Meal patterns across 10 European countries – results from the European Prospective Investigation into Cancer and Nutrition (EPIC) calibration study

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None.

Authorship

A.W. and H.B.F. initiated the study. E.H., A.W. and H.B.F. formulated the research questions, performed the analysis and wrote the manuscript taking into account comments from all co-authors. N.S., M.K. P., H.F., H.B., G.B., L.S. and E.W. contributed to the conception, analysis and interpretation of the data and drafting of the manuscript. All other co-authors were local EPIC collaborators involved in the collection of dietary data and other data. All authors read and approved the final version.

Abstract

Objective: To characterize meal patterns across ten European countries participating in the European Prospective Investigation into Cancer and Nutrition (EPIC) calibration study.

Design: Cross-sectional study utilizing dietary data collected through a standardised 24-h diet recall during 1995-2000. Eleven predefined intake occasions across a 24-h period were assessed during the interview. In this descriptive report, meal patterns were analysed in terms of daily number of intake occasions, the proportion reporting each intake occasion and the energy contributions from each intake occasion.

Setting: Twenty-seven centres across ten European countries.

Subjects: 36020 women (64%) and men (36%) aged 35-74 years.

Results: Pronounced differences in meal patterns emerged both across centres within the same country and across different countries with a trend for fewer intake occasions/day in Mediterranean countries as compared to central and northern Europe. Differences were also found for daily energy intake provided by lunch, with 38-43% for women and 41-45% for men within Mediterranean countries compared to 16-27% for women and 20-26% for men in central and northern European countries. Likewise, a south-north gradient was found for daily energy intake from snacks, with 13-20% (women) and 10-17% (men) in Mediterranean countries compared to 24-34% (women) and 23-35% (men) in central/northern Europe.

Conclusion: We found distinct differences in meal patterns with marked diversity for intake frequency and lunch and snack consumption between Mediterranean and central/northern European countries. Monitoring of meal patterns across various cultures and populations could provide critical context to the research efforts to characterize relationships between dietary intake and health.

Keywords

Meal patterns, intake occasion, intake frequency, meals, snacks, energy intake, standardisation, 24-hour dietary recall, EPIC

Introduction

The focus of human nutrition research during the last decades has been to define the relation between food choices, nutrient composition of the diet, and health; however, a growing body of evidence suggests that meal patterns may explain part of the variation in diet-related disease outcomes between individuals (1-3) and be a significant contributor to the obesity epidemic (4-6). Meal patterns can broadly be defined as patterned structures of food and drink intake and comprise daily frequency of meals and snacks, temporal distribution of energy intake and consistency of eating behaviours (7-9). There is evidence that frequency of meals and snacks and temporal distribution of energy intake are linked to cultural and environmental factors (10, 11), metabolic responses (12, 13) and circadian variations in appetite-regulating hormones and digestion (14, 15). Thus, there is an urgent need to examine the relative importance of meal patterns for metabolic risk factors and concurrent health in different populations in order to guide development of evidence-based dietary policies.

Today, few European authorities provide public health recommendations on meal patterns and although advice on regular meals exist in some countries, specific recommendations on frequency or temporal distribution of meals and snacks are rarely included (9). Further, in the latest revision of the Nordic Nutrition Recommendations from 2012 (16), the guideline on meal pattern from 2005 proposing 1-3 snacks/day (17) was withdrawn without comment. The absence of recommendations is likely to be due to a lack of consistency in the current literature examining the importance of meal patterns for health parameters which, in part, can be explained by several recurring methodological problems. These problems include a wide range of assessment methods used to examine meal patterns, heterogeneity in how meal patterns are analysed, lack of a standardized terminology and small study samples in specific populations (7, 18). Hence, these limitations have obstructed the research field and made interpretation and comparability between studies and countries challenging. Therefore, there is a need to map differences in meal patterns using consistent methodology and objective terminology in large and diverse population samples to advance the research field and promote development of dietary guidelines.

In the European Prospective Investigation into Cancer and Nutrition (EPIC) calibration study, standardized 24-h diet recalls were collected among approximately 37 000 participants from 27 centres in ten European countries (19). Dietary data were consistently collected through computerised and harmonized interview software, allowing for a homogenous comparison of dietary patterns across the European countries (19, 20). Thus, in the light of the heterogeneous methodology traditionally used to assess and analyse meal patterns, the EPIC calibration study provides a unique opportunity to examine and describe differences in meal patterns across the European countries which will be a valuable resource and benchmark for Europe. Hence, the aim of this descriptive report is to characterize country and centre specific meal patterns in terms of daily intake frequency and temporal distribution of energy intake in the EPIC calibration study.

