

A Review of the Challenges, Glycaemic Risks and Self-Care for People with Type 1 Diabetes when Consuming Alcoholic Beverages.

J. Charlton ^{1,2}, Gill. J ³., Elliott. L ⁴., Whittaker. A ³., Farquharson. B ³., M. Strachan ¹.

1: NHS Lothian. 2: Edinburgh Napier University. 3: University of Stirling. 4: Glasgow Caledonian University.

Jacqui Charlton, MScRes, BSc, PgCTLHE, RGN; Edinburgh Napier University, Calder Road, Edinburgh. Metabolic Unit, Western General Hospital, Crewe road, Edinburgh.

Jan Gill, Nursing, Midwifery and Allied Health Professions (NMAHP) Research Unit, University of Stirling.

Lawrie Elliott Department of Nursing and Community Health, Glasgow Caledonian University, Glasgow, UK

Anne Whittaker, Nursing, Midwifery and Allied Health Professions (NMAHP) Research Unit, University of Stirling.

Barbara Farquharson, Nursing, Midwifery and Allied Health Professions (NMAHP) Research Unit, University of Stirling.

Mark Strachan, Metabolic Unit, Western General Hospital, Crewe road, Edinburgh.

Contact details: Jacqui Charlton, Room 3B35, Sighthill Campus, Edinburgh Napier University, Edinburgh, EH11 4BN.

Tele no: 0131 4555676

Email address: j.charlton@napier.ac.uk

Key words: Type 1 diabetes mellitus, alcohol consumption, blood glucose, hypoglycaemia, hyperglycaemia, insulin, carbohydrates, self-care.

Key messages:

1. Hypoglycaemia, hyperglycaemia, glucose variability and unpredictability are all consequences of alcohol consumption in type 1 diabetes.
2. Carbohydrate, glucose, alcohol by volume (ABV), and volume of beverage consumed alongside food will affect blood glucose concentrations.
3. The common risk period for hypoglycaemia is 8-12 hours after alcohol consumption.
4. A strategy to prevent hypoglycaemia is to cause deliberately an episode of hyperglycaemia.
5. Many people with Type 1 Diabetes Mellitus (T1DM) currently adopt alcohol-health related behaviours through trial and error.

Abstract

Background: Evidence based information for people with type 1 diabetes mellitus (T1DM) when consuming alcoholic beverages is sparse and simplistic. In clinical practice, erratic blood glucose levels with hypoglycaemia and hyperglycaemia are regularly observed, with episodes of severe hypoglycaemia being a potential risk. Preventative health behaviour strategies are often based on trial and error, with deliberately caused hyperglycaemia being a common tactic. Although important, there are no systematic reviews that synthesise the research evidence on the acute effects of alcohol on blood glucose and the impact in real-life.

Aim: To investigate the acute effect of alcoholic beverages on blood glucose, and to use appropriate evidence to recommend self-care advice to help maintain safe glycaemic control in people with T1DM.

Methods and Findings: A literature search from eight bibliographic databases was performed. Seventeen appropriate publications were identified. Most original research was performed in a laboratory environment and demonstrated inconsistencies in the effects of alcohol on blood glucose. Few studies were conducted in the real-life environment, with advice from ‘diabetes associations’ focussing on abstinence rather than alcohol harm reduction strategies.

Conclusion: Key components to consider when designing future interventions include: The biochemical response to alcohol; the role of exogenous insulin; the presence and timing of carbohydrate foodstuffs in relation to alcohol; the impact of the constituents and amount of an alcoholic beverage consumed; and the effects of alcohol on cognition and behaviours.

Introduction

Socio-cultural issues can impact on diabetes self-care resulting in erratic and poor glycaemic control ¹. One social activity that can have detrimental effects on blood glucose homeostasis is the consumption of alcoholic beverages. In 2017, 57% out of 7,100 adults in the general population of Great Britain had consumed alcohol in the previous week ². Furthermore, in 2016, 26% of all Scottish adults had drunk at hazardous or harmful levels (>14units per week), with males consuming significantly more alcohol on their heaviest drinking day than females ³. In particular, amongst the 16-24 year group men consumed 12.1units vs 9.3 units in females on the heaviest drinking day ³, **which is the highest consumption out of all age groups** ².

