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Running title: Lifetime alcohol and abdominal adiposity

Abstract

Background:

The relation between lifetime use of alcohol and measures of abdominal and general adiposity is unknown.

Methods:

Among 99,381 men and 158,796 women of the European Prospective Investigation into Cancer and Nutrition (EPIC) study, means of waist circumference (WC), waist-to-hip-ratio (WHR) and body mass index (BMI), and odds ratios (OR) for a larger WC than predicted for a given BMI (WClp=positive residuals of gender specific linear regression of BMI on WC) across categories of average lifetime use of alcohol (total, from wine and from beer) were calculated, all adjusted for socio-demographic, lifestyle and health factors.

Results:

WC, WHR and BMI in men using lifetime ≤6g/d alcohol were 95.1cm, 0.942 and 27.3kg/m^2, and 96.2cm, 0.961 and 28.3kg/m^2 when using >96g/d. WC and WHR in women was 83.2cm and 0.813 for ≤6g/d, and 84.6cm and 0.830 for >60g/d while BMI deviated only slightly with the lowest BMI (26.7kg/m^2) observed for >6-24g/d. Compared to ≤6g/d, OR for a WClp in both genders increased steadily across categories of alcohol use (up to 1.40 (95% confidence interval 1.32, 1.49) in men using >60g/d and 1.63 (1.54, 1.73) in women using >24g/d); though increase was higher for alcohol from beer than from wine (p for difference between beer and wine<0.001 (men) and =0.002 (women)).

Conclusion:

Lifetime alcohol use is positively related to abdominal and general adiposity in men, possibly following the male weight gain pattern; in women it is positively related only to abdominal adiposity. In this context, beer may contribute additionally to abdominal adiposity.

Key words: alcohol, waist circumference, waist-to-hip ratio, BMI, multi-centric cohort study

Introduction

Abdominal fat accumulation, independently from general adiposity, increases the risk for adverse health outcomes (Pischon et al., 2008). The association of alcohol use with measures of abdominal and general adiposity in cross-sectional and prospective epidemiological studies was so far inconclusive. Abdominal adiposity was more prominent in men or in women who used alcohol heavily (Dallongeville et al., 1998; Duncan et al., 1995; Halkjaer et al., 2004; Laws et al., 1990; Slattery et al., 1992). However, some studies did not reveal such a relationship (Halkjaer et al., 2006; Koh-Banerjee et al., 2003) or did not show the relationship in both genders (Halkjaer et al., 2004). Also results on types of beverages and anthropometric measures vary depending on gender and country (Dallongeville et al., 1998; Duncan et al., 1995; Halkjaer et al., 2004; Lukasiewicz et al., 2005; Vadstrup et al., 2003).

Alcohol-related body measures may also result from metabolic changes due to a long term exposure to alcohol and therefore, information on a long term exposure to alcohol is important. However, most of the previous studies are based on information on use of alcohol over a short period of time, e.g. in the past year, month, or week, and lifetime abstainers were not distinguished from users of alcohol who had quitted at the time of the measurement. In the European Prospective Investigation into Cancer and Nutrition (EPIC) information on alcohol use in the past was collected, offering the opportunity to investigate the role of lifetime alcohol use on measures of abdominal and general adiposity.

Methods

Study Population

The European Prospective Investigation into Cancer and Nutrition (EPIC) is an ongoing multi-centric cohort study. The study has been described in full elsewhere (Riboli et al., 2002). In brief, the EPIC population consists of 521,448 individuals, ages 25 to 70 years, recruited from the general population in 23 centres in 10 European countries during 1992–2000. Persons who accepted the invitation to participate in the study gave informed consent and completed questionnaires on their diet, lifestyle, and medical history, and visited a study centre where a blood sample and anthropometric measurements were taken.

Because we used a common data set created also for prospective data analyses, subjects with unknown vital status during follow-up (n=1,517) had been excluded. Further, whose ratio of energy intake to estimated energy requirement calculated from body weight, height, and age was in the top or bottom 1% (n=10,273) was excluded because alcohol use may have been reported invalidly too (Bingham et al., 1994). We further excluded participants who had not filled out the dietary or lifestyle questionnaires (n=6,611), were pregnant at recruitment (n=623), had the anthropometric examination more than one year apart from the recruitment data collection (n=22,084), had extreme or implausible values in body mass index (BMI<16), height (<1.30 m) or waist circumference (WC>160) (n=397), had no anthropometric measures (n=1,429), had missing information (n=4,072) or an implausible high average lifetime alcohol use of >250 g/d (n=158). Information on lifetime use of alcoholic beverages was not available for the study centres Naples (Italy), Bilthoven (The Netherlands), Sweden and Norway (n=116,149). We also excluded the health conscious part of the Oxford cohort (Great Britain) (n=47,651; 85% of the British cohort)) and the French cohort (n=51,267) since anthropometry was self-reported (Park et al., 2011). Therefore, 258,177 (99,381 men and 158,796 women) participants from Denmark (Aarhus, Copenhagen), Germany (Heidelberg, Potsdam), Greece, Italy (Florence, Varese, Ragusa, Turin), the Netherlands (Utrecht), Spain (Asturias, Granada, Murcia, Navarra, San Sebastian), and the United Kingdom (Cambridge, Oxford), representing 50% of the original cohort, were eligible for this analysis.

