

Drinking and Obesity

BACKGROUND

Obesity in Context

The World Health Organization (WHO) defines obesity as an abnormal accumulation of body fat that may have a negative impact on one's health [1]. The combination of excessive energy intake, lack of physical activity, and genetic disposition are believed to be the main drivers of obesity.

- Body mass index (BMI), which is calculated by dividing an individual's weight (in kilograms) by his/her height (in meters) squared, is generally used to measure body fat.
- WHO classifies a person with a BMI greater than 25 as overweight and a BMI greater than 30 as obese [1].

Obesity is a major risk factor for numerous noncommunicable diseases (NCDs), including:

- cardiovascular diseases;
- type 2 diabetes;
- musculoskeletal disorders; and
- some cancers [1-3].

In 2010, an estimated 3.4 million deaths and 93.6 million disability-adjusted life years (DALYs)¹ were attributed to being overweight or obese [4-6]. The worldwide prevalence of obesity increased 28% for adults and 47% for children between 1980 and 2013 [5].

Alcohol as a modifier of body weight

A number of factors have been implicated in the development of adult obesity, one of which is the consumption of alcohol [2].

Compared to other substrates metabolized by the body, ethanol has a relatively high energy content. Pure ethanol has an energy density of 7.1 kcal/g, while that of lipids (fat) is 9 kcal/g; proteins and carbohydrates have an energy density of 4 kcal/g [7].

Thus, excessive consumption of ethanol may result in a positive energy balance, which may, over time, result in being overweight or obese [7].

The current evidence surrounding alcohol as a potential modifier of body weight will be summarized in this health review.

1. DALYs are a measure of years of healthy life lost. They are calculated by summing the years of life lost (YLL) due to premature mortality and the years lost due to disability (YLD) for individuals living with a health condition.

SUMMARY OF THE LITERATURE

Mechanisms of action

To date, research on the relationship between alcohol consumption and obesity has produced inconsistent findings [7-10]. This may be explained, in part, by the myriad of factors that modify the nature of the relationship between alcohol consumption and the development of obesity.

Alcohol consumption has been shown to have differing associations for men and women with respect to both general obesity [11-23] and abdominal obesity [24-26]².

- Numerous studies have reported divergent results for men and women [11, 12, 14-18, 20, 25-31]. For example, one study found no significant relationship between alcohol consumption and BMI or hip circumference among men, but did find positive associations between consumption and waist circumference and waist-hip ratio. Among women, the same study found negative associations between alcohol consumption and BMI, hip circumference, and waist circumference, but a positive association between alcohol consumption and waist-hip ratio [16].

Evidence that certain personality traits, such as impulsivity and sensation-seeking, are associated with both harmful eating behaviors and potentially harmful drinking patterns further supports the notion that both harmful activities involve the same neural pathways [32-40].

Eating behaviors may also modify the relationship between alcohol consumption and obesity. Research has revealed a co-occurrence of alcohol consumption and disordered eating and/or exercise patterns in certain individuals.

- Much of this research has examined college-age women and has found that many young women are likely to limit food intake prior to alcohol consumption, engage in extreme physical activity, or purge following heavy-drinking episodes [41-44].

Increased energy intake from alcohol

Research suggests that some of the same neural pathways in the brain are involved in physiological responses to both alcohol consumption and food intake.

- Release of the neurotransmitter dopamine, a component of the brain's reward system, is stimulated by alcohol intake [45, 46] and also plays a role in the rewarding properties of eating and overeating [47].
- Alcohol acts on the opioid neurotransmitter system, which is also implicated in the regulation of the sensory reward components of eating [48, 49].
- Finally, alcohol binds to a subtype of gamma-aminobutyric acid (GABA) receptor that has been implicated both in the motivation to drink alcohol [50] and in the control of food intake in animal models [49, 51-53].

Studies have shown that overall energy intake is often increased following consumption of alcohol [54]. Although multiple explanations for this have been offered, the empirical evidence is inconsistent.

- Some researchers have hypothesized that alcohol influences taste or stimulates appetite and increases hunger, referred to as the "appetizer effect," yet there is no clear evidence to support this hypothesis [48, 55-58].
- Alternatively, it has been suggested that alcohol may increase energy intake by interfering with mechanisms of satiety, or "fullness." However, studies have failed to find evidence of a direct effect of alcohol consumption on satiety [59-64].
- Another possibility is that the frequent pairing of alcohol and food may lead to a linkage between alcohol and food consumption through associative condition and expectancy effects [57]³.
- Still another interpretation suggests that alcohol may inhibit cognitive controls over eating, leading to increased food intake among restrained eaters in particular [65], but evidence in support of this theory is mixed [66-68].

