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Objectives: To describe the intake of the fat-soluble nutrients retinol, β-carotene, vitamin E and vitamin D and their food sources among 27 redefined centres in 10 countries participating in the European Prospective Investigation into Cancer and Nutrition (EPIC) study.

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Contributors: MJ carried out the statistical analysis, preparation of tables and figures, and wrote the paper, taking into account the comments from all co-authors. NS was the overall coordinator of this project and the EPIC Nutrient Database project. CB assisted in the statistical analysis and preparation of the tables and figures. SS, CHvG, MB, SS-S, BB, HV, MT, CB and PW were members of the writing group and gave inputs on the statistical analysis, drafting of the manuscript and interpretation of the results. EL, MW, NR, AMJ, JL, HB, EV, VD, SS, CS, PF, JM, SN, AAW, RT, MCB-R, MN, HBB-de-M, YTvdS, MJT, AB, ER and SB were local EPIC collaborators involved in the collection of dietary and other data, and contributed to the ENDB project. ER is the overall coordinator of the EPIC study.

Methods: Between 1995 and 2000, 36 034 subjects (age range: 35–74 years) completed a single standardized 24-h dietary recall using a computerized interview software program (EPIC-SOFT). Intakes of the fat-soluble nutrients were estimated using the standardized EPIC Nutrient Database.
Results: For all the nutrients, in most centres, men had a higher level of intake than did women, even after adjustments for total energy intake and anthropometric confounders. Distinct regional gradients from northern to southern European countries were observed for all nutrients. The level intake of β-carotene and vitamin E also showed some differences by level of education, smoking status and physical activity. No meaningful differences in the nutrient intake were observed by age range.
Conclusions: These results show differences by study centre, gender, age and various lifestyle variables in the intake of retinol, β-carotene, vitamin E and vitamin D between 10 European countries.

Introduction

Vitamins A, D and E belong to the family of fat-soluble vitamins. Similar to their water-soluble counterparts, these fat-soluble vitamins have important metabolic and physiological roles (Debier and Larondelle, 2005; Holick, 2005). In addition, their intake may also be associated with reduced risk of several chronic diseases, particularly some cancers (Giovannucci, 2007, 2008; Constantinou *et al.*, 2008) and heart disease (Fairfield and Fletcher, 2002; Singh *et al.*, 2005; Voutilainen *et al.*, 2006; Wallis *et al.*, 2008). In contrast to water-soluble vitamins, fat-soluble vitamins are stored in the liver and fatty tissues and are only slowly excreted from the body. Thus, they may have deleterious or toxic consequences if consumed at very high levels. Although in well-fed populations serious deficiencies of these vitamins are rare, mild intake insufficiencies may be present, particularly in certain sub-populations, such as vegetarians, individuals consuming low-fat diets or those with fat absorption problems (Fairfield and Fletcher, 2002). These factors make the comparative assessment of the dietary intake levels of these nutrients in different European countries an important issue.

Vitamin A, also known as retinol, has essential roles in night vision and cell differentiation, particularly during embryological development, as well as in carcinogenesis, glycoprotein synthesis, epithelial cell integrity, immune cell maintenance and human growth hormone production (Love and Gudas, 1994; McCullough *et al.*, 1999; Marceau *et al.*, 2007; Sommer, 2008). In addition, some data suggest that, similar to vitamin E, vitamin A may also have an anti-oxidative function, but this remains to be better clarified (Palace *et al.*, 1999). For the most part, dietary sources of vitamin A are of animal origin (e.g., dairy products, fatty fish, liver, eggs, etc.), and populations that do not consume many of these animal products may be at risk of insufficiency of these nutrients. Vitamin A may also be produced endogenously from dietary precursor pro-vitamin A carotenoids (α-carotene, β-carotene and β-cryptoxanthin; from plant origin). However, the efficiency of this conversion is rather low and these carotenoids have a lower bioavailability or efficiency of intestinal uptake than retinol itself. Vitamin A from animal products is mostly consumed as retinyl esters, which are easily hydrolysed endogenously to form retinol (Debier and Larondelle, 2005). There is strong interest in the disease-protective role of retinol (Goodman *et al.*, 2008), and data obtained from the European Prospective Investigation into Cancer and Nutrition (EPIC) suggest that higher blood concentrations are associated with a reduced risk of gastric cancer (Jenab *et al.*, 2006).

Vitamin E is a general term describing the α-, β-, δ- and γ-forms of the tocopherol and tocotrienol chemical classes, although the inclusion of various other isomers of tocopherols and tocotrienols into the definition of vitamin E is currently under debate. The main role of vitamin E in the body is as an anti-oxidant, and it is this role that has sparked interest in the potential of vitamin E in chronic disease prevention (Singh *et al.*, 2005; Traber and Atkinson, 2007; Constantinou *et al.*, 2008).

Vitamin D can be diet-derived or produced endogenously from sun exposure (Holick, 2007). The degree of endogenous production depends on several variables such as genetics, degree of sun exposure, geographical location, ethnicity, etc (Nesby-O'Dell *et al.*, 2002; Kimlin, 2008). The dietary sources of vitamin D are limited, being found primarily in fatty fish (including cod liver oil), egg yolk and fortified dairy products. Vitamin D is essential for calcium/phosphorus metabolism and bone health (Holick, 2007), but more recent data suggest that it may also have a chronic disease-protective role (Zittermann *et al.*, 2005; Ali and Vaidya, 2007; Wallis *et al.*, 2008).

Very high levels of these nutrients, whether from dietary sources or by way of supplementation, may have a negative impact. For example, in a comprehensive review of randomized clinical trials, supplementation of β-carotene, vitamin A and vitamin E was associated with an increased risk of mortality (Miller III *et al.*, 2005; Bjelakovic *et al.*, 2008). In addition, very high daily supplementation of vitamin D can also lead to severe toxicity (Heaney, 2008). Indeed, safe tolerable upper intake limits have been established for many of these nutrients.

The objective of this study was to conduct a comparative analysis of the dietary intake levels of these nutrients

with consideration of food sources, lifestyle confounders and seasonal variations, using data obtained from EPIC, a cohort of 10 European countries (Riboli and Kaaks, 1997; Bingham and Riboli, 2004). Consumption of these nutrients as food supplements is described elsewhere in this special issue (Skeie *et al.*, in this supplement). The data to be presented in this study use the newly developed standardized EPIC Nutrient Database (ENDB) (Slimani *et al.*, 2007) and are based on the EPIC calibration study subcohort (Slimani *et al.*, 2002a). A better understanding of dietary exposures of these nutrients in various countries can provide further insight into potential aetiological links with chronic disease risk.

Materials and methods

Study population, design and dietary assessment

The rationale and methods of the EPIC study have been previously described in detail (Riboli and Kaaks, 1997; Riboli *et al.*, 2002; Bingham and Riboli, 2004). The EPIC cohort consists of 23 subcohorts in 10 European countries (Denmark, France, Greece, Germany, Italy, the Netherlands, Norway, Spain, Sweden and the United Kingdom), providing a wide range of cancer occurrence rates, lifestyle and dietary habits. The EPIC subcohorts represent heterogeneous groups that were population based (Bilthoven centre of the Netherlands, Greece, Germany, Sweden, Denmark, Norway, Spain, Italy, Cambridge centre of the United Kingdom and part of the Oxford centre of the United Kingdom), health-conscious individuals (a majority of the Oxford centre of the United Kingdom), participants in breast-screening groups (Utrecht centre of the Netherlands) or teachers and school workers (France). In France, Norway, the Utrecht centre of the Netherlands and the Naples centre of Italy, all subjects were women. For this study, the initial 23 EPIC administrative centres have been redefined into 27 geographical regions relevant to the analysis of dietary consumption patterns (Slimani *et al.*, 2002a). The EPIC study was approved by the ethics review boards of the IARC (International Agency for Research on Cancer) and all local EPIC centres. All EPIC participants provided informed consent.

Within the design of the EPIC study, a subsample of each study centre was randomly (age, sex stratified) chosen for the application of a standardized 24-h dietary recall (24-HDR) assessment gathered using computerized software (EPIC-SOFT) (Slimani *et al.*, 1999, 2000). This subcohort is referred to as the EPIC Calibration Substudy and was undertaken between 1995 and 2000. Each participant provided a single 24-HDR in a face-to-face interview (Slimani *et al.*, 1999), except in Norway where it was obtained by telephonic interview (Brustad *et al.*, 2003). By design, the sampling procedures of the EPIC Calibration Substudy were defined to control for seasonal and day-of-the-week variations in dietary intake (Slimani *et al.*, 2002a). In total, complete 24-HDR information exists on 36 994 subjects (13 486 men and 23 508 women), representing ~8% of the entire EPIC cohort. A total of 36 034 subjects with 24-HDR data were included in this analysis, after exclusion of 960 subjects aged under 35 or over 74 years, because of low participation in these age categories. Using EPIC-SOFT, information on the intake of all foods and beverages was collected, described, quantified, entered and coded according to common rules. The classification of the EPIC-SOFT food groups and food subgroups used in the calibration study is derived from a system described in detail elsewhere (Slimani *et al.*, 2002a).

Intakes of retinol, β-carotene, vitamin D and vitamin E were estimated using the ENDB project (Slimani *et al.*, 2007). Although the ENDB values are obtained from country-specific food composition tables, they are standardized as much as possible across the EPIC countries by matching EPIC foods to the national databases, deriving the nutrient values of unavailable foods, and imputation of missing values using common procedures and algorithms (Slimani *et al.*, 2007).

Data on other lifestyle factors, including education level, total physical activity and smoking history considered in this analysis, were collected at baseline through standardized questionnaires and clinical examinations, and have been described elsewhere (Riboli *et al.*, 2002, Slimani *et al.*, 2002a). Data on age as well as body weight and height were self-reported by the participants during the 24-HDR interview. The mean time interval between these baseline questionnaire measures and the 24-HDR interview varied by country, from 1 day to 3 years later (Slimani *et al.*, 2002a).

Statistical methods

Intakes of retinol, β-carotene, vitamin D and vitamin E were calculated as least square means and standard error (s.e.) by EPIC centre (ordered from southern to northern European centres), by age (10 year categories from 35 to 74), by gender, as well as by combined values for all centres and for men and women. The main food groups contributing to the intake levels of each of the above-mentioned nutrients were also determined. The statistical models were adjusted for age as well as a set of weights to control for the day of the week (Monday–Thursday; Friday–Sunday) and season (Spring, Summer, Autumn, Winter) of the 24-HDR collection (referred to as 'minimally-adjusted model'). Models with further adjustments for height, weight and total energy intake were also run and are referred to as fully adjusted models in this text.

Differences in intake levels were compared according to categories of education level (none/primary, technical/secondary, university or higher), smoking status (smoker, former smoker, never smoker), level of physical activity (active, moderately active, moderately inactive, inactive), body mass index (BMI; <25, 25 to <30, $\geqslant 30\,kg/m^2$) and European region (South: all centres in Greece, Spain, Italy and the south of France; Central: all centres in the north-east and north-west of France, Germany, the Netherlands and the

United Kingdom; North: all centres in Denmark, Sweden and Norway). *P*-values for trend across age categories were computed. Statistical significance of differences in intake levels by each of these stratifications was assessed and *P*-values <0.05 were considered as statistically significant. Statistical significance for differences by gender was also assessed.

Analyses were also carried out to determine the main food source of each of the four nutrients of interest, by study centre and gender. All analyses were conducted using the SAS statistical software (version 9.1, SAS Institute, Cary, NC, USA).

Results

Table 1 shows the mean intakes and s.e.m. for retinol, β-carotene, vitamin D and vitamin E, presented for each centre by gender and also by age range at recruitment. These data are shown with further adjustments for height, weight and total energy intake (so-called 'fully adjusted model') in Table A1 in the Appendix. Table 2 shows the overall intake of each nutrient (for all centres combined) stratified by European region, as well as a number of important lifestyle variables that may potentially affect nutrient intake levels. Tables 3 and 4 show the percentage contribution of the main food groups to the intake of each nutrient in men and women, respectively. Table 5 shows the country-specific mean intakes of the nutrients by the season in which the 24-HDR was administered, stratified by gender. For all four nutrients, intakes by the day of the week in which the 24-HDR was administered were sporadic and no remarkable variation was observed (data not shown). In tables presenting information by EPIC centre, the data are arranged geographically from south to north.

Mean intakes of retinol

For men, the mean intake of retinol ranged from 422 (Granada, Spain) to 1715 μg/day (Malmö, Sweden), whereas for women the range was 241 (Ragusa, Italy) to 1219 μg/day (Umeå, Sweden) (Table 1 and Figures 1a and b). In all centres, except in the Florence centre of Italy, men had a higher mean intake than did women. The intakes for women ranged from 13.7 (Navarra, Spain) to 66.5% (Ragusa, Italy) and were lower than those for men. Overall, for all centres combined, men had a significantly higher consumption of retinol than did women (848 versus 600 μg/day, *P* difference by gender <0.01) (Table 1). Considering centre-specific data, no trends in retinol intake are apparent by age range for either men or women (Table 1). Further adjustments for age, height, weight and total energy intake did not meaningfully alter the observed intake values or patterns (Table A1 in the Appendix).

A clear and statistically significant regional gradient of increasing retinol intakes is apparent from Southern to Northern Europe in both men and women (Table 2). In men, but not in women, a statistically significant difference in intake was also observed by the level of physical activity, with active individuals consuming significantly more retinol than inactive subjects. In both men and women, former smokers had lower retinol intakes than did either never smokers or smokers (Table 2).

Overall, for men, it is clear that the major contributing food sources of retinol are meats/meat products (51.7%), added fats (18.5%) and dairy products (15.6%) with considerable variability between centres (Table 3). Compared with men, women appear to consume slightly less retinol from meats/meat products (44.9%), more from dairy products (20.9%) and a roughly similar amount from added fats (15.8%) (Table 4). For both genders, vegetables and fruits provide no retinol, whereas the other food groups appear to be very small yet consistent sources of this nutrient (Tables 3 and 4).

Mean intakes of retinol show little variation by season (Table 5).

Mean intakes of β-carotene

The intake of β-carotene ranged from 1901 (Umeå, Sweden) to 3907 μg/day (Health Conscious, UK) in men and from 1520 (Asturias, Spain) to 4590 μg/day (North-West, France) in women (Table 1 and Figures 1a and b). In most centres, men tended to have a higher intake of β-carotene than did women (range from 1.5% in Turin, Italy to 24.2% in Asturias, Spain), with the exception of centres in Germany, Denmark and Sweden where the intakes of β-carotene by women were higher (range from 7.0% in Malmo, Sweden to 29.4% in Aarhus, Denmark). However, for all centres combined, the intakes of β-carotene were relatively similar between men and women (2760 versus 2887 μg/day, *P* difference by gender $=0.10$; Table 1). No remarkable trends in β-carotene intake are apparent by age range (Table 1). Further adjustments for age, height, weight and total energy intake did not meaningfully alter the observed intake values or patterns (Table A1 in the Appendix).

Differences in the levels of β-carotene intake were apparent by European region in both men and women (Table 2). Men and women from Central European countries consumed a statistically significantly higher level of β-carotene than did those from Northern countries, whereas those from Southern countries had an intermediate intake level (Table 2). Subjects in the lowest category of schooling consumed significantly less β-carotene than did those with higher levels of education. This difference was particularly evident in women. Smokers showed a significantly lower intake of β-carotene than did either former smokers or never smokers. In terms of level of physical activity, active men showed a statistically higher level of β-carotene intake than did inactive men, whereas no differences of intake were apparent for women (Table 2).