The study was approved by ethical review boards of the single centres and the International Agency for Research on Cancer in Lyon, France.

Assessment of lifetime alcohol use

Lifetime alcohol use was assessed based on data collected during the recruitment procedure by applying questionnaires on lifestyle and diet during the past 12 month. Glasses alcoholic beverage used at certain ages and during the 12 month prior to the recruitment have been self-reported and transformed into grams alcohol used per day by applying gender specific definitions of a standard drink for each country included in the EPIC study. We favoured this approach, since the application of common standard drinks for the calculation of alcohol intake involve some methodological problems (Lemmens, 1994), and specific data in the form of 36,994 24-hour dietary recalls (Slimani, 1999) had been available. Variations of concentrations and amounts of alcohol used on weekdays vs. weekend days and filling levels were taken into account by calculating weighed averages of alcohol content of one glass wine, beer, and hard liquor (based on a sub-sample of EPIC participants (N=12,443) who reported the use of alcoholic beverages during the 24-hour dietary recall).

The average alcohol use in g/d at ages 20, 30, 40, and 50 years and at recruitment was then calculated as the sum of the number of glasses per week of the respective beverage multiplied with the calculated alcohol content per glass divided by seven. Because time intervals across points in time where information on alcohol use was available were not equal for all participants, lifetime use of alcohol was calculated as the weighted average of intakes at different ages, including recruitment, with weights equal to the total subject-specific time of investigation, i.e. the individual time until recruitment

Participants were categorized as ‘never users’ of alcohol when reported alcohol use was zero at all points in time and as ‘former users’ when use of alcohol was reported for past points in time but not for the 12 month before recruitment.

Assessment of anthropometric data

Weight and height were measured by trained personnel with subjects wearing no shoes. Depending on study centre, WC (cm) was measured either at the narrowest torso circumference, at the midpoint between the lower ribs and iliac crest, or by a combination of methods, whereby in most centres, WC was measured at the narrowest torso circumference. Hip circumference (HC; cm) was measured horizontally at the level of the largest lateral extension of the hips, or over the buttocks. Body weight, WC and HC were corrected for differences in clothing worn during measurement. A constant was subtracted from the original measure depending on whether study participants were measured in light underwear (no correction), in normal clothing without shoes (weight minus 1.5 kg; circumference minus 2.0 cm), or in light clothing without shoes (weight minus 1.0 kg) (Haftenberger et al., 2002).

Assessment of data on confounding factors

Standardized self-administered questionnaires were applied at recruitment to collect information on the attained educational level, physical activity during the 12 month prior to the recruitment, smoking status including number of cigarettes and duration of smoking, and in women also reproductive history and hormone replacement therapy. (Riboli et al., 2002). Dietary variables were derived from country specific validated food-frequency questionnaires which covered between 98 and 266 food items. Self-reported frequencies of consumption were transformed into calorie intake per day by applying a standardized food-composition table (Slimani et al., 2007).

Statistical Analysis

Adjusted means of WC, WHR (WC divided by HC), and BMI (weight (kg) divided by squared height (m)) across categories of average lifetime use of alcohol were calculated for men and women separately using generalized linear models. Cut points for categorization of alcohol use were based on the assumption that any glass of alcoholic beverage (drink) contains in average 12 g/d alcohol: never users, former users, and lifetime users of alcohol in g/d of ≤6, >6–12, >12–24, >24–60, >60–96, >96. Means were adjusted for age (years, continuous), study centre, education (no graduation or primary school, technical or professional school, secondary school, university degree, unknown), physical activity (index, combining work activity and leisure time physical activity with gender specific cut points: inactive, moderately inactive, moderately active, active, unknown), non-alcoholic energy intake (kcal, continuous), smoking status (never smokers, ex-smokers for ≥10 or for <10 years, smokers at recruitment of <15 or of ≥15 cigarettes per day, status unknown), smoking duration (<10yrs, 10-<20yrs, 20-<30yrs, 30-<40yrs, 40 or more, unknown), and prevalent diseases (self-reported myocardial infarction, stroke, cancer, diabetes, hypertension, unknown) at the time of recruitment. Models for women additionally included menopausal status (premenopausal, postmenopausal, unknown), and parity (nulliparous, 1–2, >2 live birth, unknown) and models for WC in both genders height and weight. Linear regression was used to investigate the trend of the association of alcohol use and anthropometric measures among lifetime users (per 12 g/d increment) continuously.

