total consumption. Of the 21 items reported, cauliflower was the most commonly consumed variety, accounting for 25% of the total; 'cabbage', comprising white cabbage, the commonest variety, plus unspecified cabbage, accounted for another 25%, and broccoli accounted for 18%. These three

Table 3. Consumption of cruciferous vegetables by participants in the EPIC study

Country	No. of participants	Intake (g/day)		
		Mean	Standard error	Proportion of total vegetable intake (%)
Denmark	3918	18.9	0.9	13
France ^a	4639	23.5	0.8	11
Germany	4418	30.2	0.9	18
Greece	2686	13.4	1.1	6
Italy	3956	18.4	0.9	9
Netherlands	3984	26.8	0.9	20
Norway ^a	1798	32.2	1.4	26
Spain	3220	12.0	1.0	6
Sweden	6050	15.8	0.8	13
United Kingdom	975	34.4	1.9	21

Means and standard errors adjusted by age, day of the week, season and sex when the two were combined

^a Only women

Table 4. Consumption of cruciferous vegetables by participants in the EPIC study, as a proportion of total vegetable intake

Cruciferous vegetable	Proportion of all vegetables	
	%	Cumulative %
Cauliflower (including romanesco)	25	25
Broccoli	18	43
White cabbage	13	56
Cabbage, unspecified	12	68
Radish	6	74
Brussels sprouts	6	80
Red cabbage	5	84
Swede, Swedish turnip, rutabaga	4	88
Turnip	3	91
Other (12 items)	9	100

Only cruciferous vegetables accounting for at least 90% of total consumption are listed.

represented more than two-thirds of all cruciferous vegetables eaten.

Most of the cruciferous vegetables (90%) eaten by participants in the EPIC study belonged to the genus *Brassica*; cruciferous vegetables belonging to other genera accounted

for more than 10% (22.3%) of intake only in France (Figure 2). Within the genus *Brassica*, several varieties and subspecies of the species *B. oleracea* (including cauliflower, cabbage and broccoli) predominated in most European countries.

Two or three commonly eaten cruciferous vegetables accounted for one-half of total intake, and six or fewer accounted for about 90%. In countries with the lowest absolute intake, there was also less variety in the vegetables eaten: only eight items were reported to be eaten in Greece and Spain, and only four accounted for more than 90% of total consumption. France was the only country where a frequently eaten cruciferous vegetable did not belong to the genus *Brassica*: radish (*Raphanus sativus*) accounted for 19% and ranked second. In Norway, the most commonly eaten cruciferous vegetable was rutabaga (*B. napus* var. *napobrassica*), which accounted for 27% of total intake, and this the only country where the most commonly consumed cruciferous vegetable was not a variety of *B. oleracea*.

Intake by sex, age and smoking habit

Table 5 shows the intake of cruciferous vegetables according to sex, age and smoking habits in the EPIC study. All the means were adjusted by day of the week, season and centre. No difference in cruciferous vegetable intake was found between men and women. Differences in consumption were seen by age but might reflect differences in recruitment among countries. Current smokers ate an average of 20 g per day of cruciferous vegetables, while former smokers and lifelong non-smokers ate 21 g per day. Nevertheless, the overall differences by smoking status did not reach statistical significance.

Production

Information on the production of cruciferous vegetables between 1961 and 2000 in selected regions of the world is shown in Figure 3. Total production (3a) and production per capita (3b) show similar trends. The highest

