

Alcohol Consumption and Obesity Risk in Women

Findings from the Women's Health Study

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Overview

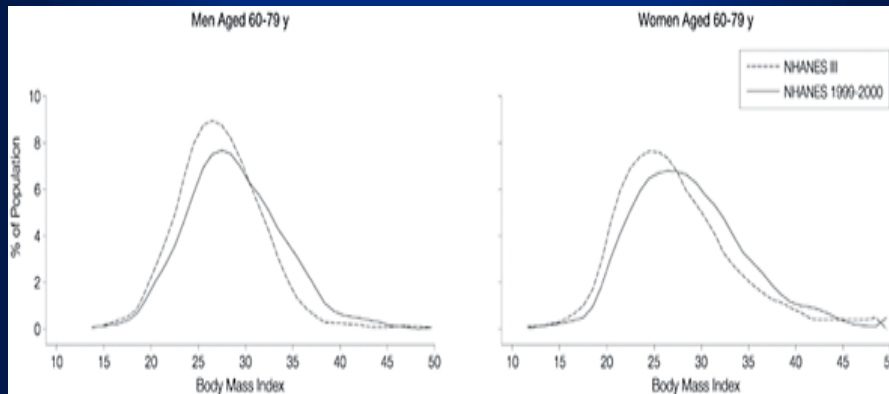
1. Background knowledge on alcohol consumption and obesity development
2. Previous epidemiologic studies on alcohol, body weight change, and risk of obesity
3. Our study findings from Women's Health Study
4. Potential mechanisms underlying the observed associations
5. Clinical implications of our study
6. Future research direction

Why it is important to investigate the relation between alcohol consumption and obesity development ?

Obesity – A Prevalent Modifiable Risk Factor for Multiple Chronic Diseases

- Obesity is a well-recognized modifiable risk factor for many adult-onset chronic diseases.
- Based upon the NHANES data:
 - The prevalence of obesity doubled from 1980 to 2002 among US adults aged ≥ 20 years.
 - From 2003 to 2008, the prevalence of obesity has been relatively stable.
 - As of 2007-2008, about 1/3 of US adults have BMI ≥ 30 kg/m² and about 2/3 have BMI ≥ 25 kg/m².
- The estimated total costs of health care for obesity-related conditions are as high as \$139 billion annually.

Smoothed Distributions of Body Mass Index for Men and Women Aged 60 to 79 Years, NHANES III (1988-1994) to NHANES 1999-2000

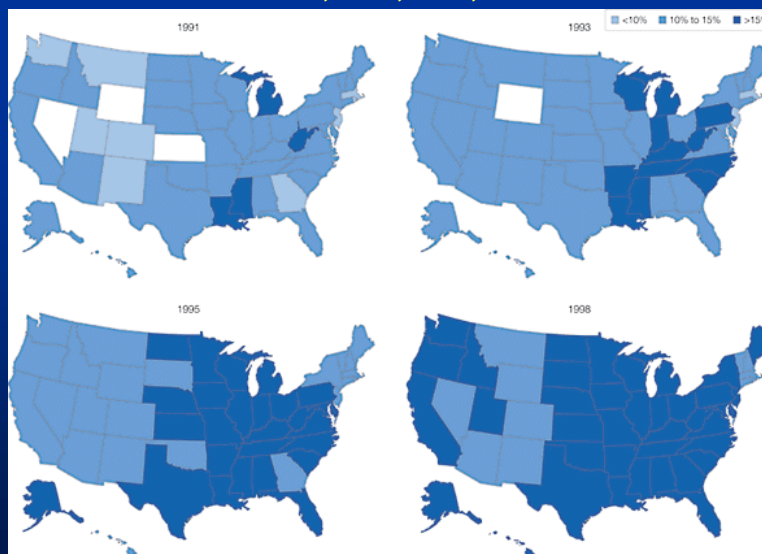


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Flegal, K. M. et al. JAMA 2002;288:1723-1727.



Prevalence of Obesity Among US Adults, Years 1991, 1993, 1995, and 1998

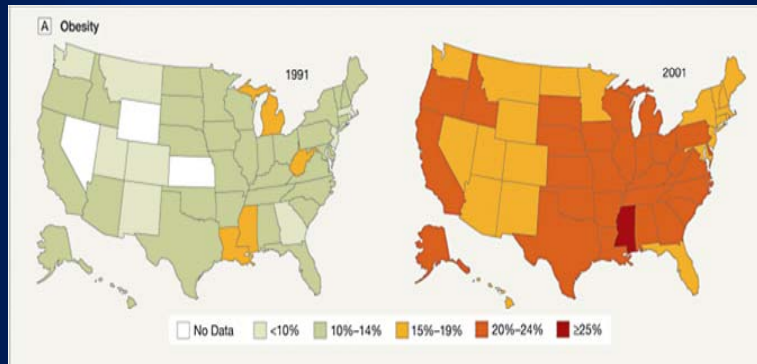


Data were calculated using the Behavioral Risk Factor Surveillance System.

Mokdad, A. H. et al. JAMA 1999;282:1519-1522.



