

# Alcohol consumption and the incidence of type 2 diabetic mellitus: “issue that requires more attention”

## Abstract

In recent decades, the significant rise in the magnitude of diabetic mellitus (DM) has been proved in almost in all regions of the world where it includes both economically developed and developing countries. Besides, the burden of diabetes is also alarming globally. Alcohol use is also rising worldwide whilst it is identified that heavy alcohol ingesting is a significant lifestyle risk factor for chronic disease such as DM and its-related complications. Therefore, this review article was aimed to discuss about alcohol consumption and the incidence of Type 2 DM (T2DM) by examining the different studies conducted on this issue. Consequently, several studies have reported that light to moderate alcohol consumption decreases the risk of T2DM. However, the heavy alcohol consumption increases the risk of T2DM. Finally, this review concludes heavy alcohol consumption contributes for the high incidence of T2DM. It also recommends that more focus is required to this critical problem to prevent its occurrence and the morbidity and mortality associated to T2DM.

**Keywords:** diabetic mellitus, alcohol consumption, incidence, risk, T2DM

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## Introduction

DM is a group of metabolic diseases characterized by hyperglycemia which results from the defects in insulin secretion, insulin action, or both.<sup>1</sup> In people with diabetes, the pancreas does not produce adequate insulin in type 1 DM or the body does not respond properly to the insulin T2DM. The hormone insulin, which is produced in the pancreas, is a significant controller of blood glucose levels.<sup>2</sup> Impaired insulin secretion and augmented insulin resistance are the key pathophysiological characteristics of T2DM. They together contribute to the development of T2DM. Currently, it has become broadly known that the functional pancreatic  $\beta$ -cell mass reduces over time and T2DM is a progressive disease.<sup>3</sup>

The DM epidemic was occurred during the 20<sup>th</sup> century and continues into the 21<sup>st</sup> century. It has already engaged an extraordinary ring on the U.S. population through its acute and chronic complications, disability, and premature death.<sup>4</sup> The magnitude of DM in adults expected to be 8.8% whilst this was predicted to rise to 10.4% in 2040,<sup>5</sup> while in 2017, it was 8.8% of the world population, with the expectancy to rise to 9.9% by 2045 globally. This means there were 424.9 million subjects with the disease and this was projected to rise by 48% to 628.6 million individuals by 2045.<sup>6</sup> The global prevalence of diabetes has increased in adults from 4.7% in 1980 to 8.5% in 2014. 90 to 95% of adults with diabetes have T2DM.<sup>7</sup> T2DM and its-related complications create a main global public health problem, influencing nearly all populations in both developed and developing countries with high rates of diabetes-related morbidity and mortality.<sup>8</sup>

Alcohol use is a principal risk factor for global disease burden and causes significant health loss. The risk of all-cause mortality, and of cancers specifically, increases with rising levels of drinking, and the level of drinking that minimizes health loss is zero.<sup>9</sup> Globally, over 40% of the world's adult population drinks alcohol where the average ingestion per drinker is 17.1 litres per year. But the proportion of

abstention, level of alcohol ingestion and patterns of consumption vary widely across regions of the world.<sup>10</sup>

Alcohol accounts for 4 to 6% of the average energy consumption in most Western countries. Alcohol-induced hypoglycaemia is a well-recognized and feared complication in insulin-dependent diabetic (IDDM) patients.<sup>11</sup> The study concludes that moderate amount of alcohol consumption is associated to a self-perception of good health.<sup>12</sup> The alcohol intake is less common among populations with diabetes when compared to the general population. Type of alcoholic beverage, gender, and body mass index are factors that affect outcomes of alcohol consumptions.<sup>13</sup> The healthy lifestyle could reduce risk for T2DM.<sup>14</sup> A research showed that alcohol intake and illicit drugs may be related to an earlier development of T2DM when taken alone or in combination.<sup>15</sup>