2. General obesity is typically measured by body mass index (BMI). Abdominal obesity addresses the distribution of fat, using measures such as waist circumference, hip circumference, and waist-to-hip ratio.

3. Individuals can unconsciously affect expected outcomes. If, for example, a person believes alcohol increases his appetite, this expectation may cause him to feel hungry after consuming alcohol.

Drinking patterns and obesity

Research on alcohol consumption and obesity also suggests that variation in drinking patterns, and not simply levels of consumption, may play an important role in alcohol's association with obesity.

While many studies have evaluated the effects of varying levels of consumption, far fewer studies have examined drinking patterns in greater detail. There is, however, some evidence that the relationship between alcohol consumption and obesity may differ depending on the frequency and intensity of consumption.

There is limited evidence suggesting that drinking frequency is inversely correlated with general and abdominal obesity [28, 31, 69, 70].

- For example, one study found individuals consuming 1-2 drinks per week had a higher risk of obesity (odds ratio of 1.8) than those consuming 3-5 drinks per week (odds ratio of 1.6) [69].
- Another study compared obesity among individuals who drank daily, weekly, less than weekly, or abstained entirely, and found daily drinkers had the smallest measures of abdominal obesity, followed by weekly drinkers [28].

Whereas more frequent alcohol consumption may protect against the development of obesity, the available evidence suggests the opposite may be true for drinking intensity.

- Studies have found the number of drinks per drinking day to be positively associated with abdominal obesity [28, 71]. While there is an association, this relationship may be due to underlying personality factors such as impulsivity, which has been linked to obesity, binge eating, and binge drinking [72].

Does type of alcoholic beverage matter?

Although it has been suggested that the type of beverage consumed may also modify the relationship between alcohol consumption and development of obesity, the results are inconsistent.

- Some studies have shown differences across beverage categories [14, 18, 24, 25, 28, 30, 73-82], while others have failed to show a difference [16, 77, 83-85].

A 2012 systematic review and meta-analysis of beer consumption and obesity studies found that higher levels of consumption tend to be associated with greater abdominal obesity in men, with inconsistent results for women. No association was found for general or abdominal obesity at lower levels of consumption for either men or women [9]. However, in the absence of comparable systematic reviews for the other beverage categories, it is difficult to draw meaningful conclusions from this work regarding the influence of beverage type on obesity.

It is also important to keep in mind that in some cases the relationships observed between beverage type and obesity may be attributable to additional factors related to both beverage preference and obesity, and not necessarily due to the properties of the particular beverages themselves.

For example:

- In some cultures, studies have found that, compared to other drinkers or abstainers, wine drinkers tend to have higher education levels, socioeconomic status, diet quality, and levels of physical activity [86-92], all of which are factors associated with a lower obesity risk [93-95].
- Associations can, however, vary across cultures. For instance, in Portugal, research indicates that less-educated men tend to consume higher amounts of wine than beer or spirits [96].
- Beverage preference may also be related to differences in drinking frequency and intensity. The nature of these differences can also vary according to the cultural context [97-99].

When interpreting research findings on risk factors and associated health outcomes, a number of methodological issues should be taken into consideration.

METHODICAL CONSIDERATIONS

Measurement of Obesity

There are many techniques for measuring obesity. Most obesity research relies on BMI as an approximation of general obesity, due to its strong correlation with body fat percentage; however, though more difficult to estimate, abdominal obesity is a stronger predictor of obesity-related diseases, especially cardiovascular disease [100, 101].

Underreporting

The underreporting of drinking is a central concern of alcohol-related research. It is well-established that survey respondents often underestimate their alcohol consumption. The magnitude of underreporting varies by respondent, context, and the approach used to measure consumption.

Misclassification of drinkers

Studies suggest that the underreporting of consumption can result in the misclassification of drinkers, especially between the low and moderate consumption categories. This misclassification can make it difficult to establish a clear relationship between low or moderate alcohol intake and disease outcomes. This, in turn, makes it difficult to identify definitive thresholds at which alcohol consumption increases the risk for specific diseases.