Since abdominal adiposity was in the focus of this analysis, we investigated the relative contribution of alcohol to a positively deviating WC from that predicted by the BMI. Firstly, for men and women separately, positive residuals of linear regression analysis with BMI as the independent and WC as the dependent variable were utilized to create a dichotomized variable (yes, no) for a WC that was larger than predicted (WClp) for a given BMI (Han et al., 1998). Secondly, the relative contribution of each category of lifetime alcohol use, and alcohol from wine and from beer to a larger WC than predicted was investigated by employing logistic regression with the lifetime users of ≤6 g/d alcohol as the reference category, mutually controlling for alcohol from wine or from beer in the respective models. Models were further adjusted for alcohol from other beverages, and variables listed for the adjusted means. Heterogeneity of odds ratios (OR) for alcohol from wine and alcohol from beer across EPIC-centres was tested calculating Cochran's *Q* and I^2 (Higgins et al., 2003). While Cochran's *Q* gives the test statistic for the heterogeneity, I^2 describes the percentage of total variation across study centres, which is due to heterogeneity rather than due to chance.

All p-values presented are two-tailed and the level of significance was 0.05. Analyses were performed using SAS 9.1 (SAS Institute, Cary, NC).

Results

Men and women who did use alcohol in the past but not at recruitment (former alcohol users) were older, more likely to be also former smokers (men) or have a prevalent disease (myocardial infarction, stroke, cancer, diabetes, or hypertension) than those who were lifetime alcohol users (table 1). Among lifetime heavy alcohol using men of >96 g/d, proportion of long term smokers (>20 years) and non-alcoholic calorie and dietary fat intake was highest. The highest proportion of university graduates was seen among men who used ≤24 g/d alcohol. Among women who used lifetime >24 g/d alcohol average age was little younger and the percentage of smokers at the time of recruitment, nulliparity, or university degree was highest.

Lifetime alcohol use was positively associated with WC, WHR and BMI in men (table 2). Men who used lifetime on average >96 g/d had a 1.1 cm larger WC and a 1.0 kg/m^2 higher BMI than those who used ≤6 g/d alcohol. WC, WHR and BMI of men who never used alcohol or who were former users were comparable with that of men who used ≤24 g/d. WC and WHR were highest among heavy alcohol users of >96 g/d alcohol. Differences of means between lowest and highest category of alcohol use for WC, WHR and BMI were greater for beer than for wine.

In women lifetime use of alcohol was positively related to WC and WHR and U-shaped to BMI with the lowest BMI observed among women who used on average >6-24 g/d alcohol. Conversely, the difference of WC between the lowest and the highest category of lifetime alcohol use was 1.7 cm; and WC and WHR increased steadily across categories of lifetime alcohol use (table 2). Women who never used alcohol during lifetime were heaviest (BMI 27.6 kg/m^2), but their WC was comparable to those women who used low amounts of alcohol (≤12 g/d).

While in men differences of means of WC, WHR and BMI between lowest and highest category of alcohol use were greater for beer than for wine it wasn't as clear in women (table 2).

In table 3 the OR of a WClp reflect the relative risk of abdominal adiposity across categories of lifetime alcohol use. In men and in women the OR increased steadily across categories of lifetime alcohol use which was true for alcohol from wine and from beer. However, the OR for alcohol from beer were higher than that for the same amount of alcohol from wine, and the differences appeared more pronounced in women compared to men. The OR for wine and beer varied across countries (figure 1 and 2). Between 50% and 80% of the total variation across study centres was due to heterogeneity rather than due to chance. In general, OR for beer were higher in men and women residing in beer preferring countries (Denmark, Germany, The Netherlands, and UK). In the Mediterranean centres, the role of beer for WClp was not so clear, though a positive relationship for beer was also seen for some of these centres (e.g. Asturias, Navarra (men), and Varese (women). However, Wine was also positively associated with a WClp in men and women of most centres.

Discussion

In men and women participating in this large European cohort study, lifetime alcohol use was related to the risk of abdominal adiposity, whereas alcohol from beer played a prominent role in men and in women as well, though risk was also higher for alcohol from wine. Lifetime alcohol use was also positively associated with general adiposity in men. Although differences of adjusted means of WC, WHR and BMI appeared small, on the population level they exhibit health relevant differences.

Positive associations between the use of alcohol and abdominal adiposity have consistently been reported for men and frequently for women in cross-sectional (Dallongeville et al., 1998; Han et al., 1998; Marti et al., 1991; Randrianjohany et al., 1993; Slattery et al., 1992; Troisi et al., 1991) or prospective studies (Grinker et al., 1995; Vadstrup et al., 2003; Vernay et al., 2004). Studies showing different results focused on the role of alcohol for the *change* of anthropometric measures (Halkjaer et al., 2004; Halkjaer et al., 2006; Koh-Banerjee et al., 2003).

