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Research status of alcohol consumption and obesity

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Abstract: **Obesity has become a common disease. According to the data reported in 2010, the prevalence of central obesity above 18 years old was 30%-40%. Obesity not only is a serious chronic disease, but also increases the morbidity and mortality of some diseases, such as cardiovascular disease, diabetes, cancer and musculoskeletal disorders. In male, most studies have demonstrated that alcohol consumption is associated with obesity, and those studies have rendered a J-shaped dose-response trend; in female, most studies have suggested that it is no association or inverse association. The conclusion of drinking different categories is slightly different. Beer is a risk factor for central obesity; some studies have suggested that it's a J-shaped relationship between wine consumption and body mass index (BMI); there is a linear correlation between spirits and obesity. Some studies have thought that alcohol consumption is a U-shaped relationship between obesity, and heavy drinking is a risk factor for obesity, and moderate drinking is recommended. At present, there is no consistent conclusion on the relationship between alcohol consumption and obesity.**

Keywords: Alcohol consumption; General obesity; Central obesity

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1. Introduction

With the rapid development of the global economy, obesity is spreading worldwide at an alarming rate. In the world, 1.9 billion people are overweight, and a third of them are obesity[1]. In China, the prevalence of obesity is also rising rapidly. In 2002, the obesity rate of more than 18 years old was 7.1%. However, the obesity rate in 2010 among 18 years old increased to 12.0%. The prevalence of central obesity was 30%-40% in more than 18 years old. Now, obesity has become a common disease and is gradually increasing in China. It can cause more and more serious diseases, such as cardiovascular disease, diabetes, cancer and musculoskeletal disorders, which can increase morbidity and mortality and lead to 3 million deaths worldwide each year[2].

Among mangy previous studies, they have supported that heavy alcohol drinking may increase the risk of obesity[3]. On the other hand, some studies have believed that alcohol consumption is not a risk factor for weight gain, and the volume and frequency of drinking are negatively correlated with BMI[4]. Some studies have observed a U-shaped relationship between alcohol consumption and obesity. However, other studies have suggested a J-shaped relationship between alcohol consumption and obesity[5]. At present, it is still controversial between alcohol consumption and obesity.

2. General obesity

2.1. General demographic characteristics

The relationship between alcohol consumption and general obesity may differ between sexes. Among some previous studies, a common trend appears to that regular drinking likely to result in weight gain in male, while weight loss in female[6]. Indeed, several previous studies have shown a negative association between alcohol consumption and obesity in male[7-9]. Most recently, several studies have shown that alcohol consumption is a risk factor for obesity in male[10-13]. After adjusting for a range of confounding factors, a J-shaped curves been found by a Spanish cohort study between alcohol intake and BMI in middle-aged males (greater than 39.2 years old)[14]. An analysis of data from the European Prospective Investigation into Cancer (EPIC) found that daily alcohol consumption was positively associated with general obesity and abdominal obesity in male[13]. For female, some studies have found that there is a positive correlation between alcohol intake and general obesity. However, several studies have suggested a negative correlation[15-17] or no correlation[14]. This may be caused by the differences in drinking patterns. A prospective study of more than 40,000 females found a U-shaped dose-response relationship between heavy drinking and obesity in female[18]. A negative association been found by a cross-sectional study in 524 males and 611 females between alcohol consumption and body fat in female[15]. A cohort study conducted in Spain and included 8,706 individuals (3,643 males and 5,063 females) found alcohol consumption was not associated with BMI[14].

Some studies have suggested that the risk of general obesity increases with age[19, 20], which is an important confounding factor for alcohol consumption and obesity. A study shown that people between the ages of 31 and 50 had a higher risk of general obesity than people younger than 30[21].

Alcohol consumption has different effects on different age groups. Some studies have suggested that middle-aged individuals gain less weight as age[6]. For young people, alcohol consumption is a risk factor for overweight and general obesity[22] and should be controlled to prevent obesity. A cohort study of 7,491 young Americans who consumed alcohol found that occasional heavy drinking was a potential risk factor for gaining weight and transitioning to obesity in young people[23]. However, some studies have suggested that there is a negative correlation between alcohol intake and BMI in young people and the correlation is stronger in young people than in old people[24].