CONCLUDING REMARKS

Unhealthy diet and insufficient physical activity contribute to a positive energy balance that is associated with weight gain. Demographic factors such as age, race, ethnicity, and socioeconomic status also play an important role in the development of obesity [102-104].

Additionally, there is a well-documented inverse association between cigarette smoking and body weight. Individuals who smoke cigarettes tend to have lower body weights than those who do not [105, 106].

Further investigation could look into factors that may modify alcohol's association with obesity, such as

- Gender;
- Extreme eating and exercise behaviors; and
- Drinking patterns, including drinking frequency, intensity, and beverage type.

Future research should also take genetic factors into consideration.

- Genetic factors may account for 45% to 75% of BMI variation between individuals and have been shown to play a strong role in the development of obesity-related outcomes [107].

REFERENCES

1. World Health Organization (WHO). (2013). *Obesity and overweight: Fact sheet no. 311*. Retrieved March 18, 2014, from <http://www.who.int/mediacentre/factsheets/fs311/en/>
2. World Health Organization (WHO). (2015). *Global status report on noncommunicable diseases 2014*. Geneva: World Health Organization. Retrieved from http://apps.who.int/iris/bitstream/10665/148114/1/9789241564854_eng.pdf?ua=1
3. Latino-Martel, P., Cottet, V., Druesne-Pecollo, N., Pierre, F. H., Touillaud, M., Touvier, M., et al. (2016). Alcoholic beverages, obesity, physical activity and other nutritional factors, and cancer risk: A review of the evidence. *Crit Rev Oncol Hematol*, 99, 308-323.
4. World Health Organization (WHO). (2011). *Global status report on noncommunicable diseases 2010*. Geneva: World Health Organization (WHO).
5. Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., et al. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet*, 384(9945), 766-781.