## Alcohol use and the incidence of T2DM

### Light to moderate alcohol consumptions

Several studies showed that light to moderate consumption of alcohol reduces the risk of T2DM.<sup>13,16-44</sup> A systematic review and meta-analysis found that the relationships between average amount of alcohol ingested per day and risk of incident T2DM among women was found to be protective at moderate consumption for both gender which was statistically significant.<sup>16</sup> Alcohol intake decreases the incidence of T2DM. Acute consumption of alcohol does not rise risk of hypoglycemia particularly in diet treated individuals, but when sulphonyl urea is co-administered. Chronic alcohol consumption appears to be linked with enhanced glycemic control in T2DM.<sup>38</sup>

The study done on middle-aged Japanese men indicated that moderate alcohol ingestion among apparently healthy Japanese men is linked with decreased risk of IFG or T2DM development.<sup>37</sup> In women, the associations between alcohol use and risk of T2DM are more complex where the risk is reduced with low or medium consumption.<sup>20</sup>

The moderate amount of alcohol intake does not rise risk of T2DM in either middle-aged men or women.<sup>22</sup> The national alcohol survey in U.S found that a regular light to moderate amount of alcohol consumption has a protect effect against diabetes.<sup>23</sup> A meta-analysis of prospective observational studies suggests that a nearly 30% decrease in risk of T2DM in moderate alcohol drinkers.<sup>24</sup> A systematic review and dose-response meta-analysis showed that the Light and moderate alcohol use was associated with a lower risk of T2DM.<sup>26</sup> The study showed that light to moderate alcohol consumption was protective against diagnosis of T2DM in normal and overweight subjects but not in the obese.<sup>45</sup> The study showed that men individuals who drink light to moderate amount of alcohol have a reduced risk of T2DM.<sup>29</sup>

Numerous types of alcohol-related consumptions found to be associated with a lower prevalence of T2DM. The respondents who consumed the greatest volumes of wine or beer but not liquor were less likely to report being diagnosed with T2DM compared with non-drinkers.<sup>46</sup> The systematic review and meta-analysis found that wine was associated with a more significant reduced risk of T2DM. And also concludes that wine might be more helpful for protection against T2DM than beer or spirits.<sup>47</sup> The moderate amount of alcohol consumption was associated with a small improvement in physical health-related quality of life 2 years later and vice versa in young and middle-aged women.<sup>48</sup>

The study found that light to moderate regular drinking of alcohol may be a beneficial for women for the stoppage of diabetes. However, this pattern of ingestion may likely to be negative overall health impact for many people.<sup>49</sup> The magnitude of the diabetes reduced with low-risk alcohol ingestion and augmented with high-risk alcohol ingestion.<sup>50</sup> The alcohol intake offers the highest protection against T2DM, even though a level of ingestion per drinking day is low.<sup>51</sup> The study revealed that 1 drink/occasion frequently more than six times in a week was related to the lowest risk of developing DM.<sup>52</sup> Wine ingestion was linked with a decreased risk of T2DM. But, a heavy alcohol daily consumption, even only one to three days/week, may rise the risk of DM in men.<sup>53</sup>

### Heavy alcohol consumptions

However, the evidence from prospective study showed that alcohol consumption seems to be linked with risk of non-insulin-dependent diabetes mellitus.<sup>54</sup> Several studies showed that heavy alcohol consumption is significantly associated with increased risk of T2DM.<sup>16,18–22,28,41,55–60</sup> A systematic review and meta-analysis found that the relationships between high amount of alcohol ingested per day and risk of incident T2DM among women were found to be hazardous effect. But for men, the hazardous effect for the higher consumption not statistically significant.<sup>16</sup> However, the other study found that high alcohol use rises the risk of abnormal glucose regulation in both gender which in turn rises the risk of T2DM.<sup>20</sup> A meta-analysis of prospective observational studies suggests that no decrease in risk of T2DM is observed in drinkers of  $\geq 48$ g/day or heavy drinkers.<sup>24</sup>