Alcohol, in distinction to other sources of energy, cannot be stored. This is why it has absolute priority in metabolism using different pathways, e.g. increasing thermogenesis or decreasing lipolysis (Buemann & Astrup, 2001; Suter, 2005; Yeomans et al., 2003). Alcohol metabolism may also trigger endocrine changes, such as increased cortisol secretion or modified steroid metabolism in the liver (Bjorntorp, 1990; Sarkola et al., 2001; Suter, 2005). Androgen hormone status was shown to be related to fat distribution, whereas men with lower levels and women with higher levels of androgen sex hormones were at higher risk of abdominal fat accumulation (Blouin et al., 2008; Khaw & Barrett-Connor, 1992). Alcohol use in other studies was associated with higher levels of androgen hormones in women and lower levels in men (Eriksson et al., 1994; Sarkola et al., 2000).

There was a role of beverage type for the degree of abdominal adiposity in our study, where alcohol from beer showed a higher risk of having a larger waist circumference than would be expected from the BMI than alcohol from wine. There was heterogeneity across centres of the EPIC study, and the Southern (except most of the Spanish) centres showed wider confidence intervals for alcohol from beer due to lower numbers of beer users in these centres. Conversely, wine use seemed to be common among women and men in almost all centres. This was indicated by the generally smaller confidence intervals for alcohol from wine in men and in women; whereas the confidence intervals for alcohol from beer were small only in countries or centres where beer was more common.

One prospective study in a Danish population found in women, but not men, high intakes of beer to be associated with gain in WC (Halkjaer et al., 2004). In cross-sectional studies beer intake was either not related to WHR or BMI (Bobak et al., 2003; Lukasiewicz et al., 2005) or it was related in both genders and all ethnic groups (Slattery et al., 1992; Wannamethee et al., 2005). However, comparable to our study, abdominal adiposity was also seen for other types of beverage, independent from BMI (Dallongeville et al., 1998).

Since there are many possible confounders (Suter, 2005), it also cannot be ruled out that residual confounding influenced our results. For instance, alcohol use in general and type of beverage in particular may be differentially related to smoking. Smoking has been shown to be associated with abdominal adiposity (Travier et al., 2009). In our analysis, in both genders, among current smokers at recruitment using lifetime alcohol heavily (>60 g/d) the BMI was lower than that of never or ex-smokers using the same amount of alcohol. In contrast, the WC among current smokers who used alcohol lifetime heavily was noticeable higher.

Our study has limitations: We had no information about the onset and times and reasons for cessation of alcohol use. The categories of average lifetime use of alcohol may misclassify never, former or lifetime users of alcohol due to misreporting or due to the design of the question that inquires only about the use of alcohol at defined ages. Furthermore, the retrospective direction of the information collected on lifetime alcohol use is prone to recall bias. This problem was already addressed in the 1958 British Birth Cohort Study where it was shown that a certain proportion of the individuals' retrospective reports about abstention, occasional or regular drinking of alcohol were inconsistent (Caldwell et al., 2006). However, the opportunities to obtain information on lifetime use of alcohol in a population based cohort study are limited, and the method used in our study was judged to generate acceptable information (Friesema et al., 2004; Lemmens et al., 1997). In our study, the amount of alcoholic beverages used in history by comparable age cohorts at certain ages was validated by comparison of self-reported data with the respective per capita measures (Klipstein-Grobusch et al., 2002).

Further, information on lifetime alcohol use was not available in all centres, which is why we had to exclude participants of the respective centres from this analysis. Due to further exclusion of the health conscious part of the UK and the French cohort because anthropometric variables were self-reported, the final data set consisted of about 50% of the original cohort. To test the sensitivity of our results to these exclusions, we rerun the models with the cohorts included, and the associations remained unchanged.

Strengths of our study include a large sample size of men and women throughout Europe, information on the use of alcohol over adult life period, including never and former use of alcoholic beverages, and measured body weight, height, waist and hip circumference. We adjusted the models for dietary, lifestyle and health factors potentially confounding the association and performed a sensitivity analysis by excluding individuals who reported a prevalent myocardial infarction, stroke, cancer, diabetes, or hypertension at recruitment.

Future research in this field may investigate biological pathways of alcohol as a possible long term determinant of abdominal adiposity including interaction of sex and stress related hormones, genetic variations and behavioural factors. It also would be important to investigate whether the risk of abdominal adiposity could be reversed by cutting down the alcohol use and how long it would take to see effects.

In conclusion, lifetime use of alcohol in men is positively related to abdominal and general adiposity, and in women it is related to abdominal adiposity. In this context, beer may contribute additionally to abdominal adiposity.

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Conflict of interest.

The authors declare no conflict of interest.