6. Lim, S. S., Vos, T., Flaxman, A. D., Danaei, G., Shibuya, K., Adair-Rohani, H., et al. (2012). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: A systematic analysis for the Global Burden of Disease Study 2010. *Lancet*, 380(9859), 2224-2260.
7. Suter, P. M. (2005). Is alcohol consumption a risk factor for weight gain and obesity? *Critical Reviews in Clinical Laboratory Sciences*, 42(3), 197-227.
8. *Alcohol and obesity: A systematic review and scoping study*. (2013). Centre for Alcohol Policy Research, Foundation for Alcohol Research & Education.
9. Bendsen, N. T., Christensen, R., Bartels, E. M., Kok, F. J., Sierksma, A., Raben, A., et al. (2013). Is beer consumption related to measures of abdominal and general obesity? A systematic review and meta-analysis. *Nutrition Reviews*, 71(2), 67-87.
10. Sayon-Orea, C., Martinez-Gonzalez, M. A., & Bes-Rastrollo, M. (2011). Alcohol consumption and body weight: A systematic review. *Nutrition Reviews*, 69(8), 419-431.
11. Alcacera, M. A., Marques-Lopes, I., Fajo-Pascual, M., Puzo, J., Blas Perez, J., Bes-Rastrollo, M., et al. (2008). Lifestyle factors associated with BMI in a Spanish graduate population: The SUN Study. *Obesity Facts*, 1(2), 80-87.
12. Appleby, P. N., Thorogood, M., Mann, J. I., & Key, T. J. (1998). Low body mass index in non-meat eaters: The possible roles of animal fat, dietary fibre and alcohol. *International Journal of Obesity and Related Metabolic Disorders*, 22(5), 454-460.
13. Bobak, M., Skodova, Z., & Marmot, M. (2003). Beer and obesity: A cross-sectional study. *European Journal of Clinical Nutrition*, 57(10), 1250-1253.
14. Burazeri, G., & Kark, J. D. (2010). Alcohol intake and its correlates in a transitional predominantly Muslim population in southeastern Europe. *Addictive Behaviors*, 35(7), 706-713.
15. Colditz, G. A., Giovannucci, E., Rimm, E. B., Stampfer, M. J., Rosner, B., Speizer, F. E., et al. (1991). Alcohol intake in relation to diet and obesity in women and men. *American Journal of Clinical Nutrition*, 54(1), 49-55.
16. Dallongeville, J., Marecaux, N., Ducimetiere, P., Ferrieres, J., Arveiler, D., Bingham, A., et al. (1998). Influence of alcohol consumption and various beverages on waist girth and waist-to-hip ratio in a sample of French men and women. *International Journal of Obesity and Related Metabolic Disorders*, 22(12), 1178-1183.
17. French, M. T., Norton, E. C., Fang, H., & Maclean, J. C. (2010). Alcohol consumption and body weight. *Health Economics*, 19(7), 814-832.
18. Gutierrez-Fisac, J. L., Rodriguez-Artalejo, F., Rodriguez-Blas, C., & del Rey-Calero, J. (1995). Alcohol consumption and obesity in the adult population of Spain. *Journal of Epidemiology and Community Health*, 49(1), 108-109.
19. Hou, X., Jia, W., Bao, Y., Lu, H., Jiang, S., Zuo, Y., et al. (2008). Risk factors for overweight and obesity, and changes in body mass index of Chinese adults in Shanghai. *BioMed Central Public Health*, 8, 389.
20. Rose, D., Murphy, S. P., Hudes, M., & Viteri, F. E. (1995). Food energy remains constant with increasing alcohol intake. *Journal of the American Dietetic Association*, 95(6), 698-700.
21. Shankar, S., Nanda, J. P., Bonney, G., & Kofie, V. (2000). Obesity differences between African-American men and women. *Journal of the National Medical Association*, 92(1), 22-28.
22. Williamson, D. F., Forman, M. R., Binkin, N. J., Gentry, E. M., Remington, P. L., & Trowbridge, F. L. (1987). Alcohol and body weight in United States adults. *American Journal of Public Health*, 77(10), 1324-1330.