In complete contrast to retinol, the major contributing food sources of β-carotene in both genders appear to be vegetables (men: 67.8%, women: 70.7%), fruits (men: 7.8%,

Table 1 Minimally adjusted[a] mean daily intakes of retinol, β-carotene, vitamin D and vitamin E, by centre ordered from south to north, gender and age group

Country and centre	*Men*											*Women*											*Men and women*	
	N	*All*		*35–44 years*		*45–54 years*		*55–64 years*		*65–74 years*		N	*All*		*35–44 years*		*45–54 years*		*55–64 years*		*65–74 years*		*M*	*s.e.*
		M	*s.e.*	*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*		*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*		
													Retinol (μg/day)											
Greece	1311	594	61	528	185	705	126	471	114	619	97	1373	441	42	586	113	318	73	514	75	427	85	511	35
Spain																								
Granada	214	422	149	—	—	389	315	424	203	440	339	300	360	89	364	230	458	150	280	139	342	287	385	80
Murcia	243	514	140	323	438	552	253	457	196	1003	489	304	431	88	452	178	359	149	283	147	—	—	473	77
Navarra	444	438	104	823	454	474	174	422	148	210	319	271	378	94	440	246	436	154	325	143	—	—	417	68
San Sebastian	490	715	100	411	236	802	138	852	189	334	500	244	349	99	369	211	387	160	314	167	—	—	607	67
Asturias	386	569	111	535	421	553	187	600	167	540	303	324	439	86	579	208	327	139	510	138	339	315	512	68
Italy																								
Ragusa	168	720	169	—	—	957	252	619	264	—	—	138	241	131	170	218	172	245	152	234	—	—	514	103
Naples												403	262	77	257	250	269	122	243	118	333	249	264	91
Florence	271	467	133	616	420	529	228	432	189	—	—	784	606	55	575	185	604	96	658	76	242	216	572	56
Turin	676	489	84	517	274	604	141	449	121	209	323	392	401	78	250	247	709	130	227	109	—	—	461	55
Varese	327	520	121	—	—	567	270	510	146	247	409	794	311	55	218	176	258	91	389	82	250	165	371	54
France																								
South coast												620	731	62			789	102	644	97	788	129	728	73
South												1425	580	41			630	64	581	65	468	92	578	48
North-East												2059	659	34			629	53	660	53	715	78	656	40
North-West												631	708	61			856	97	539	93	786	148	705	72
Germany																								
Heidelberg	1034	952	69	771	182	1042	108	964	101	—	—	1087	717	47	742	80	625	85	779	78	—	—	841	40
Potsdam	1233	1219	62	1287	180	1222	126	1242	82	931	244	1061	709	47	681	94	815	92	679	70	507	299	987	38
The Netherlands																								
Bilthoven	1024	1119	71	1061	134	1250	107	1066	120	—	—	1086	761	48	720	83	827	73	713	90	—	—	951	40
Utrecht												1870	773	36			800	61	742	55	780	72	768	42
United Kingdom																								
General population	402	760	109	648	360	689	195	714	200	903	198	570	531	64	543	175	469	97	621	124	516	156	623	58
Health-conscious	114	554	205	—	—	288	335	430	317	—	—	197	370	110	409	312	314	165	386	183	459	340	441	103
Denmark																								
Copenhagen	1356	1349	59			1250	97	1440	78	938	300	1484	730	40			657	62	765	55	989	217	1024	34
Aarhus	567	1312	92			1307	130	1333	132	—	—	510	786	68			787	89	816	104	—	—	1064	55
Sweden																								
Malmö	1421	1715	61			1956	175	1724	92	1616	83	1711	1206	38			1224	70	1201	66	1187	68	1421	33
Umeå	1344	1678	60	1510	202	1708	112	1669	83	1748	178	1574	1219	39	1218	86	1297	64	1152	64	1307	145	1428	33
Norway																								
South and East												1004	792	49	846	109	782	55	841	129			802	58
North and West												793	718	55	819	116	698	61	755	154			728	65
All centres	13 025	1060	20	877	66	1059	35	1084	29	1084	51	23 009	708	10	684	32	699	17	699	16	777	28	835	10
													β-carotene (μg/day)											
Greece	1311	2760	94	2010	284	2323	193	3217	175	2963	150	1373	2361	103	2113	280	2374	181	2613	185	2181	211	2557	71

Table 1 *Continued*

Country and centre	Men											Women										Men and women	
	N	All		35–44 years		45–54 years		55–64 years		65–74 years		N	All		35–44 years		45–54 years		55–64 years		65–74 years		
		M	s.e.	M	s.e.	M	s.e.	M	s.e.	M	s.e.		M	s.e.	M	s.e.	M	s.e.	M	s.e.	M	s.e.	M	s.e.
Spain																							
Granada	214	2549	230	—	—	2560	485	2690	313	2440	522	300	2290	220	2466	569	2469	371	2125	345	1963	710	2400	161
Murcia	243	2630	216	2982	675	2229	389	2506	302	4300	753	304	2204	219	2329	440	2246	369	1935	364	—	—	2393	157
Navarra	444	2829	160	2266	699	2510	268	3179	228	2516	491	271	2265	231	1692	609	2116	380	2170	354	—	—	2612	137
San Sebastian	490	2860	154	3185	363	2785	212	2738	291	1805	769	244	2732	244	2423	522	3368	397	2321	412	—	—	2806	136
Asturias	386	2007	171	1585	648	1772	288	2310	257	1787	466	324	1520	212	1338	515	1548	345	1553	341	1431	780	1783	137
Italy																							
Ragusa	168	2331	260	—	—	2552	388	2038	407	—	—	138	1981	325	1728	540	1587	606	2529	579	—	—	2168	209
Naples												403	2131	190	3196	619	1713	302	2077	293	2996	617	2136	182
Florence	271	3095	205	3041	647	3343	351	3072	292	—	—	784	2562	136	2936	458	2628	236	2534	189	1958	533	2699	113
Turin	676	3024	130	3032	421	2742	217	3116	185	3501	497	392	2979	192	3179	609	2904	320	2982	269	—	—	3001	112
Varese	327	2812	186	—	—	3027	415	2723	224	3231	629	794	2194	135	2286	436	2045	226	2398	204	1771	409	2376	109
France																							
South coast												620	4528	153			4715	253	4765	239	3879	320	4529	147
South												1425	4199	101			3856	157	4444	161	4484	227	4201	97
North-East												2059	4440	84			4090	131	4572	132	4989	194	4442	81
North-West												631	4590	152			4572	241	4613	230	4646	365	4592	146
Germany																							
Heidelberg	1034	3402	106	3022	281	3461	167	3397	155	—	—	1087	3770	117	3850	198	3777	211	3623	193	—	—	3588	80
Potsdam	1233	3371	96	3797	276	3300	194	3320	126	3095	375	1061	3895	117	3606	232	4322	228	3817	172	2886	739	3611	77
The Netherlands																							
Bilthoven	1024	2187	109	2087	206	2194	164	2046	185	—	—	1086	1891	118	1860	205	1862	180	1828	223	—	—	2028	81
Utrecht												1870	2035	89			2023	152	2044	135	2129	179	2035	85
United Kingdom																							
General population	402	3234	168	1787	553	3166	300	3760	308	3264	305	570	3020	159	3037	480	2947	262	3085	289	3061	342	3109	117
Health-conscious	114	3907	315	—	—	3307	515	4208	487	—	—	197	3752	271	3504	860	3751	445	3608	428	4364	751	3807	208
Denmark																							
Copenhagen	1356	2895	91			2788	149	2944	119	3224	461	1484	3352	99			3214	164	3422	128	3789	471	3131	69
Aarhus	567	2819	141			2875	200	2746	202	—	—	510	3995	169			3853	238	4140	244	—	—	3372	111
Sweden																							
Malmö	1421	1836	94			1925	269	1910	141	1906	127	1711	1975	94			1999	189	1976	153	2060	144	1916	68
Umeå	1344	1901	92	1612	312	1694	172	2100	127	1819	275	1574	2216	96	2273	233	2126	172	2278	147	2152	308	2071	68
Norway																							
South and East												1004	2351	122	2153	290	2291	147	2567	298			2363	117
North and West												793	2714	137	2518	310	2608	165	3179	356			2726	131
All centres	13 025	2667	30	2552	101	2635	53	2775	44	2476	78	23 009	2964	26	2651	81	2916	42	3089	41	2970	71	2857	20
												Vitamin D (μg/day)											
Greece	1311	3.9	0.2	4.0	0.6	4.1	0.4	4.3	0.4	3.3	0.3	1373	2.8	0.1	2.8	0.4	3.3	0.2	2.6	0.2	2.3	0.3	3.3	0.1
Spain																							
Granada	214	4.6	0.5	—	—	5.7	1.1	4.1	0.7	5.1	1.2	300	3.0	0.3	2.7	0.8	3.4	0.5	2.4	0.5	4.6	0.9	3.7	0.3
Murcia	243	4.8	0.5	5.3	1.5	5.4	0.9	4.6	0.7	3.4	1.7	304	3.5	0.3	3.7	0.6	3.1	0.5	3.7	0.5	—	—	4.1	0.3
Navarra	444	5.1	0.4	4.3	1.6	6.6	0.6	4.6	0.5	2.6	1.1	271	3.0	0.3	2.9	0.8	3.6	0.5	2.7	0.5	—	—	4.3	0.2

Table 1 *Continued*

Country and centre	*Men*											*Women*										*Men and women*	
	N	*All*		*35–44 years*		*45–54 years*		*55–64 years*		*65–74 years*		N	*All*		*35–44 years*		*45–54 years*		*55–64 years*		*65–74 years*		*M*	*s.e.*
		M	*s.e.*	*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*		*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*		
San Sebastian	490	6.6	0.3	7.7	0.8	6.1	0.5	7.6	0.7	2.9	1.7	244	4.4	0.3	5.2	0.7	5.0	0.5	3.5	0.5	—	—	5.9	0.2
Asturias	386	8.0	0.4	8.4	1.4	7.0	0.6	8.7	0.6	8.4	1.0	324	4.9	0.3	4.6	0.7	5.5	0.5	4.5	0.5	4.1	1.0	6.6	0.2
Italy																								
Ragusa	168	2.1	0.6	—	—	2.2	0.9	1.8	0.9	—	—	138	2.0	0.4	1.8	0.7	2.5	0.8	2.0	0.8	—	—	2.1	0.4
Naples												403	2.0	0.3	3.1	0.8	1.8	0.4	2.0	0.4	2.0	0.8	2.1	0.3
Florence	271	2.4	0.5	2.5	1.4	2.9	0.8	2.3	0.7	—	—	784	1.7	0.2	1.5	0.6	1.6	0.3	1.8	0.3	1.9	0.7	1.9	0.2
Turin	676	2.6	0.3	2.7	0.9	3.2	0.5	2.3	0.4	1.8	1.1	392	1.7	0.3	2.0	0.8	1.6	0.4	1.8	0.4	—	—	2.3	0.2
Varese	327	2.1	0.4	—	—	2.4	0.9	2.0	0.5	1.9	1.4	794	1.9	0.2	2.0	0.6	2.1	0.3	1.8	0.3	1.5	0.5	1.9	0.2
France																								
South coast												620	2.8	0.2			2.2	0.3	3.3	0.3	2.9	0.4	2.8	0.2
South												1425	2.4	0.1			2.3	0.2	2.5	0.2	2.7	0.3	2.4	0.1
North-East												2059	2.8	0.1			2.7	0.2	3.3	0.2	2.2	0.3	2.8	0.1
North-West												631	2.9	0.2			2.7	0.3	3.1	0.3	2.8	0.5	2.9	0.2
Germany																								
Heidelberg	1034	3.4	0.2	2.9	0.6	3.3	0.4	3.3	0.3	—	—	1087	3.0	0.2	3.0	0.3	3.2	0.3	2.8	0.3	—	—	3.3	0.1
Potsdam	1233	4.9	0.2	5.0	0.6	5.1	0.4	5.0	0.3	3.9	0.8	1061	3.7	0.2	3.4	0.3	3.6	0.3	3.9	0.2	3.1	1.0	4.4	0.1
The Netherlands																								
Bilthoven	1024	5.6	0.2	5.8	0.5	5.6	0.4	5.6	0.4	—	—	1086	3.8	0.2	3.9	0.3	3.6	0.2	3.9	0.3	—	—	4.8	0.1
Utrecht												1870	3.9	0.1			4.0	0.2	3.9	0.2	3.8	0.2	3.9	0.1
United Kingdom																								
General population	402	4.7	0.4	4.4	1.2	4.9	0.7	4.7	0.7	4.7	0.7	570	3.4	0.2	2.8	0.6	3.4	0.3	3.5	0.4	3.4	0.5	3.9	0.2
Health-conscious	114	3.2	0.7	—	—	3.0	1.2	2.5	1.1	—	—	197	2.9	0.4	2.7	1.1	2.1	0.6	3.3	0.6	4.3	1.0	3.0	0.3
Denmark																								
Copenhagen	1356	5.7	0.2			5.2	0.3	5.6	0.3	9.5	1.0	1484	4.0	0.1			3.7	0.2	4.3	0.2	3.2	0.6	4.8	0.1
Aarhus	567	5.3	0.3			6.1	0.4	4.7	0.5	—	—	510	3.6	0.2			3.5	0.3	3.6	0.3	—	—	4.5	0.2
Sweden																								
Malmö	1421	8.2	0.2			8.0	0.6	8.1	0.3	8.3	0.3	1711	6.0	0.1			5.6	0.3	5.9	0.2	6.4	0.2	6.9	0.1
Umeå	1344	9.1	0.2	9.1	0.7	8.7	0.4	9.2	0.3	9.3	0.6	1574	6.1	0.1	5.9	0.3	6.0	0.2	6.2	0.2	6.6	0.4	7.5	0.1
Norway																								
South and East												1004	4.0	0.2	4.0	0.4	3.7	0.2	4.8	0.4			4.0	0.2
North and West												793	4.4	0.2	4.3	0.4	4.1	0.2	5.3	0.5			4.4	0.2
All centres	13 025	5.5	0.1	5.2	0.2	5.3	0.1	5.5	0.1	6.1	0.2	23 009	3.6	0.0	3.6	0.1	3.5	0.1	3.7	0.1	3.8	0.1	4.3	0.0
												Vitamin E (mg/day)												
Greece	1311	20.1	0.3	20.7	0.8	19.3	0.5	20.3	0.5	20.0	0.4	1373	15.0	0.2	13.2	0.5	15.6	0.3	15.4	0.3	14.6	0.4	17.4	0.2
Spain																								
Granada	214	14.8	0.6	—	—	15.7	1.3	14.3	0.8	16.0	1.4	300	11.7	0.4	11.2	1.0	12.7	0.7	11.1	0.6	10.7	1.3	13.0	0.4
Murcia	243	17.2	0.6	22.9	1.8	15.9	1.1	16.8	0.8	18.2	2.0	304	15.1	0.4	15.7	0.8	14.4	0.7	15.4	0.7	—	—	16.1	0.3
Navarra	444	16.7	0.4	23.0	1.9	17.3	0.7	16.1	0.6	14.3	1.3	271	13.1	0.4	11.9	1.1	13.3	0.7	13.2	0.6	—	—	15.4	0.3
San Sebastian	490	19.3	0.4	22.9	1.0	18.7	0.6	19.9	0.8	13.3	2.1	244	15.2	0.4	17.7	1.0	16.3	0.7	13.1	0.8	—	—	18.1	0.3
Asturias	386	14.4	0.5	16.2	1.8	14.3	0.8	14.5	0.7	13.2	1.3	324	11.8	0.4	11.9	0.9	12.5	0.6	11.6	0.6	9.5	1.4	13.2	0.3