In people with Type 1 Diabetes Mellitus (T1DM), the intake and pattern of drinking influences the risk of life-threatening hypo or hyperglycaemia ⁴. Therefore, for young people (YP) with T1DM it could be presumed that abstention from alcohol would be the preferred choice ⁵, as hypoglycaemia is the most feared and anxiety-provoking challenge of having diabetes ⁶. However data suggest the contrary, in that adolescents with T1DM have similar or only slightly lower rates of participation in alcohol consumption compared to peers without diabetes ^{4,5,7,8}. In one study of 17-18 year olds, reported drunkenness was higher in the group with T1DM vs those without T1DM (37.4% vs 18.9%), with significantly higher alcohol consumption over the previous year (78.3 vs 64.6%) ⁴.

Despite the reported excess consumption in YP, this age group has a lower weekly intake compared to other age groups, with a tendency towards binge drinking ². This could be due to the increasing prevalence of recreational drug use, which for a person with T1DM can have a lesser impact on blood glucose levels, especially overnight and the following day ⁹, with hyperglycaemia being the most common effect ¹⁰.

To date there are no systematic reviews that synthesise the research evidence on the acute effects of alcohol on blood glucose related to specific alcoholic beverages. There is a gap in the existing literature regarding the impact on blood glucose and potential self-care strategies to overcome glucose challenges in real-life.

Aims

The purpose of this narrative review is to investigate the acute effect of alcoholic beverages on blood glucose, and to use this evidence to recommend self-care advice for people with T1DM to help them maintain safe glycaemic control.

Methods

A systematic search of eight bibliographic databases was performed during October and November 2015 and updated June 2019 using: Applied Social Sciences Index and Abstracts (ASSIA), Cochrane Controlled Trails Register, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Embase, MEDLINE, PsycINFO, PubMed, Social Science Citation Index (SSCI).

The following search terms were used: “Type 1 diabetes” and “Alcohol drinking, Alcohol consumption or Alcoholism” and “Alcoholic beverage, Beer, Wine, Alcopops, or Spirits” and “Blood glucose monitoring” and “Self-care” and “Hypoglycaemia” and “Hyperglycaemia” and “Patient education” and “Health intervention” and “Psychology” and “Social/Community networks. The search strategy included MeSH and terms were truncated with (*) to allow for multiple spellings and endings. The search identified 1029 records and titles screened, 273 abstracts were screened and 115 full-text articles were assessed for eligibility.

Inclusion Criteria

Results were limited to: A). Type 1 diabetes, B). Individuals over 18 years, C). Alcohol consumption, D). All types of insulin administration or insulin regimen, E). Effects on blood glucose control, behaviour, and self-care strategies, F). English language.

Exclusion Criteria

The exclusion criterion were: A). studies which included other types of diabetes rather than Type 1, because these individuals may have different pathophysiology and subsequent response to alcohol consumption, B). children under 18 years of age, C). Articles which only reported basic science data, where the findings could not be translated into self-care and real-life, D). Participants with alcohol dependence or who have alcohol-related health problems, E). Studies examining the effects on long-term behaviour and glycaemic control, because the present study was concerned only with the acute response to alcohol consumption, F). Animal studies.

Effects of acute alcohol consumption on blood glucose.

The search resulted in: three review publications, 15 original research publications, and ten related articles which are included in this review.

In 2018, one systematic review ⁷ of 13 studies investigating alcohol, plasma glucose and hypoglycaemia found mixed effects of alcohol on glucose. However, the majority of studies found that alcohol was associated with an increased risk of hypoglycaemia (8 studies). Potential mechanisms included impaired hepatic gluconeogenesis, impaired growth hormone response, and alcohol-induced impaired awareness of hypoglycaemia. The time of increased hypoglycaemia risk was concluded to be 8-12 hours after consumption with no risk in the shorter term ⁷.

