

Fruit and vegetable availability among ten European countries: how does it compare with the ‘five-a-day’ recommendation?*

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Recasting the role of fruit and vegetables (F&V) in the diet, and planning national and international campaigns to enhance their consumption are major public health service objectives. The present study seeks to describe F&V availability patterns in ten European countries and examine compliance with current recommendations. The mean and median F&V availability (g/person per d) was estimated based on household budget survey data retrieved from the Data Food Networking (DAFNE) databank. Low F&V consumers were identified based on WHO international recommendations (minimum combined F&V intake of about 400 g/person per d) and current conservative guidelines of a minimum daily intake of three portions of vegetables and two portions of fruit. Considerable disparities in F&V availability were found among the surveyed European populations. Only in Mediterranean countries did the mean daily population intake clearly exceed combined F&V recommendations. Dietary patterns were positively skewed in all populations studied, on account of the presence of exceptionally high values among segments of the populations. Moreover, the correlation was unexpectedly weak between the proportion of low fruit and low vegetable consumers (Spearman's correlation coefficient +0.18). More than 50% of the households in the surveyed populations are likely to consume less than the recommended daily vegetable intake of three portions, and this applies even to the two Mediterranean populations. The efficiency of F&V promoting strategies may be enhanced if F&V are addressed separately; furthermore, interventions that would specifically focus on vegetables are probably needed.

Nutrition policy: Household budget surveys: Fruit and vegetable availability

Abbreviations: DAFNE, Data Food Networking; F&V, fruit and vegetables; HBS, household budget surveys.

* The German household budget survey data used in the DAFNE project (German contract database) do not necessarily correspond to the non-anonymised statistical microdata from which the contract database was prepared. The British household budget survey data is Crown copyright. It has been made available by the Office for National Statistics (ONS) through the Data Archive, based at the University of Essex. Neither the ONS nor the Data Archive bear any responsibility for the analysis or interpretation of the data reported here.

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Epidemiological data strongly suggest a protective effect of increased fruit and vegetable (F&V) consumption against several common neoplasms, especially of the respiratory and alimentary tract. An inverse association has been also noted between F&V intake and CHD, stroke, cataracts and birth defects (Steinmetz & Potter, 1991a; Block *et al.* 1992; Willett, 1994). Metabolic and animal data have also indicated variable benefits of F&V consumption (Steinmetz & Potter, 1991b, 1996). The responsible nutrient and non-nutrient constituents, however, remain poorly understood (Zino *et al.* 1997).

Virtually all countries and international organisations frame their recommendations in terms of consuming generous amounts of F&V. In the *Dietary Guidelines for Americans* report published as early as 1980 (US Department of Agriculture and US Department of Health and Human Services, 1980), the importance of consuming two to three servings of fruit and three to five servings of vegetables daily was explicitly advocated. Emphasis was later put on the consumption of green and yellow vegetables and citrus fruits, as important sources of carotenoids and vitamin C (Block, 1991). Later, the US Department of Agriculture recommended that three to five servings of vegetables and two to four servings of fruits should be daily consumed (Heimendinger & Van Duyn, 1995; US Department of Agriculture, 1995). At an international level, the WHO at the beginning of 1990s (World Health Organization, 1990), has set the lower *per capita* limit goal for F&V consumption to 400 g/d, 30 g of which should be pulses, nuts and seeds. European guidelines generally recommend that the daily *per capita* intake should exceed 400 g.

The 'at least five portions a day' message has been used by the Europe Against Cancer (1994) programme and adopted by various European countries and the popular media (Department of Health, 1994; World Cancer Research Fund/American Institute for Cancer Research, 1997; Johansson & Andersen, 1998). Several European countries, such as the UK (Health Education Authority, 1992; Bean, 1993), have been involved in large-scale public health campaigns promoting the daily consumption of at least five portions of F&V. Recasting the role of F&V in the diet, and planning national and international campaigns to enhance their consumption, have become major public health objectives for the year 2000.