23. Liu, S., Serdula, M. K., Williamson, D. F., Mokdad, A. H., & Byers, T. (1994). A prospective study of alcohol intake and change in body weight among US adults. *American Journal of Clinical Nutrition*, 140(10), 912-920.
24. Halkjaer, J., Tjonneland, A., Thomsen, B. L., Overvad, K., & Sorensen, T. I. (2006). Intake of macronutrients as predictors of 5-y changes in waist circumference. *American Journal of Clinical Nutrition*, 84(4), 789-797.
25. Halkjaer, J., Sorensen, T. I., Tjonneland, A., Togo, P., Holst, C., & Heitmann, B. L. (2004). Food and drinking patterns as predictors of 6-year BMI-adjusted changes in waist circumference. *British Journal of Nutrition*, 92(4), 735-748.
26. Duvigneaud, N., Wijndaele, K., Matton, L., Philippaerts, R., Lefevre, J., Thomis, M., et al. (2007). Dietary factors associated with obesity indicators and level of sports participation in Flemish adults: A cross-sectional study. *Nutrition Journal*, 6(26).
27. Schutze, M., Schulz, M., Steffen, A., Bergmann, M. M., Kroke, A., Lissner, L., et al. (2009). Beer consumption and the 'beer belly': Scientific basis or common belief? *European Journal of Clinical Nutrition*, 63(9), 1143-1149.
28. Dorn, J. M., Hovey, K., Muti, P., Freudenheim, J. L., Russell, M., Nochajski, T. H., et al. (2003). Alcohol drinking patterns differentially affect central adiposity as measured by abdominal height in women and men. *The Journal of Nutrition*, 133(8), 2655-2662.
29. Bergmann, M. M., Schutze, M., Steffen, A., Boeing, H., Halkjaer, J., Tjonneland, A., et al. (2011). The association of lifetime alcohol use with measures of abdominal and general adiposity in a large-scale European cohort. *European Journal of Clinical Nutrition*, 65(10), 1079-1087.
30. Lukasiewicz, E., Mennen, L. I., Bertrais, S., Arnault, N., Preziosi, P., Galan, P., et al. (2004). Alcohol intake in relation to body mass index and waist-to-hip ratio: The importance of type of alcoholic beverage. *Public Health Nutrition*, 8(3), 315-320.
31. Tolstrup, J. S., Halkjaer, J., Heitmann, B. L., Tjonneland, A. M., Overvad, K., Sorensen, T. I., et al. (2008). Alcohol drinking frequency in relation to subsequent changes in waist circumference. *American Journal of Clinical Nutrition*, 87(4), 957-963.
32. Wiederman, M. W., & Pryor, T. (1996). Multi-impulsivity among women with bulimia nervosa. *International Journal of Eating Disorders*, 20(4), 359-365.
33. Steiger, H., Lehoux, P. M., & Gauvin, L. (1999). Impulsivity, dietary control and the urge to binge in bulimic syndromes. *International Journal of Eating Disorders*, 26(3), 261-274.
34. Nederkoorn, C., Smulders, F. T., Havermans, R. C., Roefs, A., & Jansen, A. (2006). Impulsivity in obese women. *Appetite*, 47(2), 253-256.
35. Nederkoorn, C., Jansen, E., Mulken, S., & Jansen, A. (2007). Impulsivity predicts treatment outcome in obese children. *Behavioral Research and Therapy*, 45(5), 1071-1075.
36. Nederkoorn, C., Braet, C., Van Eijs, Y., Tanghe, A., & Jansen, A. (2006). Why obese children cannot resist food: The role of impulsivity. *Eating Behaviors*, 7(4), 315-322.
37. Nasser, J. A., Gluck, M. E., & Geliebter, A. (2004). Impulsivity and test meal intake in obese binge eating women. *Appetite*, 43(3), 303-307.
38. Dawe, S., & Loxton, N. J. (2004). The role of impulsivity in the development of substance use and eating disorders. *Neuroscience and Biobehavioral Reviews*, 28(3), 343-351.
39. Cassin, S. E., & von Ranson, K. M. (2005). Personality and eating disorders: A decade in review. *Clinical Psychology Review*, 25(7), 895-916.
40. Balodis, I. M., Potenza, M. N., & Olmstead, M. C. (2009). Binge drinking in undergraduates: Relationships with sex, drinking