An earlier review in 2017 described similar physiological mechanisms, namely alcohol-induced inhibition of gluconeogenesis and growth hormone secretion, as well as increased lipolysis with impaired fatty acid oxidation ⁵. The delayed onset of hypoglycaemia at 8-12 hours was also found. In addition it was suggested that early death in YP can be related to alcohol and drug use with a greater mortality risk greater in YP with diabetes than those without. Although in this review hyperglycaemia was not described, it was identified that people consume pre-mixed and sweetened drinks to counter the increased hypoglycaemia risk. Also discussed was the risk of ketosis which is seen in both people with and without diabetes due to increased lipolysis after consuming alcohol.

In patient guidelines, hyperglycaemia as a consequence of drinking alcoholic beverages is not commonly acknowledged, despite studies demonstrating hyperglycaemia rather than hypoglycaemia ¹¹. Furthermore, in clinical practice and experience, hyperglycaemia is observed to occur, which maybe a result of a hypoglycaemia prevention strategy, with carbohydrate consumption being used deliberately to cause hyperglycaemia ⁹. Hypoglycaemia is the greatest risk of alcohol consumption described in guidelines for people with T1DM written by various different 'diabetes associations' (n=13). Recommendations mainly promoted alcohol avoidance and food consumption ⁷. General hypoglycaemia prevention strategies for only light consumption were described with no recommendations for binge drinking or consumption of moderate to high amounts of alcohol.

The glycaemic effects of different alcoholic beverages, food consumption, and insulin administration in T1DM.

Study findings regarding the effects of alcohol on glycaemia predominantly refer to hypoglycaemia. However, alcoholic beverages vary considerably with the carbohydrate and glucose content, the alcohol by volume (ABV) of the drink, plus volume/amount of drink

consumed, as shown in table 1 ¹². When considering physiological effects on glucose and alcohol metabolism this could be assumed to cause variability in glucose concentrations. It has been suggested that alcohol has no effect on insulin requirements and external influences must effect the risk of hypo and hyperglycaemia ¹³.

In one study, stimulated social drinking conditions using a vodka aperitif, evening meal with wine, followed by cognac resulted in superimposable blood glucose levels and insulin profiles in the control and alcohol groups with no impact on glucose in the evening and overnight ¹⁴. In comparison, YP when drinking socially show increased glucose variability and less risk of hypoglycaemia compared to a control group ¹⁵, with participants drinking pre-mixed sweetened beverages and consuming carbohydrate prior to and after drinking to prevent hypoglycaemia which has also been reported by other authors ⁹.

To explore possible reasons for these differences, the evidence regarding glycaemic risks for specific alcoholic beverages are discussed below, based on the results of 15 studies of participants with T1DM, >1 year duration, hypoglycaemia awareness, and consuming weekly alcohol. Study characteristics are shown in table 2.

Hypoglycaemia:

Beer: Low carbohydrate beer with high ABV, in conjunction with an evening meal has been shown to increase hypoglycaemia at bed and breakfast ¹⁷. Comparable hypoglycaemic findings were demonstrated in the afternoon when low carbohydrate beer was consumed without food, although data collection was only for 3 hours ¹⁸. In comparison, consuming higher carbohydrate beer with low alcohol ABV showed less hypoglycaemia at breakfast the following day¹⁷.

Vodka: Spirits usually lower the blood glucose ^{19,20}. This is dependent on the mixer drink and if sugar-free or glucose-containing drinks are used. One study used an adjusted insulin/glucose clamp to prevent hypoglycaemia occurring ¹⁹. The impact of vodka on interstitial glucose has also been explored and twice as many episodes of hypoglycaemia were self-reported after vodka during the following 24 hour period, especially the following morning, although no episodes requiring 3rd party assistance occurred ²⁰.