Table 1 *Continued*

Country and centre	Men											Women										Men and women	
	N	All		35–44 years		45–54 years		55–64 years		65–74 years		N	All		35–44 years		45–54 years		55–64 years		65–74 years		M	s.e.
		M	s.e.	M	s.e.	M	s.e.	M	s.e.	M	s.e.		M	s.e.	M	s.e.	M	s.e.	M	s.e.	M	s.e.		
Italy																							
Ragusa	168	13.6	0.7	—	—	13.9	1.1	13.9	1.1	—	—	138	11.2	0.6	10.8	1.0	9.6	1.1	13.8	1.1	—	—	12.7	0.5
Naples												403	10.3	0.3	14.3	1.1	9.9	0.6	9.9	0.5	10.2	1.1	10.3	0.4
Florence	271	13.8	0.6	14.2	1.8	14.1	0.9	14.5	0.8	—	—	784	10.1	0.2	10.7	0.8	10.2	0.4	9.9	0.3	10.0	1.0	11.1	0.2
Turin	676	12.9	0.4	13.2	1.1	12.5	0.6	13.2	0.5	13.5	1.3	392	10.8	0.4	10.5	1.1	10.7	0.6	11.0	0.5	—	—	12.2	0.2
Varese	327	12.4	0.5	—	—	13.1	1.1	11.9	0.6	14.8	1.7	794	9.5	0.2	9.6	0.8	9.6	0.4	9.8	0.4	8.5	0.7	10.4	0.2
France																								
South coast												620	12.7	0.3			11.7	0.5	13.2	0.4	13.2	0.6	12.7	0.3
South												1425	11.2	0.2			10.7	0.3	11.6	0.3	11.3	0.4	11.2	0.2
North-East												2059	11.2	0.2			11.2	0.2	11.1	0.2	11.1	0.4	11.1	0.2
North-West												631	10.3	0.3			10.2	0.4	10.5	0.4	9.6	0.7	10.3	0.3
Germany																								
Heidelberg	1034	16.5	0.3	15.7	0.8	16.5	0.5	17.1	0.4	—	—	1087	13.8	0.2	14.7	0.4	13.6	0.4	13.1	0.4	—	—	15.2	0.2
Potsdam	1233	18.5	0.3	20.1	0.7	18.2	0.5	18.6	0.3	16.9	1.0	1061	13.5	0.2	12.5	0.4	13.7	0.4	13.8	0.3	20.0	1.4	16.3	0.2
The Netherlands																								
Bilthoven	1024	15.5	0.3	17.2	0.6	15.9	0.4	14.8	0.5	—	—	1086	11.1	0.2	11.9	0.4	11.1	0.3	10.4	0.4	—	—	13.4	0.2
Utrecht												1870	10.3	0.2			10.4	0.3	10.3	0.2	10.1	0.3	10.3	0.2
United Kingdom																								
General population	402	11.8	0.5	13.2	1.5	13.1	0.8	10.6	0.8	11.0	0.8	570	8.7	0.3	9.1	0.9	9.1	0.5	8.5	0.5	8.3	0.6	10.0	0.3
Health-conscious	114	16.1	0.9	—	—	16.0	1.4	15.9	1.3	—	—	197	13.3	0.5	10.3	1.6	13.9	0.8	14.4	0.8	11.0	1.4	14.4	0.5
Denmark																								
Copenhagen	1356	10.6	0.2			10.3	0.4	10.7	0.3	11.5	1.2	1484	8.3	0.2			8.3	0.3	8.4	0.2	7.7	0.9	9.4	0.2
Aarhus	567	11.3	0.4			11.1	0.5	11.6	0.5	—	—	510	9.7	0.3			9.9	0.4	9.5	0.4	—	—	10.6	0.2
Sweden																								
Malmö	1421	9.3	0.3			9.4	0.7	9.0	0.4	8.9	0.3	1711	7.7	0.2			8.1	0.3	7.7	0.3	7.4	0.3	8.3	0.1
Umeå	1344	10.0	0.2	11.2	0.8	10.0	0.5	9.7	0.3	9.6	0.7	1574	7.8	0.2	7.8	0.4	8.0	0.3	7.8	0.3	7.8	0.6	8.8	0.1
Norway																								
South and East												1004	7.7	0.2	7.7	0.5	7.7	0.3	8.0	0.5			7.8	0.3
North and West												793	7.8	0.3	8.4	0.6	7.7	0.3	7.7	0.7			7.8	0.3
All centres	13 025	14.2	0.1	17.3	0.3	14.3	0.2	13.8	0.1	13.2	0.2	23 009	10.6	0.0	11.5	0.2	10.5	0.1	10.6	0.1	10.2	0.1	11.9	0.0

Abbreviations: M, mean; s.e., standard error; '—' If fewer than 20 persons are present in a certain age group, the mean intake is not presented.
[a]Adjusted for age (when not stratified for age) and weighted by season and day of recall.

Table 2 Minimally adjusted[a] mean daily intakes of retinol, β-carotene, vitamin D and vitamin E by gender and selected characteristics

Stratification variable	*Men (mean (s.e.))*				*Women (mean (s.e.))*			
	Retinol (μg/day)	*β-carotene (μg/day)*	*Vitamin D (μg/day)*	*Vitamin E (mg/day)*	*Retinol (μg/day)*	*β-carotene (μg/day)*	*Vitamin D (μg/day)*	*Vitamin E (mg/day)*
European region								
South	553.9 (32.6) a	2743.0 (50.5) a	4.2 (0.1) a	16.6 (0.1) a	470.9 (18.0) a	2877.4 (45.6) a	2.6 (0.1) a	12.1 (0.1) a
Central	1056.2 (36.3) b	3057.6 (56.4) b	4.7 (0.1) a	16.4 (0.2) a	700.5 (16.7) b	3342.3 (42.3) b	3.4 (0.1) b	11.4 (0.1) b
North	1545.9 (32.5) c	2283.4 (50.4) c	7.4 (0.1) b	10.1 (0.1) b	964.3 (18.4) c	2597.7 (46.5) c	5.0 (0.1) c	8.0 (0.1) c
Level of schooling								
None/primary	838.5 (38.2)	2547.8 (58.6) a	4.8 (0.1)	14.6 (0.2)	604.7 (21.2)	2636.1 (52.6) a	3.4 (0.1)	11.0 (0.1) a
Technical/secondary	870.7 (36.4)	2736.6 (55.8) b	5.0 (0.1)	14.5 (0.2)	608.3 (17.9)	2963.7 (44.5) b	3.3 (0.1)	11.0 (0.1) a
University or higher	769.6 (44.0)	2892.5 (67.5) b	4.7 (0.2)	14.2 (0.2)	565.5 (25.1)	3227.6 (62.2) c	3.4 (0.1)	11.5 (0.1) b
Smoking status								
Smoker	914.5 (40.7)	2481.5 (62.2) a	5.1 (0.1)	14.1 (0.2) a	651.0 (26.3) a	2696.2 (64.7) a	3.3 (0.1)	10.7 (0.1) a
Former smoker	805.4 (35.4)	2851.6 (54.0) b	4.7 (0.1)	14.5 (0.1) ab	565.1 (23.7) b	2933.7 (58.4) b	3.4 (0.1)	10.8 (0.1) a
Never smoker	846.4 (38.1)	2878.0 (58.2) b	4.8 (0.1)	14.7 (0.2) b	600.3 (15.9) ab	2931.0 (39.3) b	3.4 (0.1)	11.3 (0.1) b
Physical activity								
Active	975.3 (62.7) a	3114.7 (97.8) a	5.0 (0.2)	15.4 (0.3) a	567.7 (43.2)	2971.1 (105.8)	3.3 (0.1)	11.9 (0.2)
Moderately active	784.1 (37.9) ab	2805.3 (59.2) b	4.6 (0.1)	15.0 (0.2) a	555.4 (19.5)	2946.7 (47.7)	3.1 (0.1)	11.5 (0.1)
Moderately inactive	828.8 (41.0) ab	2723.7 (63.9) b	4.5 (0.1)	14.7 (0.2) a	560.3 (23.2)	2962.9 (56.8)	3.2 (0.1)	11.4 (0.1)
Inactive	685.8 (50.2) b	2752.1 (78.4) b	4.6 (0.2)	14.0 (0.2) b	584.8 (33.3)	2899.1 (81.6)	3.2 (0.1)	11.3 (0.2)
Body mass index (kg/m^2)								
<25	881.5 (39.2)	2857.7 (60.4)	5.1 (0.1)	14.7 (0.2) a	610.0 (16.9)	2958.3 (41.9) a	3.4 (0.1)	11.3 (0.1) a
25 to <30	815.2 (31.1)	2746.9 (48.0)	4.8 (0.1)	14.5 (0.1) ab	598.0 (19.8)	2841.3 (49.0) ab	3.3 (0.1)	10.8 (0.1) b
$\geqslant 30$	890.9 (50.2)	2629.9 (77.3)	4.7 (0.2)	14.0 (0.2) b	572.4 (28.8)	2745.9 (71.2) b	3.4 (0.1)	10.9 (0.1) b

Abbreviations: M, mean; s.e., standard error.
[a]Adjusted for age and weighted by season and day of recall.
Within each stratification variable, values with different letters in a column are significantly different ($P<0.05$).

women: 9.0%) and soups/bouillon (men: 6.6%, women: 7.8%) (Tables 3 and 4). These sources appear to be consistent between centres, with little regional variability.

In both men and women, the mean intakes of β-carotene show little variation by season (Table 5). Compared with the other seasons, the summer intakes of this nutrient are higher in men and women from Spain, Italy, Germany and Sweden. In the UK Health Conscious, intakes for men were highest in the winter and spring, whereas those for women were highest in the summer (Table 5).

Mean intakes of vitamin D

The highest mean intake of vitamin D was in Umeå (Sweden) for both men (9.1 μg/day) and women (6.1 μg/day). The lowest mean intakes were in Ragusa and Varese (Italy) for men (2.1 μg/day) and Florence and Turin (Italy) for women (1.7 μg/day) (Table 1 and Figures 2a and b). Men tended to have higher intakes of vitamin D than did women in most centres, ranging from 4.8% higher in Ragusa, Italy to 41.2% in Navarra, Spain (Table 1). For all centres combined, men consumed 4.9 μg/day compared with 3.4 μg/day for women (P difference by gender <0.01). No clear trends in intake were apparent by age range (Table 1). Further adjustments for age, height, weight and total energy intake did not meaningfully alter the observed intake values or patterns (Table A1 in the Appendix).

Subjects from Northern countries consumed significantly higher levels of vitamin D than did those from Southern countries, with intermediate levels in Central European countries (Table 2). However, for both men and women, no remarkable differences in intake levels were noted for any of the lifestyle variables (Table 2).

For men, the major contributing food group sources of vitamin D are fish/shellfish (41.9%), added fats (21.8%), meats/meat products (9.7%) and dairy products (9.6%) (Table 3). Similar to men, fish/shellfish are also the major sources of vitamin D in women (39.6%) followed by added fats (19.3%), dairy products (10.4%) and meat/meat products (9.4%) (Table 4). In both men and women, fish/shellfish appear to contribute to a greater percentage of vitamin D in Southern than in Central countries, and the reverse appears to be true for dairy products (Tables 3 and 4).

Intakes of vitamin D showed slight sporadic variation by season in most countries with the exception of Greece, Spain and Sweden where both men and women tended to have higher intakes in the summer, compared with the other seasons (Table 5).

Table 3 Percentage contribution of main food groups to the intake of retinol, β-carotene, vitamin D and vitamin E—men

Country and centre	*Dietary food groups (percentage contribution of each food group to total intake of the nutrient)*											
	Vegetables	*Fruits*	*Dairy products*	*Cereals and products*	*Meats and products*	*Fish/shellfish*	*Eggs and products*	*Added fats*	*Cakes*	*Condiments/ sauces*	*Soups/ bouillon*	*All other food groups*
						Retinol						
Greece	0.0	0.0	30.4	0.3	53.8	1.9	4.7	3.6	3.0	1.4	0.4	0.5
Spain												
Granada	0.2	0.0	38.9	0.1	18.7	4.6	13.1	7.3	5.9	0.8	9.5	0.9
Murcia	0.0	0.0	20.8	0.1	45.1	2.9	10.2	4.0	9.7	0.3	4.8	2.1
Navarra	0.0	0.0	21.0	0.0	43.1	5.3	18.6	1.4	5.7	0.5	3.1	1.3
San Sebastian	0.0	0.0	17.0	0.0	57.3	3.4	14.5	1.3	4.3	0.2	1.3	0.8
Asturias	0.0	0.0	25.9	0.0	38.0	6.2	13.7	3.0	5.1	0.1	7.1	0.9
Italy												
Ragusa	0.0	0.0	14.6	1.3	71.1	2.5	4.3	0.6	3.1	0.5	0.0	2.1
Florence	0.0	0.0	24.0	1.4	50.1	2.2	6.0	4.6	8.3	1.0	0.0	2.3
Turin	0.0	0.0	27.0	1.8	49.8	1.6	6.0	2.7	7.4	1.1	0.0	2.7
Varese	0.0	0.0	27.3	1.2	52.7	0.7	2.3	5.1	7.4	1.0	0.0	2.2
Germany												
Heidelberg	0.0	0.0	16.0	1.3	55.3	0.5	3.2	14.6	6.1	1.3	0.5	1.1
Potsdam	0.0	0.0	13.6	0.4	50.1	0.5	3.1	25.6	4.9	0.8	0.4	0.6
The Netherlands												
Bilthoven	0.2	0.0	14.8	0.2	49.7	1.6	2.8	24.4	3.2	2.4	0.0	0.7
United Kingdom												
General population	0.0	0.0	19.1	1.2	29.5	0.6	3.4	32.8	8.7	1.1	0.6	3.0
Health-conscious	0.0	0.0	10.6	0.9	36.3	0.2	2.4	35.4	8.3	0.6	1.4	4.0
Denmark												
Copenhagen	0.0	0.0	10.1	0.2	62.5	3.0	2.9	13.3	4.2	2.6	0.3	0.8
Aarhus	0.0	0.0	11.6	0.2	57.4	2.9	3.0	15.3	5.5	2.9	0.2	1.1
Sweden												
Malmö	0.0	0.0	11.9	1.2	52.4	0.4	2.0	24.1	4.2	2.7	0.2	0.8
Umeå	0.0	0.0	15.5	1.2	45.3	0.4	2.2	26.4	5.5	2.1	0.6	0.8
All centres	0.0	0.0	15.6	0.7	51.7	1.5	3.7	18.5	4.9	1.9	0.6	1.0
						β-carotene						
Greece	86.9	1.5	2.4	0.0	0.1	0.0	0.0	3.4	0.4	3.0	0.6	1.9
Spain												
Granada	55.0	14.0	2.0	0.0	1.9	0.0	0.4	2.2	0.9	1.1	17.8	4.5
Murcia	60.4	17.2	1.5	0.0	1.8	0.1	0.4	1.4	1.5	2.4	10.4	2.8
Navarra	65.3	10.5	1.4	0.0	3.6	0.0	0.6	1.1	1.0	2.2	12.7	1.5
San Sebastian	62.1	11.9	1.8	0.0	3.6	0.0	0.8	0.5	1.1	3.6	13.3	1.3
Asturias	58.2	14.8	3.4	0.0	5.9	0.1	0.8	1.2	1.7	2.4	7.5	3.9
Italy												
Ragusa	48.7	27.3	3.9	2.1	2.0	0.0	0.6	0.3	0.4	12.3	0.0	2.2
Florence	55.9	29.5	2.3	1.6	0.3	0.0	0.4	0.6	0.7	6.0	0.7	2.0
Turin	64.9	21.7	2.7	2.3	0.4	0.0	0.4	0.3	0.5	4.2	0.6	2.0
Varese	62.0	17.7	4.0	2.5	0.2	0.0	0.2	0.8	0.8	8.5	1.2	2.1