2.2. Drinking volume

To explore the relationship between drinking volume and obesity, some studies have showed that light-to-moderate drinking is not associated with obesity, while heavy alcohol intake is more consistently related to adiposity. Compared with males who consumed less than or equal to 6g/d, the WC and BMI increased 1.1cm and 1.0kg/m2, respectively, in those who consumed more than or equal to 96g/d[13]. Some studies have suggested that heavy drinking may increase the risk of obesity[18]. A study conducted in Spain showed that the BMI in male who drink heavily (greater than 30g/d) was about 0.9-1.2kg/m2 higher than abstainers. In middle-aged male, there is a J-shaped correlation between the drinking volume and BMI[14]. For moderate drinking, studies have shown a negative association between drinking volume and obesity [6] or no association[14]. Most studies have supported moderate drinking and suggested that it is a healthy form[25] and can reduce the risk of obesity[26]. While many studies have considered moderate drinking to be healthy, some have suggested that moderate drinking varies between the sexes. A prospective study conducted in the United States from 1999 to 2002 found that drinking three glasses a day (the recommended moderate amount) may increase the risk of obesity in female and reduce it in male[27].

2.3. Category of drinking

Different categories of alcohol have different effects on obesity[28]. **Beer:** Several previous studies have suggested that it is no association between beer consumption and WHR or BMI[5, 29]. But, a growing number of studies have suggested that beer intake contributes to obesity. In a follow-up study of 15,765 individuals, it replaced beer with water or other low-energy drinks and found the risk of obesity be reduced[25]. **Wine:** Several researches have suggested that wine consumption is negatively associated to general obesity[15, 25]. After adjusting for age, energy intake, the consumption of beer and spirits as well as the education level, a study of 524 males and 611 females found that a negative correlation between wine consumption and body fat percentage in female[15]. Other studies have found no correlation[14]. **Liquor:** A cross-sectional study of healthy volunteers who likes to drink found a linear correlation between alcohol consumption and BMI in both male and female[5]. However, some studies don't believe that there is a correlation between drinking liquor and obesity. When using water as the substitute of liquor to observe the impact of liquor on obesity, they found that there was no correlation between drinking liquor and obesity in either the incidence of obesity or the change of body weight[25].

2.4 .The frequently of drinking

Currently, studies have shown that there is a negative correlation between the frequency of drinking and obesity[30]. This may be caused by that drinkers often substitute alcohol for other foods, which potentially leading to a negative energy balance[7]. With the same amount of alcohol consumed, there was a negative correlation between BMI and the frequency of drinking in beer and wine[31], and the correlation was stronger in the more than 100g group than in the 30-100g group[3].

3. Central Obesity

Central obesity is more harmful than general obesity, and it can increase the risk of adverse health outcomes[32]. Belly fat is rife among heavy drinkers both sexes[33]. Most studies have suggested a link on alcohol consumption and abdominal obesity[34]. However, other studies have suggested that normal drinking is not correlated with abdominal obesity[35], and preventing the abdominal obesity should cultivate healthy drinking habits[36].

3.1. General demographic characteristics

Heavy drinking in daily life is positively associated with WC[37] and increase the risk of abdominal obesity in both male and female[13]. In a study of 11,289 aged 40-63 south Koreans found that the normal weight individuals who heavily drank every time had a higher risk of developing central obesity than individuals who consumed less than 2 cups both in male and female. The normal weight males who consumed greater than 7 standard cups and the normal weight females who drank more than 10 standard cups had a higher risk of developing central obesity[36]. Other studies have suggested that drinking can increase the accumulation of abdominal fat in male, which is a risk factor for abdominal obesity[15]. Binge drinking in normal weight males were at the risk for central obesity, but not in females[38]. For female, some studies have

suggested that alcohol intake is a risk factor for central obesity. For instance, a follow-up study of 158,796 females in EPIC found a correlation between alcohol consumption in daily life and abdominal obesity[13]. People who is normal weight and has abdominal obesity are older than those who were normal weight and did not have abdominal obesity[36]. A Japanese study showed that age had a significantly higher impact on the effect of drinking on WC and waist-to-hip ratio (WHR) than on BMI. This may mean that age has a higher impact on abdominal obesity than on general obesity[24].

3.2. Drinking volume

For both male and female, the risk of obesity increases as drinking volume[37]. A study conducted in South Korea found that the proportion of obesity and central obesity were high in alcohol abusers and there was a dose-response relationship, while only central obesity was high in heavy drinkers[34]. Among males, heavy beer drinkers (more than 1,000 ml) have significantly more WC than non-beer drinkers[39].