White wine: White wine consumed after the evening meal rather than with food showed no significant difference in blood glucose during the evening or overnight, after a reduction of 70% mealtime soluble insulin. However, the fasting, morning and post-breakfast levels were significantly lower requiring hypoglycaemia treatment after breakfast despite the insulin

reduction. There was also a significant fall in growth hormone secretion between midnight and 4am after wine ²¹. Other studies of wine did not continue data collection overnight, hence delayed hypoglycaemia effects cannot be compared ^{11 22 23}.

To counterbalance the hypoglycaemia risk; carbohydrate food consumption before and after drinking, inclusion of some sweetened mixer drinks, reduced insulin doses and reduced physical exercise ¹⁵, would be strategies to prevent hypoglycaemia. The consumption of higher fat content foods to delay carbohydrate/glucose absorption and possibly increase blood glucose levels when hypoglycaemia is a risk could be considered. For evening drinking with sugar-free alcoholic beverages, taking these before bed will give a delayed glucose absorption to counteract early morning hypoglycaemia ¹⁴. For insulin adjustment, modest amounts of glucose-free alcohol ingestion consumed with food can increase the risk of immediate hypoglycaemia and bolus insulin may need to be reduced by up to 70% ²¹. For evening drinking, delayed hypoglycaemia is also a risk, and overnight basal insulin may need to be reduced ^{19, 20}. Another important factor is to check blood glucose in the morning at breakfast time, and also possibly reduce breakfast bolus insulin ^{20, 21}.

Hyperglycaemia:

Beer: In one study, ordinary beer that had a high glycaemic index (comparable to white bread), required prandial insulin, however, as the study duration was limited to 3 hours, the delayed effect was not studied ¹⁸. Bolus insulin may be required with ordinary and high carbohydrate beer with low <5% ABV, as hyperglycaemia may occur after consumption ^{17 18}.

White wine: Consumed at lunchtime, showed no impact on blood glucose, but there was a significant rise in post-prandial B-hydroxybutyrate levels, which remained elevated for four hours after food consumption. The carbohydrate type was pasta, which can have a delayed absorption with consequently delayed hyperglycaemia that requires insulin. The ketone levels were statistically significant but not clinically significant or probably relevant for patient education ²³, which may be due to the impaired oxidation of fatty acids ⁵ and the increased amount of alcohol.

Red wine: In an attempt to mimic social drinking practices, one study analysed the effect of red wine (6 units) with a standard Italian lunch and supper ¹¹. The authors found that red wine with an Italian meal produced no change in blood glucose over 15 hours, but stated that alcohol

intake was associated with an increased insulin requirement. Another study group also concluded that red wine (4 units) taken with a meal consisting of bread and pasta had no effect on glucose or insulin, after the start of the meal and for 6 hours after consumption²². Although an increased insulin requirement after 2 hours in the alcohol group was required, this was not statistically significant. Both studies used water in the control group and provided similar carbohydrate type implying that red wine was the causative factor for increased insulin requirements. Changes in levels of lactate and ketones bodies were also described, which although not significant, led authors to suggest that alcohol consumption has the potential to increase the risk of ketoacidosis and lactic acidosis¹¹ in people with T1DM with poor glycaemic control in the context of reduced insulin availability.

Glucose variability:

Various/mixed alcoholic beverages: Studies using these drinks are scarce, but one study group used a socially relevant design, which alluded to pre-mixed sweetened drinks including beer, wine and spirits¹⁵. Other factors were acknowledged that may coincide with social drinking such as dancing, walking, sex and convenience foods that had not been accounted for, and no doubt would have a substantial effect on blood glucose and self-care. ***Also insulin absorption, and duration of diabetes should all be considered²⁰. The study results demonstrated increased glucose variability within the alcohol group. In the control group, a significant increase in low glucose levels were found which possibly occurred because of increased physical activity.***