Prevalence of Obesity Among US Adults, 1991 and 2001



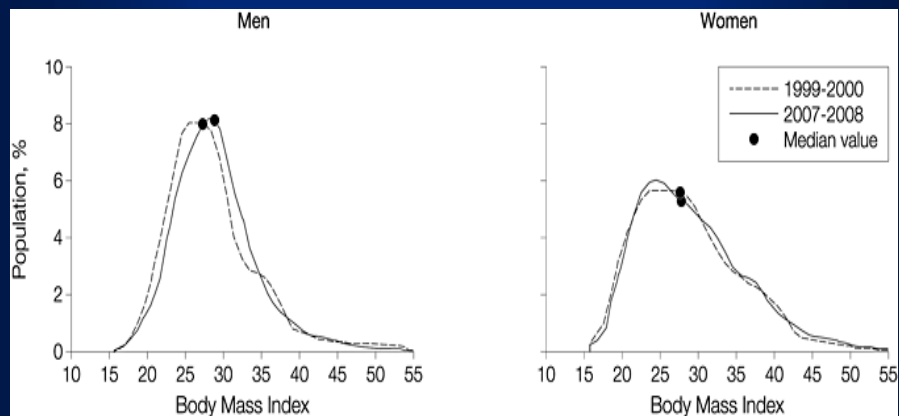
Data were calculated using the Behavioral Risk Factor Surveillance System.

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Mokdad, A. H. et al. JAMA 2003;289:76-79.

JAMA

Smoothed Distributions of Body Mass Index for Men and Women Aged 40 to 59 Years, NHANES 1999-2000 and 2007-2008



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Flegal, K. M. et al. JAMA 2010;303:235-241.

JAMA

Prevalence of Obesity and Overweight for Adults Aged ≥20 Years, NHANES 2007-2008

Table 2. Prevalence of Obesity and Overweight for Adults Aged 20 Years or Older^a

Categories by Age	% of Adults (95% Confidence Interval)				
	All ^b	Non-Hispanic White	Non-Hispanic Black	All Hispanics ^c	Mexican American
BMI ≥30					
All, age, y					
≥20	33.9 (31.7-36.1)	32.8 (29.4-36.1)	44.1 (39.9-48.3)	37.9 (32.3-43.4)	39.3 (32.0-46.6)
≥20 ^d	33.8 (31.6-36.0)	32.4 (28.9-35.9)	44.1 (40.0-48.2)	38.7 (33.5-43.9)	40.4 (34.2-46.6)
Men, age, y					
≥20 ^d	32.2 (29.5-35.0)	31.9 (28.1-35.7)	37.3 (32.3-42.4)	34.3 (28.2-40.3)	35.9 (26.3-44.4)
20-39	27.5 (23.8-31.2)	26.3 (20.9-31.7)	34.7 (26.5-40.9)	32.3 (23.9-40.7)	33.8 (22.7-44.9)
40-59	34.3 (29.8-38.8)	34.0 (28.1-39.8)	39.7 (30.0-49.5)	37.4 (29.0-45.8)	38.2 (26.3-50.1)
≥60	37.1 (33.1-41.0)	38.4 (34.1-42.6)	38.0 (31.3-44.7)	32.6 (23.5-41.7)	35.8 (21.9-49.8)
Women, age, y					
≥20 ^d	35.5 (33.2-37.7)	33.0 (29.3-36.6)	49.6 (45.5-53.7)	43.0 (37.9-48.2)	45.1 (38.9-51.2)
20-39	34.0 (29.0-39.1)	31.3 (23.3-39.3)	47.2 (41.3-53.1)	37.6 (32.3-42.8)	39.6 (33.7-45.5)
40-59	38.2 (33.8-42.6)	35.7 (29.7-41.7)	51.7 (47.2-56.1)	46.6 (37.3-55.9)	48.9 (38.0-59.6)
≥60	33.6 (30.2-36.9)	31.4 (27.3-35.5)	50.5 (40.5-60.5)	46.7 (41.0-52.3)	48.1 (43.0-53.3)
BMI ≥25					
All, age, y					
≥20	68.3 (66.6-70.0)	67.5 (65.0-70.1)	73.7 (71.2-76.2)	76.9 (72.9-80.8)	77.5 (73.4-81.6)
≥20 ^d	68.0 (66.3-69.8)	66.7 (64.1-69.3)	73.8 (71.3-76.3)	77.9 (74.5-81.4)	78.8 (75.2-82.4)
Men, age, y					
≥20 ^d	72.3 (70.4-74.1)	72.6 (69.9-75.3)	68.5 (65.2-71.8)	79.3 (74.7-83.9)	80.0 (75.5-84.5)
20-39	63.5 (60.8-66.2)	62.6 (58.0-67.2)	61.5 (54.6-68.5)	74.2 (66.8-81.5)	75.0 (67.4-82.7)
40-59	77.8 (74.0-81.7)	77.7 (72.8-82.6)	73.5 (65.9-81.2)	87.2 (81.4-93.0)	88.0 (80.8-95.1)
≥60	78.4 (74.8-81.9)	81.4 (77.9-84.9)	72.5 (65.2-79.8)	75.4 (70.2-80.7)	75.8 (68.4-83.1)
Women, age, y					
≥20 ^d	64.1 (61.3-66.9)	61.2 (56.7-65.7)	78.2 (74.5-81.9)	76.1 (72.0-80.1)	76.9 (71.8-81.9)
20-39	59.5 (54.5-64.5)	54.9 (46.3-63.6)	76.0 (71.8-80.2)	68.5 (61.4-75.7)	70.3 (62.7-77.9)
40-59	66.3 (63.3-69.3)	63.8 (59.8-67.8)	78.4 (74.1-82.6)	81.2 (77.3-85.1)	80.3 (73.6-87.0)
≥60	68.6 (64.4-72.7)	67.6 (62.2-73.1)	78.2 (70.7-85.8)	80.7 (77.3-84.1)	82.6 (77.2-88.0)

Abbreviation: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared).

^aBased on data from the National Health and Nutrition Examination Survey (NHANES) 2007-2008.