The present study seeks to describe F&V availability patterns in ten European countries, on the basis of household budget survey (HBS) data, analysed in the context of the Data Food Networking (DAFNE) project (Trichopoulou & Lagiou, 1997, 1998; Lagiou *et al.* 1999; Trichopoulou *et al.* 1999). Compliance of the population with current recommendations was examined and disparities pointed out.

Subjects and methods

HBS collect data on food availability at the household level, taking into consideration household purchases together with contributions from own production and food items offered to members of the household as gifts (Trichopoulou & Lagiou, 1997). Estimates of the individual daily availability of F&V are based on data collected during a period in about

1990 in the following European countries, with the recording period of the respective HBS shown in parentheses (Trichopoulou, 1992; Trichopoulou *et al.* 1996, 1999): Belgium (variable, up to 1 year), Germany (1 month), Greece (1 week), Hungary (2 months), Republic of Ireland (2 weeks), Luxembourg (15 d), Norway (2 weeks), Poland (3 months), Spain (1 week), UK (1 week). Pulses, potatoes and nuts were not considered in the present study. With the exception of Norway, where the survey refers to 3 years, the data collection is accomplished within 1 year, with due attention to capture seasonal variation (Table 1).

The harmonisation of food and socio-economic HBS data was completed for the ten European countries listed earlier, in the context of the European Union-funded DAFNE project. The applied methodology has been fully described in two European Union publications (Trichopoulou & Lagiou, 1997, 1998) and was reported to be 'a success story' in a special European Union publication (European Commission, 1998). The starting point for our methodological developments was the already accepted, by the Statistical Office of the European Communities (EUROSTAT), comparability of HBS. Between-country comparisons are feasible at the level of forty-five food groups, which can be further aggregated to form twelve main food groupings. The process of harmonisation included the establishment of operational criteria for the classification of foods, qualitatively and quantitatively, iterative cross-coding, as well as several working group meetings and bilateral visits to address specific problems.

Individual availability of F&V, as purchased, was estimated without making allowances for the edible proportion, and under the assumption of equal distribution of food within the household and during the survey period. Thus, if a sample contains information from n households, each having m_i members and the availability of a specific food item is equal to y_i , where i is 1, 2, 3, ..., n , then an estimate of the availability on a per person basis (x_i) is:

$$x_i = y_i / m_i d,$$

where d is the survey period. Weighting factors w_i , where i is 1, 2, 3, ..., n , were taken into account for each household, depending on the sampling ratios from various population strata. In the case of countries where no such factors were introduced, their value was considered as being 1 (Trichopoulou *et al.* 1996).

The cumulative distribution functions of the F&V

Table 1. Characteristics of the household budget surveys that were utilised in the present study

Country	Year of survey	No. of households
Belgium	1987–8	3235
Germany	1988	45 085
Greece	1987–8	6489
Hungary	1991	11 813
Republic of Ireland	1987	7705
Luxembourg	1993	3008
Norway	1993, 1994, 1995	2164, 2180, 2174
Poland	1988	29 664
Spain	1990–1	21 155
UK	1993	8043

Table 2. Mean and median fruit and vegetable availability in the ten countries participating in the Data Food Networking (DAFNE) project, about 1990 (g/person per d)
(Mean values and standard deviations, and medians with first and third quartile)

Country	Fruits				Vegetables				Total			
	Mean	SD	Median	1st, 3rd quartile	Mean	SD	Median	1st, 3rd quartile	Mean	SD	Median	1st, 3rd quartile
Belgium	198	133	168	111 254	162	111	143	93 198	360	205	316	227 448
Germany	202	165	168	97 268	141	105	123	72 189	343	236	299	182 450
Greece	350	378	261	121 471	267	234	219	113 363	617	506	512	293 804
Hungary	159	197	98	47 197	201	225	124	70 244	360	376	232	136 442
Republic of Ireland	103	97	80	36 141	130	104	105	65 165	233	161	198	127 295
Luxembourg	234	246	184	100 300	180	522	124	67 207	414	599	329	201 504
Norway	174	175	134	64 229	102	100	78	39 134	276	225	228	129 351
Poland	100	122	68	35 126	202	171	160	106 250	302	233	233	154 373
Spain	308	400	249	134 404	180	189	140	64 242	488	486	406	242 630
UK	132	156	91	26 187	158	141	128	64 217	290	252	239	119 392

availability were estimated using histogram-type estimates (Stuart & Ord, 1994) and smoothed curves were plotted. To avoid 'noise' induced by extreme consumptions, the empirical distributions included data up to the 97.5 upper centile point.