Methods

Study population

Data presented in this report were derived from the EPIC calibration study which was nested within the EPIC study and performed during 1995-2000. Details on the design, rationale and methodology of the EPIC study and the calibration study have been described in detail previously (19, 21). In short, EPIC is a multicentre prospective cohort study investigating the association between diet, lifestyle and cancer among approximately 520 000 participants across 23 administrative centres in ten European countries: Denmark, France, Germany, Greece, Italy, the Netherlands, Norway, Spain, Sweden and the United Kingdom (UK). Participants in the EPIC study were recruited from the general population (Bilthoven (the Netherlands), Greece, Germany, Sweden, Denmark, Norway, Cambridge (UK), Spain and Italy), breast cancer screening (Utrecht (the Netherlands), Florence (Italy)), members of a health insurance for school employees (France) and blood donors (some centres in Italy and Spain). In Oxford (UK), most of the participants (87%) were vegetarians or vegans and/or had a special interest in health and are therefore evaluated separately (the "Health-conscious" in contrast to the "General population" from Cambridge). For descriptive dietary analyses, the original 23 administrative centres have been reclassified into 27 centres according to their geographic region from which 19 centres recruited both female and male participants and 8 centres recruited women only (centres belonging to France, Norway, Utrecht (the Netherlands) and Naples (Italy)). The study began in 1992 and was approved by the ethical review boards of the International Agency for Research on Cancer (Lyon, France) and from all local recruiting institutes. Written informed consent was obtained from all participants.

Within the EPIC study, information on usual individual dietary intake was assessed using country-specific diet history or food frequency questionnaires (21). Thus, the EPIC calibration study was developed to correct for random and systematic errors in baseline dietary measurements and involved a single 24-h diet recall in a subsample of almost 37 000 participants to be used as the reference calibration method (19, 22, 23). The subsample represented approximately an 8% stratified random sample of the total EPIC cohort and was weighted according to the cumulative numbers of cancer cases expected by gender and 5-year age strata. The results in this paper are based on dietary data from the standardized 24-h diet recall.

Assessment of dietary intake

Information on dietary intake in the calibration study was collected using a standardized computer-assisted and interviewer-administered software program (EPIC-SOFT) specifically designed to standardize the 24-h diet recall across the EPIC centres. The structure and functions of the software program have been described in detail elsewhere (19, 20). In brief, the interview was structured into two steps; a first step where participants were asked to recall all foods and drinks consumed during the previous day, and a second step where they were asked to describe and quantify their intake. To standardize the memory aids used by the interviewer during the recall, eleven food consumption occasions (FCO) were predefined and asked for and information on all foods and drinks consumed were entered as one of the following FCOs according to the participant's answer: before breakfast, breakfast, during morning, before lunch, lunch, after lunch, during afternoon, before dinner, dinner, after dinner and during evening. For each FCO, questions on time (per full hour) and place of consumption were asked as additional probes; thus, each FCO could be selected several times because of intakes in different hours (except for breakfast, lunch and dinner). The diet interview was conducted according to a "wake-up to wake-up" approach with participants listing all foods and drinks consumed between waking up on the recall day to waking up on the interview day. However, the mean duration of the recalled day was always about 24 hours across the centres and countries (19). Interviews were conducted over various seasons and days of the week, however; interviews with regard to diet on Saturdays were conducted on Mondays in most countries for logistical reasons. All participants provided the diet recall through face-to-face interviews, except in Norway where a telephone interview was conducted (24). Energy and nutrient intakes were calculated using the EPIC nutrient database which was developed to harmonize nutrient databases across the EPIC countries (25, 26).

Definitions used to analyse meal patterns

In this report, all FCOs including food and/or drinks are defined as separate intake occasions except for FCOs consisting of water only (tap and mineral water), which were excluded. As a result, intake frequency describes the total number of intake occasions per day which can consist of food only, drinks only or food and drinks combined. In order not to limit intake frequency to a maximum of eleven intake occasions per day, we included information on time to separate single FCOs selected at several time points (e.g. FCO "during morning" consumed at both 9 and 11 am). No further criteria on time or energy intake were applied. Further, meals are defined as "breakfast", "lunch" and "dinner" while all other FCOs are defined as “snacks”. Thus, the following aspects of meal patterns are presented in this report: daily intake frequency, the proportion reporting at least one intake occasion at each FCO and the absolute as well as relative energy contribution from meals and snacks.

Statistical analysis

Data are presented as mean (range), mean (standard error (SE)) and proportions stratified by gender, country and/or center as indicated. Intake frequencies displayed in Figure 1 are adjusted for age and weighted by season and day of the week using analysis of covariance to account for over- and under-sampling across all countries. Consequently, the adjusted means represent the mean number of intake occasions/day of a population with balanced distribution of recalls over season, day of the week and the mean age of 55.3 years for women and 56.8 years for men. In addition to the main analysis, we also conducted sensitivity analysis to exclude over- and under-reporters of energy intake. This was performed by calculating the ratio of reported energy intake over estimated basal metabolic rate taking age, sex, weight and height into account. The ratio of 1.55 was then used to calculate the confidence limits according to a 95% confidence interval (lower and upper limit of <0.88 and >2.72, respectively). Ratios falling below or above the 95% confidence limits were used to define the presence of misreporting (27, 28). Although this method has poor sensitivity for identifying invalid reports of energy intake at the individual level from a single 24-h recall (29), it was considered sufficient to examine potential influence of extreme misreporting on the overall results. Data were analysed using SPSS version 21.0 (IBM, Somers, NY, USA).