After adjusting for confounding factors such as age, BMI, education, smoking status, income, physical activity and energy intake, a south Korean study found that normal-weight females who drank 10 or more standard cups each time were more likely to be obese than those who drank 2 or less[36]. For normal weight males, drinking more than 7 standard cups each time increased the risk of abdominal obesity. While for females, drinking more than 10 standard cups each time increased the risk of abdominal obesity[36]. After adjusting for age, smoking status, physical activity, income and marital status both in male and female, there was a significant association between alcohol consumption(more than 20g/d) and central obesity compared with nondrinkers[37].

3.3. The category of drinking

Beer: when studying the effect of beer on obesity, several studies have believed that there is no statistical correlation between beer consumption and central obesity[15]. By analyzing the relationship between beer consumption and the change of WC in 8.5 years, EPIC did not believe that drinking beer would lead to the "beer belly", and believe that natural changes of fat are responsible for “beer belly” in male[39]. Some studies have suggested that drinking a lot of beer can increase WC and lead to central obesity[28]. A large European cohort study found a link between daily alcohol consumption, in particular beer, and abdominal obesity[13]. Whether drinking beer can cause abdominal obesity may be related to the amount of beer drinking. According to a meta-analysis, the existing scientific research evidence was not insufficient to prove that moderate drinking (less than 500ml/d) causes abdominal obesity. But it cannot be excluded that there is a positive correlation between heavy beer consumption and abdominal obesity[40]. Studies found that the WC and weight gain in male who quitted drinking beer were significantly different from those who drank beer in small quantities and were very close to those who drank beer seriously. This might suggest that the history of beer drinking would increase the risk of obesity[39].

Wine and hard liquor: Some studies have found no or negative correlation between wine consumption and WHR[5, 31]. Others have found a U-shaped correlation between wine consumption and WC in both male and female[41]. To explore the influence of liquor on abdominal obesity, some studies have believed that moderate consumption of liquor will lead to the increase of WC both in male and female[28]. A Danish cohort study followed participants for five years and concluded that liquor can increase female’s WC[41].

3.4. Drinking frequency

There was no association between drinking frequency and normal weight abdominal obesity[36]. However, a prospective cohort study followed participants in 5 years and concluded that there was a correlation between drinking frequency and abdominal obesity, and the correlation was more significant than alcohol consumption. Drinking frequency was negatively correlated with changes in WC in female, but not in male[42].

4. Mechanism

When the energy intake exceeds the consumption, it will cause the accumulation of fat and obesity. Dangers of obesity and alcoholism are well known, but the mechanism of action between alcohol and obesity remains unclear. It is well-known that 1 gram of alcohol contains 7.1 kcal. Alcohol is an important part of the daily diet[43], which can provide 5%-10% of the energy intake in adults, but this part energy cannot replace the energy in food and may increase the total energy intake[37]. The energy from alcohol may be different from the energy from other sources, and it cannot be stored in the body, which may explains why the energy in alcohol is prioritized in different metabolic processes, such as increasing heat production or decreasing lipolysis[44]. Alcohol intake inhibits the oxidation of fat, which allows fat to be stored in the body[44]. It also promotes glucocorticoid release by stimulating the hypothalamic pituitary gonad axis[45], which can alter fat distribution patterns[46]. Alcohol metabolism may also cause endocrine changes, such

as increased cortisol production in the liver or modified steroid metabolism[11]. Those who consider that there is a negative correlation between the drinking frequency and obesity believe that the main reasons are as follows. First, due to the physiological effects of alcohol on heart rate and activity, high frequency of drinking may lead to a large amount of energy consumption[47].Second, daily drinking may activate the microsomal ethanol oxidation system to promote heat production and heat loss[48]. Long-term daily drinking may affect the absorption of macronutrients and reduce energy intake[48]. The normal weight individuals who slightly drinking have a healthy metabolism, while those who are obese and heavy drinking have fewer healthy metabolisms[49].

5. Concluding remarks

At present, there is no consistent conclusion on the relationship between alcohol consumption and obesity. Different gender, age, education level, alcohol consumption, types of alcohol, frequency of alcohol consumption, physical activity, smoking status, energy intake and other factors have different effects on the relationship between alcohol consumption and obesity. Exploring the relationship between drinking and obesity can help people to drink in a healthy and reasonable way and prevent the occurrence of obesity.

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