Impact of alcohol consumption on cognitive function

Some symptoms of hypoglycaemia or hyperglycaemia are similar to those of alcohol intoxication, which could impair blood glucose awareness. The blood alcohol concentration (BAC) is a measure of the ethanol content in the blood, and the pharmacological effects on cognitive function in a human are apparent although minimal, even when plasma concentrations are small (46mg/100ml). An example of plasma ethanol amounts in daily life is at 80mg/100ml it is illegal to drive in most of the UK, although in Scotland the limit is 50mg/100ml²⁴. ***Correlations between BAC and clinical symptoms demonstrate at 10-50mg/dl; mild euphoria, decreased inhibitions, diminished judgement, which are similar to mild hypoglycaemia. At this stage, polyuria and thirst are common which may portray hyperglycaemia. At 50-100mg/dl; impaired co-ordination, loss of critical judgement, impaired memory and concentration, and then progressing to confusion, disorientation, impaired***

balance, slurred speech, exaggerated emotional states at 150-300mg/dl. Then 250-400mg/dl presents sleep, stupor, incontinence, muscular incoordination, and coma and possible death at 400-500mg/dl²⁵. These signs do replicate the effects of mild to severe hypoglycaemia, and why the effects of moderate alcohol consumption can mask hypoglycaemia awareness when awake²⁶. To verify this, blood glucose perceptions after alcohol consumption in one study were 75% inaccurate at bed, which corresponded with an increased risk of nocturnal hypoglycaemia²⁷.

Vulnerable drinkers with T1DM

When considering at-risk groups in T1DM, results differ where one study group found no statistical differences in alcohol consumption between those with higher or lower HbA1c⁴, compared with another where a significant association between high alcohol consumption and higher HbA1c was revealed⁸. In T1DM the prevalence of intoxication within the last month was associated with lower HbA1c ($p=0.021$), and associated with a higher incidence of severe hypoglycaemia ($p=0.04$) in one study⁴. Whereas another indicated an increased risk of hyperglycaemia with potential Diabetic Ketoacidosis (DKA) amongst alcohol consumers compared to abstainers⁸. The DKA prevalence was significantly increased in those classified as high-risk drinkers with poor glycaemic control⁸. The investigation did not include beverage or food types.

With regard to people at risk, an increased significant risk of severe hypoglycaemia with drinkers compared to abstainers of alcohol has also been identified⁸. There was no significant difference with reported incidence of hypoglycaemia between low and high-risk drinkers although a significant difference was shown with abstainers. Intoxication within the last month was associated with significant higher incidence of severe hypoglycaemia compared to abstainers⁴. Another review also supported the increased hypoglycaemia risk and stated the lack of evidence analysing YP self-reported behaviours and experiences, along with any self-care research findings, to subsequently translate into evidence based educational tools¹⁶.

Limitations of studies

Data extraction for 15 studies is presented in table 2. The length of time blood glucose was monitored following alcohol consumption varied between individual studies with seven

running >12 hours overnight ^{11,14,15,17,20,21,27}, and four <3 hours duration ^{13,18,19,26}. Those with shorter periods of measurement clearly had the potential to miss late changes in blood glucose. Most studies were laboratory based (n=11), and the variation in study designs reflected the difficulties in attempting to reproduce typical social drinking conditions (n=2) ^{15,20}. This causes challenges in applying the data into a ‘real-life’ context. Most original studies were published prior to 2008 (n=13) with alcoholic beverages such as beer, wine and vodka. Only one study was identified that examined the effects of currently popular beverages such as alcopops, flavoured cider, shots and spirits with different mixer drinks ¹⁵. **The current trend of binge drinking has not been alluded to in any study.**

Most studies had less than 10 participants (n=10 studies), and participants were predominantly male (n=11), with participants acting as their own control (n=12). The impact on self-care of using newer technologies such as insulin pumps and flash glucose monitoring has not been studied, nor the impact of more recently available insulin analogues.