Table 3 *Continued*

Country and centre	*Dietary food groups (percentage contribution of each food group to total intake of the nutrient)*											
	Vegetables	*Fruits*	*Dairy products*	*Cereals and products*	*Meats and products*	*Fish/shellfish*	*Eggs and products*	*Added fats*	*Cakes*	*Condiments/ sauces*	*Soups/ bouillon*	*All other food groups*
Germany												
Heidelberg	59.7	8.2	3.2	0.6	0.4	0.0	0.0	8.6	1.9	4.3	6.9	6.2
Potsdam	49.7	10.4	4.5	0.3	0.8	0.0	0.1	9.6	1.8	3.2	7.5	12.3
The Netherlands												
Bilthoven	63.5	3.5	5.9	0.3	0.1	0.0	0.1	9.7	1.2	3.3	10.0	2.3
United Kingdom												
General population	83.8	0.5	2.1	0.5	0.2	0.0	0.0	4.2	1.4	1.5	2.8	3.1
Health-conscious	77.7	0.8	0.9	0.4	0.0	0.0	0.0	3.0	0.8	1.4	5.2	9.9
Denmark												
Copenhagen	79.6	2.4	2.4	0.0	0.1	0.0	0.3	3.0	1.3	1.7	4.5	4.7
Aarhus	74.8	3.1	2.9	0.0	0.0	0.0	0.3	3.8	1.7	1.7	3.8	7.7
Sweden												
Malmö	71.6	4.0	4.0	0.4	0.4	0.6	0.4	1.8	0.6	1.8	11.2	3.4
Umeå	68.7	2.9	4.6	0.6	1.0	0.2	0.4	3.0	0.7	2.2	12.8	2.9
All centres	67.8	7.8	3.2	0.5	0.8	0.1	0.2	4.2	1.1	3.0	6.6	4.6
						Vitamin D						
Greece	0.1	0.0	29.7	0.6	13.0	40.5	7.0	3.1	3.4	1.8	0.5	0.4
Spain												
Granada	0.1	0.0	5.2	0.4	6.3	71.1	10.2	2.2	3.4	0.3	0.5	0.1
Murcia	0.0	0.0	2.6	0.5	7.2	71.2	9.1	1.4	6.1	0.2	0.3	1.5
Navarra	0.0	0.0	3.3	0.2	7.1	68.5	15.2	0.6	3.8	0.4	0.5	0.3
San Sebastian	0.0	0.0	3.5	0.4	7.0	70.8	13.8	0.7	3.1	0.2	0.4	0.1
Asturias	0.0	0.0	3.3	0.6	3.7	78.5	9.2	1.3	2.5	0.1	0.6	0.2
Italy												
Ragusa	0.0	0.0	4.6	4.1	19.4	46.5	12.4	0.2	6.0	3.8	0.0	3.0
Florence	3.4	0.0	6.0	1.9	21.5	42.3	9.8	1.3	8.0	2.8	0.0	2.9
Turin	3.4	0.0	5.1	2.4	21.6	48.2	9.0	0.6	6.3	1.9	0.0	1.5
Varese	1.2	0.0	6.5	2.5	31.1	41.3	4.4	1.3	7.7	2.2	0.0	1.9
Germany												
Heidelberg	3.8	0.0	14.1	1.6	2.4	45.2	10.5	12.1	7.4	1.3	0.5	1.0
Potsdam	1.6	0.0	8.7	0.2	1.3	50.5	8.1	23.2	4.8	0.7	0.3	0.4
The Netherlands												
Bilthoven	0.0	0.0	6.6	0.3	11.2	19.0	5.3	45.3	5.6	5.2	0.2	1.3
United Kingdom												
General population	0.0	0.0	4.2	5.9	13.8	18.8	5.0	37.3	11.7	1.1	0.1	2.2
Health-conscious	0.0	0.0	5.2	6.5	3.5	9.9	4.2	52.5	14.2	0.9	0.2	2.7

Table 3 *Continued*

Country and centre	*Dietary food groups (percentage contribution of each food group to total intake of the nutrient)*											
	Vegetables	*Fruits*	*Dairy products*	*Cereals and products*	*Meats and products*	*Fish/shellfish*	*Eggs and products*	*Added fats*	*Cakes*	*Condiments/ sauces*	*Soups/ bouillon*	*All other food groups*
Denmark												
Copenhagen	0.5	0.0	6.3	0.3	14.0	66.5	4.7	3.4	1.6	2.1	0.3	0.4
Aarhus	0.6	0.0	7.4	0.2	15.0	63.7	5.2	3.1	2.3	2.0	0.3	0.2
Sweden												
Malmö	0.0	0.0	9.5	2.3	9.9	22.7	2.9	40.4	7.5	3.8	0.5	0.4
Umeå	0.0	0.0	13.3	2.0	8.2	21.9	2.8	39.0	8.5	2.8	1.2	0.4
All centres	0.5	0.0	9.6	1.3	9.7	41.9	6.2	21.8	5.7	2.3	0.5	0.6
						Vitamin E						
Greece	11.2	11.4	1.1	2.1	0.9	1.7	0.9	62.1	2.5	3.5	0.6	1.9
Spain												
Granada	11.1	16.6	2.9	1.9	2.0	6.0	2.7	39.3	1.6	6.1	5.0	4.8
Murcia	11.4	23.9	1.7	1.4	1.8	6.1	2.2	36.9	3.3	2.4	1.6	7.3
Navarra	11.4	12.3	1.6	0.7	2.3	5.7	3.9	50.9	1.9	2.5	2.1	4.8
San Sebastian	7.7	12.5	1.7	0.9	2.3	6.1	4.2	51.3	1.9	3.9	2.2	5.2
Asturias	5.8	15.3	3.0	2.0	2.7	10.6	4.2	41.1	3.2	3.2	1.5	7.4
Italy												
Ragusa	9.7	13.5	1.6	3.4	1.3	2.7	1.3	39.8	4.9	18.8	0.0	2.9
Florence	12.8	13.4	2.1	3.5	1.3	3.6	1.2	45.8	4.8	7.7	0.3	3.6
Turin	15.9	15.6	2.3	5.0	1.4	3.4	1.1	41.1	4.5	7.3	0.2	2.1
Varese	11.3	14.4	3.1	3.6	2.2	2.3	0.6	30.8	6.0	22.5	0.4	2.8
Germany												
Heidelberg	8.1	8.0	2.7	8.9	3.7	2.1	1.5	25.3	6.5	26.3	1.4	5.6
Potsdam	5.9	6.6	2.6	7.0	3.1	2.6	1.5	48.8	5.6	10.6	1.2	4.4
The Netherlands												
Bilthoven	6.3	5.6	3.2	3.5	1.2	1.6	3.1	51.0	5.0	15.8	0.1	3.6
United Kingdom												
General population	9.6	5.2	3.9	11.9	2.0	4.0	1.2	37.9	10.7	7.7	1.1	4.8
Health-conscious	11.1	16.0	1.4	10.0	0.2	0.2	0.6	37.1	7.7	5.7	1.2	8.8
Denmark												
Copenhagen	7.2	10.3	4.0	9.6	2.6	9.9	3.5	26.3	7.3	13.3	0.6	5.4
Aarhus	6.3	10.8	4.3	9.7	2.2	7.7	3.3	31.5	9.5	9.4	0.5	4.8
Sweden												
Malmö	6.2	7.5	4.5	10.8	6.4	6.6	3.6	30.7	10.4	7.9	1.4	3.9
Norway												
South and East	—	—	—	—	—	—	—	—	—	—	—	—
North and West	—	—	—	—	—	—	—	—	—	—	—	—
All centres	8.4	10.1	2.8	6.1	2.7	4.3	2.4	42.2	5.7	10.0	1.2	4.2

Values are percentages derived from models adjusted for age and weighted by season and day of recall (minimally adjusted models).

Table 4 Percentage contribution of main food groups to the intake of retinol, β-carotene, vitamin D and vitamin E—women

Country and centre	*Dietary food groups (percentage contribution of each food group to total intake of the nutrient)*											
	Vegetables	*Fruits*	*Dairy products*	*Cereals and products*	*Meats and products*	*Fish/ shellfish*	*Eggs and products*	*Added fats*	*Cakes*	*Condiments/ sauces*	*Soups/bouillon*	*All other food groups*
							Retinol					
Greece	0.0	0.0	32.3	0.2	49.7	1.5	4.9	4.0	5.0	1.3	0.3	0.7
Spain												
Granada	0.1	0.0	28.0	0.0	43.1	3.0	8.2	6.6	4.8	0.2	4.8	1.3
Murcia	0.0	0.0	20.9	0.2	50.6	2.2	8.8	3.8	8.6	0.2	3.5	1.2
Navarra	0.1	0.0	28.4	0.0	36.9	4.0	13.2	3.8	8.8	0.6	2.6	1.6
San Sebastian	0.1	0.0	26.5	0.1	35.0	5.3	16.5	4.1	8.9	0.2	1.7	1.6
Asturias	0.0	0.0	30.4	0.0	34.0	4.7	12.4	4.8	6.6	0.1	5.8	1.2
Italy												
Ragusa	0.0	0.0	31.7	1.9	39.8	4.2	9.0	1.1	9.4	0.6	0.1	2.2
Naples	0.0	0.0	50.9	4.4	10.4	2.7	9.6	2.3	14.7	0.7	0.0	4.3
Florence	0.0	0.0	18.8	1.1	63.9	0.6	3.9	2.8	6.3	0.6	0.0	2.0
Turin	0.0	0.0	27.5	1.3	49.0	0.7	6.8	3.1	7.3	0.8	0.0	3.5
Varese	0.0	0.0	35.4	1.8	33.8	1.5	7.1	5.8	8.9	1.4	0.1	4.3
France												
South coast	0.0	0.0	24.9	0.5	49.9	2.1	4.0	8.2	7.4	1.3	0.6	1.1
South	0.0	0.0	28.0	1.0	40.7	2.3	5.0	10.2	8.7	2.1	0.4	1.7
North-East	0.0	0.0	25.6	0.7	43.2	2.0	4.3	11.7	9.3	1.1	0.5	1.6
North-West	0.0	0.0	23.0	0.4	44.2	2.5	4.3	14.3	8.5	0.7	0.6	1.5
Germany												
Heidelberg	0.0	0.0	21.9	1.3	46.5	0.4	3.9	14.4	8.1	1.6	0.5	1.4
Potsdam	0.0	0.0	19.9	0.6	39.5	0.6	4.8	23.8	7.8	1.5	0.4	1.1
The Netherlands												
Bilthoven	0.6	0.0	16.7	0.3	46.2	1.7	3.7	21.8	5.2	2.4	0.1	1.2
Utrecht	0.4	0.0	18.9	0.3	43.4	2.5	3.6	21.0	5.6	3.0	0.0	1.3
United Kingdom												
General population	0.0	0.0	19.1	0.6	37.6	0.6	4.0	23.8	9.1	1.0	1.0	3.3
Health-conscious	0.0	0.0	22.9	1.2	5.5	1.0	3.7	41.6	15.2	1.7	1.7	5.6
Denmark												
Copenhagen	0.0	0.1	15.9	0.3	50.4	4.3	4.4	13.7	6.7	2.3	0.5	1.4
Aarhus	0.0	0.1	16.7	0.5	47.4	2.3	4.8	12.8	10.0	3.2	0.4	1.8
Sweden												
Malmö	0.0	0.0	15.0	1.4	49.7	0.6	2.7	19.9	6.1	2.9	0.5	1.4
Umeå	0.0	0.0	16.8	1.3	48.8	0.5	2.4	19.4	6.6	2.3	0.7	1.3
Norway												
South and East	0.0	0.0	21.0	0.4	38.2	1.9	5.9	19.8	7.9	2.3	0.3	2.3
North and West	0.0	0.0	21.9	0.5	31.3	3.0	6.4	21.5	10.5	2.6	0.5	1.9
All centres	0.1	0.0	20.9	0.8	44.9	1.7	4.4	15.8	7.3	2.0	0.5	1.6

Table 4 *Continued*

Country and centre	*Dietary food groups (percentage contribution of each food group to total intake of the nutrient)*											
	Vegetables	*Fruits*	*Dairy products*	*Cereals and products*	*Meats and products*	*Fish/ shellfish*	*Eggs and products*	*Added fats*	*Cakes*	*Condiments/ sauces*	*Soups/bouillon*	*All other food groups*
							β-carotene					
Greece	87.9	1.7	2.5	0.1	0.0	0.0	0.0	3.0	0.5	2.8	0.3	1.0
Spain												
Granada	60.7	15.4	1.9	0.0	1.3	0.0	0.3	1.8	0.9	1.7	9.7	6.1
Murcia	63.9	18.8	1.9	0.0	1.0	0.1	0.4	1.5	1.6	1.9	5.7	3.2
Navarra	59.9	16.5	2.3	0.0	2.5	0.0	0.5	1.3	1.8	2.2	7.3	5.8
San Sebastian	64.0	13.0	1.6	0.0	1.7	0.0	0.5	0.6	1.2	2.5	11.2	3.7
Asturias	54.0	16.9	4.2	0.0	3.4	0.1	0.7	1.3	1.8	2.5	8.3	6.8
Italy												
Ragusa	45.1	34.3	3.7	1.2	0.7	0.0	0.6	0.3	0.7	11.9	0.3	1.3
Naples	63.8	22.1	4.3	0.9	0.0	0.0	0.5	0.3	0.9	5.4	0.1	1.8
Florence	64.6	23.1	2.5	2.0	0.7	0.0	0.3	0.5	0.6	3.2	0.6	1.8
Turin	67.4	22.0	2.2	1.3	0.6	0.0	0.4	0.3	0.5	3.0	0.7	1.7
Varese	62.6	22.0	3.3	1.9	0.5	0.0	0.4	0.6	0.6	5.4	1.4	1.4
France												
South coast	67.8	9.9	2.0	0.1	0.1	0.0	0.1	1.1	1.1	1.0	15.9	1.0
South	67.2	11.3	1.9	0.2	0.0	0.0	0.1	1.2	1.1	0.9	14.5	1.6
North-East	65.3	12.7	2.0	0.1	0.1	0.0	0.1	1.5	1.4	0.8	14.2	1.8
North-West	66.4	10.4	1.9	0.1	0.0	0.0	0.1	1.8	1.3	0.9	15.2	1.8
Germany												
Heidelberg	61.7	10.2	3.1	0.4	0.2	0.0	0.0	5.8	1.6	3.2	4.1	9.8
Potsdam	54.6	11.5	3.7	0.2	0.3	0.0	0.0	5.0	1.5	2.3	4.0	16.6
The Netherlands												
Bilthoven	66.0	4.3	4.9	0.2	0.2	0.0	0.1	6.3	1.7	2.2	9.6	4.5
Utrecht	67.4	6.2	5.1	0.2	0.1	0.0	0.1	5.3	1.3	1.7	9.8	2.8
United Kingdom												
General population	86.1	1.1	1.5	0.2	0.1	0.0	0.0	2.4	1.2	0.8	3.9	2.8
Health-conscious	84.1	1.2	1.0	0.3	0.0	0.0	0.0	2.4	0.9	0.9	3.7	5.5
Denmark												
Copenhagen	84.7	2.9	1.6	0.0	0.0	0.1	0.2	1.4	0.8	1.1	3.1	4.1
Aarhus	81.1	2.9	1.5	0.0	0.0	0.0	0.2	1.1	1.7	0.8	3.9	6.7
Sweden												
Malmö	73.9	5.7	3.4	0.3	0.4	0.5	0.3	1.0	0.6	2.1	8.6	3.2
Umeå	76.6	3.5	3.3	0.4	0.6	0.3	0.3	1.3	0.7	1.7	9.0	2.4
Norway												
South and East	84.7	1.9	4.9	0.1	0.2	0.5	0.0	1.4	0.6	1.1	3.3	1.3
North and West	85.5	1.7	4.3	0.1	0.1	0.5	0.0	1.2	0.7	0.9	3.9	1.1
All centres	70.7	9.0	2.8	0.3	0.3	0.1	0.1	2.2	1.1	1.8	7.8	3.8