Further, rising alcohol consumption to the heavy levels may worsen blood glucose (BG) regulation. On the other hand, decreasing alcohol use among heavy drinkers may reduce the risk of T2DM via improved beta-cell function.<sup>56</sup> The prospective community-based population study demonstrated that there was an inverse association between alcohol use and the risk of diabetes. The amount of the alcohol ingestion associated with lower risk was different in gender, and the association was more pronounced among subjects with higher

BMI.<sup>61</sup> The frequency of alcohol ingestion is associated with the risk of DM, whereas alcohol use over 3 to 4 days per week is related with the lowest risk of DM even considering an average weekly alcohol use into account.<sup>62</sup> The high amount of alcohol use rises T2DM risk among middle-aged men.<sup>22</sup> Overall, heavy alcohol consumption in men was related to augmented risk of diabetes.<sup>63</sup> However, a systematic review and dose-response meta-analysis showed that heavy alcohol use was not related to the risk of T2DM.<sup>26</sup>

Whereas, moderate amount of alcohol use is related with lower plasma fetuin-A in non-diabetic women participants. Fetuin-A and insulin showed a significant proportion of the association between alcohol drinking and incident T2DM.<sup>36</sup> Fetuin-A is identified as it inhibit insulin signalling and it is a biomarker for risk of T2DM. Since, alcohol drinking may affect the concentrations of circulating fetuin-A this reflects that in turn moderate alcohol consumption reduces that diabetes risk through changing the insulin signal. So that, the benefits of moderate alcohol consumption for these subjects have been suggested to include a mechanism of enhanced insulin sensitivity.

The alcohol consumption is associated with the reduced in insulin resistance.<sup>64</sup> Alcohol ingestion has an effect on the glucose metabolism in numerous ways on diabetic and non-diabetic subjects. It prevents both gluconeogenesis and glycogenolysis, so that its acute drinking without food may aggravate hypoglycaemia, particularly in cases of the combination of depleted glycogen stores and sulphonyl urea.<sup>39</sup> The decrease of the risk of T2DM may be described by an improved in insulin sensitivity after moderate amount of alcohol use. The possible mechanisms for action of alcohol on insulin sensitivity may comprise modulation of changes in the endocrine functioning of fat tissue, the inflammatory status of several organs, and the of glucose and fatty acid metabolism.<sup>33</sup>

Furthermore, Long-term alcohol consumption increases glycemic control this reflects the role of alcohol in reducing the risk of T2DM which could be probably due to improved insulin sensitivity.<sup>38</sup> This improvement of insulin sensitivity may be accounted for the lower incidence of T2DM reported to be related to light-to moderate consumption.<sup>39</sup> Moderate ingestion of alcohol has effects on blood pressure, lipid metabolism, haemostatic balance and also found to improve insulin sensitivity.<sup>39</sup> A systematic review and meta-analysis of Intervention revealed that moderate alcohol ingesting may decline fasting insulin and HbA1c concentrations among nondiabetic individuals. Also, it may improve insulin sensitivity in women which was not do so overall.<sup>65</sup>

The probable mechanisms of malignant effect of alcohol with regard to development of diabetes are worsening glucose tolerance, deteriorate beta cell function, and insulin resistance. The evidence showed increases in alcohol use were associated with higher BG levels and deteriorated beta cell function. Where this mean heavy alcohol use affects BG regulation by inducing beta-cell dysfunction.<sup>56</sup> The chronic heavy amount of alcohol ingestion worsens glucose tolerance and insulin resistance.<sup>57</sup> The evidence showed that alcohol using can lead to weight gain where this is based on the fact that energy content in 1 gram of alcohol is 29kJ or 7.1kcal.<sup>66</sup>

There is a non-linear relation between alcohol intake and the risk of T2DM. Serum insulin and HDL-cholesterol explained a small amount 20% of the reduction in risk of T2DM associated with moderate drinking. The adverse effect of heavy alcohol ingestion looked to be partially mediated through its impact on body weight.<sup>28</sup> Further, the

measured insulin sensitivity index or homeostasis model assessment score showed that a considerable decrease in alcohol drinking from 7.2 to 0.8 standard drinks/day in healthy men wasn't change insulin sensitivity.<sup>67</sup> As suggestions, advice on alcohol use should largely aim at lowering heavy alcohol ingestions in non-diabetes individuals.<sup>41,56</sup>