- behaviors, impulsivity, and the perceived effects of alcohol. *Behavioural Pharmacology*, 20(5-6), 518-526.
41. Rahal, C. J., Bryant, J. B., Darkes, J., Menzel, J. E., & Thompson, J. K. (2012). Development and validation of the Compensatory Eating and Behaviors in Response to Alcohol Consumption Scale (CEBRACS). *Eating Behaviors*, 13(2), 83-87.
 42. Bryant, J. B., Darkes, J., & Rahal, C. (2012). College students' compensatory eating and behaviors in response to alcohol consumption. *Journal of American College Health*, 60(5), 350-356.
 43. Barry, A. E., & Piazza-Gardner, A. K. (2012). Drunkorexia: Understanding the co-occurrence of alcohol consumption and eating/exercise weight management behaviors. *Journal of American College Health*, 60(3), 236-243.
 44. Blackmore, P. I., & Gleaves, D. H. (2013). Self-induced vomiting after drinking alcohol. *International Journal of Mental Health and Addiction*, 11, 453-457.
 45. Trinko, R., Sears, R. M., Guarnieri, D. J., & DiLeone, R. J. (2007). Neural mechanisms underlying obesity and drug addiction. *Physiology & Behavior*, 91(5), 499-505.
 46. Berridge, K. C. (1996). Food reward: Brain substrates of wanting and liking. *Neuroscience and Biobehavioral Reviews*, 20(1), 1-25.
 47. Wang, G. J., Volkow, N. D., Logan, J., Pappas, N. R., Wong, C. T., Zhu, W., et al. (2001). Brain dopamine and obesity. *Lancet*, 357(9253), 354-357.
 48. Yeomans, M. R., & Gray, R. W. (2002). Opioid peptides and the control of human ingestive behaviour. *Neuroscience and Biobehavioral Reviews*, 26(6), 713-728.
 49. Ward, B. O., Somerville, E. M., & Clifton, P. G. (2000). Intraaccumbens baclofen selectively enhances feeding behavior in the rat. *Physiology & Behavior*, 68(4), 463-468.
 50. Lobo, I. A., & Harris, R. A. (2008). GABA(A) receptors and alcohol. *Pharmacology, Biochemistry, and Behavior*, 90(1), 90-94.
 51. Higgs, S., & Cooper, S. J. (1996). Hyperphagia induced by direct administration of midazolam into the parabrachial nucleus of the rat. *European Journal of Pharmacology*, 313(1-2), 1-9.
 52. Higgs, S., & Barber, D. J. (2004). Effects of baclofen on feeding behaviour examined in the runway. *Progress in Neuro-Psychopharmacology & Biological Psychiatry*, 28(2), 405-408.
 53. Basso, A. M., & Kelley, A. E. (1999). Feeding induced by GABA(A) receptor stimulation within the nucleus accumbens shell: Regional mapping and characterization of macronutrient and taste preference. *Behavioral Neuroscience*, 113(2), 324-336.
 54. Breslow, R. A., Chen, C. M., Graubard, B. I., Jacobovits, T., & Kant, A. K. (2013). Diets of drinkers on drinking and nondrinking days: NHANES 2003-2008. *American Journal of Clinical Nutrition*, 97(5), 1068-1075.
 55. Yeomans, M. R. (2010). Short term effects of alcohol on appetite in humans. Effects of context and restrained eating. *Appetite*, 55(3), 565-573.
 56. Yeomans, M. R. (1996). Palatability and the micro-structure of feeding in humans: The appetizer effect. *Appetite*, 27(2), 119-133.
 57. Hetherington, M. M., Cameron, F., Wallis, D. J., & Pirie, L. M. (2001). Stimulation of appetite by alcohol. *Physiology & Behavior*, 74(3), 283-289.
 58. Mattes, R. D., & DiMeglio, D. (2001). Ethanol perception and ingestion. *Physiology & Behavior*, 72(1-2), 217-229.
 59. Yeomans, M. R. (2004). Effects of alcohol on food and energy intake in human subjects: Evidence for passive and active over-consumption of energy. *British Journal of Nutrition*, 92(Suppl 1), S31-34.