Table 4 *Continued*

Country and centre	*Dietary food groups (percentage contribution of each food group to total intake of the nutrient)*											
	Vegetables	*Fruits*	*Dairy products*	*Cereals and products*	*Meats and products*	*Fish/ shellfish*	*Eggs and products*	*Added fats*	*Cakes*	*Condiments/ sauces*	*Soups/bouillon*	*All other food groups*
							Vitamin D					
Greece	0.1	0.0	41.4	0.9	9.9	29.1	7.2	3.3	5.8	1.5	0.3	0.6
Spain												
Granada	0.0	0.0	6.2	0.2	4.8	68.2	10.1	5.0	4.4	0.1	0.5	0.4
Murcia	0.0	0.0	4.2	0.6	5.4	66.6	10.3	2.7	7.7	0.1	0.2	2.2
Navarra	0.1	0.0	5.4	0.1	6.7	61.5	14.5	1.9	7.4	0.5	0.5	1.4
San Sebastian	0.0	0.0	5.1	1.7	5.0	67.0	13.1	1.9	4.9	0.1	0.3	0.8
Asturias	0.0	0.0	6.0	0.8	3.4	72.8	9.9	2.1	3.9	0.0	0.6	0.4
Italy												
Ragusa	1.1	0.0	4.8	2.4	17.6	52.4	11.3	0.2	8.0	1.8	0.0	0.6
Naples	1.3	0.0	6.4	3.6	15.5	44.0	10.8	0.4	11.3	2.2	0.0	4.4
Florence	4.2	0.0	7.1	2.7	24.4	35.1	11.0	1.1	10.7	2.0	0.0	1.7
Turin	2.2	0.0	6.5	2.5	24.0	40.0	12.8	1.1	7.7	1.5	0.0	1.8
Varese	2.8	0.0	6.2	3.3	23.1	42.6	10.2	1.1	7.5	1.7	0.0	1.4
France												
South coast	2.6	0.0	10.7	3.1	8.3	48.6	9.4	6.3	7.7	0.6	0.6	2.1
South	3.7	0.0	10.2	4.5	8.1	47.0	10.0	5.5	8.1	0.6	0.3	2.0
North-East	3.2	0.0	10.6	2.7	8.5	46.7	8.9	7.8	8.8	0.6	0.4	1.8
North-West	3.5	0.0	9.9	1.8	7.7	48.2	8.8	9.7	7.7	0.6	0.4	1.7
Germany												
Heidelberg	3.5	0.0	16.6	1.6	2.0	43.6	11.2	10.0	8.6	1.3	0.4	1.3
Potsdam	2.7	0.0	10.2	0.2	1.1	49.2	10.6	17.4	6.2	1.3	0.4	0.7
The Netherlands												
Bilthoven	0.1	0.0	7.3	0.5	9.5	20.7	7.1	38.3	8.8	5.1	0.3	2.2
Utrecht	0.0	0.0	7.4	0.4	8.4	25.0	6.6	34.3	9.3	6.2	0.2	2.2
United Kingdom												
General population	0.0	0.0	4.2	9.6	12.3	25.4	6.2	27.2	12.1	0.9	0.2	2.0
Health-conscious	0.0	0.0	3.5	7.4	2.4	30.1	4.1	35.2	14.2	1.3	0.2	1.5
Denmark												
Copenhagen	0.6	0.0	7.7	0.3	12.0	66.4	5.6	2.7	2.2	1.5	0.3	0.6
Aarhus	0.7	0.0	9.3	0.5	13.7	60.2	7.1	2.3	3.6	1.8	0.3	0.3
Sweden												
Malmö	0.0	0.0	11.4	2.5	9.3	26.2	3.7	31.7	9.9	3.5	1.0	0.7
Umeå	0.0	0.0	13.9	2.3	8.3	26.1	3.2	30.6	10.6	2.8	1.6	0.6
Norway												
South and East	0.0	0.0	2.5	0.4	1.0	41.5	5.7	34.6	9.9	2.8	1.0	0.6
North and West	0.0	0.0	2.2	0.3	0.9	46.0	4.9	30.6	11.0	2.5	1.1	0.4
All centres	1.0	0.0	10.4	1.8	8.3	39.6	7.0	19.3	8.3	2.4	0.6	1.2

Table 4 *Continued*

Country and centre	Dietary food groups (percentage contribution of each food group to total intake of the nutrient)											
	Vegetables	Fruits	Dairy products	Cereals and products	Meats and products	Fish/ shellfish	Eggs and products	Added fats	Cakes	Condiments/ sauces	Soups/bouillon	All other food groups
							Vitamin E					
Greece	11.5	10.8	1.3	2.1	0.6	1.8	1.0	59.8	4.8	3.4	0.4	2.6
Spain												
Granada	14.1	19.0	2.7	2.3	1.3	5.1	2.2	38.8	2.5	3.6	4.6	3.6
Murcia	14.3	17.7	2.0	1.8	1.3	4.3	2.0	40.8	7.6	2.0	1.1	5.1
Navarra	11.1	17.3	2.4	1.9	1.9	5.3	3.0	46.0	4.0	2.4	0.8	3.8
San Sebastian	8.8	16.4	1.9	2.0	1.8	5.2	3.4	48.5	2.5	3.8	1.5	4.2
Asturias	5.4	20.9	3.4	3.5	1.7	7.0	3.5	36.3	7.6	3.4	1.3	6.1
Italy												
Ragusa	9.8	16.0	1.7	3.8	1.2	2.5	1.3	40.6	6.7	14.3	0.1	2.1
Naples	13.6	13.4	2.6	4.4	1.0	2.9	1.3	40.1	5.1	12.0	0.0	3.5
Florence	15.6	15.4	2.3	4.6	1.3	2.3	1.2	43.7	5.8	4.5	0.2	3.1
Turin	18.3	16.7	2.2	5.2	1.2	2.8	1.3	38.5	5.2	6.0	0.3	2.4
Varese	13.9	16.5	2.7	4.4	1.5	2.9	1.3	26.7	6.6	20.6	0.5	2.5
France												
South coast	13.3	12.2	4.4	5.0	2.2	3.1	1.5	27.6	4.7	20.9	1.9	3.1
South	12.7	12.5	4.1	5.4	2.0	2.9	1.6	23.0	4.0	27.0	1.8	3.1
North-East	12.5	12.4	4.4	5.5	2.3	2.9	1.6	21.2	5.2	26.7	2.0	3.2
North-West	11.4	13.8	4.6	5.4	2.5	4.7	1.8	15.9	5.0	29.4	2.0	3.4
Germany												
Heidelberg	9.8	9.6	3.2	8.0	2.6	1.8	1.5	21.3	8.0	27.3	1.1	6.0
Potsdam	10.0	9.6	3.2	7.0	2.2	2.4	1.9	35.4	7.0	14.2	1.0	6.1
The Netherlands												
Bilthoven	8.1	5.2	3.5	4.8	1.2	1.6	4.0	43.1	7.9	15.8	0.2	4.7
Utrecht	8.5	7.8	4.1	4.7	1.1	2.2	4.2	40.9	8.9	14.1	0.1	3.6
United Kingdom												
General population	13.7	9.0	4.5	12.4	1.5	4.6	1.4	26.3	11.1	8.8	1.2	5.4
Health-conscious	15.7	19.9	2.2	9.9	0.2	1.7	0.6	24.1	7.6	6.0	1.5	10.5
Denmark												
Copenhagen	10.0	17.1	4.3	10.0	2.1	9.3	3.6	18.6	8.5	9.5	0.7	6.3
Aarhus	9.5	18.6	4.2	9.2	1.9	6.7	3.7	17.5	13.3	8.3	0.6	6.5
Sweden												
Malmö	8.7	11.7	4.7	9.5	5.3	6.1	4.0	22.8	12.3	7.7	2.1	5.0
Umeå	7.6	11.0	4.8	12.1	4.9	6.1	3.4	23.4	12.4	5.9	3.1	5.3
Norway												
South and East	9.2	11.3	4.7	12.8	3.9	8.5	9.2	13.0	11.4	5.6	1.5	8.8
North and West	8.4	10.6	4.4	12.6	3.7	11.4	9.0	12.4	12.6	5.1	1.7	8.2
All centres	10.9	12.2	3.6	6.4	2.2	4.0	2.7	31.2	7.4	13.7	1.2	4.5

Values are percentages derived from models adjusted for age and weighted by season and day of recall (minimally adjusted models).

Table 5 Minimally adjusted[a] mean (s.e.) daily intakes of retinol, β-carotene, vitamin D and vitamin E by season of 24 hour recall collection, stratified by gender

Country	*Men—intakes by season (mean (s.e.))*				*Women—intakes by season (mean (s.e.))*			
	Spring	*Summer*	*Autumn*	*Winter*	*Spring*	*Summer*	*Autumn*	*Winter*
				Retinol (μg/day)				
Greece	588.6 (63.1)	592.7 (103.3)	563.5 (283.7)	569.0 (125.9)	305.6 (69.3)	271.3 (146.8)	649.5 (80.5)	456.6 (77.2)
Spain	548.7 (53.7)	493.2 (101.2)	670.5 (105.5)	384.9 (116.1)	407.0 (74.7)	476.4 (78.8)	308.4 (91.2)	409.8 (82.9)
Italy	510.7 (59.5)	483.1 (110.0)	304.2 (139.7)	546.2 (119.4)	280.8 (54.6)	609.1 (73.5)	412.0 (61.1)	368.4 (61.1)
France					673.1 (38.1)	630.9 (62.8)	609.9 (46.9)	657.1 (41.1)
Germany	1107.8 (47.7)	1067.8 (91.7)	1160.5 (85.4)	999.9 (113.3)	729.6 (59.1)	698.7 (57.1)	713.4 (85.4)	764.8 (77.1)
The Netherlands	1098.2 (72.8)	1078.2 (138.6)	1027.9 (129.6)	1000.5 (142.0)	765.3 (57.6)	641.8 (51.2)	817.5 (60.4)	851.1 (59.0)
UK, general population	748.5 (112.5)	639.0 (217.7)	1096.3 (247.2)	549.1 (207.5)	461.4 (110.0)	678.6 (135.5)	545.2 (135.1)	534.3 (144.2)
UK, health-conscious	728.6 (211.1)	1082.1 (305.0)	309.6 (457.3)	563.7 (617.0)	312.4 (198.1)	428.4 (249.3)	354.2 (221.7)	357.0 (218.1)
Denmark	1330.5 (51.4)	1244.3 (110.6)	1459.8 (147.8)	1470.6 (97.6)	652.9 (74.1)	813.3 (89.9)	744.1 (70.1)	725.6 (55.1)
Sweden	1696.8 (44.4)	1574.7 (86.0)	1626.7 (89.2)	1839.8 (99.8)	1219.1 (51.2)	1180.8 (54.1)	1188.9 (60.6)	1240.8 (51.5)
Norway					763.8 (71.6)	829.2 (100.7)	725.1 (66.7)	759.2 (66.2)
All centres	856.1 (45.3)	803.2 (41.5)	877.8 (47.1)	895.2 (41.3)	601.8 (23.2)	578.2 (20.5)	602.2 (24.6)	616.5 (21.4)
				β-carotene (μg/day)				
Greece	2754.9 (157.8)	2339.5 (433.2)	3038.5 (192.2)	2982.2 (164.2)	2475.8 (173.1)	1800.6 (367.0)	2714.3 (201.2)	2473.5 (193.0)
Spain	2394.0 (154.5)	3131.3 (161.1)	2476.8 (177.2)	2308.5 (162.5)	1893.7 (186.6)	2508.9 (196.8)	2163.9 (227.9)	2170.6 (207.2)
Italy	2980.0 (168.0)	3284.0 (213.3)	2460.6 (182.3)	2549.9 (170.6)	2443.0 (136.4)	2896.0 (183.6)	2160.3 (152.8)	2174.6 (152.6)
France					4457.5 (95.2)	4920.3 (156.9)	3990.6 (117.3)	3997.9 (102.8)
Germany	3320.5 (140.0)	3545.0 (130.3)	3201.5 (173.0)	3541.6 (145.2)	3498.1 (147.6)	4144.9 (142.7)	3538.0 (213.5)	3854.0 (192.6)
The Netherlands	1918.2 (211.7)	2026.5 (197.9)	2088.9 (216.8)	2554.0 (250.0)	2001.1 (144.1)	2016.5 (127.9)	1890.3 (151.0)	2045.4 (147.4)
UK, general population	3323.3 (332.3)	2991.3 (377.3)	3306.6 (316.8)	3174.6 (354.4)	3056.3 (275.1)	3488.5 (338.7)	3476.1 (337.6)	2235.3 (360.5)
UK, health-conscious	4060.7 (465.6)	3370.2 (698.1)	3176.3 (942.0)	5065.8 (733.9)	3623.2 (495.1)	4519.6 (623.0)	3776.8 (554.3)	3574.0 (545.1)
Denmark	2332.6 (168.8)	3245.1 (225.6)	2656.8 (148.9)	3167.4 (126.0)	3407.0 (185.1)	3306.4 (224.6)	3239.6 (175.1)	4116.6 (137.8)
Sweden	1714.4 (131.3)	1991.3 (136.2)	1870.8 (152.4)	1954.4 (116.3)	1945.6 (128.0)	2242.4 (135.1)	2032.9 (151.4)	2067.2 (128.7)
Norway					1934.5 (179.0)	3135.9 (251.7)	2391.9 (166.6)	2624.1 (165.4)
All centres	2634.5 (69.1)	2583.6 (63.3)	2915.0 (71.9)	2826.4 (63.1)	2715.9 (57.9)	2791.5 (51.3)	3114.7 (61.5)	2841.0 (53.5)
				Vitamin D (μg/day)				
Greece	3.3 (0.4)	5.2 (1.0)	3.5 (0.4)	3.5 (0.4)	2.6 (0.2)	3.3 (0.5)	2.6 (0.3)	2.6 (0.3)
Spain	5.2 (0.3)	8.1 (0.4)	5.6 (0.4)	5.0 (0.4)	3.6 (0.2)	4.4 (0.3)	3.7 (0.3)	3.5 (0.3)
Italy	2.7 (0.4)	2.1 (0.5)	2.4 (0.4)	2.7 (0.4)	1.7 (0.2)	2.1 (0.2)	1.8 (0.2)	1.8 (0.2)
France					2.9 (0.1)	2.9 (0.2)	2.4 (0.2)	2.7 (0.1)
Germany	3.7 (0.3)	4.3 (0.3)	4.4 (0.4)	4.7 (0.3)	3.6 (0.2)	2.7 (0.2)	3.4 (0.3)	3.5 (0.3)
The Netherlands	6.0 (0.5)	5.4 (0.4)	5.7 (0.5)	5.3 (0.6)	3.8 (0.2)	4.1 (0.2)	3.7 (0.2)	3.9 (0.2)
UK, general population	4.7 (0.7)	4.4 (0.8)	5.1 (0.7)	4.9 (0.8)	3.3 (0.4)	3.2 (0.4)	3.2 (0.4)	3.8 (0.5)
UK, health-conscious	3.4 (1.0)	2.1 (1.6)	3.9 (2.1)	3.9 (1.6)	2.6 (0.6)	3.3 (0.8)	2.3 (0.7)	3.9 (0.7)
Denmark	5.4 (0.4)	5.1 (0.5)	6.4 (0.3)	5.6 (0.3)	3.8 (0.2)	3.7 (0.3)	3.9 (0.2)	4.2 (0.2)
Sweden	8.5 (0.3)	8.9 (0.3)	8.7 (0.3)	8.5 (0.3)	6.3 (0.2)	6.3 (0.2)	5.9 (0.2)	5.7 (0.2)
Norway					4.5 (0.2)	4.0 (0.3)	4.1 (0.2)	4.0 (0.2)
All centres	5.0 (0.2)	4.6 (0.1)	5.3 (0.2)	4.8 (0.1)	3.2 (0.1)	3.4 (0.1)	3.4 (0.1)	3.3 (0.1)
				Vitamin E (mg/day)				
Greece	19.8 (0.4)	19.5 (1.2)	21.4 (0.5)	20.3 (0.4)	14.8 (0.3)	13.1 (0.7)	15.5 (0.4)	16.5 (0.3)
Spain	16.4 (0.4)	18.1 (0.4)	15.9 (0.5)	16.4 (0.4)	11.5 (0.3)	14.5 (0.4)	14.1 (0.4)	12.8 (0.4)
Italy	13.4 (0.4)	13.9 (0.6)	12.3 (0.5)	12.0 (0.5)	10.2 (0.2)	11.0 (0.3)	9.6 (0.3)	10.1 (0.3)
France					11.1 (0.2)	11.9 (0.3)	11.0 (0.2)	10.7 (0.2)
Germany	18.0 (0.4)	17.4 (0.3)	16.8 (0.5)	17.5 (0.4)	13.9 (0.3)	14.5 (0.3)	13.5 (0.4)	12.0 (0.3)
The Netherlands	15.4 (0.6)	14.7 (0.5)	15.8 (0.6)	15.4 (0.7)	10.6 (0.3)	11.2 (0.2)	10.4 (0.3)	10.2 (0.3)
UK, general population	12.4 (0.9)	11.5 (1.0)	11.1 (0.8)	12.5 (0.9)	8.8 (0.5)	9.4 (0.6)	8.8 (0.6)	8.3 (0.6)
UK, health-conscious	15.1 (1.2)	14.8 (1.9)	17.7 (2.5)	15.8 (2.0)	14.0 (0.9)	16.0 (1.1)	11.0 (1.0)	11.9 (1.0)
Denmark	10.0 (0.5)	11.5 (0.6)	11.1 (0.4)	10.8 (0.3)	8.3 (0.3)	9.3 (0.4)	8.3 (0.3)	8.5 (0.2)
Sweden	9.5 (0.4)	9.8 (0.4)	9.8 (0.4)	9.7 (0.3)	7.8 (0.2)	8.1 (0.2)	7.6 (0.3)	7.7 (0.2)
Norway					7.7 (0.3)	7.6 (0.5)	7.8 (0.3)	7.6 (0.3)
All centres	14.4 (0.2)	14.3 (0.2)	14.8 (0.2)	14.3 (0.2)	10.9 (0.1)	10.9 (0.1)	11.7 (0.1)	10.8 (0.1)