Results

Study participants

A total of 36 020 participants (22 985 women and 13 035 men) with dietary data from the 24-h diet recall were included in this report after exclusion of participants aged under 35 or over 74 years due to low participation in these age groups (N=960) and individuals with incomplete information (N=14). Mean (range) age for women and men ranged from 49.0 (35.0-65.5) and 50.0 (35.2-65.2) years (Bilthoven, the Netherlands) to 61.4 (45.3-74.2) and 64.1 (50.5-74.3) years (Malmö, Sweden), respectively. Mean body mass index of women varied from 22.9 (14.4-37.6) (South of France, France) to 29.3 (17.9-48.8) kg/m^2 (Granada, Spain) and from 23.9 (18.2-31.8) (UK Health-conscious) to 29.3 (20.9-46.2) kg/m^2 (Granada, Spain) for men. Data on energy intake across the centres has previously been reported by Ocké et al (30).

Intake frequency across countries

After adjustment for age and weighting by season and day of recall, mean intake frequency for women ranged from 5.0 intake occasions/day in Greece and Italy to 7.0 intake occasions/day in the Netherlands. The corresponding numbers for men ranged from 4.9 in Italy to 6.8 in the UK General population (Figure 1 and Supplementary Table 1). There was a south-north gradient in intake frequency, with fewer intake occasions in the Mediterranean countries (Greece, Spain, Italy and France) as compared to central European (Germany, the Netherlands and UK) and Nordic (Denmark, Sweden and Norway) countries. Also, in several countries there was a tendency for slightly higher intake frequency in women than in men. For snack frequency only, see Supplementary Table 2.

Intake occasions across countries and centres

Tables 1 and 2 give the proportion of women and men reporting at least one intake occasion at the eleven different FCOs and the mean energy contribution from each FCO. As displayed in the tables, differences in meal patterns were found both across centres within the same country and across different countries with greatest heterogeneity for snack consumption. For example, the proportion of women having an intake occasion during the morning ranged from 31% in the north and west of Norway to 90% in Utrecht (the Netherlands). Further, the same discrepancy was seen during the afternoon with 30% of women in north and west of Norway and 93% of women in Utrecht (the Netherlands) reporting an intake occasion. The corresponding numbers for men ranged from 38% in Granada (Spain) to approximately 80% in Bilthoven (the Netherlands) and UK General population for intake occasions during the morning, and from 37% in Murcia (Spain) to 89% in Aarhus (Denmark) for intake occasions during the afternoon. Likewise, a south-north gradient appeared for intake occasions during the evening with 2-33% of women in Mediterranean countries, 49-87% of women in central European countries and 73-77% of women in Nordic countries reporting an intake occasion. The same was revealed for men reporting an intake occasion during the evening with 2-30%, 59-85% and 78% in Mediterranean, central European and Nordic countries, respectively. As for main meals, the majority of participants across all countries reported consumption of breakfast (range 85-100%), lunch (range 76-100%) and dinner (range 90-99%); however, participants in central and northern European countries reported lunch to somewhat lesser degree than did Mediterranean countries.

Likewise, geographical differences in meal patterns were also found within countries. In Spain, 37-38% of women and men in Granada versus 60% of women and men in San Sebastian reported an intake occasion during morning. Moreover, 8-10% of Italian women and men in Ragusa reported an intake occasion during evening as compared to 32-36% in Turin. Finally, in Denmark, 66% of women in Copenhagen reported an intake occasion during evening as compared to 91% in Aarhus and this difference was also evident among Danish men (73% versus 90%, respectively).

Energy contribution of meals and snacks

Figures 2a and 2b as well as Supplementary Table 3 display the proportion of daily energy intake consumed as meals and snacks across countries. Breakfast contributed 11-19% and 9-20% of daily energy intake among women and men, respectively, across all countries. However, greater differences were revealed for lunch which provided 38-43% and 41-45% of daily energy intake for women and men within Mediterranean countries as compared to 16-27% and 20-26% for women and men in central European and Nordic countries. Less pronounced differences were observed for dinner which provided 24-37% and 29-40% of daily energy intake among women and men across all countries. Further, heterogeneity was also found for energy contribution of snacks with Mediterranean countries consuming 13-20% (women) and 10-17% (men) of daily energy intake as snacks while the corresponding numbers were 24-34% (women) and 23-35% (men) in central and northern countries. Figure 3 illustrates the overall differences in proportional distribution of daily energy intake across meals and snacks between Mediterranean, central European and Nordic countries with women and men combined as no major differences were found between genders.