 60. Westerterp-Plantenga, M. S., & Verwegen, C. R. (1999). The appetizing effect of an aperitif in overweight and normal-weight humans. *American Journal of Clinical Nutrition*, 69(2), 205-212.
 61. Raben, A., Agerholm-Larsen, L., Flint, A., Holst, J. J., & Astrup, A. (2003). Meals with similar energy densities but rich in protein, fat, carbohydrate, or alcohol have different effects on energy expenditure and substrate metabolism but not on appetite and energy intake. *American Journal of Clinical Nutrition*, 77(1), 91-100.
 62. Poppitt, S. D., McCormack, D., & Buffenstein, R. (1998). Short-term effects of macronutrient preloads on appetite and energy intake in lean women. *Physiology & Behavior*, 64(3), 279-285.
 63. de Castro, J. M., & Orozco, S. (1990). Moderate alcohol intake and spontaneous eating patterns of humans: Evidence of unregulated supplementation. *American Journal of Clinical Nutrition*, 52(2), 246-253.
 64. Caton, S. J., Marks, J. E., & Hetherington, M. M. (2005). Pleasure and alcohol: Manipulating pleasantness and the acute effects of alcohol on food intake. *Physiology & Behavior*, 84(3), 371-377.
 65. Herman, C. P., & Polivy, J. (1980). Restrained eating. In A. J. Stunkard (Ed.), *Obesity* (pp. 208-225). Philadelphia: Saunders.
 66. Yeomans, M. R., Hails, N. J., & Nescic, J. S. (1999). Alcohol and the appetizer effect. *Behavioural Pharmacology*, 10(2), 151-161.
 67. Polivy, J., & Herman, C. P. (1976). Effects of alcohol on eating behavior: Influence of mood and perceived intoxication. *Journal of Abnormal Psychology*, 85(6), 601-606.
 68. Polivy, J., & Herman, C. P. (1976). The effects of alcohol on eating behavior: Disinhibition or sedation? *Addictive Behaviors*, 1(2), 121-125.
 69. Dumesnil, C., Dauchet, L., Ruidavets, J. B., Bingham, A., Arveiler, D., Ferrieres, J., et al. (2013). Alcohol consumption patterns and body weight. *Annals of Nutrition & Metabolism*, 62(2), 91-97.
 70. Tolstrup, J. S., Heitmann, B. L., Tjonneland, A. M., Overvad, O. K., Sorensen, T. I., & Gronbaek, M. N. (2005). The relation between drinking pattern and body mass index and waist and hip circumference. *International Journal of Obesity*, 29(5), 490-497.
 71. Arif, A. A., & Rohrer, J. E. (2005). Patterns of alcohol drinking and its association with obesity: data from the Third National Health and Nutrition Examination Survey, 1988-1994. *BioMed Central Public Health*, 5(126).
 72. Yeomans, M. R. (2010). Alcohol, appetite and energy balance: Is alcohol intake a risk factor for obesity? *Physiol Behav*, 100(1), 82-89.
 73. Marques-Vidal, P., Montaye, M., Haas, B., Bingham, A., Evans, A., Juhan-Vague, I., et al. (2001). Relationships between alcoholic beverages and cardiovascular risk factor levels in middle-aged men, the PRIME Study. Prospective Epidemiological Study of Myocardial Infarction Study. *Atherosclerosis*, 157(2), 431-440.
 74. Kahn, H. S., Tatham, L. M., Rodriguez, C., Calle, E. E., Thun, M. J., & Heath, C. W., Jr. (1997). Stable behaviors associated with adults' 10-year change in body mass index and likelihood of gain at the waist. *American Journal of Public Health*, 87(5), 747-754.
 75. Jacobsen, B. K., & Thelle, D. S. (1987). The Tromso Heart Study: The relationship between food habits and the body mass index. *Journal of Chronic Diseases*, 40(8), 795-800.