Heavy drinkers should be encouraged to decrease alcohol consumption to have an improved BG control.<sup>56</sup>

Collectively, below is the brief summary of the systematic reviews and meta-analysis covering the risk of T2DM among alcohol consuming population (Table 1).<sup>16,19,21,24,26,47,68</sup>

**Table 1** Summary of the systematic reviews with meta-analysis covering the risk of T2DM among alcohol consuming population

Author	Year	Design	Findings
Carlsson et al. <sup>19</sup>	2005	13 cohorts	Moderate alcohol consumption has a protective effect in the order of 30% ([RR] meta=0.72, 95% CI=0.67–0.77) but it is impossible to exclude a risk for T2DM in high alcohol ingesting subjects.
Baliunas et al. <sup>16</sup>	2009	20 cohort studies	(RR) for T2DM among men was most protective when consuming 22 g/day alcohol (RR 0.87 [95% CI 0.76–1.00]) and became deleterious at just over 60g/day alcohol (1.01 [0.71–1.44]). Among women, consumption of 24 g/day alcohol was most protective (0.60 [0.52–0.69]) and became deleterious at about 50g/day alcohol (1.02 [0.83–1.26]).
Howard et al. <sup>21</sup>	2004	32 studies	moderate alcohol consumption (1 to 3 drinks/d) is associated with a 33% to 56% lower incidence of diabetes compared with no alcohol use. Whereas, heavy consumption (>3 drinks/d) may be associated with up to a 43% augmented incidence of diabetes relative to moderate drinking.
Koppes et al. <sup>24</sup>	2005	The 15 original prospective cohort studies	Compared with non-consumers, the (RR) for T2DM in those who consumed ≤6g/day alcohol was 0.87 (95% CI 0.79–0.95). For the moderate consumption ranges of 6–12, 12–24, and 24–48 g/day, RRs of 0.70 (0.61–0.79), 0.69 (0.58–0.81), and 0.72 (0.62–0.84) were found, respectively. The risk of T2DM in heavy drinkers (≥48g/day) was equal to that in non-consumers (1.04 [0.84–1.29]).
Li et al. <sup>26</sup>	2016	26 studies	Compared with the minimal category of alcohol consumption, light (RR: 0.83; 95% CI: 0.73, 0.95; P=0.005) and moderate (RR: 0.74; 95% CI: 0.67, 0.82; P=0.001) alcohol drinking was associated with a lower risk of T2DM. However, heavy alcohol ingestion had little or no effect on subsequent T2D risk.
Huang et al. <sup>47</sup>	2017	13 prospective studies	Wine ingestion was associated with a significant reduction of the risk of T2DM, with the pooled relative risks of 0.85, whereas beer or spirits intake led to a slight trend of lessening risk of T2DM (RR; 0.96, 0.95, respectively) compared with no or rare alcohol drinking.
Knott et al. <sup>68</sup>	2015	38 Observational Studies	Reductions in the risk of T2DM were present at all levels of alcohol intake <63 g/day, with risks rising above this threshold. Peak risk reduction was present between 10-14g/day at an 18% decline in hazards.

## Conclusion

The magnitude of T2DM is rising to the shocking level. It is a major public health issue. This review article has found that light to moderate alcohol consumption decreases the risk of T2DM. However, heavy alcohol consumption increases the risk of T2DM. As a recommendation, advice on alcohol consumption should largely intended at lowering heavy alcohol consumption in individuals to reduce the incidence of T2DM by improving the glycemic level. Finally, this review concludes that a heavy alcohol consumption contributes for the high incidence of T2DM. It also recommends that more focus is required to this critical problem to prevent its occurrence and the morbidity and mortality associated to T2DM.

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## Author's contributions

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## Conflicts of interest

The author declares no conflicts of interest in this work.

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