^bIncludes racial and ethnic groups not shown separately.

^cIncludes Mexican Americans.

^dAge adjusted by the direct method to the year 2000 Census population using the age groups 20-39 years, 40-59 years, and 60 years or older.

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Flegal, K. M. et al. JAMA 2010;303:235-241.



Development of Obesity

- Energy imbalance :
energy intake >>> energy expenditure
↓
adipocyte number and size ↑
- Diet (intake) and exercise (expenditure) are the most common behavior targets for prevention and treatment of obesity.
- Body weight regulation involves complex interactions among genetic, environmental, and psychosocial factors.

Alcohol Consumption as a Potential Risk Factor for Obesity Development

- In 2002, 55% US adults are current alcohol drinkers, 45% of US adults do not drink any alcohol.
- Caloric value of usual energy sources:
 - Carbohydrates: 1 gram = 4 calories
 - Protein: 1 gram = 4 calories
 - Fat: 1 gram = 9 calories
 - Alcohol: 1 gram = 7.1 calories*
- Alcohol consumption potentially lead to a positive energy balance by adding energy intake.

How alcohol consumption was related to body weight in previous epidemiologic studies?

Alcohol Consumption and Body Weight: Cross-sectional Studies

Study Subjects	Main Findings	Alcohol Intake Amount	Body Weight Evaluation	Study Sample
Men	Positive	up to ≥ 10 drks/w	BMI $> 30 \text{ kg/m}^2$	<i>Finnish Population surveys</i>
		up to ≥ 40 ml/d	BMI	<i>LRC Prevalence Study</i>
		mean of 7 g/day	BMI	<i>Zutphen Study</i>
		up to ≥ 35 drks/w	BMI, WHR	<i>British Regional Heart Study</i>
	Null	up to ≥ 14 drks/w	body weight	<i>Behavior Risk Factor Survey</i>
		up to ≥ 24 g/day	BMI	<i>NHANES I</i>
		up to ≥ 14 drks/w	body weight	<i>NHANES II</i>
Women	Inverse	up to ≥ 40 ml/d	BMI	<i>LRC Prevalence Study</i>
		up to ≥ 14 drks/w	body weight	<i>Behavior Risk Factor Survey</i>
		up to ≥ 24 g/day	BMI	<i>NHANES I</i>
		up to 7-13 drks/w	body weight	<i>NHANES II</i>
		up to 50 g/day	BMI	<i>Nurses' Health Study I</i>
	Null	- -	body weight	<i>Healthy Worker Project</i>
		up to ≥ 10 drks/w	BMI $> 30 \text{ kg/m}^2$	<i>Finnish Population surveys</i>

Alcohol Consumption and Body Weight Change: Prospective Studies

Study Subjects	Main Findings	Alcohol Intake Amount	Body Weight Change	Study Sample
Men	Positive	≥ 30 g/day	wt. gain $\geq 4\%$	<i>British Regional Heart Study</i>
		heavy drinking	wt. gain ≥ 5 kg	<i>Finnish National Survey</i>
		yes vs. no	wt. gain ≥ 5 kg	<i>China Health and Nutrition Survey</i>
	Null	% energy	weight change	<i>Pound of Prevention</i>
		up to ≥ 2 drk/d	wt. gain ≥ 10 kg	<i>NHANS I Follow-up</i>
Women	Inverse	- -	weight change	<i>Healthy Worker Project</i>
		1-6.9 drk/d	wt. gain ≥ 10 kg	<i>NHANS I Follow-up</i>
		up to 15 g/day	weight change	<i>Nurses' Health Study I</i>
		up to 30 g/day	wt. gain ≥ 5 kg	<i>Nurses' Health Study II</i>
	Null	% energy	weight change	<i>Pound of Prevention</i>
		yes vs. no	wt. gain ≥ 5 kg	<i>China Health and Nutrition Survey</i>
		≥ 30 g/day	wt. gain ≥ 5 kg	<i>Nurses' Health Study II</i>
	Positive	- -	weight change	<i>Healthy Worker Project</i>
		heavy drinking	wt. gain ≥ 5 kg	<i>Finnish National Survey</i>

What have we examined in our study?

We prospectively examined the association between baseline alcohol consumption and the risk of becoming overweight or obese among middle-aged and older women who initially had normal body weight (body mass index 18.5-<25 kg/m²) and were free from cardiovascular disease and cancer.

Study Population

- The Women's Health Study (WHS): a randomized clinical trial of female US health professionals aged ≥45 years (N=39,876)
- WHS participants who had a normal body weight (BMI 18.5-<25 kg/m²) at baseline
- Exclusions:
 - Missing data on baseline alcohol intake
 - Missing BMI at baseline or at all follow-up points
 - Pre-randomization cardiovascular disease or cancer
 - Baseline diabetes
- A baseline population of 19,220 women remained for our analyses.

Assessment of Alcohol Consumption

- Average consumption of alcoholic beverages in the preceding year reported on enrollment questionnaires
- A total of 9 responses were reported for beer, red wine, white wine, and liquor.
- Total alcohol intake was calculated as the sum of beverage-specific ethanol content, assuming:
 - 13.2 g ethanol per 360 ml (12 ounces) of beer
 - 10.8 g ethanol per 120 ml (4 ounces) of wine
 - 15.1 g ethanol per 45 ml (1.5 ounces) of liquor
- Total alcohol intake was divided into 5 predetermined categories: 0, >0-<5, 5-<15, 15-<30, ≥30 g/day.