Recommendations for self-care strategies to reduce the risks of alcohol consumption in people with T1DM.

The recommendations from ‘diabetes associations’ mainly promote alcohol avoidance and this advice can be futile ⁷. There are various issues that require consideration when contemplating why blood glucose disparities occur and how they can be prevented in T1DM, and from our review we identified six underlying themes (see table 3). These themes interact and must be considered as a whole for patient education and subsequent self-care. Hence, it would be advantageous to examine all of these in future studies. The biochemical response to alcohol, exogenous insulin, the presence and timing of carbohydrate food consumption, the constituents and amount of alcohol in individual beverages, can all have an important impact on glucose homeostasis. The actual cognitive effect of alcohol can also affect adversely awareness of hypoglycaemia and the ability to treat such episodes ^{5,9,26}.

For patient education, we are not aware of any exploratory research findings being developed into glycaemic prevention strategies for real-life. Two studies investigated self-care preventative strategies regarding insulin adjustment and carbohydrate intake but the corresponding effect on glucose was not described and so the effectiveness cannot be determined ^{16 28}. From the publications discussed in our review, key messages have been extracted for clinical practice and summarised in table 4.

Conclusion

In summary, there is a dearth of research evaluating self-care strategies for prevention of either hypo or hyperglycaemia when consuming alcohol, **and in particular for binge drinking**. Research in this area is required to inform patient education for people with T1DM. Different beverage types have different effects on blood glucose levels. Many people with T1DM currently adopt self-care behaviours based on individual trial and error with inherent risks associated. The introduction of flash glucose monitoring might improve self-care strategies but needs evaluation. However, it is important to highlight the risk of premature death and dangerous episodes of hypoglycaemia and hyperglycaemia, especially in YP with T1DM that can be as a result of drinking alcohol. As recommended by many of the authors cited, evidence based self-care guidelines are required. **From this review, the use of table 1, 3, and 4 could be used as a toolkit within education sessions when discussing alcohol consumption.**

Table 1: Alcoholic beverages with ABV and units of alcohol ¹²

Drink type, volume (ml) and ABV (10ml or 8g pure alcohol = 1 unit)	Units of alcohol per drink
Single small shot of spirits (35ml, ABV 40%)	1 unit
Single large shot of spirits (25ml, ABV 40%)	1.4 units
Alcopop (275ml, ABV 5.5%)	1.5 units
Small glass of red/white/rosé wine (125ml, ABV 12%)	1.5 units
Standard glass of red/white/rosé wine (175ml, ABV 12%)	2.1 units
Large glass of red/white/rosé wine (250ml, ABV 12%)	3 units
Bottle of lager/beer/cider (330ml, ABV 5%)	1.7 units
Can of lager/beer/cider (440ml, ABV 5.5%)	2 units
Pint of lower-strength lager/beer/cider (ABV 3.6%)	2 units
Pint of higher-strength lager/beer/cider (ABV 5.2%)	3 units

Table 3: Themes

Themes:	Components to consider
1. Acute complication risk	<ul style="list-style-type: none"> • Hypoglycaemia • Hyperglycaemia • Glucose variability
2. Physiological effects on glucose homeostasis	<ul style="list-style-type: none"> • Gluconeogenesis • Counter-regulatory hormones • Insulin sensitivity
3. Exogenous insulin	<ul style="list-style-type: none"> • Insulin type and time action • Evidence for insulin adjustment • Dawn phenomenon
4. Consumed carbohydrate	<ul style="list-style-type: none"> • Possible effects of the carbohydrate type and absorption
5. Cognition	<ul style="list-style-type: none"> • Cognitive effect of alcohol on self-care • Cognitive effect on hypoglycaemic awareness
6. Alcohol amount and type of beverage	<ul style="list-style-type: none"> • Units of alcohol and effects on BG levels • Differences between glucose-containing and glucose-free beverages.