WHO recommendations (minimum F&V intake of about 400 g/d; World Health Organization, 1990) were used to identify the percentage of low consumers. Additionally, and in an attempt to separately evaluate the F&V intakes, different cut-off points for the two categories were used. On the basis of the US guidelines, and with the assumption that a 'decent sized' portion of vegetables or fruits is about 80 g, a minimum consumption of three servings of vegetables and two servings of fruit corresponds to

approximately 250 and 150 g/d respectively. Based on these factors we estimated the percentages of individuals whose daily intake did not exceed 250 g vegetables or 150 g fruit, by participating country. These guidelines were chosen as more conservative than those from most European countries; in Greece, for instance, six portions of vegetables and three portions of fruit daily are recommended (Ministry of Health and Welfare, Supreme Scientific Health Council, 1999).

Results

The mean F&V availability is summarised in Table 2. Pulses, potatoes and nuts were not included in the groupings. In Greece and Spain the mean fruit availability per

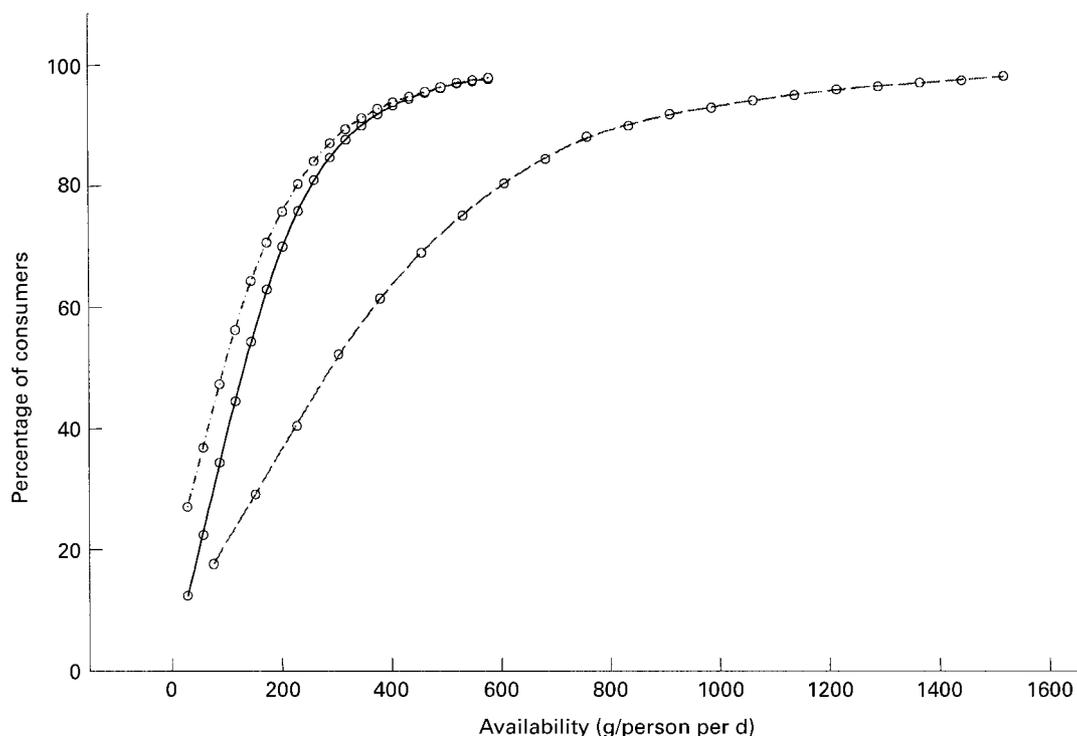


Fig. 1. Cumulative distribution curves of fruit availability in countries participating in the Data Food Networking (DAFNE) project, about 1990. (—○—), Greece; (---○---), Norway; (····○····), UK. For details of procedures, see pp. 550–551.