Number of Women (%) according to Intake Frequency of Each Alcoholic Beverage at Baseline of the Women's Health Study

Intake Frequency	Beer	Red wine	White wine	Liquor
Rarely/Never	14534 (77.7)	13951 (75.2)	10043 (53.6)	13307 (70.9)
1-3 drinks/month	2284 (12.2)	2682 (14.5)	4427 (23.6)	2789 (14.9)
1 drink/week	664 (3.55)	623 (3.36)	1217 (6.49)	735 (3.92)
2-4 drinks/week	729 (3.89)	837 (4.51)	1786 (9.53)	1035 (5.51)
5-6 drinks/week	212 (1.13)	181 (0.98)	468 (2.50)	288 (1.53)
1 drink/day	141 (0.75)	192 (1.03)	463 (2.47)	359 (1.91)
2-3 drink/day	133 (0.71)	92 (0.50)	318 (1.70)	244 (1.30)
4-5 drinks/day	16 (0.09)	4 (0.02)	18 (0.10)	14 (0.07)
6+ drinks/day	4 (0.02)	1 (0.01)	4 (0.02)	2 (0.01)

Assessment of Body Weight

- Height and weight were self-reported on baseline questionnaire.
- Self-reported body weight was updated on follow-up questionnaires.
- Body mass index (kg/m^2) was calculated at baseline and each follow-up time point (total $n=8$).
- Body weight status was classified using WHO category.

WHO Category	Body Mass Index
Normal weight	18.5 - $<25 \text{ kg/m}^2$
Overweight	25 - $<30 \text{ kg/m}^2$
Obese	$\geq 30 \text{ kg/m}^2$

Definition of Incident Overweight/Obesity

- Among 19,220 women with normal body weight at baseline, 7,942 became overweight or obese at any time point during 12.9-y follow-up.
- Follow-up time was calculated as the time leading to 'the date of event':
 - For each case, the estimated time when her BMI crossed the cutoff
 - For non-cases, the latest date when a BMI of $<25 \text{ kg/m}^2$ was reported
- Women who developed intermediate diabetes were censored on the date of diabetes diagnosis.

Number of Women (%) by Body Weight Status at Baseline and during Follow-up of the Women's Health Study

Baseline	Follow-up			
	Normal weight	Overweight	Obese	Total
Normal weight	11644	7210	732	19220
Overweight	251	6637	4769	11657
Obese	8	173	6376	7126
	12673	14196	12639	

Other Baseline Variables

- Demographic factors:
 - age, race
- Lifestyle factors:
 - smoking, physical activity, menopausal status, postmenopausal hormone use, and multivitamin use
- Clinical factors:
 - history of hypertension and hypercholesterolemia
- Dietary factors:
 - total energy intake, intake of fruits and vegetables, grains, meats, dairy products, and fat, protein, carbohydrates, and fiber intake

Baseline Characteristics of 19,220 Women With a BMI of 18.5 to Less Than 25 kg/m²

Table 1. Baseline Characteristics of 19 220 Women With a BMI of 18.5 to Less Than 25^a

	Total Alcohol Intake, g/d					P Value ^b
	0	>0 to <5	5 to <15	15 to <30	≥30	
Median alcohol intake, g/d	0	1.73	8.64	19.4	38.6	...
No. (%) of participants	7346 (38.2)	6312 (32.8)	3865 (20.1)	1129 (5.9)	568 (3.0)	...
Demographic characteristics						
Age, y	54.9 (7.4)	53.8 (6.7)	54.1 (6.9)	55.6 (7.4)	56.6 (7.4)	<.001
White race	92.9	96.6	98.0	98.1	98.8	<.001
Baseline BMI	22.5 (1.6)	22.5 (1.6)	22.3 (1.6)	22.3 (1.6)	22.3 (1.6)	<.001
Energy intake and expenditure						
Total energy intake, kcal/d	1670 (528)	1710 (513)	1723 (499)	1738 (499)	1786 (521)	<.001
Nonalcohol energy intake, kcal/d	1670 (528)	1696 (513)	1659 (499)	1589 (501)	1493 (519)	<.001
Physical activity, kcal/wk	920 (1143)	1065 (1183)	1162 (1269)	1101 (1244)	930 (1290)	<.001
Behavior						
Current smoker	13.8	12.0	13.7	16.5	33.1	<.001
Postmenopausal	56.6	50.3	52.0	56.8	65.9	<.001
Current postmenopausal hormone use	43.0	44.7	44.0	48.1	42.0	.01
Current multivitamin use	31.1	31.4	29.8	30.8	31.0	.53
Clinical						
History of hypercholesterolemia	27.4	23.5	22.5	25.5	28.5	<.001
History of hypertension	16.5	14.5	15.1	20.4	24.8	<.001
Food intake, servings per day						
Fruit and vegetables	6.1 (4.1)	6.2 (3.3)	6.3 (3.1)	6.3 (3.2)	5.8 (3.3)	.96
Whole grains	1.5 (1.3)	1.4 (1.2)	1.4 (1.2)	1.3 (1.1)	1.2 (1.3)	<.001
Refined grains	2.2 (1.5)	2.2 (1.4)	2.1 (1.4)	2.0 (1.3)	1.8 (1.3)	<.001
Red meats and poultry	1.1 (0.7)	1.1 (0.6)	1.1 (0.6)	1.1 (0.6)	1.2 (0.7)	<.001
Low-fat dairy products	1.2 (1.1)	1.3 (1.1)	1.2 (1.0)	1.0 (0.9)	0.9 (0.9)	<.001
High-fat dairy products	0.7 (0.9)	0.7 (0.9)	0.8 (0.9)	0.8 (1.0)	0.8 (1.1)	<.001
Nutrient intake, g/d ^c						
Total fat	56.7 (12.4)	56.5 (11.4)	55.6 (11.1)	55.5 (11.0)	54.6 (12.1)	<.001
Saturated fat	19.3 (5.2)	19.2 (4.7)	18.8 (4.6)	18.7 (4.6)	18.5 (5.2)	<.001
Monounsaturated fat	21.1 (5.3)	21.0 (4.9)	20.8 (4.8)	20.8 (4.7)	20.6 (5.2)	.002
Polysaturated fat	11.0 (2.9)	11.0 (2.8)	10.8 (2.7)	10.8 (2.9)	10.4 (2.9)	<.001
Carbohydrates	226 (80)	226 (76)	217 (74)	204 (71)	193 (70)	<.001
Protein	77.1 (27.1)	79.8 (25.5)	79.5 (24.7)	78.4 (24.5)	76.6 (25.6)	.97
Fiber	19.2 (8.8)	19.2 (7.9)	19.0 (7.9)	18.3 (7.5)	16.8 (7.3)	<.001