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Figure 1

Odds ratio of having a larger waist circumference than expected from BMI for increase of one more alcoholic drink (12 g alcohol) per day across centres of the EPIC study in men (Adjusted for age, centre, education, physical activity, smoking status, smoking duration, non-alcoholic calorie intake, prevalent chronic diseases)

Figure 2

Odds ratio of having a larger waist circumference than expected from BMI for increase of one more alcoholic drink (12 g alcohol) per day across centres of the EPIC study in women (Adjusted for age, centre, education, physical activity, smoking status, smoking duration, non-alcoholic calorie intake, prevalent chronic diseases, menopausal status and number of live birth)

Table 1. Frequency distribution and description of characteristics at recruitment across categories of lifetime use of alcohol in a sub-sample of the EPIC study

Use of alcohol	Overall	Never	Former	Lifetime					
g/d[1]		0	>0	≤6	>6–12	>12–24	>24–60	>60–96	>96
Men									
N	99381	1715	4792	13843	15971	24919	29258	6006	2877
Age (mean, SD, in years)	53.9 (8.4)	54.0 (10.8)	55.9 (9.6)	54.0 (9.5)	54.8 (8.4)	54.2 (7.9)	53.3 (7.8)	52.8 (7.9)	52.5 (8.0)
non-alcoholic calorie intake (mean, SD, kcal[2])	2269 (632)	2281 (679)	2262 (675)	2269 (648)	2230 (617)	2228 (608)	2284 (630)	2364 (639)	2494 (674)
Total fat intake (mean, SD)	98.3 (36.0)	98.3 (36.0)	94.4 (35.1)	95.2 (33.4)	93.7 (31.9)	94.6 (31.6)	98.0 (32.9)	105.4 (35.2)	114.5 (38.6)
University degree (%)	25.0	18.7	12.5	25.4	28.5	29.5	25.2	16.8	8.0
High/very high physical activity (%)	48.6	41.6	48.3	46.2	49.3	50.8	49.6	45.4	40.9
Smokers (%)	31.7	27.7	30.6	25.2	26.1	29.5	35.3	44.8	54.5
Ex-smokers (%)	38.6	24.2	42.5	33.3	38.4	40.9	41.0	35.4	29.3
>20 years of ever smoking (%)	65.4	66.6	70.1	58.5	60.6	63.3	67.2	76.0	83.0
Prevalent chronic diseases[3] (%)	11.4	13.9	22.7	12.3	12.2	10.1	10.1	10.2	12.6
Women									
N	158796	19863	10906	70769	31045	20533	5495	185	
Age (mean, SD, in years)	52.9 (9.0)	52.5 (10.3)	54.5 (9.7)	52.7 (9.1)	53.2 (8.4)	52.8 (8.1)	52.2 (7.8)	51.7 (8.5)	
non-alcoholic calorie intake (mean, SD, kcal[2])	1867 (520)	1824 (525)	1863 (536)	1874 (521)	1881 (506)	1868 (515)	1862 (539)	1907 (580)	
Total fat intake (mean, SD)	78.1 (27.2)	79.0 (28.7)	77.2 (27.8)	78.0 (27.3)	77.8 (25.9)	78.2 (26.4)	78.9 (28.2)	80.7 (31.5)	
University degree (%)	14.7	7.3	8.5	14.3	18.0	19.5	22.9	24.3	
High/very high physical activity (%)	63,3	78.6	72.4	63.0	56.9	57.2	53.6	55.1	
Smokers (%)	21.3	15.1	18.4	19.6	22.7	28.1	37.4	43.2	
Ex-smokers (%)	21.7	9.2	18.6	20.3	27.1	29.6	30.5	29.2	
>20 years of ever smoking (%)	52.3	44.7	54.5	49.0	53.3	57.6	64.9	63.5	
Prevalent chronic diseases[3] (%)	9.2	10.5	15.2	8.9	8.0	8.0	8.6	10.0	
Prämenopausal (%)	31.1	37.3	28.1	31.8	28.3	28.8	30.3	31.9	
Nulliparous (%)	13.0	10.5	13.3	12.0	13.7	15.9	20.9	27.0	
1-2 live birth (%)	59.1	53.1	51.4	60.7	61.5	60.0	58.1	51.4	

1 12 grams alcohol equivalents about one drink.
2 1 kcal = 4.186kJ
3 Self-report of myocardial infarction, stroke, cancer, diabetes, hypertension at the time of enrolment into the study.

Table 2. Mean body measures according to categories of lifetime alcohol use in a sub-sample of the EPIC study