Abbreviation: s.e., standard error.

[a]Adjusted for age and weighted by season and day of recall.

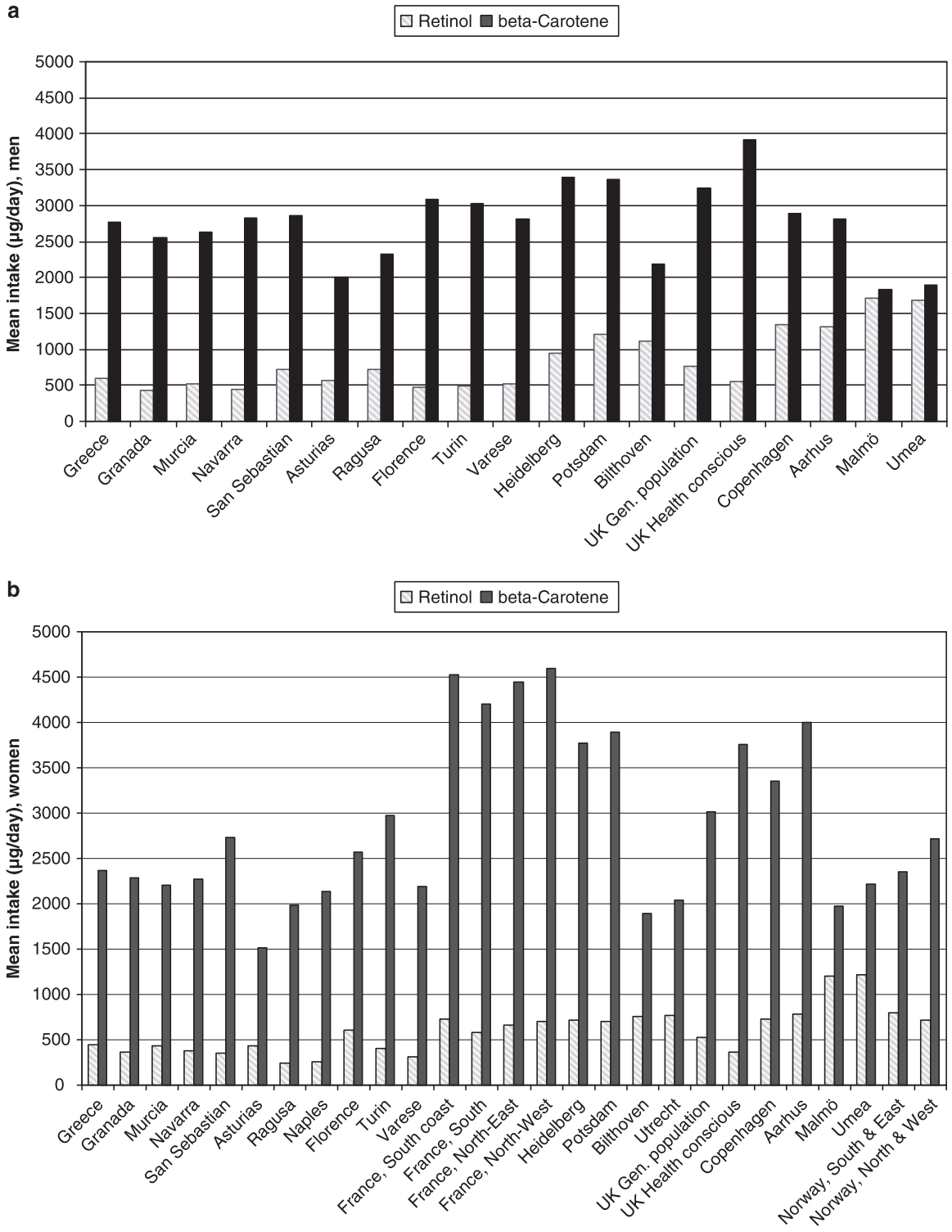

Figure 1 Minimally adjusted mean intake of retinol and β-carotene (µg/day), stratified by gender and centre ordered from south to north, adjusted for age and weighted by season and day of dietary recall (**a**) men and (**b**) women.

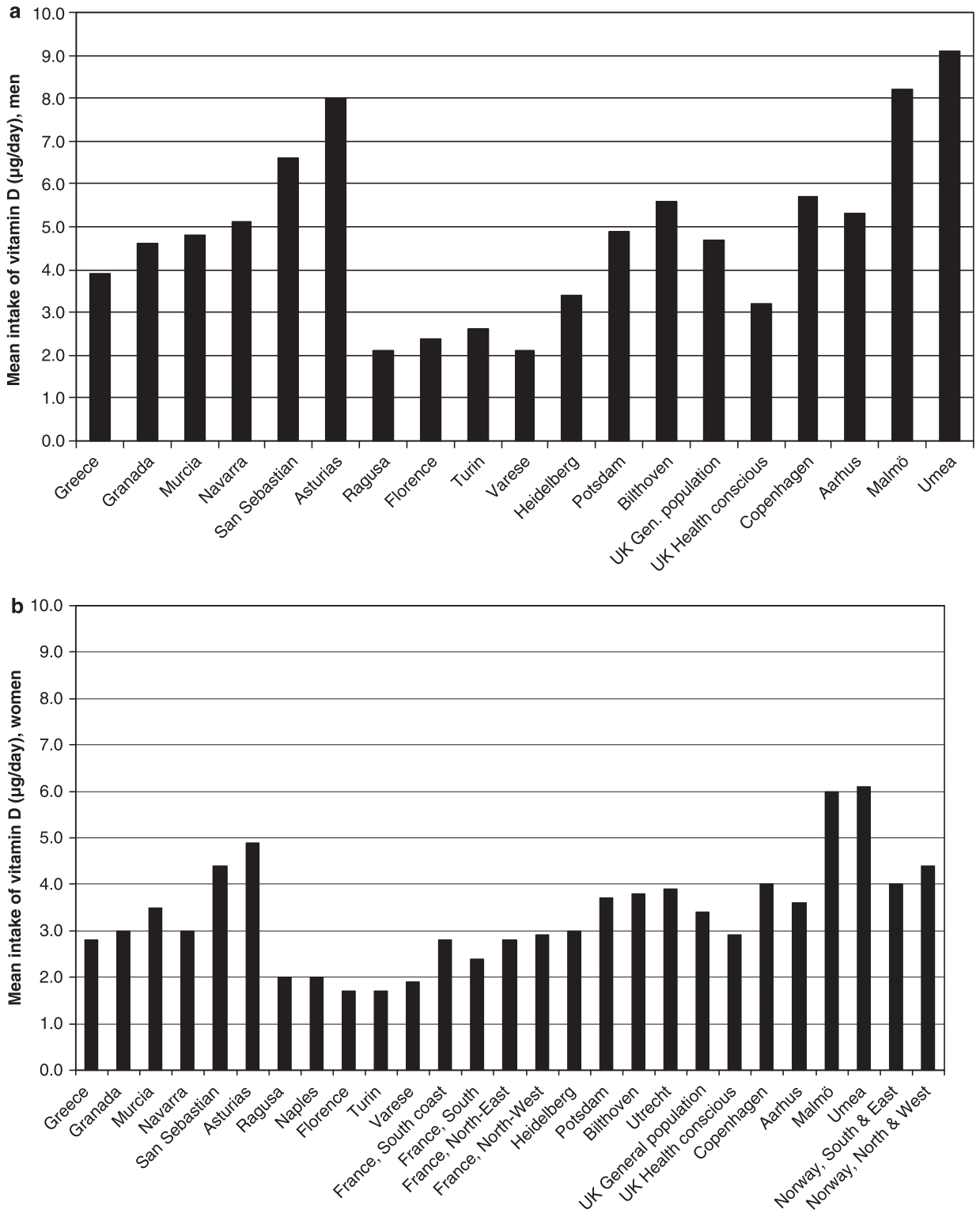

Figure 2 Minimally adjusted mean intake of vitamin D (µg/day), stratified by gender and centre ordered from south to north, adjusted for age and weighted by season and day of dietary recall (**a**) men and (**b**) women.

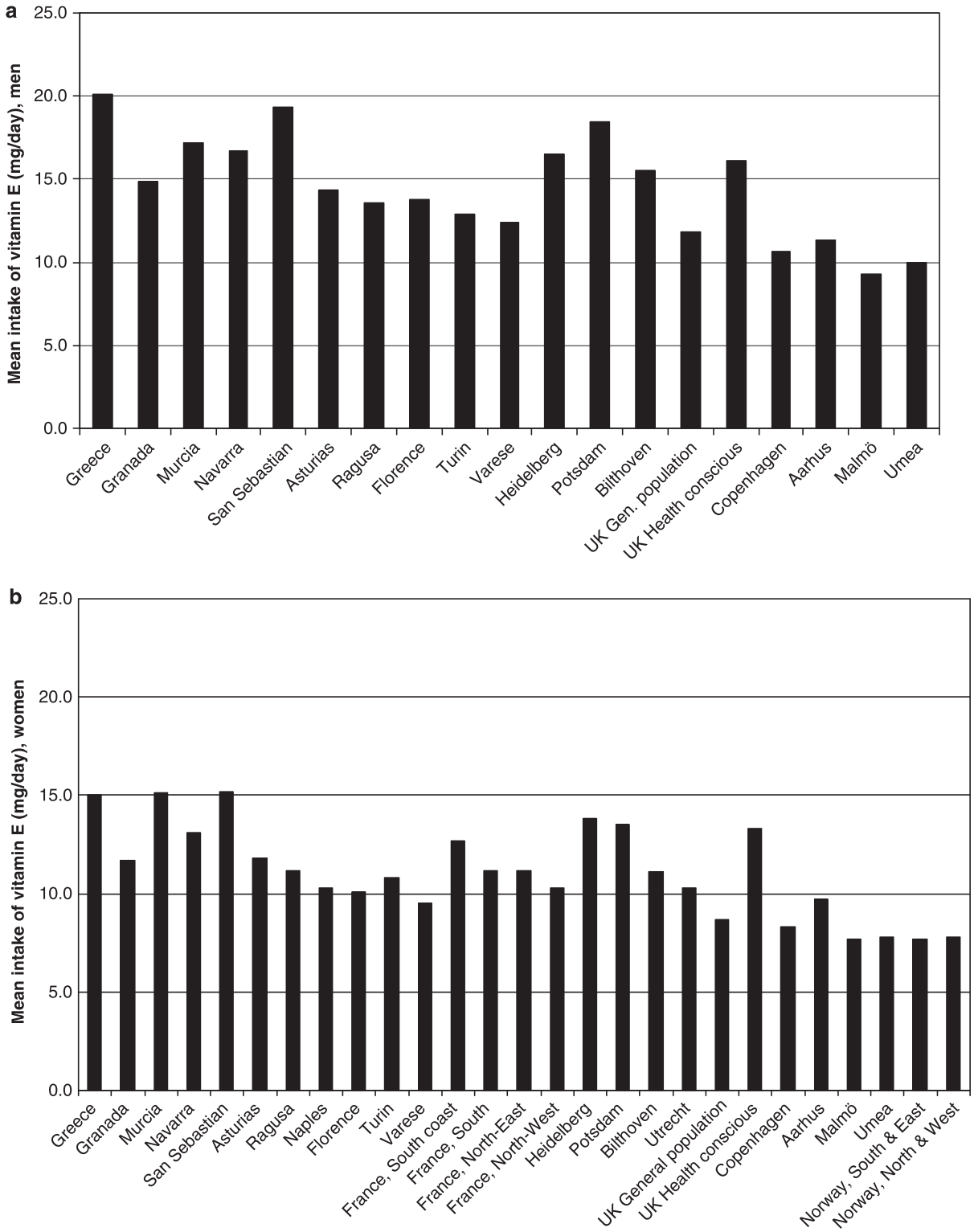

Figure 3 Minimally adjusted mean intake of vitamin E (mg/day), stratified by gender and centre ordered from south to north, adjusted for age and weighted by season and day of dietary recall (**a**) men and (**b**) women.