Abbreviations: BMI, body mass index (calculated as the weight in kilograms divided by height in meters squared); ellipses, not applicable.

^aData are given as mean (SD) for continuous variables and percentage for categorical variables unless otherwise indicated.

^bP for trend test was used for continuous variables and χ^2 for categorical variables.

^cEnergy was adjusted using the residual method.

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Wang, L. et al. Arch Intern Med 2010;170:453-461.

Adjusted Mean Body Weight Change (in Kilograms) During 12.9-Year Follow-up According to Baseline Total Alcohol Intake

Table 2. Adjusted Mean Body Weight Change (in Kilograms) During 12.9-Year Follow-up According to Baseline Total Alcohol Intake

Follow-up Duration	No. (%) of Participants	Total Alcohol Intake, g/d ^a				
		0	>0 to <5	5 to <15	15 to <30	≥30
2 y						
Age adjusted	18 998 (98.8)	1.49	1.39	1.22	1.11	0.77
Multivariate adjusted ^b	17 955 (93.4)	1.55	1.41	1.14	0.89	0.51
3 y						
Age adjusted	18 096 (94.2)	1.97	1.79	1.64	1.46	1.26
Multivariate adjusted ^b	17 118 (89.1)	2.05	1.81	1.53	1.22	0.95
5 y						
Age adjusted	18 065 (94.0)	2.68	2.61	2.26	2.11	1.61
Multivariate adjusted ^b	17 105 (89.0)	2.77	2.65	2.16	1.78	1.16
6 y						
Age adjusted	17 775 (92.5)	2.99	2.88	2.54	2.38	1.93
Multivariate adjusted ^b	16 820 (87.5)	3.10	2.92	2.42	2.11	1.47
9 y						
Age adjusted	15 341 (79.8)	3.44	3.35	2.94	2.74	2.11
Multivariate adjusted ^b	14 576 (75.8)	3.52	3.40	2.83	2.50	1.57
11 y						
Age adjusted	16 322 (84.9)	3.47	3.39	2.91	2.65	2.31
Multivariate adjusted ^b	15 481 (80.5)	3.55	3.46	2.81	2.40	1.83
12 y						
Age adjusted	15 992 (83.2)	3.57	3.48	2.97	2.63	2.41
Multivariate adjusted ^b	15 178 (79.0)	3.67	3.53	2.86	2.37	2.02
13 y						
Age adjusted	15 634 (81.3)	3.53	3.50	3.05	2.87	2.09
Multivariate adjusted ^b	14 849 (77.3)	3.63	3.56	2.95	2.56	1.55

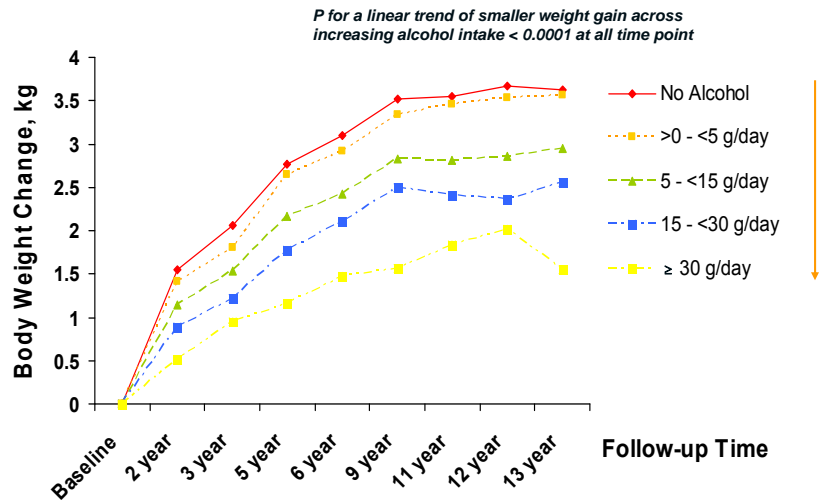
^aLinear trends were tested using the median value of each alcohol intake category as an ordinal variable. All were $P < .001$.

^bMultivariate model was additionally adjusted for race (white or nonwhite), baseline weight (continuous), randomized treatment (vitamin E, aspirin, beta carotene, or placebo), total nonalcohol energy intake (continuous), physical activity level (<200, 200 to <600, 600 to <1500, and ≥1500 kcal/wk), smoking status (never, former, or current), postmenopausal status (yes, no, or uncertain), postmenopausal hormone use (never, former, or current), multivitamin use (never, former, or current), history of hypercholesterolemia (yes or no) and hypertension (yes or no), and intake of fruit and vegetables, whole grains, refined grains, red meats and poultry, low-fat dairy products, high-fat dairy products, energy-adjusted total fat, carbohydrates, and fiber (all in quintiles).