Sensitivity analysis

In general, mean energy intake from each intake occasion and the proportion reporting an intake occasion at each FCO increased slightly for both women and men after exclusion of misreporters, with some minor exceptions (Supplementary Tables 4 and 5). For intake frequency, sensitivity analyses differed by 0.0-0.2 and 0.0-0.1 intake occasions/day for women and men, respectively, except for UK Health-conscious (0.4 and 0.7 intake occasions/day for women and men, respectively).

Discussion

In this study, we aimed to characterize and compare meal patterns across ten European countries participating in the EPIC calibration study, taking advantage of the harmonized and detailed data collection across all the regions. We found pronounced geographical differences in meal structures across both countries and across centres within the same country. In general, a trend emerged that lunch provided a greater proportion of total energy intake in Mediterranean countries compared to central and northern European countries. In contrary, greater proportion of participants in central and northern countries reported intake occasions in between main meals and larger energy contribution of snacks, compared to participants in Mediterranean countries.

There is currently a discussion whether regular and socially shared meals are becoming increasingly rare and if grazing meal patterns, characterized by frequent snacking, are taking the place of traditional meals and dissolving collective norms guiding temporal eating (31, 32). In the present study, we examined meal patterns during 1995-2000 in an adult European population aged 35-74 years and found that most countries still shared uniformity in the three-meal-a-day pattern at that time, with a high proportion reporting consumption of breakfast, lunch and dinner across all countries, even though lunch was less frequently reported in Nordic and central European countries as compared to Mediterranean countries. This three-meal continuity has also been reported in more recent studies in Nordic (31), French (32-34) and Flemish (35) populations. However, for most central and northern countries, snacks contributed more to daily energy intake than did breakfast or lunch and in some countries snacks contributed nearly as much energy as did dinner. Still, for Mediterranean countries in general and for Italy and France in particular, snacks contributed significantly less energy than did lunch and dinner, indicating a preserved tradition in these regions for main meals to provide the majority of daily energy intake. Nevertheless, as these data were collected 15-20 years ago in a middle aged and elderly adult population, more recent shifts in meal patterns as well as meal patterns in younger populations need to be further explored.

Although we found the three-meal pattern to be widespread across Europe, we demonstrated different distribution of energy intake across the main meals. For example, a south-north gradient was found for lunch with Mediterranean countries consuming greater proportion of their daily energy intake at lunch as compared to central and northern countries. This gradient was also reported in the SENECA study where meal patterns among 2600 elderly participants from 12 European countries were assessed in 1988-1989 (36, 37). In that study, lunch contributed 45-48% of daily energy intake in Italy and France as compared to 21-33% in northern and central Europe. The authors also found that total energy intake among women was higher in centres where energy contribution of lunch was low (36). As studies have reported evening meals to be less satiating than morning meals and glucose tolerance and insulin secretion to decrease over the day (9, 14, 38), consuming a high proportion of total energy intake at lunch has been suggested to compose an additional positive component of the Mediterranean diet when looking beyond the solely nutritive aspects (39). Further, as previous research has found snacking and high intake frequency to be positively associated with energy intake and overweight and obesity (4, 6), absence of snacking might be yet another favourable component of the Mediterranean diet. However, aspects such as meal times and timing of snacks need to be further explored in order to fully characterize differences in temporal disposal of energy intake across Europe. In sum, future research should consider if the beneficial effects of the Mediterranean diet are possibly also mediated by a meal pattern with greater energy contribution from lunch and less from snacking by widening the scope of dietary surveys to include assessment of meal structures and temporal distribution of energy intake.

We reported high intake frequency in northern and central Europe, with participants in the UK and the Netherlands consuming an average of 6-7 intake occasions/day. Prominent snacking among Dutch subjects was also reported in the SENECA study where 31-32% of daily energy intake was derived by snacks and in the latest Dutch national food consumption survey from 2007-2010 (30% of daily energy intake from snacks) (40), similar to the 34-35% in the EPIC cohort. Further, the SENECA study also found low energy contribution of snacks among Mediterranean countries with 6-8% in France and Italy (36, 37) as compared to 10-13% in the EPIC cohort. The consequences of different intake frequencies are a hot topic within the research field, dividing scientists into opposing opinions. On one hand, snacks have been reported to be less nutritive, more energy dense and more motivated by social and/or cultural drivers than by biological energy needs as compared to meals (4, 41). Hence, this would suggest that transition to grazing meal patterns might have negative health consequences given the risk for overconsumption of energy intake. On the other hand, snacks have the potential to increase the opportunity for healthy, nutrient-dense foods such as fruit and fiber-rich grains (42-44). In addition, gender differences have been suggested such that women are more likely to make healthier food choices while men more often choose sweets, savouries and sugar-sweetened drinks (42). Also, as energy compensation for drinks has been demonstrated to be weak in comparison to solid foods (45, 46), the effect of drinks consumed as snacks warrant further exploration. Thus, there is a need to characterize not only frequency but also quality of snacks, especially in countries and populations where people derive high percentages of energy through snacks, as snacks have the potential to improve overall dietary intake and impact health.