Use of alcohol		Never	Former	Lifetime						Trend[2]
	g/d[1]	0	>0	≤6	>6–12	>12–24	>24–60	>60–96	>96	
Men										
Total alcohol	N	1715	4792	13843	15971	24919	29258	6006	2877	
	WC (cm)[3]	95.4	95.3	95.1	95.1	95.3	95.7	96.0	96.2	+
	WHR[4]	0.944	0.942	0.942	0.942	0.944	0.951	0.957	0.961	+
	BMI (kg/m^2)[4]	27.3	27.1	27.3	27.2	27.3	27.5	27.9	28.3	+
Alcohol from beer	N	10431	10402	40716	16362	12968	7522	787	193	
	WC (cm)[3,5]	95.4	95.5	95.5	95.6	95.9	96.4	97.1	97.7	+
	WHR[4,5]	0.945	0.947	0.947	0.951	0.956	0.964	0.975	0.982	+
	BMI (kg/m^2)[4,5]	27.5	27.5	27.5	27.6	27.9	28.2	28.4	28.7	+
Alcohol from wine	N	7493	5813	43510	14736	12307	12248	2416	858	
	WC (cm)[3,5]	96.0	96.0	95.8	95.9	96.0	96.2	96.4	96.8	+
	WHR[4,5]	0.958	0.955	0.956	0.954	0.956	0.958	0.963	0.967	+
	BMI (kg/m^2)[4,5]	27.7	27.5	27.8	27.7	27.7	27.7	28.3	28.8	+
Women										
Total alcohol	N	19863	10906	70769	31045	20533	5495	185		
	WC (cm)[3]	83.1	83.3	82.9	83.2	83.7	84.5	84.6		+
	WHR[4]	0.818	0.818	0.812	0.813	0.818	0.827	0.830		+
	BMI (kg/m^2)[4]	27.6	27.2	27.1	26.7	26.7	26.9	27.1		–
Alcohol from beer	N	62331	14958	76526	3607	1133	231	10		
	WC (cm)[3,5]	83.5	83.6	83.6	84.5	85.1	86.4	84.5		+
	WHR[4,5]	0.817	0.819	0.817	0.827	0.834	0.854	0.839		+
	BMI (kg/m^2)[4,5]	26.9	27.0	26.7	26.6	26.7	27.1	26.6		–
Alcohol from wine	N	30132	11335	83641	20321	11129	2190	48		
	WC (cm)[3,5]	84.0	84.2	83.8	84.2	84.7	85.3	84.8		+
	WHR[4,5]	0.829	0.830	0.824	0.825	0.829	0.838	0.831		+
	BMI (kg/m^2)[4,5]	27.4	27.1	27.0	26.7	26.6	26.8	25.9		–

BMI body mass index; WC waist circumference; WHR waist-to-hip ratio

1 12 grams alcohol equivalents about one drink.

2 estimated by linear regression in lifetime users only; + positive trend, –negative trend, significant at the 0.05 level

3 adjusted for age, center, education, physical activity, smoking status, smoking duration, non-alcoholic calorie intake, prevalent chronic diseases, height and weight (women also for menopausal status and number of live birth).

4 adjusted for age, center, education, physical activity, smoking status, smoking duration, non-alcoholic calorie intake, and prevalent chronic diseases, (women also for menopausal status and number of live birth).

5 additionally mutually adjusted for alcohol from beer or from wine

Table 3. Odds ratios for having a waist circumference larger than predicted for a given body mass index across categories of lifetime alcohol use of in a sub-sample of the EPIC study

Use of alcohol		Never	Former	Lifetime				
	g/d[1]	0	>0	≤6	>6–12	>12–24	>24–60	>60
Men								
Total alcohol	N	1715	4792	13843	15971	24919	29258	4947
	OR (95% CI)[2]	1.02 (0.92–1.14)	1.07 (1.00–1.15)	REF	1.01 (0.96–1.06)	1.06 (1.02–1.11)	1.20 (1.15–1.26)	1.40 (1.32–1.49)
Alcohol from beer[§]	N	10431	10402	40716	16362	12968	7522	980
	OR (95% CI)[2,4]	0.98 (0.93–1.03)	1.03 (0.98–1.09)	REF	1.06 (1.02–1.10)	1.15 (1.10–1.20)	1.36 (1.29–1.44)	1.76 (1.53–2.02)
Alcohol from wine[§]	N	7493	5813	43510	14736	12307	12248	3274
	OR (95% CI)[2,4]	1.04 (0.99–1.10)	1.04 (0.98–1.11)	REF	1.05 (1.00–1.09)	1.06 (1.01–1.10)	1.13 (1.07–1.19)	1.28 (1.18–1.40)
P for difference between wine and beer		0.098	0.798		0.650	0.007	<0.001	<0.001
Women								
Total alcohol	N	19863	10906	70769	31045	20533	3257	
	OR (95% CI)[3]	1.04 (1.00–1.07)	1.12 (1.08–1.18)	REF	1.10 (1.07–1.13)	1.31 (1.27–1.36)	1.63 (1.54–1.73)	
Alcohol from beer[§]	N	62331	14958	76526	3607	1133	241	
	OR (95% CI)[3,4]	0.98 (0.95–1.00)	1.00 (0.96–1.04)	REF	1.32 (1.23–1.42)	1.51 (1.33–1.71)	2.57 (1.93–3.45)	
Alcohol from wine[§]	N	30132	11335	83641	20321	11129	2238	
	OR (95% CI)[3,4]	1.05 (1.02–1.08)	1.14 (1.09–1.19)	REF	1.13 (1.10–1.17)	1.34 (1.28–1.40)	1.59 (1.45–1.74)	
P for difference between wine and beer		<0.001	<0.001		<0.001	0.083	0.002	