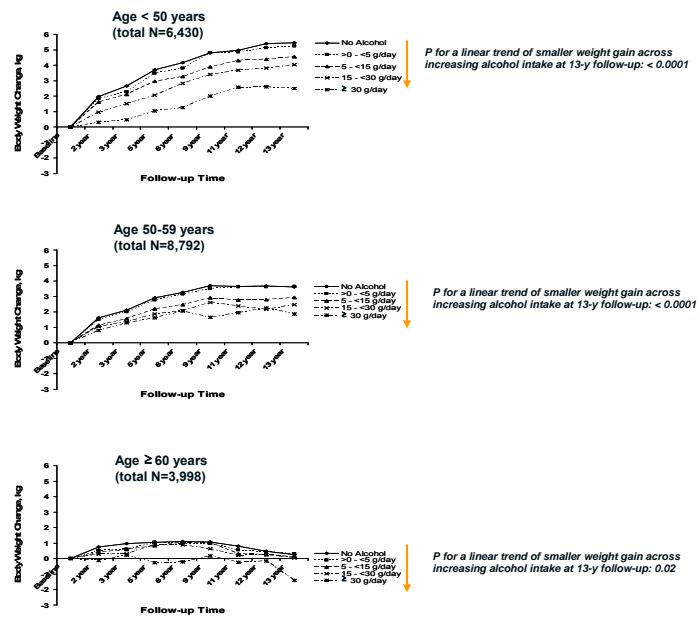
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Wang, L. et al. Arch Intern Med 2010;170:453-461.

Multivariate Adjusted Mean Body Weight Change (in kg) according to Baseline Alcohol Intake



Multivariate Adjusted Mean Body Weight Change (in kg) according to Baseline Alcohol Intake, Stratified by Baseline Age



Relative Risks (RRs) and 95% Confidence Intervals (CIs) of Becoming Overweight and/or Obese Across Baseline Total Alcohol Intake

Table 3. Relative Risks (RRs) and 95% Confidence Intervals (CIs) of Becoming Overweight and/or Obese Across Alcohol Intake

	Total No. (%) of Participants	No. (%) of Participants	Incident Overweight or Obesity, BMI ≥ 25		Incident Obesity, BMI ≥ 30	
			RR (95% CI)		RR (95% CI)	
			Age-Adjusted	Multivariate-Adjusted ^a	Age-Adjusted	Multivariate-Adjusted ^a
All alcohol intake, g/d						
0	7346 (38.2)	3150 (39.7)	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
>0 to <5	6312 (32.8)	2721 (34.3)	0.96 (0.91-1.01)	0.96 (0.91-1.01)	0.79 (0.67-0.93)	0.75 (0.63-0.89)
5 to <15	3865 (20.1)	1500 (18.9)	0.84 (0.79-0.89)	0.86 (0.80-0.92)	0.55 (0.44-0.68)	0.43 (0.34-0.56)
15 to <30	1129 (5.9)	376 (4.7)	0.73 (0.65-0.81)	0.70 (0.62-0.79)	0.55 (0.38-0.81)	0.39 (0.25-0.60)
≥ 30	568 (3.0)	195 (2.5)	0.78 (0.67-0.90)	0.73 (0.62-0.85)	0.66 (0.52-0.85)	0.29 (0.15-0.54)
P value, linear ^b	...	...	<.001	<.001	<.001	<.001
P value, curvilinear ^c	...	...	<.001	<.001	<.001	<.001
Beer						
Rarely/never	14 638 (77.7)	6143 (78.7)	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
1-4 drinks per mo	2969 (15.8)	1184 (15.2)	0.94 (0.87-1.00)	0.93 (0.87-1.00)	0.77 (0.60-0.97)	0.74 (0.57-0.95)
2-5 drinks per wk	941 (5.0)	362 (4.6)	0.89 (0.79-0.99)	0.86 (0.76-0.97)	0.79 (0.54-1.17)	0.65 (0.42-0.99)
≥ 1 drink per d	298 (1.6)	119 (1.5)	0.92 (0.75-1.12)	0.76 (0.62-0.94)	1.11 (0.63-1.97)	0.63 (0.34-1.18)
P value, linear ^b	...	...	.04	<.001	.37	.02
P value, curvilinear ^c	...	...	.02	.04	.03	.007
Red wine						
Rarely/never	14 043 (75.1)	5980 (77.3)	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
1-4 drinks per mo	3528 (17.8)	1304 (16.8)	0.90 (0.84-0.96)	0.95 (0.89-1.02)	0.70 (0.55-0.89)	0.75 (0.59-0.97)
2-5 drinks per wk	1026 (5.5)	369 (4.8)	0.83 (0.74-0.93)	0.89 (0.79-1.00)	0.66 (0.43-1.01)	0.63 (0.40-0.96)
≥ 1 drink per d	292 (1.6)	88 (1.1)	0.65 (0.51-0.82)	0.66 (0.52-0.84)	0.52 (0.22-1.26)	0.47 (0.19-1.14)
P value, linear ^b	...	...	<.001	<.001	.002	.004
P value, curvilinear ^c	...	...	.04	.07	.14	.25
White wine						
Rarely/never	10 117 (53.6)	4315 (55.4)	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
1-4 drinks per mo	5678 (30.1)	2364 (30.3)	0.96 (0.91-1.01)	1.00 (0.94-1.06)	0.92 (0.77-1.11)	0.93 (0.77-1.13)
2-5 drinks per wk	2269 (12.0)	845 (10.8)	0.85 (0.78-0.92)	0.91 (0.84-0.99)	0.74 (0.56-0.99)	0.71 (0.52-0.96)
≥ 1 drink per d	807 (4.3)	268 (3.4)	0.76 (0.67-0.87)	0.88 (0.77-1.02)	0.58 (0.35-0.95)	0.41 (0.22-0.74)
P value, linear ^b	...	...	<.001	.03	.002	<.001
P value, curvilinear ^c	...	...	...	.002	.15	.09
Liquor						
Rarely/never	13 409 (70.9)	5559 (71.1)	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
1-4 drinks per mo	3542 (18.7)	1545 (19.8)	1.12 (1.05-1.19)	1.01 (0.95-1.07)	1.17 (0.96-1.43)	1.04 (0.84-1.28)
2-5 drinks per wk	1330 (7.0)	518 (6.6)	1.03 (0.94-1.14)	0.95 (0.86-1.06)	0.90 (0.63-1.28)	0.73 (0.50-1.06)
≥ 1 drink per d	620 (3.3)	198 (2.5)	0.88 (0.76-1.03)	0.76 (0.65-0.90)	0.66 (0.34-1.28)	0.38 (0.17-0.81)
P value, linear ^b	...	...	.87	.008	.26	.005
P value, curvilinear ^c	...	...	.96	.04	.66	.87