Table 4: Key messages from original studies to apply into clinical practice and alcohol education for people using basal (intermediate/long-acting insulin) and bolus (fast-acting insulin) insulin.

Possible application of findings into real-life

General suggestions

In a fasting state, ethanol/alcohol given in a controlled environment does not affect insulin requirements, blood glucose or consumed glucose. External influences such as consumed carbohydrates, alcoholic drink ingredients, physical activity, and insulin doses must have an effect on the risk of hypo/hyperglycaemia¹³. Carbohydrate consumption is also used to deliberately cause hyperglycaemia as a hypoglycaemia prevention strategy⁹.

Alcohol can adversely affect a person to predict the blood glucose level accurately^{26,27}. During and after drinking alcohol it is important to check blood glucose levels regularly and not guess them. Alcohol can reduce the awareness of hypoglycaemia and it is important not to rely on autonomic symptoms and neuroglycopenic symptoms as these may be impaired. Hyperglycaemic symptoms can be confused with alcohol consumption i.e. thirst and polyuria²⁶.

People with a lower HbA1c may provoke a bigger risk of hypoglycaemia compared to more stable or higher glucose control²¹.

DKA risk is increased with high alcohol drinkers. If blood glucose is higher, a blood ketone test is recommended, especially for people with a high HbA1c⁸.

White wine and spirits usually lower the blood glucose

When drinking modest amounts, bolus and basal insulin doses may need reduced²¹.

However, when drinking white wine, there is an increased risk of ketosis if blood glucose higher (although still in normal range). If blood glucose higher and especially if drinking sweet wine, check blood glucose levels and if hyperglycaemic it may be useful to check for blood ketones²³.

Beer can cause hypo and hyperglycaemia

For a person with T1DM it would be useful to understand the effects of alcohol and carbohydrate content of beer. A low CHO (3-7g) content beer (per half-pint or 1 unit of alcohol), with 5% or less ABV should cause less glycaemic effects¹⁷.

Low <5% ABV and ordinary or high carbohydrate beer, can cause hyperglycaemia^{17,18}.

High >5% ABV and low CHO beer, may cause or increase the risk of hypoglycaemia within 3 hours after consumption¹⁷.

Red wine can cause hyperglycaemia

Two glasses of wine consumed with a low GI meal does not appear to cause glycaemic risks.

When drinking red wine at lunchtime, increased bolus insulin may be required to prevent post-prandial hyperglycaemia (depending on the amount of alcohol consumed)^{11,22}.