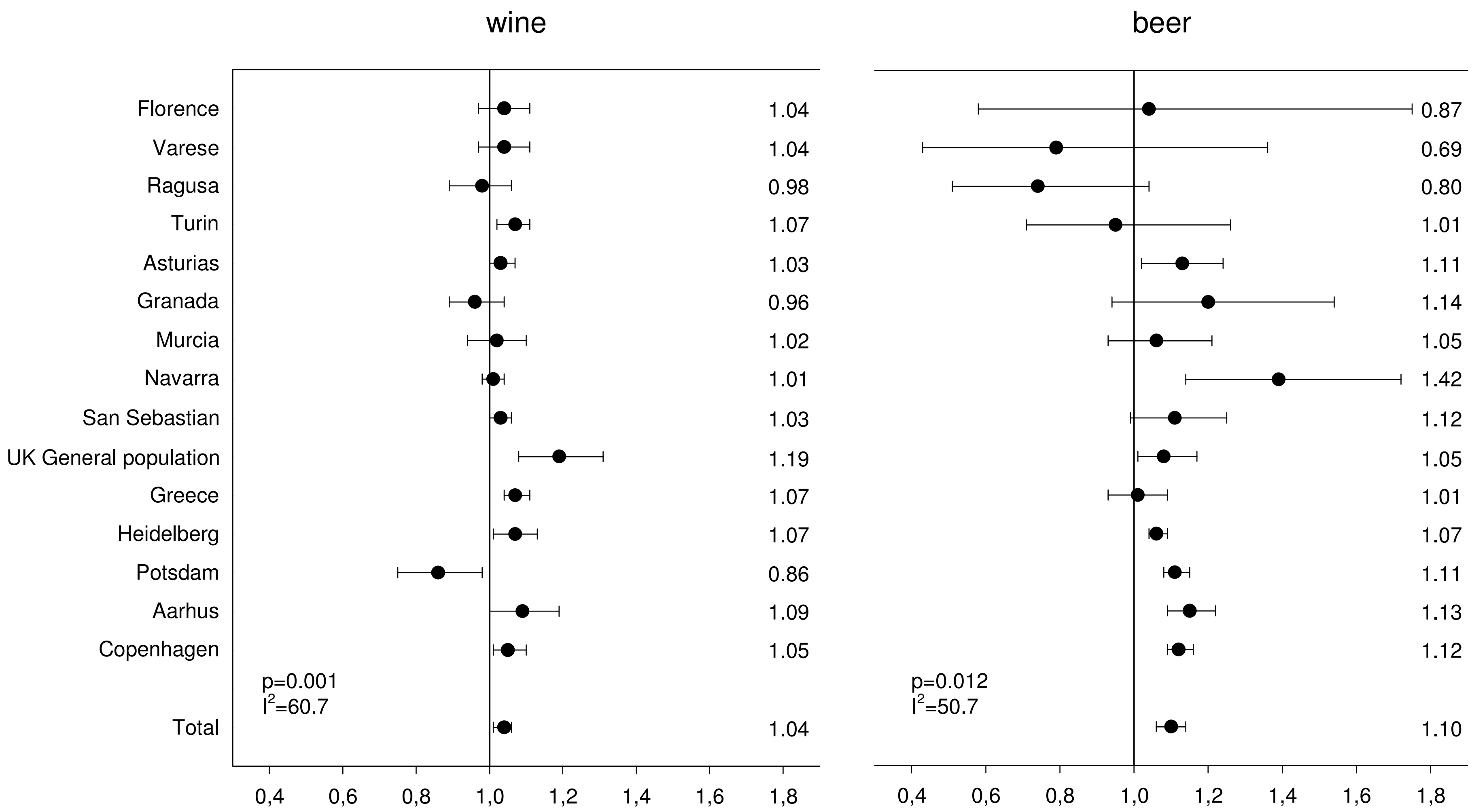
OR Odds ratio; 95% CI 95 percent confidence interval

1 12 grams alcohol equivalents about one drink.

2 adjusted for age, centre, education, physical activity, smoking status, smoking duration, non-alcoholic calorie intake, prevalent chronic diseases