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); ellipses, not applicable.

^a Multivariate model was additionally adjusted for race (white or nonwhite), baseline BMI (continuous), randomized treatment (vitamin E, aspirin, beta carotene, or placebo), total nonalcohol energy intake (continuous), physical activity level (<200 , 200 to <600 , 600 to <1500 , and ≥ 1500 kcal/wk), smoking status (never, former, or current), postmenopausal status (yes, no, or uncertain), postmenopausal hormone use (never, former, or current), multivitamin use (never, former, or current), history of hypercholesterolemia (yes or no) and hypertension (yes or no), intake of fruit and vegetables, whole grains, refined grains, red meats and poultry, low-fat dairy products, high-fat dairy products, energy-adjusted total fat, carbohydrates, and fiber (all in quintiles).

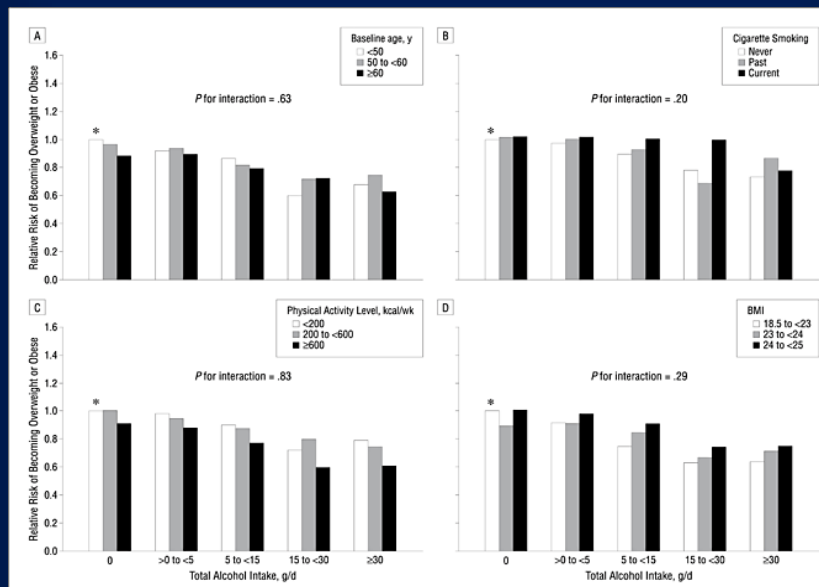
^b Linear trends were tested using the median value of each alcohol intake category as an ordinal variable.

^c Curvilinear trends were tested by including the quadratic term of continuous alcohol intake in the model.

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Wang, L. et al. Arch Intern Med 2010;170:453-461.

Relative risks of becoming overweight or obese according to baseline alcohol intake in subgroups of women



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Wang, L. et al. Arch Intern Med 2010;170:453-461.

What are the underlying mechanisms for the inverse relation between alcohol consumption and body weight change?

Potential Confounding by Lifestyle and Dietary Pattern

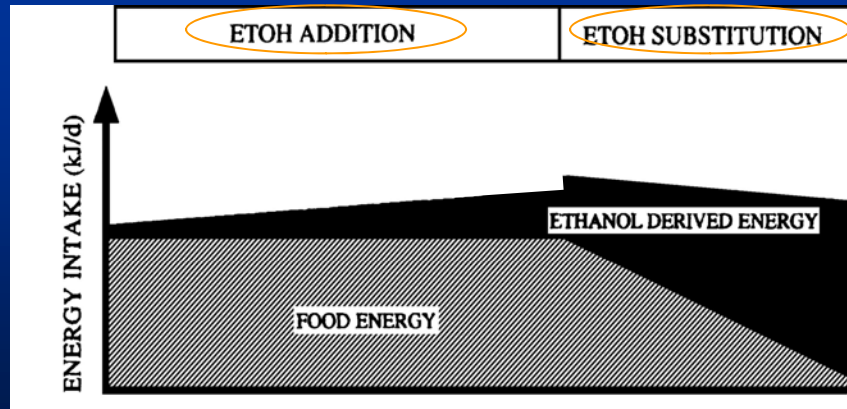
- Multivariate adjustment included an extensive set of demographic, behavioral, clinical, and dietary factors.