person per d exceeded 300 g, whereas Poland and the Republic of Ireland were at the lower end. With regard to vegetables, on the other hand, Greece led the availability with 267 g/person per d, with Norway trailing with 102 g/person per d. In six countries more fruit than vegetables were available, whereas in Hungary, the Republic of Ireland, Poland and the UK, the pattern was reversed.

In Table 2 medians and quartiles are also given separately for F&V for each of the participating countries. From further examination of data in Table 2, several patterns emerge:

- (1) since mean values consistently exceeded the corresponding medians, it can be inferred that in all countries the frequency distributions are positively skewed;
- (2) the absolute variability (g/person per d), as assessed by the difference of the third and first quartile, with regard to fruit, is highest in Greece (350) and Spain (270) and lowest in Poland (91) and Republic of Ireland (105); with regard to vegetables, the highest absolute variability (g/person per d) is found again in Greece (250) and Spain (178) and the lowest in Norway (95) and again Republic of Ireland (100);
- (3) the relative variability defined as absolute variability divided by the corresponding median is probably a better measure of disparity. With regard to both F&V, it is high in Hungary and the UK and low in Belgium and Germany.

Smoothed curves of the cumulative distribution functions of the F&V availability are presented in Figs. 1 and 2 for three countries (Greece, Norway and the UK) that represent the range of the recorded availability. These curves allow a more detailed examination of the differences

in the distribution patterns of F&V availability in the countries studied.

The percentages of consumers who were not in accordance with current WHO recommendations (400 g/d; World Health Organization, 1990) and of those whose F&V availability was below 150 g/d and 250 g/d respectively are presented in Table 3. It is apparent that the majority of citizens in the European countries studied did not comply with the 'five-a-day' recommendation, with the exception of the Greeks and Spaniards. Moreover, non-compliance was generally higher with regard to vegetables than fruits. Last, very little correlation was found between the proportion of non-compliers with regard to fruit on the one hand and vegetables on the other; Spearman's correlation coefficient being only +0.18.

Discussion

Multi-purpose HBS are conducted in most European countries. Although not primarily designed for nutritional purposes, information is collected on the food commodities available at the household level, and can therefore constitute a source of nutritional data at both national and international level. Based on a representative sample of the population and conducted at regular time intervals, HBS could provide a useful tool in the hands of nutrition policy makers for formulating, implementing and evaluating programmes to improve nutritional well-being.

It has been generally acknowledged that no survey can estimate food intake without error (Bingham, 1987). Recognition of the nature and magnitude of the inherent limitations allows a better understanding of the potential of the surveys. HBS data on F&V refer to those commodities as