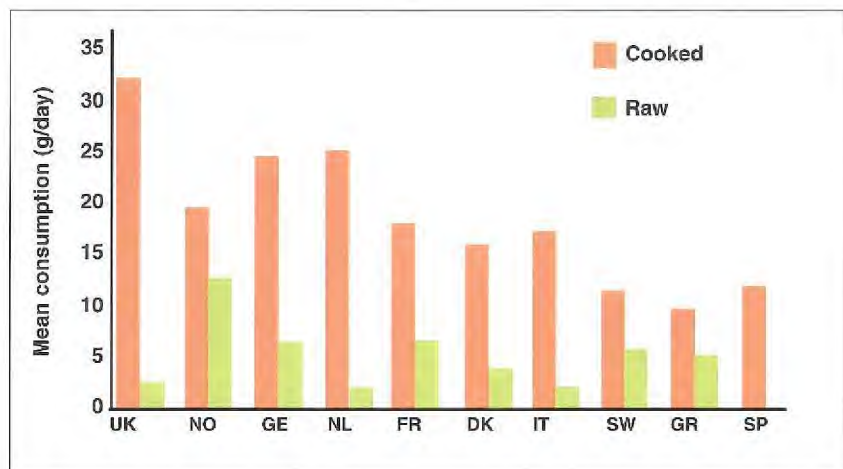


Figure 1 Mean consumption of cruciferous vegetables, cooked and raw, by participants in 10 countries in the EPIC study

UK, United Kingdom; NO, Norway; GE, Germany; NL, Netherlands; FR, France; DK, Denmark; IT, Italy; SW, Sweden; GR, Greece; SP, Spain

Table 5. Consumption of cruciferous vegetables by participants in the EPIC study, by sex, age and smoking habit

	No. of participants	Mean consumption (g/day)
Sex		
Men	12 917	20.8
Women	22 727	21.4
Age (years)		
35–44	3 302	18.7
45–54	12 431	20.3
55–64	14 799	22.5
65–74	5 102	21.2
Smoking status		
Never	17 160	21.3
Former	10 138	21.5
Current	7 668	20.3

Intake adjusted by centre, day of the week and season and by age and sex for smoking status

production volume was in eastern Europe, with little variation over time. A decreasing trend in production was seen in some regions over time, from 18% to 9% in western Europe and from 22% to 9% in Australia and New Zealand. The production volume in South and South-East Asia increased from about 10% in 1961 to 15% in 1980 and then fell to 10% in 2000. In Canada and the USA, cruciferous vegetables accounted for about 7% of all vegetable production. Per capita production changed little over time, except in western Europe, where it decreased from 20 to 13 kg per person per year, and in East and South-East Asia, where it increased from 7 to 19 kg per person per year.