Dietary and Lifestyle Factors according to categories of total alcohol intake

	Total Alcohol Intake (g/day)					P _{trend}
	0	>0-<5	5-<15	15-<30	≥30	
N	7289	6269	3845	1120	567	
Behavior						
Physical activity (kcal/wk)	920	1065	1162	1101	930	0.0007
Current smoking (%)	13.8	12.0	13.7	16.5	33.1	< 0.0001
Foods Intake						
Fruits and vegetables (sv/d)	6.1	6.2	6.3	6.3	5.8	0.96
Whole grains (sv/d)	1.5	1.4	1.4	1.3	1.2	< 0.0001
Refined grains (sv/d)	2.2	2.2	2.1	2.0	1.8	< 0.0001
Red meats and poultry (sv/d)	1.1	1.1	1.1	1.1	1.2	0.0002
Low-Fat dairy products (sv/d)	1.2	1.3	1.2	1.0	0.9	< 0.0001
High-Fat dairy products (sv/d)	0.7	0.7	0.8	0.8	0.8	< 0.0001

Impact of Alcohol Consumption on Energy Intake

addition of energy vs. substitution of energy



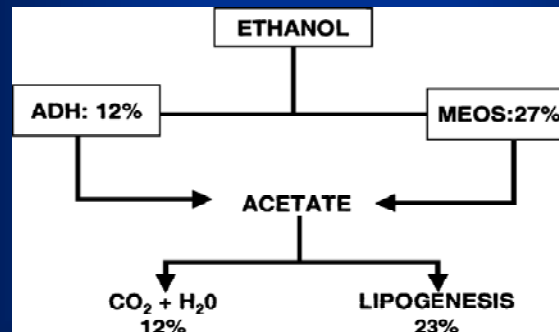
Suter, PM. Nutr Reviews 1997;55:157-171.

Total energy intake and intake from usual energy sources according
to categories of alcohol intake, the Women's Health Study

	Total Alcohol Intake (g/day)					P_{trend}
	0	>0-<5	5-<15	15-<30	≥ 30	
N	7289	6269	3845	1120	567	
Energy intake						
Total (kcal/d)	1670	1710	1723	1738	1788	< 0.0001
Nonalcoholic (kcal/d)	1670	1696	1659	1589	1493	< 0.0001
Energy sources						
Total fat (g/d)	56.7	56.5	55.6	55.5	54.6	< 0.0001
Carbohydrates (g/d)	226	226	217	204	193	< 0.0001
Protein (g/d)	77.1	79.8	79.5	78.4	76.6	0.97

Impact of Alcohol Consumption on Energy Expenditure

Thermic response of alcohol degradation through the alcohol dehydrogenase (ADH) vs. hepatic microsomal ethanol oxidating system (MEOS) pathways



Suter, PM. Crit Rev Clin Lab Sci. 2005;42(3):197-227.

Thermic effect of usual energy sources:
fat: 3%, carbohydrates: 8%, mixed meal: 12%

Effect of alcohol on other nutrients digestion, absorption, and metabolism

- Change appetite and perception of satiety.
- Decrease secretion of digestive enzymes and then inhibit the breakdown of nutrients into small molecules for absorption.
- Impair the cells lining the stomach and then the absorption and the transport of nutrients from intestines into blood.
- Enhance lipid oxidation and counteract fat accumulation.

Potential Modifier of Alcohol Effects

- Gender
- Absolute amount of alcohol consumption
- Frequency of drinking
- Alcoholic beverage type
- Concomitant food intake
- Baseline body weight status
- Physical activity
- Medical condition
- Genetic background

Key Specifics of Our Study for Clinical Implications

- Middle-aged and older women
- Generally healthy population
- Normal body weight at baseline
- Light-to-moderate alcohol consumption, up to 2 sv/day
360 ml (12 oz.) beer
Or 150 ml (5 oz.) wine
Or 45 ml (1.5 oz.) liquor
- Only 3% (n=568) reported heavy alcohol intake.

Current AHA Recommendation on Alcohol and Cardiovascular Disease

- Excessive alcohol drinking is harmful (↑ risk of hypertension, diabetes, stroke, cardiac arrhythmia, heart failure.)
- If you drink, do so in moderation (an average of 1-2 /days for men and 1/day for women).
- No direct evidence from trials to determine the specific effect of wine or other alcohol on risk of cardiovascular disease.
- AHA does not recommend drinking alcohol to gain potential benefits.

US Department of Agriculture Recommendation on Alcoholic Beverages

- Consumption of alcohol can be harmful or beneficial depending on the characteristics of the person and specifics of the situation.
- Individuals susceptible to the harmful effects of alcohol should not drink at all.
- Alcohol may have beneficial effect when consumed in moderation (up to 1 /day for women, 2 /day for men).
- It is NOT recommended that anyone begin drinking or drinking more frequently on the basis of health consideration.

Take-Home Message

- Middle-aged and older women who were generally healthy, have normal body weight initially, and already have a habit of drinking light-to-moderate amount of alcohol could keep their drinking habits without gaining more weight compared with similar women who did not drink any alcohol.
- The mechanisms by which alcohol may mitigate long-term weight gain have yet to be further investigated.
- Alcohol consumption must be carefully considered in the context of its potential adverse effects.
- For the purpose of weight control, never forget healthy eating and exercise.

Future Research Direction

- The relation between alcohol consumption and body weight change in other ethnic or socioeconomic populations and in men
- The specific mechanisms through which alcohol affect long-term weight gain
- Any behavioral, physiological, or genetic factors that may modify the effect of alcohol consumption on body weight

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Thank You