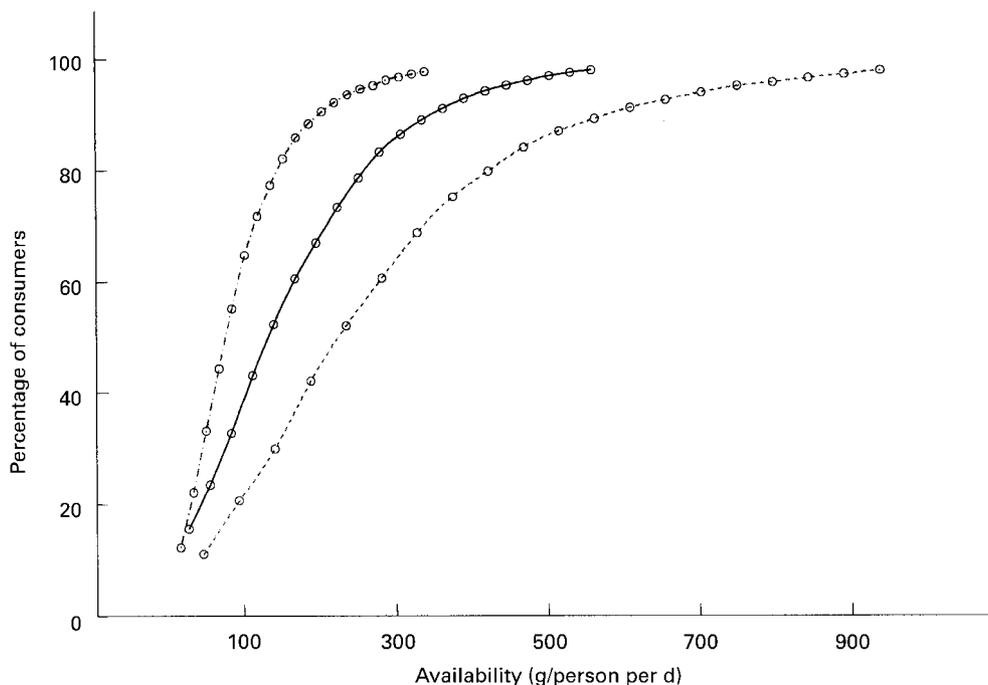


Fig. 2. Cumulative distribution curves of vegetable availability in countries participating in the Data Food Networking (DAFNE) project, about 1990. (—○—), Greece; (---○---), Norway; (····○····), UK. For details of procedures, see pp. 550–551.

Table 3. Percentage of low consumers in the ten countries participating in the Data Food Networking (DAFNE) project, about 1990

Country	Fruit and Vegetables < 400 g/person per d*	Fruit < 150 g/person per d	Vegetables < 250 g/person per d
Belgium	68	42	85
Germany	69	45	88
Greece	37	32	56
Hungary	72	66	76
Republic of Ireland	88	78	90
Luxembourg	62	41	83
Norway	81	55	93
Poland	78	81	75
Spain	49	30	76
UK	76	68	81

* According to WHO recommendations (World Health Organization, 1990).

purchased, which indicates that the actual deficit of intake is larger, if anything, than that observed. Moreover, the edible proportion may vary across countries or even during the year but none of these possible sources of variation can seriously challenge the validity of our conclusions.

HBS data require special handling of foods rarely consumed or purchased in bulk. For these foods short-duration surveys may generate a high proportion of zero values, whose frequency tends to decline with the length of the recording period (Institute of European Food Studies, 1998). Thus, zero availability does not always indicate a non-consuming household. A zero value can imply either that the household members are inclined to purchase certain foods in bulk quantities at intervals exceeding the recording period, or that, being irregular consumers, household members happened not to buy these specific foods during the survey period.

Estimating mean food availability, excluding zero values, will lead to estimates higher than those derived when data from all households are taken into consideration. Both approaches may be useful, however, depending on the purpose of analysis. When data are used to identify groups at risk of exposure to dietary constituents with contaminating or ambiguous action (e.g. pesticide residues, food-packaging-material migrants and food additives), an overestimation of actual intake may be acceptable. The rationale is to ensure that consumer intakes do not exceed a certain level, and thus assessment should be based on worst-case scenarios. When, on the other hand, the aim is to assess eating patterns and identify low consumers in order to improve their nutritional status, an overestimation of consumption may result in misleading conclusions. In this instance, the objective is to ensure that consumers' intake exceeds a certain level, and thus the accepted margin of error is in the opposite direction.

Since the aim of our analysis is the identification of low F&V consumers, all estimations presented are based on mean population data, taking into account both consumers and non-consumers. Nevertheless, replication of the analysis with the exclusion of zero values led to similar conclusions, even though *per capita* consumption estimates increased disproportionately in countries with high proportions of non-consumers.