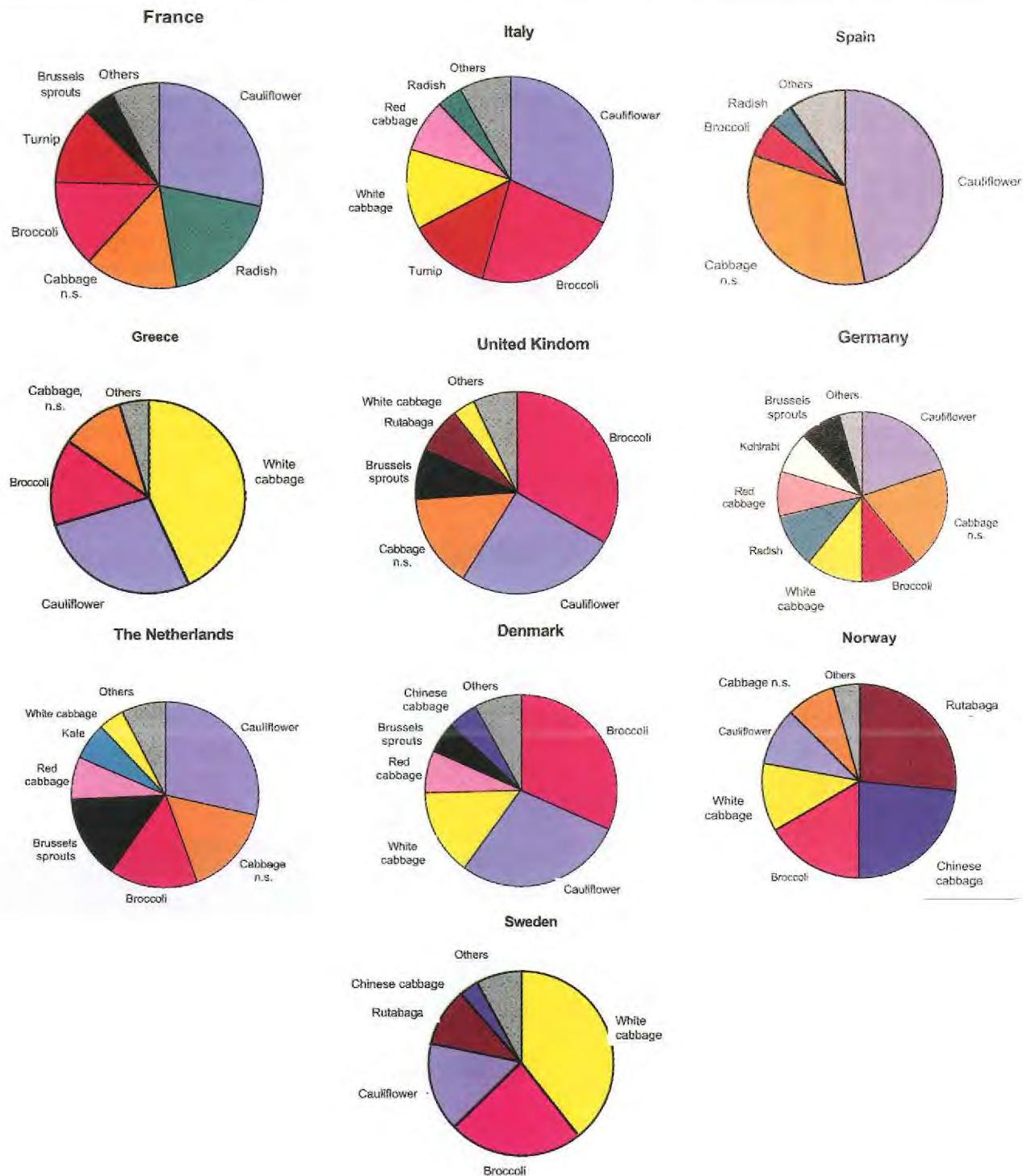


Figure 2 Consumption of cruciferous vegetables by participants in the EPIC study, as a proportion of consumption of all vegetables. Only women in France and Norway. Proportions for the United Kingdom exclude vegetarians. n.s., not specified