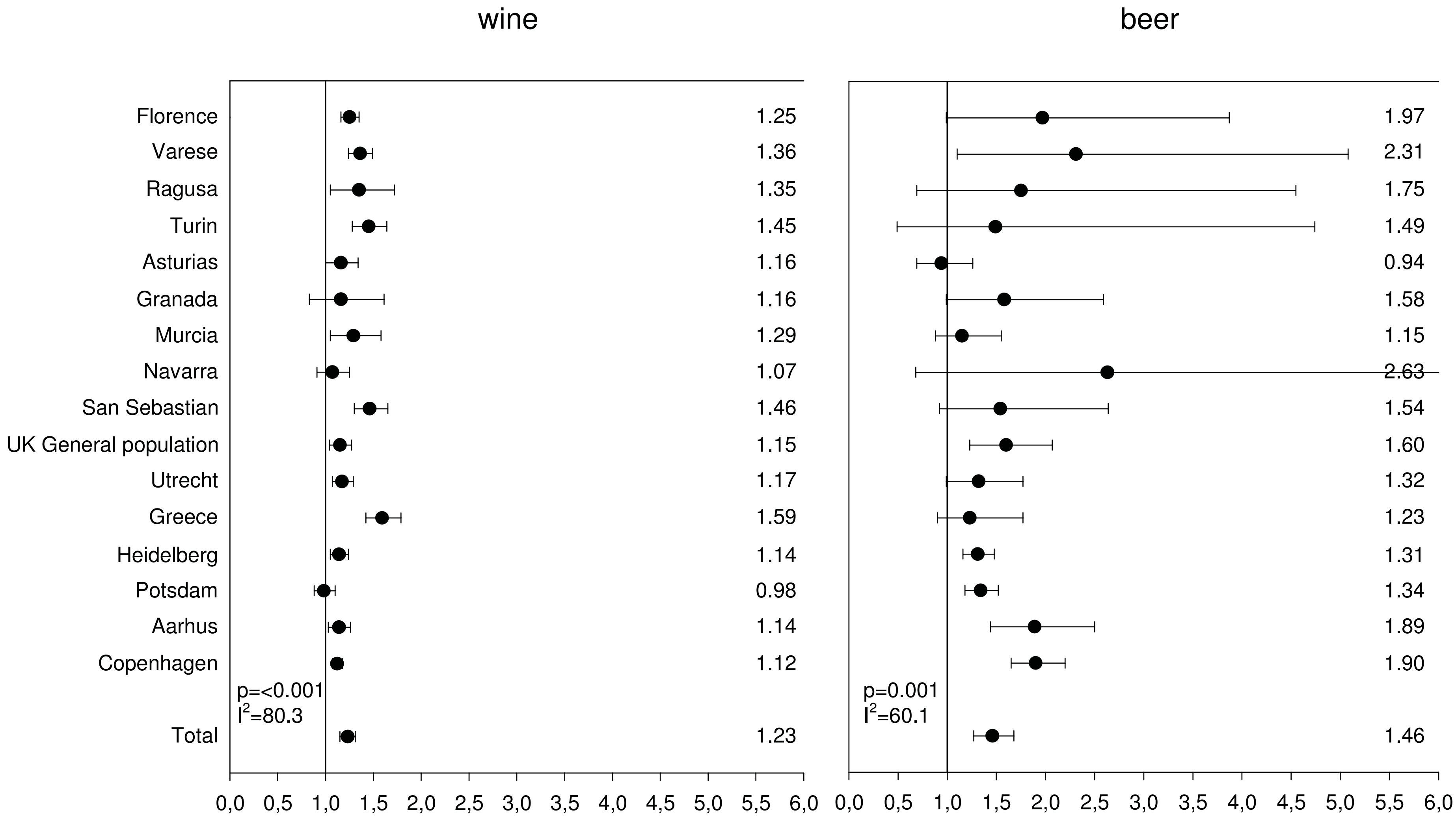
3 adjusted for age, centre, education, physical activity, smoking status, smoking duration, non-alcoholic calorie intake, prevalent chronic diseases, menopausal status and number of live birth

4 additionally mutually adjusted for alcohol from beer and from wine.



wine
beer
Florence
Varese
Ragusa
Turin
Asturias
Granada
Murcia
Navarra
San Sebastian
UK General population
Greece
Heidelberg
Potsdam
Aarhus
Copenhagen
Total
1.04
1.04
0.98
1.07
1.03
0.96
1.02
1.01
1.03
1.19
1.07
1.07
0.86
1.09
1.05
1.04
p=0.001
I2=60.7
0.87
0.69
0.80
1.01
1.11
1.14
1.05
1.42
1.12
1.05
1.01
1.07
1.11
1.13
1.12
1.10
p=0.012
I2=50.7
0,4
0,6
0,8
1,0
1,2
1,4
1,6
1,8

Figure 1



wine
beer
Florence
Varese
Ragusa
Turin
Asturias
Granada
Murcia
Navarra
San Sebastian
UK General population
Utrecht
Greece
Heidelberg
Potsdam
Aarhus
Copenhagen
Total
1.25
1.36
1.35
1.45
1.16
1.16
1.29
1.07
1.46
1.15
1.17
1.59
1.14
0.98
1.14
1.12
1.23
p=<0.001
I^2=80.3
1.97
2.31
1.75
1.49
0.94
1.58
1.15
2.63
1.54
1.60
1.32
1.23
1.31
1.34
1.89
1.90
1.46
p=0.001
I^2=60.1
0,0 0,5 1,0 1,5 2,0 2,5 3,0 3,5 4,0 4,5 5,0 5,5 6,0

Figure 2