The strengths of this report include a large and diverse population sample across several European countries concurrent with standardized and homogeneous methodology which enabled an objective assessment and comparison of meal patterns across a broad geographical span. However, there are some limitations to this report. Firstly, populations included in the EPIC study are not nationally representative samples of the European general population (19) and younger adults may have different meal patterns than those reported here. Nevertheless, data may still reveal significant geographical differences in meal pattern due to the broad range of participating countries and harmonized methodology used. Second, one 24-h diet recall does not provide data at the individual level; however, due to the large sample size, trends in proportions consuming various intake occasions across the day should still appear. Third, underreporting of energy intake is a limitation within all self-reported dietary assessments and a previous EPIC report found that underreporting was more prevalent among women and participants with overweight and obesity (47). Thus, as underreporting has been reported to affect both energy intake and intake occasions (8, 48), intake frequencies and proportions are likely to be underestimated as demonstrated by the slight increase when misreporters were excluded in the sensitivity analysis. Fourth, as the predefined FCOs only enabled three main meals to be reported, foods considered to be consumed as a main meal beyond the three predefined meals have been classified as snacks in this report. Thus, this could influence the interpretation of meal and snack patterns in countries where traditionally four meals are considered “main meals” as for example in Norway (breakfast, lunch, dinner and evening meal). Also, as no predefined time- or energy content criteria for FCOs were provided to participants, food and drinks were entered as different FCOs according to participant description. Finally, considering these data are now 15-20 years old, differences in meal patterns reported here need to be confirmed in more recent data; still, this study provides a valuable resource and benchmark for studying trends in Europe.

Conclusion

We examined meal patterns in a large scale study across ten European countries. We found distinct differences in meal patterns with marked diversity for intake frequency and lunch and snack consumption between Mediterranean and central/northern European countries. Monitoring of meal patterns, currently and over time, across various cultures and populations could provide critical context to the research efforts to characterize relationships between dietary intake and health.

Table 1

The proportion of women reporting at least one intake occasion at the specific food consumption occasions (FCO) and the average energy contribution from each FCO in the EPIC calibration study.

Country and centre	N	Before breakfast			Breakfast			During morning			Before lunch			Lunch			After lunch			During afternoon			Before dinner			Dinner			After dinner			During evening		
		%	kJ	SE	%	kJ	SE	%	kJ	SE	%	kJ	SE	%	kJ	SE	%	kJ	SE	%	kJ	SE	%	kJ	SE	%	kJ	SE	%	kJ	SE	%	kJ	SE
Greece	1368	12.9	565	45	92.8	853	19	53.9	626	24	12.8	700	56	98.6	2840	40	21.4	523	39	75.2	617	22	14.0	630	46	93.5	1647	34	21.3	664	47	1.6	612	120
Spain	1443	15.2	220	21	98.4	1104	20	48.0	598	23	19.3	577	36	99.6	3216	40	23.7	330	26	66.3	746	27	10.9	676	52	97.6	2175	35	24.5	483	26	8.1	392	38
Granada	300	25.7	232	46	98.0	1150	40	36.7	575	59	25.7	415	44	100	2828	81	25.7	265	36	70.3	688	41	14.7	782	104	95.3	1857	59	23.3	433	45	11.0	386	60
Murcia	304	17.8	165	26	99.0	1004	49	49.0	508	69	28.0	688	81	100	3378	100	49.0	340	45	49.3	895	99	11.5	640	94	96.7	2343	84	30.6	546	66	4.6	488	99
Navarra	271	2.2	211	52	98.5	1001	35	55.4	611	45	17.3	524	89	98.9	3418	85	9.2	587	139	74.5	741	45	11.4	627	99	97.4	2020	73	22.1	478	40	9.6	302	46
San Sebastian	244	16.0	270	53	97.5	1166	49	60.2	522	37	10.2	573	110	99.2	3505	99	22.1	222	33	73.8	609	50	7.4	453	82	99.2	2365	86	26.6	364	30	13.9	476	102
Asturias	324	13.6	221	34	98.8	1195	48	42.3	477	38	13.6	703	89	99.7	3040	74	11.4	409	78	65.7	850	73	9.0	748	165	99.7	2286	79	21.0	563	72	3.1	226	48
Italy	2510	21.3	193	14	93.6	900	13	50.7	411	14	9.9	504	39	99.0	3014	31	16.8	236	22	61.4	535	16	8.8	398	61	98.4	2826	30	12.2	522	35	24.9	472	22
Ragusa	137	29.2	93	17	94.2	742	53	44.5	388	69	10.9	717	219	98.5	3332	184	21.9	140	50	61.3	474	69	10.9	489	147	100	2864	143	9.5	813	395	9.5	485	228
Florence	783	23.4	182	23	94.4	916	25	51.7	487	26	7.9	521	75	98.7	2978	51	8.7	210	45	57.9	509	28	6.0	694	125	98.9	2898	58	6.9	474	64	23.8	509	48
Turin	392	26.0	374	52	89.3	803	34	50.0	355	30	9.7	314	43	99.2	2999	77	18.1	173	36	66.3	453	38	10.7	516	81	99.0	2881	76	15.1	385	63	31.9	439	42
Varese	795	10.7	158	22	97.1	995	23	47.8	345	19	11.8	511	69	99.4	2936	51	15.2	343	40	62.3	587	26	9.8	687	100	99.1	2723	47	15.8	548	47	31.7	434	30
Naples	403	31.0	116	14	89.3	814	32	57.3	446	42	9.7	564	102	98.8	3149	93	32.5	205	48	62.0	576	47	9.9	991	209	95.3	2825	83	13.6	588	100	11.9	612	91
France	4735	11.1	195	10	99.5	1424	12	36.7	300	10	10.8	692	28	99.3	3116	22	56.0	156	6	62.7	626	14	19.0	881	33	98.8	2669	21	14.3	285	19	32.7	411	14