The alternative widely-used source of data on availability, as approximated by disappearance on the country

level, is that of food balance sheets, generated by FAO. The two sources are not always comparable because procedures for collection have different sources of errors. Nevertheless, it is remarkable that FAO data during the period of about 1990 for F&V (Organization for Economic Co-operation and Development Agricultural Statistics, 1991) show relatively high Spearman's correlation coefficients with the corresponding data in HBS. Estimates based on seven countries for which data on F&V are available from both sources have generated coefficients of +0.75 for fruit and +0.71 for vegetables.

Table 2 reveals considerable disparities in F&V availability among the various European populations. Only in the two Mediterranean countries, Greece and Spain, does the mean daily population intake clearly exceed the 400 g/d recommended by WHO (World Health Organization, 1990) for each individual. In Luxembourg the daily availability is just above the recommended levels, whereas among the rest of the countries the lowest value was estimated in the Republic of Ireland and the highest in Belgium and Hungary. It should be noted, however, that F&V availability in the last two countries is attributed to different items; Belgians seem to prefer consuming fruit, whereas Hungarians prefer vegetables.

In assessing the 'average' food habits of a population mean values or medians may be referred to. Mean values, however, are strongly affected by extremes, whereas median values are more robust and informative. Occasionally the two approaches are complementary, as in the case of vegetables in Hungary and Poland. In Hungary variability in vegetable availability is substantially larger than that in Poland. However, as a result of the high vegetable availability within a small segment of the Hungarian population the respective mean values for the two populations are similar, in spite of the considerable differences in the corresponding medians.

The percentage of consumers whose F&V availability was below WHO recommended levels (World Health Organization, 1990) is presented for each participating country in Table 3. As expected, Greece and Spain had the lowest percentages. Even in these countries, however, the percentage of underconsumers is not negligible. For the remaining countries values vary between 62% estimated in Luxembourg and 88% in the Republic of Ireland.

As F&V and, indeed, specific F&V have differing

nutritional attributes (Trichopoulos & Willett, 1996; World Cancer Research Fund/American Institute for Cancer Research, 1997) we have thought it appropriate, from a health point of view, to separate the fruit and vegetable recommendations. Thus, in Table 3, low consumers were considered to be those with an intake <150 g fruit (approximately two portions) or <250 g vegetables (approximately three portions).

In the light of the separate criteria for F&V, a discrepancy is revealed. All European populations surveyed presented a pattern of fruit availability different from that of vegetables. In almost all cases the percentages of low fruit consumers were significantly lower than those of low vegetable consumers, indicating a preference of European populations towards the consumption of fruit. Differences were less pronounced in the Republic of Ireland, the UK and Hungary, whereas Poland was the only country, among those surveyed, where the vegetable underconsumers were fewer than the fruit underconsumers. The consumption of home-made pickled vegetables is rather popular among Eastern European populations and is reflected by the high availability for vegetables such as cabbages, cucumbers, onions, garlic and tomatoes.

More than 50% of all populations surveyed were likely to consume less than the recommended daily vegetable intake of three portions, and this appeared to apply even to the two Mediterranean populations. In four of the ten countries (Belgium, Germany, Luxembourg and the UK), more than 80% of the population were identified as low consumers, whereas in the case of the Republic of Ireland and Norway, a low vegetable intake appeared to be a general dietary pattern and not a feature of underprivileged segments of the population.

Barriers to the implementation of health messages have been identified in several studies (Williams, 1995; Lechner & Brug, 1997; Cox *et al.* 1998; Trudeau *et al.* 1998). Consumer complacency about their present consumption, confusion in the interpretation of messages of health promotion campaigns and perception of F&V as poor value for money are factors responsible for the suboptimal efficiency of current promoting strategies.

With regard to F&V intake, both national and international recommendations may need clarification by addressing F&V separately. Targeted interventions that focus specifically on vegetables may have to take priority, because it is with regard to vegetables that the deficit is more substantial. The 'more than 400 g/d', the 'five servings' and the 'eating more fruit and vegetables' recommendations are open to different interpretations. Agreement is further required with regard to foods such as pulses, potatoes and nuts, the classification of which is ambiguous.

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