Mean intakes of vitamin E

The lowest mean intake of vitamin E in men was in Malmo, Sweden (9.3 mg/day) and the highest in Greece (20.1 mg/day). In women, the mean intake of vitamin E ranged from a low of 7.7 mg/day (Malmo, Sweden and South and East Norway) to a high of 15.2 mg/day (San Sebastian, Spain) (Table 1 and Figures 3a and b). Similar to all the other nutrients, the intakes of vitamin E were higher in men than in women (range from 12.2% higher in Murcia, Spain to 28.4% higher in Bilthoven, the Netherlands). Overall, men consumed 14.5 mg/day, which was significantly (P difference by gender <0.01) higher than the 11.1 mg/day intake for women. For both men and women, no apparent trends in intake were apparent by age range (Table 1). Further adjustments for age, height, weight and total energy intake did not meaningfully alter the observed intake values or patterns (Table A1 in the Appendix).

Men in Southern and Central European regions consumed significantly higher levels of vitamin E than did those in Northern countries (Table 2). Although intakes for women in all three regions were lower than those for men, a clear and statistically significant south-to-north gradient of higher to lower intake was apparent (Table 2). In both men and women, smokers (as well as former smokers in the case of women) had significantly lower intakes of vitamin E than did never smokers. Men who were physically active showed a significantly higher level of vitamin E intake than did men who were inactive, whereas no differences in intake by level of physical activity were apparent for women. In both men and women, subjects in the lowest category of BMI ($<25\,kg/m^2$) had significantly higher vitamin E intake than did those in the highest category ($\geqslant 30$).

In men, the major food group contributing to vitamin E intake is added fats (42.2%), whereas fruits (10.1%), vegetables (8.4%) and condiments/sauces (10.0%) appear to be important contributors as well (Table 3). This appears to be the case in most centres with little variability. In women, the major food group source of vitamin E is also added fats (31.2%), but compared with men a greater percentage is contributed by fruits (12.2%), vegetables (10.9%) and condiments/sauces (13.7%). Similar to men, women also show little variability between centres for food group sources of vitamin E.

In both men and women, there appeared to be little seasonal variation of vitamin E intake (Table 5).

Discussion

Standardized data across different European countries on overall intake levels, major contributing food sources, lifestyle confounders and seasonal variation of nutrients are not only important for understanding dietary and nutrient patterns in different populations but they may also assist in devising policies pertaining to diet quality, nutritional intake levels and public health. This study has shown that the intake levels and food sources of the fat-soluble nutrients retinol, β-carotene, vitamin D and vitamin E vary to some extent by both gender and European region. This is more than likely a consequence of differences and heterogeneity of dietary patterns across Europe. The populations in this study range from southern European countries, where a diet rich in fruits and vegetables (rich sources of β-carotene and vitamin E) is consumed, to Central Europe, where meat and meat products (rich sources of retinol) are popular, to Northern Europe, where fish (rich sources of vitamin D) are more strongly consumed (Agudo *et al.*, 2002; Welch *et al.*, 2002; Linseisen *et al.*, 2002b, 2006; Slimani *et al.*, 2002b).

In this context, a contrast is apparent in the food sources as well as in the regional-specific intakes of retinol and β-carotene, both of which contribute to vitamin A status in the body. From these data, it is clear that the majority of retinol in both men and women comes from animal products, such as dairy products and meats/meat products. A remarkable regional gradient of retinol intake—lowest in the south and highest in the north—is very apparent in both men and women, suggesting large differences between these centres in the intakes of the main food sources of retinol and, possibly, variations in the nutrient content of specific foods across countries. It is also interesting to note that in the southern centres, dairy products appear to provide a greater proportion of retinol intake than they do in the northern centres. In contrast to retinol, β-carotene is almost exclusively derived from fruits and vegetables. Thus, it would be expected to have a regional gradient of intake somewhat opposite to that of retinol. Yet, although both men and women from the southern regions do have significantly higher β-carotene intakes than do subjects in the north, the subjects from the central region have a significantly higher intake than do those in the other two regions. This is suggestive of a very intricate heterogeneity of dietary patterns in these European regions that merits further insight in terms of the differing fruit and vegetable sources of β-carotene (Agudo *et al.*, 2002) and may be of consequence in terms of associations with the risk of different chronic diseases.

It is also interesting to note that for all nutrients, except β-carotene, men had a higher intake than did women in most centres, and the differences were actually statistically significant when comparing men and women from all centres combined. To a large extent, the apparent gender differences in these non-energy adjusted data may be due to the fact that men consume more food than do women. When these data were adjusted for total energy intake (see Table A1), the gender differences were reduced but still apparent—likely because of the existence of gender-specific dietary patterns. For example, in the non-energy adjusted data, the gender difference was most striking for retinol, where women consumed ~59% as much as men. This may be because men may consume a greater proportion of their overall diet as meats/meat products—which are the main food source of retinol—than women. Similarly, when

considering data for all centres combined, women actually consume a higher amount of β-carotene than do men. This small difference is not statistically significant, but it is likely indicative that women may consume a higher proportion of their diet as fruits and vegetables, which are the main sources of this nutrient. It is interesting to note that in a subset of the population in this study, blood concentrations of β-carotene were also higher in women than in men (Al-Delaimy *et al.*, 2004). Within the EPIC study, blood concentrations of various carotenoids have been identified as dietary biomarkers of the intake of specific fruits and vegetables at an ecological (Al-Delaimy *et al.*, 2005b) and individual (Al-Delaimy *et al.*, 2005a) level. The data also show that blood β-carotene levels follow the north–south European gradient, with the European region, BMI, gender and smoking status being the top predictors of concentration (Al-Delaimy *et al.*, 2004). In our analysis, an inverse relationship was observed between overall dietary β-carotene intakes and BMI, particularly in women. With respect to smoking status, overall β-carotene intake was significantly lower in smokers than in former or never smokers and is probably indicative of different dietary patterns based on smoking status.

Another interesting component of these observations is the intake pattern of vitamin D. As is well known and also apparent from these data, the main food sources of vitamin D are fish/shellfish. In some centres, there was a small contribution of vegetables to overall vitamin D intake. This may be due to vitamin D from the intake of some mushrooms, or it may be as a result of mis-reporting of vegetable intake from mixed dishes that include vitamin D sources, such as eggs or milk. Interestingly, a non-negligible and relatively consistent contribution across centres was observed for meats and meat products to overall vitamin D intake. In fact, this food group has recently been suggested to provide more vitamin D than believed previously and a recent study shows that rickets and osteomalacia can be prevented by higher meat consumption, related in part to its vitamin D content (Dunnigan *et al.*, 2005). The vitamin D contribution of added fats was high in northern EPIC regions, likely because of the high consumption of marine oils. However, dietary vitamin D is only a small component of body vitamin D status as the majority of body vitamin D is produced by sun exposure—that is, in populations with adequate access to sunlight (Holick, 2002). For this reason, higher dietary intake of vitamin D-rich foods to increase body vitamin D status has been recommended for some populations in very northern European regions (Brustad *et al.*, 2004). In this study, perhaps as a conscious effort or as a consequence of supplementation of some food products, subjects in the northern European regions had significantly higher intakes of vitamin D than did those in either the central or southern regions. Similar geographic trends have been observed by some studies considering serum measures of body vitamin D status. A dated report shows higher mean serum vitamin D concentrations in Nordic countries compared with Mediterranean countries (van der Wielen *et al.*, 1995), whereas a more recent systematic review of the European literature suggests a statistically significant positive association between latitude and body vitamin D status in subjects older than 65 years, but not in younger subjects (Mullie *et al.*, 2008). Nevertheless, foods likely contribute little to overall vitamin D sufficiency (Harris, 2008).

Although some of the populations studied herein consume vitamin D in the form of multi-vitamin dietary supplements (Skeie *et al.*, 2009), in other populations the contribution of supplemented vitamin D to overall serum vitamin D levels has been shown to be minimal (Yetley, 2008). On this latter point, it is important to note that the data presented in this study pertain only to intake from dietary sources and do not include supplement intake. The only exceptions are of course for foods that are directly supplemented with a nutrient, such as vitamin D in dairy products in some European countries. However, vitamin A (retinol), vitamin E and, more recently, vitamin D are very common as dietary supplements. Thus, the overall intakes of each of these nutrients may be higher in subgroups that regularly consumed dietary supplements containing these nutrients.

In both men and women, the overall intake of vitamin E showed an interesting difference by European region (higher intake in the south, lower in the north) and by BMI (higher intake with lower BMI). These observations may be related to the food sources of vitamin E, which is primarily derived from vegetable oils. Thus, the gradient of intake by European region may be due to the higher intake of vegetable oils in the south compared with the north, where butter and mixed fat margarines are consumed more than in the south (Linseisen *et al.*, 2002a). The gradient of intake by BMI may be similarly related to varying dietary patterns of food sources vitamin E. For example, those with lower BMI may be consuming more fruits, vegetables and vegetable oils (all sources of vitamin E), whereas those with higher BMI may be consuming more butter and meats/meat products and less fruits and vegetables. Similar variations in dietary patterns may also explain differences in vitamin E intake by smoking status.

For all the nutrients presented in this study, very little variation in intake was observed by the day of the week (data not shown) or season in which the 24-HDR was administered. Intuitively, it is likely that there are some inter-individual differences in intake and dietary patterns from weekday to weekend and from season to season, but they are not being well observed herein at the population level because all these data are derived from a single 24-HDR. This limitation does not allow for any study at the individual level. On the topic of limitations, it must also be noted that although this is the largest study looking at the dietary intake levels of these nutrients, not all EPIC populations were population-based and hence these findings should not be extrapolated to general populations in each country or region.

The results presented in this study originate from the ENDB, a nutrient database that has been standardized across all the countries involved in the EPIC study. The lack of a standardized nutrient database has been a major obstacle to

obtaining comparable nutrient intake data across Europe. The ENDB is the first initiative to take into account differences in the types of food available and methods for the calculation of micronutrient and macronutrient composition of foods across the different populations enrolled in the EPIC study.

In summary, the data presented in this study show some very interesting gender- and region-specific differences in the intakes of retinol, β-carotene, vitamin D and vitamin E in 10 European countries with great heterogeneity in dietary patterns as well as incidence of cancer and other chronic diseases. Given the essential metabolic roles of these fat-soluble nutrients, these observations may provide a basis for further studies exploring potential aetiological links between the intake of these nutrients and chronic disease risk in these countries.

Conflict of interest

M Jenab has received grant support from the World Cancer Research Fund. S Shakya-Shrestha received grants support from the British Heart Foundation. P Wallström received lecture fees from Prenet AB. S Bingham has received grant support from MRC Centre. The remaining authors have declared no financial interests.

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Appendix

Table A1 Fully adjusted[a] mean daily intakes of retinol, β-carotene, vitamin D and vitamin E, presented by centre ordered from south to north, gender and age group

Country and centre	*Men*											*Women*										*Men and women*	
	N	*All*		*35–44 years*		*45–54 years*		*55–64 years*		*65–74 years*		N	*All*		*35–44 years*		*45–54 years*		*55–64 years*		*65–74 years*		*M*	*s.e.*
		M	*s.e.*	*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*		*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*		
													Retinol (μg/day)										
Greece	1311	723	62	556	182	778	125	635	114	827	99	1373	540	43	679	112	388	73	631	75	563	86	604	35
Spain																								
Granada	214	418	148	—	—	364	312	422	201	487	335	300	414	89	408	228	456	148	378	139	418	284	414	79
Murcia	243	463	140	169	433	459	250	426	195	1025	484	304	402	88	401	176	316	148	254	146	—	—	415	77
Navarra	444	386	104	564	449	318	172	423	147	358	316	271	376	93	427	244	429	152	330	142	—	—	319	67
San Sebastian	490	581	99	225	233	610	137	732	187	286	494	244	318	98	285	209	299	159	351	165	—	—	414	66
Asturias	386	504	111	438	416	470	185	548	165	473	300	324	442	85	550	206	324	138	517	137	370	312	434	67
Italy																								
Ragusa	168	692	168	—	—	891	249	624	262	—	—	138	237	130	75	216	250	243	106	232	—	—	448	102
Naples												403	271	77	183	248	278	121	279	118	285	248	391	90
Florence	271	429	131	399	415	487	225	365	187	—	—	784	623	55	553	183	619	95	684	76	261	214	612	55
Turin	676	472	84	435	271	555	140	440	119	211	319	392	420	77	236	244	722	128	253	108	—	—	382	55
Varese	327	410	120	—	—	489	267	402	144	84	404	794	317	55	194	175	257	91	400	82	288	164	378	54
France																								
South coast												620	679	62			741	101	585	96	764	128	784	72
South												1425	544	41			594	63	542	65	451	91	651	48
North-East												2059	596	34			553	53	604	53	687	78	698	40
North-West												631	663	61			799	97	508	92	755	146	770	72
Germany																								
Heidelberg	1034	959	68	715	181	1008	108	985	99	—	—	1087	711	47	696	79	596	85	796	77	—	—	793	39
Potsdam	1233	1194	62	1134	178	1192	125	1231	81	924	241	1061	722	47	685	93	803	91	696	69	520	296	926	37
The Netherlands																								
Bilthoven	1024	1072	70	916	133	1155	106	1027	119	—	—	1086	748	47	653	83	801	72	729	90	—	—	864	40
Utrecht												1870	740	36			771	61	705	54	782	72	831	41
United Kingdom																								
General population	402	812	108	584	355	703	193	799	197	1018	196	570	570	64	515	192	478	105	679	116	611	137	656	57
Health-conscious	114	658	203	—	—	448	332	516	314	—	—	197	353	109	418	344	317	178	340	171	438	300	458	101
Denmark																								
Copenhagen	1356	1291	59			1204	96	1373	77	914	296	1484	707	40			611	66	746	51	1020	189	946	34
Aarhus	567	1211	91			1190	129	1227	130	—	—	510	701	68			667	95	747	98	—	—	916	55
Sweden																								
Malmö	1421	1763	61			1962	173	1808	91	1729	82	1711	1219	38			1222	76	1237	61	1227	58	1432	33
Umeå	1344	1666	60	1341	201	1683	111	1690	82	1785	176	1574	1218	39	1165	94	1272	69	1178	59	1319	123	1391	33