South coast	620	12.7	168	17	99.8	1280	31	37.6	313	31	8.9	740	98	99.4	3196	60	46.8	135	11	62.4	599	38	18.7	947	113	98.5	2590	57	10.0	239	48	35.5	375	33
South	1425	8.3	194	15	99.6	1413	21	35.4	331	20	9.5	633	57	99.5	3201	40	48.4	152	10	60.8	626	23	16.2	796	53	99.0	2595	37	12.4	335	44	29.7	397	28
North-West	631	4.3	271	37	99.8	1513	30	31.4	191	21	10.6	637	70	99.7	3096	51	63.2	151	12	64.7	578	41	18.9	925	75	99.0	2565	50	17.0	247	41	33.3	412	35
North-East	2059	14.7	195	16	99.3	1448	18	39.1	304	15	12.3	729	39	99.1	3039	33	61.9	165	9	63.5	650	21	21.0	897	51	98.7	2775	32	16.1	280	26	33.8	432	21
Germany	2147	14.7	238	18	97.2	1481	19	60.1	657	18	12.7	403	31	89.5	2061	26	18.3	531	36	80.0	984	20	17.5	715	43	95.2	2164	28	29.3	781	33	48.5	704	20
Heidelberg	1087	17.0	222	24	96.8	1474	27	58.6	518	22	17.7	371	36	89.1	2125	40	25.5	534	43	76.6	892	27	20.8	716	58	94.9	2234	42	35.6	708	40	51.3	700	30
Potsdam	1060	12.4	259	29	97.6	1489	27	61.6	810	27	7.6	479	60	89.9	1997	34	10.9	523	65	83.5	1078	29	14.2	714	65	95.6	2092	38	22.9	898	56	45.6	709	25
The Netherlands	2946	14.9	198	12	91.0	1149	14	86.7	465	10	4.2	548	56	88.5	1906	18	3.4	362	42	92.2	610	12	19.1	683	28	97.6	2635	25	15.1	1031	57	87.0	838	15
Bilthoven	1076	14.8	190	20	86.2	1258	25	80.7	522	20	1.9	606	186	82.9	1912	32	2.0	366	89	90.9	736	25	14.7	633	50	97.5	2693	42	13.6	1113	122	86.6	1127	33
Utrecht	1870	15.0	203	15	93.7	1091	16	90.2	439	12	5.5	537	57	91.7	1903	21	4.2	361	48	93.0	548	14	21.7	702	34	97.6	2602	32	16.0	991	61	87.2	728	15
United Kingdom	767																																	
General population	571	52.2	121	12	95.3	1138	27	76.2	365	22	6.7	516	120	93.9	2048	53	11.2	379	101	80.2	453	27	20.8	625	65	93.9	2632	62	15.8	376	64	80.9	603	28
Health-conscious	196	43.9	165	32	96.4	1300	52	78.1	530	82	2.0	182	88	95.9	2057	82	5.6	121	27	81.6	607	47	11.2	806	176	94.9	2678	99	9.2	215	67	75.0	891	92
Denmark	1994	8.0	252	21	97.4	1344	18	62.0	500	17	9.0	506	65	88.0	1910	28	11.6	740	67	80.3	838	21	24.6	669	30	95.6	2801	34	24.3	780	36	72.5	957	24
Copenhagen	1484	6.3	290	30	97.5	1337	21	61.9	477	19	7.3	532	102	86.6	1910	33	13.8	735	73	77.8	792	24	24.4	715	37	94.9	2812	40	30.7	796	37	66.2	925	29
Aarhus	510	12.9	199	28	97.3	1364	35	62.2	563	35	13.9	466	52	92.0	1908	51	5.1	779	160	87.6	937	40	25.1	539	46	97.8	2772	68	5.5	531	129	91.0	1016	40
Sweden	3278	11.8	354	21	98.4	1317	12	54.7	611	14	1.2	468	75	83.7	2021	22	4.4	597	57	74.8	755	14	4.6	679	55	92.3	2557	25	15.6	881	35	76.6	855	14
Malmö	1711	6.0	310	41	98.9	1324	17	52.7	626	19	0.8	583	149	82.2	2092	31	3.1	599	85	70.5	780	20	4.1	665	74	89.9	2492	36	6.8	958	80	78.0	888	20
Umeå	1567	18.3	370	24	97.9	1309	18	56.9	595	20	1.6	404	82	85.3	1947	30	5.8	595	76	79.5	731	19	5.2	692	80	94.9	2626	35	25.1	858	39	75.0	816	19
Norway	1797	18.5	226	19	96.4	1525	20	31.9	378	25	19.6	520	39	76.4	1665	26	18.5	684	41	32.9	872	39	10.4	723	57	89.8	2643	33	38.5	1152	48	77.0	1385	28