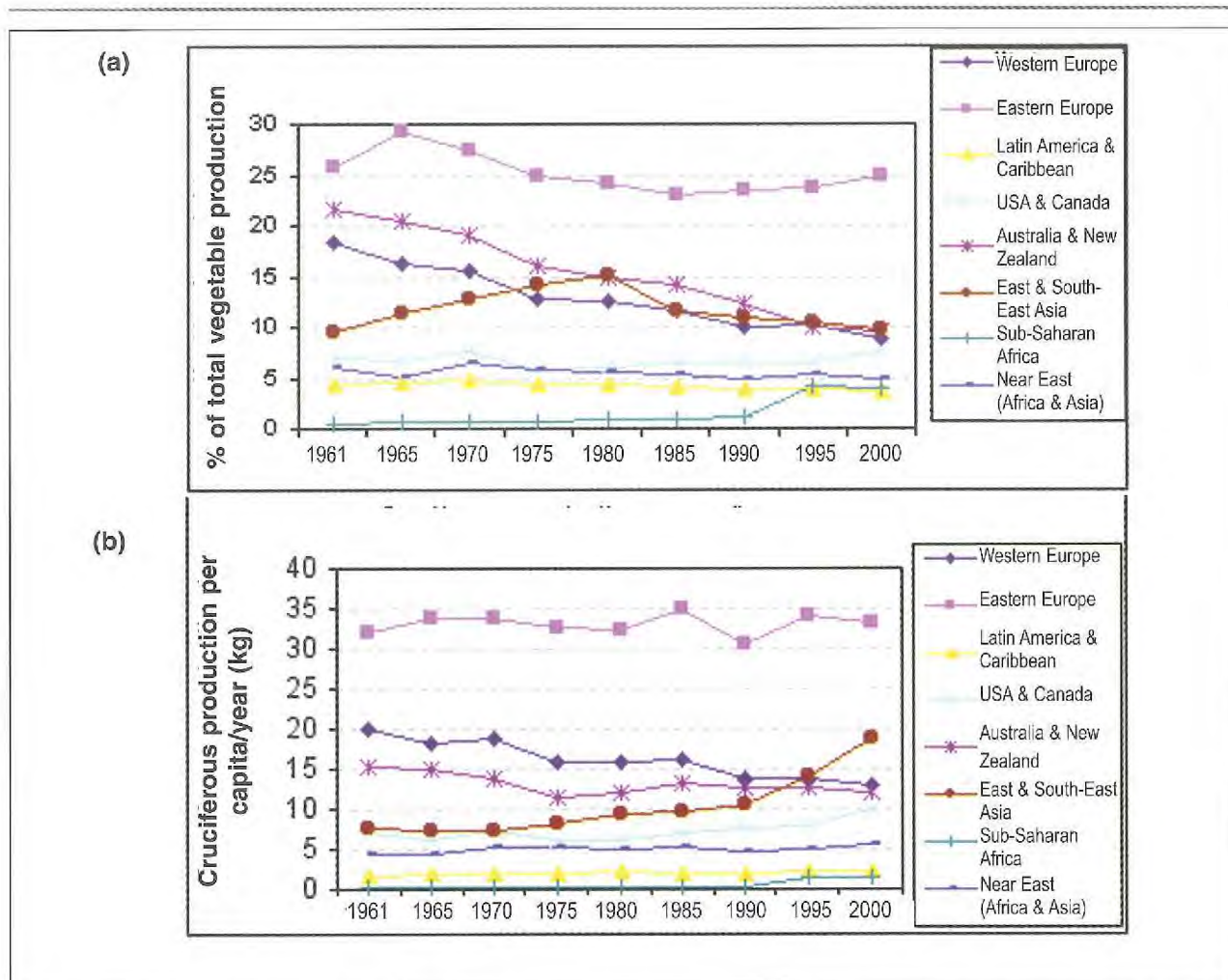


Figure 3 Production of cruciferous vegetables in selected regions worldwide: (a) relative to all vegetables and (b) per capita production

Sources: a) FAOSTAT (2000); b) FAOSTAT (2000), United Nations (2002)

The regions defined by FAO do not correspond exactly to those defined by the United Nations; furthermore, there are discrepancies in the countries included in western Europe, the near East and sub-Saharan Africa by the two bodies.

'Sub-Saharan Africa' comprises: all countries south of the Sahara Desert except South Africa, West Sahara and Sudan, which are included in the FAO data but not those from the United Nations.

East and South-East Asia comprise: Brunei Darussalam, Cambodia, China, Democratic People's Republic of Korea, Indonesia, Japan, Democratic Lao People's Republic, Malaysia, Mongolia, Myanmar, Philippines, Singapore, Thailand, Timor Leste and Viet Nam. Note that the data for China are not reliable.

'Near East' comprises: Algeria, Afghanistan, Azerbaijan, Bahrain, Cyprus, Egypt, Georgia, Palestine, Islamic Republic of Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Morocco, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, Turkey, United Arab Emirates and Yemen. Azerbaijan, Georgia, Israel and Palestine are included in the United Nations data but not in those from FAO.

'Eastern Europe' comprises: Albania, Bosnia Herzegovina, Bulgaria, Croatia, Czech Republic, Hungary, Macedonia, Poland, Romania, Serbia-Montenegro, Slovakia and the former Yugoslavia.

Western Europe includes: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.