Table A1 *Continued*

Country and centre	Men											Women										Men and women	
	N	All		35–44 years		45–54 years		55–64 years		65–74 years		N	All		35–44 years		45–54 years		55–64 years		65–74 years		M	s.e.
		M	s.e.	M	s.e.	M	s.e.	M	s.e.	M	s.e.		M	s.e.	M	s.e.	M	s.e.	M	s.e.	M	s.e.		
Norway																							
South and East												1004	799	49	768	116	783	60	832	119			896	57
North and West												793	736	55	726	124	718	67	756	143			836	64
All centres	13 025	1049	19	705	65	982	35	1091	29	1238	51	23 009	702	10	641	32	669	17	705	16	823	28	827	10
												β-carotene (μg/day)											
Greece	1311	2932	96	2033	283	2438	194	3418	177	3233	154	1373	2527	107	2231	280	2481	182	2811	188	2405	216	2653	72
Spain																							
Granada	214	2644	231	—	—	2635	485	2796	313	2560	521	300	2402	221	2542	568	2503	370	2287	346	2103	709	2443	162
Murcia	243	2694	217	2942	673	2251	388	2576	302	4487	752	304	2223	219	2284	439	2243	368	1960	364	—	—	2365	157
Navarra	444	2886	161	2126	697	2474	268	3279	229	2754	491	271	2298	232	1659	608	2134	380	2221	354	—	—	2568	137
San Sebastian	490	2831	155	3081	362	2700	212	2707	290	1832	767	244	2720	244	2317	521	3291	396	2390	411	—	—	2700	136
Asturias	386	2046	172	1590	646	1783	288	2348	257	1873	466	324	1560	212	1316	514	1571	344	1600	341	1486	779	1750	138
Italy																							
Ragusa	168	2401	261	—	—	2570	387	2147	406	—	—	138	2012	325	1636	540	1703	606	2504	579	—	—	2119	209
Naples												403	2189	191	3114	618	1760	302	2164	293	3033	617	2197	184
Florence	271	3085	204	2821	645	3298	350	3064	291	—	—	784	2588	136	2876	457	2642	236	2573	189	2018	533	2700	113
Turin	676	3048	130	2932	420	2734	217	3153	185	3546	496	392	3009	192	3164	608	2914	320	3020	269	—	—	2954	112
Varese	327	2761	187	—	—	2994	414	2683	224	3163	628	794	2214	136	2232	436	2044	226	2430	204	1843	410	2343	110
France																							
South coast												620	4437	154			4631	252	4670	239	3839	320	4469	148
South												1425	4122	102			3775	158	4372	161	4446	227	4150	99
North-East												2059	4346	85			3979	131	4495	132	4943	194	4385	82
North-West												631	4506	152			4474	241	4551	230	4586	365	4533	147
Germany																							
Heidelberg	1034	3393	105	2923	280	3388	167	3414	154	—	—	1087	3763	117	3764	198	3742	211	3652	193	—	—	3581	80
Potsdam	1233	3357	96	3637	276	3266	194	3326	126	3106	374	1061	3930	117	3588	231	4325	228	3867	172	2934	738	3606	77
The Netherlands																							
Bilthoven	1024	2126	109	1891	207	2072	165	2010	184	—	—	1086	1891	118	1771	206	1839	180	1872	223	—	—	2011	82
Utrecht												1870	2001	90			1992	152	2014	135	2150	179	2063	85
United Kingdom																							
General population	402	3237	168	1679	552	3138	300	3788	307	3335	305	570	3064	159	3026	480	2949	261	3152	288	3183	342	3137	117
Health-conscious	114	3862	316	—	—	3288	515	4150	487	—	—	197	3696	271	3465	858	3716	444	3520	428	4329	749	3771	208
Denmark																							
Copenhagen	1356	2808	92			2690	149	2866	120	3169	460	1484	3325	99			3180	165	3409	128	3831	470	3106	69
Aarhus	567	2714	142			2743	201	2650	202	—	—	510	3900	169			3733	238	4076	243	—	—	3292	112
Sweden																							
Malmö	1421	1807	95			1865	269	1923	141	1954	127	1711	1983	95			1990	189	2013	153	2117	144	1941	68
Umeå	1344	1837	93	1404	312	1599	173	2079	127	1821	274	1574	2219	96	2243	233	2107	172	2308	147	2177	308	2067	68

Table A1 *Continued*

Country and centre	Men											Women										Men and women	
	N	All		35–44 years		45–54 years		55–64 years		65–74 years		N	All		35–44 years		45–54 years		55–64 years		65–74 years		M	s.e.
		M	s.e.	M	s.e.	M	s.e.	M	s.e.	M	s.e.		M	s.e.	M	s.e.	M	s.e.	M	s.e.	M	s.e.		
Norway																							
South and East												1004	2330	123	2080	290	2245	149	2567	298			2391	117
North and West												793	2717	137	2433	310	2595	166	3195	356			2771	131
All centres	13 025	2660	30	2461	101	2595	54	2775	44	2554	79	23 009	2955	26	2572	81	2866	42	3112	41	3029	71	2850	20
												Vitamin D (μg/day)											
Greece	1311	4.6	0.2	4.1	0.6	4.5	0.4	5.3	0.4	4.5	0.3	1373	3.3	0.1	3.2	0.4	3.7	0.2	3.2	0.2	3.0	0.3	3.8	0.1
Spain																							
Granada	214	4.7	0.5	—	—	5.7	1.1	4.2	0.7	5.4	1.1	300	3.3	0.3	2.9	0.7	3.5	0.5	3.0	0.5	5.0	0.9	3.9	0.3
Murcia	243	4.6	0.5	4.6	1.5	5.0	0.8	4.5	0.7	3.7	1.6	304	3.4	0.3	3.5	0.6	2.9	0.5	3.6	0.5	—	—	3.8	0.3
Navarra	444	4.9	0.4	3.1	1.5	5.9	0.6	4.7	0.5	3.5	1.1	271	3.1	0.3	2.9	0.8	3.5	0.5	2.8	0.5	—	—	3.8	0.2
San Sebastian	490	6.0	0.3	6.8	0.8	5.2	0.5	7.0	0.6	2.7	1.7	244	4.2	0.3	4.8	0.7	4.6	0.5	3.7	0.5	—	—	5.0	0.2
Asturias	386	7.8	0.4	8.0	1.4	6.7	0.6	8.5	0.6	8.2	1.0	324	4.9	0.3	4.5	0.7	5.5	0.4	4.6	0.4	4.2	1.0	6.2	0.2
Italy																							
Ragusa	168	2.1	0.6	—	—	2.0	0.8	2.0	0.9	—	—	138	2.1	0.4	1.4	0.7	2.9	0.8	1.8	0.8	—	—	1.8	0.3
Naples												403	2.1	0.2	2.7	0.8	1.9	0.4	2.2	0.4	1.9	0.8	2.7	0.3
Florence	271	2.3	0.4	1.4	1.4	2.7	0.8	2.0	0.6	—	—	784	1.8	0.2	1.4	0.6	1.7	0.3	2.0	0.2	2.0	0.7	2.1	0.2
Turin	676	2.5	0.3	2.2	0.9	2.9	0.5	2.3	0.4	1.8	1.1	392	1.9	0.3	2.0	0.8	1.7	0.4	1.9	0.3	—	—	1.9	0.2
Varese	327	1.5	0.4	—	—	2.0	0.9	1.5	0.5	1.1	1.4	794	2.0	0.2	1.9	0.6	2.1	0.3	1.9	0.3	1.8	0.5	2.0	0.2
France																							
South coast												620	2.5	0.2			2.0	0.3	3.0	0.3	2.8	0.4	3.0	0.2
South												1425	2.3	0.1			2.2	0.2	2.4	0.2	2.7	0.3	2.8	0.2
North-East												2059	2.6	0.1			2.4	0.2	3.1	0.2	2.1	0.3	3.0	0.1
North-West												631	2.7	0.2			2.5	0.3	3.0	0.3	2.7	0.5	3.2	0.2
Germany																							
Heidelberg	1034	3.5	0.2	2.6	0.6	3.1	0.4	3.4	0.3	—	—	1087	3.0	0.2	2.7	0.3	3.0	0.3	2.9	0.3	—	—	3.0	0.1
Potsdam	1233	4.8	0.2	4.2	0.6	5.0	0.4	4.9	0.3	3.8	0.8	1061	3.8	0.2	3.4	0.3	3.5	0.3	4.0	0.2	3.2	1.0	4.1	0.1
The Netherlands																							
Bilthoven	1024	5.4	0.2	5.0	0.5	5.0	0.4	5.4	0.4	—	—	1086	3.7	0.2	3.5	0.3	3.4	0.2	3.9	0.3	—	—	4.3	0.1
Utrecht												1870	3.7	0.1			3.8	0.2	3.7	0.2	3.8	0.2	4.2	0.1
United Kingdom																							
General population	402	5.0	0.4	4.0	1.2	4.9	0.7	5.1	0.7	5.3	0.7	570	3.6	0.2	2.8	0.6	3.4	0.3	3.8	0.4	3.8	0.4	4.1	0.2
Health-conscious	114	3.6	0.7	—	—	3.6	1.1	2.8	1.1	—	—	197	2.9	0.4	2.7	1.1	2.1	0.6	3.1	0.6	4.2	1.0	3.1	0.3
Denmark																							
Copenhagen	1356	5.3	0.2			4.9	0.3	5.3	0.3	9.4	1.0	1484	3.9	0.1			3.5	0.2	4.2	0.2	3.3	0.6	4.4	0.1
Aarhus	567	4.7	0.3			5.4	0.4	4.1	0.4	—	—	510	3.2	0.2			3.0	0.3	3.2	0.3	—	—	3.8	0.2

Table A1 *Continued*

Country and centre	Men											Women										Men and women	
	N	All		35–44 years		45–54 years		55–64 years		65–74 years		N	All		35–44 years		45–54 years		55–64 years		65–74 years		M	s.e.
		M	s.e.	M	s.e.	M	s.e.	M	s.e.	M	s.e.		M	s.e.	M	s.e.	M	s.e.	M	s.e.	M	s.e.		
Sweden																							
Malmö	1421	8.4	0.2			8.0	0.6	8.4	0.3	8.8	0.3	1711	6.0	0.1			5.5	0.2	6.0	0.2	6.6	0.2	7.0	0.1
Umeå	1344	9.0	0.2	8.2	0.7	8.5	0.4	9.2	0.3	9.5	0.6	1574	6.1	0.1	5.7	0.3	6.0	0.2	6.2	0.2	6.6	0.4	7.3	0.1
Norway																							
South and East												1004	4.0	0.2	3.9	0.4	3.6	0.2	4.8	0.4			4.5	0.2
North and West												793	4.4	0.2	4.1	0.4	4.2	0.2	5.4	0.5			4.9	0.2
All centres	13 025	5.4	0.1	4.5	0.2	5.0	0.1	5.5	0.1	6.7	0.2	23 009	3.6	0.0	3.4	0.1	3.3	0.1	3.7	0.1	4.0	0.1	4.2	0.0
												Vitamin E (mg/day)												
Greece	1311	21.8	0.2	21.1	0.7	20.2	0.5	22.4	0.4	22.7	0.4	1373	16.5	0.2	14.6	0.4	16.7	0.3	17.1	0.3	16.6	0.3	18.6	0.1
Spain																							
Granada	214	14.8	0.5	—	—	15.3	1.1	14.2	0.7	16.5	1.2	300	12.5	0.3	11.9	0.9	12.7	0.6	12.6	0.5	11.8	1.1	13.2	0.3
Murcia	243	16.5	0.5	20.8	1.6	14.6	0.9	16.4	0.7	18.4	1.8	304	14.6	0.3	14.9	0.7	13.7	0.6	14.8	0.6	—	—	15.1	0.3
Navarra	444	16.0	0.4	19.6	1.6	15.3	0.6	16.1	0.5	16.2	1.2	271	13.1	0.4	11.7	1.0	13.1	0.6	13.2	0.6	—	—	13.9	0.3
San Sebastian	490	17.6	0.4	20.4	0.9	16.2	0.5	18.3	0.7	12.6	1.8	244	14.7	0.4	16.4	0.8	14.9	0.6	13.7	0.6	—	—	15.5	0.3
Asturias	386	13.5	0.4	15.0	1.5	13.2	0.7	13.8	0.6	12.2	1.1	324	11.8	0.3	11.4	0.8	12.4	0.5	11.7	0.5	10.0	1.2	12.1	0.3
Italy																							
Ragusa	168	13.2	0.6	—	—	13.0	0.9	13.9	1.0	—	—	138	11.1	0.5	9.3	0.9	10.8	1.0	13.0	0.9	—	—	11.5	0.4
Naples												403	10.4	0.3	13.1	1.0	9.9	0.5	10.4	0.5	9.3	1.0	11.5	0.3
Florence	271	13.3	0.5	11.3	1.5	13.5	0.8	13.6	0.7	—	—	784	10.3	0.2	10.4	0.7	10.4	0.4	10.3	0.3	10.2	0.8	11.4	0.2
Turin	676	12.6	0.3	12.2	1.0	11.9	0.5	13.1	0.4	13.5	1.2	392	11.1	0.3	10.3	1.0	10.9	0.5	11.3	0.4	—	—	11.1	0.2
Varese	327	10.9	0.4	—	—	12.0	1.0	10.4	0.5	12.6	1.5	794	9.6	0.2	9.2	0.7	9.6	0.4	9.9	0.3	9.0	0.6	10.1	0.2
France																							
South coast												620	11.9	0.2			11.0	0.4	12.4	0.4	12.8	0.5	13.0	0.3
South												1425	10.6	0.2			10.2	0.2	11.0	0.3	11.1	0.4	11.7	0.2
North-East												2059	10.2	0.1			10.1	0.2	10.2	0.2	10.7	0.3	11.3	0.2
North-West												631	9.6	0.2			9.4	0.4	10.0	0.4	9.2	0.6	10.7	0.3
Germany																							
Heidelberg	1034	16.6	0.2	15.0	0.7	16.1	0.4	17.3	0.4	—	—	1087	13.7	0.2	14.1	0.3	13.2	0.3	13.4	0.3	—	—	14.7	0.1
Potsdam	1233	18.2	0.2	18.2	0.7	17.8	0.5	18.5	0.3	16.7	0.9	1061	13.7	0.2	12.6	0.4	13.5	0.4	14.0	0.3	20.1	1.2	15.6	0.1
The Netherlands																							
Bilthoven	1024	14.9	0.3	15.3	0.5	14.7	0.4	14.4	0.4	—	—	1086	10.9	0.2	10.9	0.3	10.7	0.3	10.6	0.4	—	—	12.5	0.2
Utrecht												1870	9.8	0.1	—	—	9.9	0.2	9.8	0.2	10.1	0.3	11.0	0.2
United Kingdom																							
General population	402	12.5	0.4	12.4	1.3	13.3	0.7	11.7	0.7	12.5	0.7	570	9.4	0.3	9.2	0.8	9.2	0.4	9.4	0.5	9.7	0.5	10.5	0.2
Health-conscious	114	17.3	0.7	—	—	18.0	1.2	16.9	1.2	—	—	197	13.1	0.4	10.4	1.4	13.9	0.7	13.8	0.7	10.7	1.2	14.7	0.4

Table A1 *Continued*

Country and centre	*Men*											*Women*										*Men and women*	
	N	*All*		*35–44 years*		*45–54 years*		*55–64 years*		*65–74 years*		N	*All*		*35–44 years*		*45–54 years*		*55–64 years*		*65–74 years*		*M*	*s.e.*
		M	*s.e.*	*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*		*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*	*M*	*s.e.*		
Denmark																							
Copenhagen	1356	9.9	0.2			9.7	0.4	9.9	0.3	11.2	1.1	1484	8.0	0.2			7.9	0.3	8.1	0.2	8.2	0.7	8.6	0.1
Aarhus	567	10.0	0.3			9.6	0.5	10.2	0.5	—	—	510	8.3	0.3			8.3	0.4	8.5	0.4	—	—	8.8	0.2
Sweden																							
Malmö	1421	9.9	0.2			9.5	0.6	10.1	0.3	10.3	0.3	1711	7.9	0.1			8.1	0.3	8.2	0.2	8.0	0.2	8.6	0.1
Umeå	1344	9.8	0.2	9.0	0.7	9.7	0.4	10.0	0.3	10.1	0.6	1574	7.8	0.2	7.4	0.4	7.9	0.3	8.0	0.2	7.9	0.5	8.5	0.1
Norway																							
South and East												1004	7.9	0.2	7.3	0.5	7.7	0.2	8.3	0.5			9.1	0.2
North and West												793	8.1	0.2	7.8	0.5	7.9	0.3	8.1	0.6			9.3	0.2
All centres	13 025	14.0	0.1	16.4	0.3	13.8	0.1	13.7	0.1	14.2	0.2	23 009	10.5	0.0	11.4	0.1	10.3	0.1	10.5	0.1	10.2	0.1	11.8	0.0

Abbreviations: M, mean; s.e., standard error.
[a]Adjusted for age (when not stratified for age), total energy intake, weight and height and weighted by season and day of recall.
Values for men and women combined are further adjusted by gender. Values for all centres combined are further adjusted for centre.