South and East	1004	19.1	241	26	96.7	1541	27	32.4	371	33	20.0	449	48	79.6	1723	36	20.1	641	50	35.1	853	51	11.6	781	77	89.2	2665	45	35.8	1198	73	75.6	1347	39
North and West	793	17.8	206	27	96.0	1505	29	31.3	388	38	19.0	614	64	72.4	1584	36	16.4	751	68	30.1	902	60	8.8	628	82	90.4	2615	50	41.9	1102	60	78.7	1428	41

Values are country- and centre specific proportion, mean and standard error.

Table 2

The proportion of men reporting at least one intake occasion at the specific food consumption occasions (FCO) and the average energy contribution from each FCO in the EPIC calibration study.

Country and centre	N	Before breakfast			Breakfast			During morning			Before lunch			Lunch			After lunch			During afternoon			Before dinner			Dinner			After dinner			During evening		
		%	kJ	SE	%	kJ	SE	%	kJ	SE	%	kJ	SE	%	kJ	SE	%	kJ	SE	%	kJ	SE	%	kJ	SE	%	kJ	SE	%	kJ	SE	%	kJ	SE
Greece	1324	15.8	659	52	92.4	987	28	55.7	844	43	14.5	908	76	98.6	4085	55	20.4	461	38	72.2	475	25	15.4	844	79	95.5	2689	54	23.7	729	51	2.1	719	188
Spain	1777	10.4	347	26	91.0	1288	25	50.8	1154	36	23.4	958	45	99.5	4816	46	19.9	383	26	57.2	833	28	18.2	977	52	97.8	3457	45	21.0	625	33	8.7	599	45
Granada	214	23.8	364	44	97.7	1447	68	38.3	868	87	34.1	1044	98	99.1	4317	107	25.7	318	61	60.7	768	63	26.2	1185	137	99.1	2927	119	18.7	476	56	8.4	632	143
Murcia	243	14.8	311	50	93.8	1357	84	43.2	1489	135	30.0	1126	120	100	4554	135	45.7	417	61	37.0	834	93	19.8	1110	146	96.7	3366	133	27.2	819	121	5.3	513	132
Navarra	444	1.8	397	141	86.0	1067	37	60.1	1366	71	21.6	898	106	99.5	4737	76	10.8	459	56	54.5	841	55	18.7	720	63	96.4	3388	92	17.3	607	70	9.5	682	92
San Sebastian	490	8.4	303	52	90.2	1203	45	58.8	1125	66	17.1	811	82	99.2	5293	95	16.7	332	34	65.3	805	51	15.5	975	121	98.6	3819	89	22.2	558	51	12.7	535	67
Asturias	386	12.4	386	65	92.2	1494	54	41.7	815	59	23.3	952	96	99.7	4744	107	15.0	386	54	60.9	906	62	15.5	1035	121	98.4	3426	88	21.0	645	61	4.9	622	118
Italy[1]	1442	17.7	456	41	89.9	1082	24	48.9	422	21	8.3	519	59	98.8	4541	55	17.9	244	26	52.8	477	23	9.3	658	97	98.9	4454	57	17.2	607	46	30.1	687	44
Ragusa	168	28.6	240	67	86.9	1071	71	48.2	501	79	10.7	455	110	99.4	4799	174	22.6	250	74	50.0	330	60	10.7	1431	594	98.8	4192	178	14.9	941	194	8.3	1163	448
Florence	271	16.2	222	80	93.7	1221	60	50.2	542	52	10.3	348	83	98.9	4292	120	11.8	207	116	52.4	503	51	7.0	535	93	98.5	4697	146	7.7	535	173	24.0	696	126
Turin	676	21.3	632	61	86.1	952	33	47.9	410	29	6.1	586	106	98.4	4462	83	17.6	239	32	54.6	470	33	9.6	492	74	99.0	4441	77	17.8	461	52	36.1	676	58
Varese	327	5.8	205	36	96.3	1214	47	50.2	317	39	10.1	616	138	99.1	4774	104	21.1	266	47	50.8	547	50	9.8	632	151	99.1	4416	120	25.1	737	87	33.9	649	70
Naples	0																																	
France[1]	0																																	