76. Ferreira, M. G., Valente, J. G., Goncalves-Silva, R. M., & Sichieri, R. (2008). Alcohol consumption and abdominal fat in blood donors. *Revista de Saude Publica*, 42(6), 1067-1073.
77. Lapidus, L., Bengtsson, C., Hallstrom, T., & Bjorntorp, P. (1989). Obesity, adipose tissue distribution and health in women—results from a population study in Gothenburg, Sweden. *Appetite*, 13(1), 25-35.
78. Vadstrup, E. S., Petersen, L., Sorensen, T. I., & Gronbaek, M. (2003). Waist circumference in relation to history of amount and type of alcohol: Results from the Copenhagen City Heart Study. *International Journal of Obesity and Related Metabolic Disorders*, 27(2), 238-246.
79. Slattery, M. L., McDonald, A., Bild, D. E., Caan, B. J., Hilner, J. E., Jacobs, D. R., Jr., et al. (1992). Associations of body fat and its distribution with dietary intake, physical activity, alcohol, and smoking in blacks and whites. *American Journal of Clinical Nutrition*, 55(5), 943-949.
80. Sakurai, Y., Umeda, T., Shinchi, K., Honjo, S., Wakabayashi, K., Todoroki, I., et al. (1997). Relation of total and beverage-specific alcohol intake to body mass index and waist-to-hip ratio: A study of self-defense officials in Japan. *European Journal of Epidemiology*, 13(8), 893-898.
81. Rosmond, R., & Bjorntorp, P. (1999). Psychosocial and socio-economic factors in women and their relationship to obesity and regional body fat distribution. *International Journal of Obesity and Related Metabolic Disorders*, 23(2), 138-145.
82. Riserus, U., & Ingelsson, E. (2007). Alcohol intake, insulin resistance, and abdominal obesity in elderly men. *Obesity*, 15(7), 1766-1773.
83. Wang, L., Lee, I. M., Manson, J. E., Buring, J. E., & Sesso, H. D. (2010). Alcohol consumption, weight gain, and risk of becoming overweight in middle-aged and older women. *Archives of Internal Medicine*, 170(5), 453-461.
84. Thomson, C. A., Wertheim, B. C., Hingle, M., Wang, L., Neuhaus, M. L., Gong, Z., et al. (2012). Alcohol consumption and body weight change in postmenopausal women: Results from the Women's Health Initiative. *International Journal of Obesity*, 36(9), 1158-1164.
85. Koppes, L. L., Twisk, J. W., Van Mechelen, W., Snel, J., & Kemper, H. C. (2005). Cross-sectional and longitudinal relationships between alcohol consumption and lipids, blood pressure and body weight indices. *Journal of Studies on Alcohol*, 66(6), 713-721.
86. Ruidavets, J. B., Bataille, V., Dallongeville, J., Simon, C., Bingham, A., Amouyel, P., et al. (2004). Alcohol intake and diet in France, the prominent role of lifestyle. *European Heart Journal*, 25(13), 1153-1162.
87. Paschall, M., & Lipton, R. I. (2005). Wine preference and related health determinants in a U.S. national sample of young adults. *Drug and Alcohol Dependence*, 78(3), 339-344.
88. Mortensen, E. L., Jensen, H. H., Sanders, S. A., & Reinisch, J. M. (2001). Better psychological functioning and higher social status may largely explain the apparent health benefits of wine: A study of wine and beer drinking in young Danish adults. *Archives of Internal Medicine*, 161(15), 1844-1848.
89. McCann, S. E., Sempos, C., Freudenheim, J. L., Muti, P., Russell, M., Nochajski, T. H., et al. (2003). Alcoholic beverage preference and characteristics of drinkers and nondrinkers in western New York (United States). *Nutrition, Metabolism, and Cardiovascular Diseases*, 13(1), 2-11.
90. Johansen, D., Friis, K., Skovenborg, E., & Gronbaek, M. (2006). Food buying habits of people who buy wine or beer: Cross sectional study. *British Medical Journal*, 332(7540), 519-522.
91. Barefoot, J. C., Gronbaek, M., Feaganes, J. R., McPherson, R. S., Williams, R. B., & Siegler, I. C. (2002). Alcoholic beverage preference, diet, and health habits in the UNC Alumni Heart Study. *American Journal of Clinical Nutrition*, 76(2), 466-472.
92. Alcacera, M. A., Marques-Lopes, I., Fajo-Pascual, M., Foncillas, J. P., Carmona-Torre, F., & Martinez-Gonzalez, M. A. (2008). Alcoholic beverage preference and dietary pattern in Spanish university graduates: The SUN cohort study. *European Journal of Clinical Nutrition*, 62(10), 1178-1186.
93. Sobal, J., & Stunkard, A. J. (1989). Socioeconomic status and obesity: A review of the literature. *Psychological Bulletin*, 105(2), 260-275.
94. Monteiro, C. A., Moura, E. C., Conde, W. L., & Popkin, B. M. (2004). Socioeconomic status and obesity in adult populations of developing countries: A review. *Bulletin of the World Health Organization*, 82(12), 940-946.
95. Devaux, M., Sassi, F., Church, J., Cecchini, M., & Borghoni, F. (2011). Exploring the relationship between education and obesity. *OECD Journal: Economic Studies*(2011/1).
96. Dias, P., Oliveira, A., & Lopes, C. (2011). Social and behavioural determinants of alcohol consumption. *Annals of Human Biology*, 38(3), 337-344.
97. Siegel, M. B., Naimi, T. S., Creameens, J. L., & Nelson, D. E. (2011). Alcoholic beverage preferences and associated drinking patterns and risk behaviors among high school youth. *American Journal of Preventative Medicine*, 40(4), 419-426.
98. Dey, M., Gmel, G., Studer, J., Dermota, P., & Mohler-Kuo, M. (2014). Beverage preferences and associated drinking patterns, consequences and other substance use behaviours. *European Journal of Public Health*, 24(3), 496-501.
99. Huckle, T., Sweetsur, P., Moyes, S., & Caswell, S. (2008). Ready to drinks are associated with heavier drinking patterns among females. *Drug and Alcohol Review*, 27, 398-403.
100. Lakka, H. M., Lakka, T. A., Tuomilehto, J., & Salonen, J. T. (2002). Abdominal obesity is associated with increased risk of acute coronary events in men. *European Heart Journal*, 23(9), 706-713.
101. Goh, L. G., Dhaliwal, S. S., Welborn, T. A., Lee, A. H., & Della, P. R. (2014). Anthropometric measurements of general and central obesity and the prediction of cardiovascular disease risk in women: a cross-sectional study. *British Medical Journal Open*, 4(2), e004138.
102. Mayo Clinic. (2013). *Obesity: Risk factors*. Retrieved 22 April, 2014, from <http://www.mayoclinic.org/diseases-conditions/obesity/basics/risk-factors/con-20014834>
103. Yen, S. T., Chen, Z., & Eastwood, D. B. (2009). Lifestyles, demographics, dietary behavior, and obesity: A switching regression analysis. *Health Services Research*, 44(4), 1345-1369.
104. McLaren, L. (2007). Socioeconomic status and obesity. *Epidemiologic Reviews*, 29, 29-48.
105. Klesges, R. C., Meyers, A. W., Klesges, L. M., & La Vasque, M. E. (1989). Smoking, body weight, and their effects on smoking behavior: A comprehensive review of the literature. *Psychological Bulletin*, 106(2), 204-230.
106. French, S. A., & Jeffery, R. W. (1995). Weight concerns and smoking: A literature review. *Annals of Behavioral Medicine*, 17(3), 234-244.
107. Farooqi, I. S., & O'Rahilly, S. (2007). Genetic factors in human obesity. *Obesity Reviews*, 8(Suppl 1), 37-40.

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