References

1. Laffel, L. Lost in Transition: Finding a Path Forward for Young Adults with Type 1 Diabetes. *Diabetic Medicine* 2018; 35 (8): 1061-062.
2. Office for National Statistics. *Adult Drinking Habits in Great Britain: 2017*.
3. McLean J, et al. *Scottish Health Survey 2016*. Scottish Government: Edinburgh.
4. Hogendorf, A, et al. Alcohol and Cigarette Use among Adolescents with Type 1 Diabetes. *European Journal of Pediatrics* 2017; 176 (6): 713-22.
5. Pastor, A, et al. Alcohol and Recreational Drug Use in Young Adults with Type 1 Diabetes. *Diabetes Research and Clinical Practice*. (2017); 130: 186-95.
6. Wright, R, et al. Factors Influencing Glycaemic Control in Children with Type 1 Diabetes. *Diabetic Medicine* 2008; 25(3): 375-76.
7. Tetzschner, R, et al. Effects of Alcohol on Plasma Glucose and Prevention of Alcohol-induced Hypoglycemia in Type 1 Diabetes—A Systematic Review with GRADE. *Diabetes/Metabolism Research and Reviews* 2018; 34 (3)
8. Hermann, J, et al. Self-reported Regular Alcohol Consumption in Adolescents and Emerging Adults with Type 1 Diabetes: A Neglected Risk Factor for Diabetic Ketoacidosis? Multicenter Analysis of 29 630 Patients from the DPV Registry. *Pediatric Diabetes* 2017; 18 (8): 817-23.
9. Pastor, A, et al. Experiences of Young Adults with Type 1 Diabetes While Using Alcohol and Recreational Drugs: An Interpretative Phenomenological Analysis (IPA) of Semi-structured Interviews. *Diabetes Research and Clinical Practice* (2018); 141: 47-55.
10. Charlton, J, et al. The Challenges of Type 1 Diabetes and New Psychoactive Substance Misuse. *Practical Diabetes* (2018); 35 (3): 81-85a.
11. Avogaro, A, et al. Metabolic effects of moderate alcohol intake with meals in insulin-dependent diabetics controlled by artificial endocrine pancreas (AEP) and in normal subjects. *Metabolism: Clinical And Experimental*. 1983; 32: 463-470.
12. NHS. *Alcohol Units*. 2019.
13. Moriarty, K, et al. Does ethanol cause hypoglycaemia in overnight fasted patients with Type 1 diabetes? *Diabetic Medicine* 1993; 10: 61-65.
14. Koivisto, V, et al. Alcohol with a meal has no adverse effects on postprandial glucose homeostasis in diabetic patients. *Diabetes Care* 1993; 16: 1612-1614.
15. Ismail, D, et al. Social consumption of alcohol in adolescents with Type 1 diabetes is associated with increased glucose lability, but not hypoglycaemia. *Diabetic Medicine*, 2006; 23: 830-833.
16. Grando, M, et al. Characterization of Exercise and Alcohol Self-Management Behaviors of Type 1 Diabetes Patients on Insulin Pump Therapy. *Journal of Diabetes Science and Technology* 2017; 11 (2): 240-46.
17. Henderson, B, et al. The effect of different beers on blood glucose concentrations in insulin-dependent diabetes. *Practical Diabetes* 1987; 4 (6); 286-285.
18. Spraul, M, et al. Glycemic effects of beer in IDDM patients. Studies with constant insulin delivery. *Diabetes Care* 1988; 11: 659-61.

19. Kerr, D, et al. Influence of acute alcohol ingestion on the hormonal responses to modest hypoglycaemia in patients with type 1 diabetes. *Diabetic Medicine* 2007; 24: 312-316
20. Richardson, T. et al. Day after the night before: influence of evening alcohol on risk of hypoglycemia in patients with type 1 diabetes. *Diabetes Care* 2005; 28: 1801-1802
21. Turner, B. et al. The effect of evening alcohol consumption on next-morning glucose control in type 1 diabetes. *Diabetes Care* 2001; 24: 1888-1893.
22. Gin, H. et al. Short-term effect of red wine (consumed during meals) on insulin requirement and glucose tolerance in diabetic patients. *Diabetes Care*, 1992;15; 546-548.
23. Kerr, D et al. The Influence of Liberal Alcohol Consumption on Glucose Metabolism in Patients with Type 1 Diabetes: A Pilot Study. *QJM: An International Journal of Medicine*, 2009; 102 (3): 169-74.
24. Government UK. The drink – drive limit. 2019.
25. Olson, K, et al. Relationship Between Blood Alcohol Concentration and Observable Symptoms of Intoxication in Patients Presenting to an Emergency Department. *Alcohol and Alcoholism*, 2013; 48 (4): 386-89.
26. Kerr, D, et al. Alcohol causes hypoglycaemic unawareness in healthy volunteers and patients with Type 1 (insulin-dependent) diabetes. *Diabetologia* 1990; 33: 216-221.
27. Fritsche, A, et al. Effects on blood glucose perception of exercise and alcohol in IDDM patients. *Diabetes, Nutrition and Metabolism - Clinical and Experimental*, 1995; 8: 324-330.
28. Groat, D, et al. Self-Reported Compensation Techniques for Carbohydrate, Exercise, and Alcohol Behaviors in Patients With Type 1 Diabetes on Insulin Pump Therapy. *Journal of Diabetes Science and Technology*, 2018; 12 (2): 412-14.