South coast	0																																	
South	0																																	
North-West	0																																	
North-East	0																																	
Germany	2267	11.9	375	31	97.0	2122	26	57.2	905	26	9.2	511	45	87.6	2655	31	15.1	539	36	75.0	1123	26	15.6	835	47	95.4	3189	36	28.6	968	35	59.1	1001	21
Heidelberg	1034	15.5	365	36	95.2	1996	39	56.3	721	33	14.0	459	56	87.7	2711	50	22.1	523	46	69.6	1004	40	21.7	747	52	94.5	3193	56	41.6	869	41	59.9	962	30
Potsdam	1233	8.9	389	56	98.5	2225	35	57.9	1081	39	5.1	629	71	87.4	2608	39	9.2	572	60	79.6	1217	34	10.5	988	91	96.1	3185	47	17.8	1161	65	58.5	1039	29
The Netherlands[1]	1020	14.7	305	30	84.5	1749	36	80.6	777	35	1.5	851	224	82.1	2787	48	2.5	666	170	87.4	864	35	15.8	751	60	95.9	3731	59	15.9	1304	122	84.8	1692	55
Bilthoven	1020	14.7	305	30	84.5	1749	36	80.6	777	35	1.5	851	224	82.1	2787	48	2.5	666	170	87.4	864	35	15.8	751	60	95.9	3731	59	15.9	1304	122	84.8	1692	55
Utrecht	0																																	
United Kingdom	519																																	
General population	406	43.3	172	20	95.3	1618	49	80.0	569	43	6.9	688	177	92.1	2808	82	10.6	424	117	72.4	658	58	18.7	807	97	91.4	3486	87	16.5	667	118	84.7	914	53
Health-conscious	113	38.9	179	57	96.5	1731	98	70.8	466	60	1.8	215	93	92.0	2640	147	4.4	641	517	75.2	925	127	6.2	375	107	92.0	3450	171	3.5	153	76	75.2	1142	128
Denmark	1923	7.2	344	44	96.9	1852	25	67.0	641	23	10.1	491	39	86.1	2916	40	14.2	609	46	79.0	901	29	29.4	848	34	95.9	3873	46	23.1	1008	55	78.1	1204	28
Copenhagen	1356	5.5	403	74	97.1	1829	31	67.6	616	27	8.3	527	55	85.0	2930	47	17.4	625	52	74.9	895	39	30.6	865	39	95.4	3897	56	29.7	1035	59	73.2	1201	37
Aarhus	567	11.1	275	36	96.5	1908	43	65.6	699	42	14.6	442	53	88.7	2882	73	6.7	510	93	88.9	911	40	26.5	802	65	97.2	3817	81	7.4	751	123	89.8	1209	43
Sweden	2763	10.1	470	29	98.3	1820	19	54.7	800	21	1.0	450	90	82.9	2741	31	3.6	719	105	69.9	849	19	3.9	789	71	93.2	3452	34	15.4	992	46	77.7	1049	19
Malmö	1421	4.4	378	58	98.8	1888	27	51.6	883	33	1.2	535	128	81.1	2692	45	2.0	734	194	64.0	827	27	3.2	922	119	90.4	3251	49	5.5	863	101	80.3	1021	25
Umeå	1342	16.2	496	33	97.7	1746	28	57.9	724	27	0.8	319	113	84.8	2790	41	5.4	713	126	76.0	869	25	4.7	692	87	96.1	3652	48	25.9	1021	51	75.0	1082	28
Norway[1]	0																																	

South and East	0											
North and West	0											

Values are country- and centre specific proportion, mean and standard error. [1]Eight centres recruited women only (centres belonging to France, Norway, the Netherlands (Utrecht) and Italy (Naples)).

Figure 1

Mean number of intake occasions/day by country and sex, adjusted for age and weighted by season and day of dietary recall. Error bars represent standard error.

Figures 2a and 2b

Proportion of daily energy intake consumed as breakfast, lunch, dinner and snacks by country and sex for (a) women and (b) men.

Figure 3

The proportion of daily energy intake consumed as breakfast, lunch, dinner and snacks in Mediterranean, central European and Nordic countries for women and men combined.

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