

Original Article

Alcohol Consumption as a Risk Factor for the Development of Type 2 Diabetes Mellitus in Patients at Hospital Central de Nampula, Northern Mozambique

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Abstract

Introduction: Diabetes mellitus (DM) is a disorder characterized by high levels of blood glucose. Biochemically, it is classified into type 1, type 2, and gestational diabetes. The factors associated with type 2 diabetes mellitus include obesity, sedentary lifestyle and alcoholism. We investigated the effect of alcohol on the development of type 2 diabetes mellitus in patients at Hospital Central de Nampula. **Material and Methods:** A laboratory-based and cross-sectional study was conducted. We quantified sugar and pH levels of popular beverages and analyzed 74 type 2 diabetes mellitus patients. **Results:** distilled beverages had a higher sugar amount (the mean value was 14.3%, 143g) than undistilled (4.33%, 43.3g). The pH showed no significant difference, and it was approximately 4. Overall, type 2 diabetes mellitus alcohol consumers were 30 (40.5%) and the majority 44 (59.5%) were non-alcoholic. Most of those deemed type 2 diabetes mellitus patients had a first-degree family history of DM (47.3%; n= 35). The other 27 (36.5%) had no family history, and 12 (16.2%) did not know. Of the 27 patients with no DM family history, 16 (59.3%) consumed alcohol before the disease diagnosis, and most of them consumed undistilled beverages. The other 11 (40.7%) did not consume alcohol. Despite alcohol consumption, frequency and level were moderate. **Conclusion:** Our results strongly suggest that previous alcohol consumption is not a factor for the development of type 2 diabetes mellitus.

Keywords: Alcohol, Type 2 diabetes mellitus, Patients

Introduction

Diabetes mellitus (DM) is a chronic disease characterized by a disorder of the glucose homeostasis, triggering high levels of blood sugar (considered chronic hyperglycemia [1]). It is a cause for growing public health problems both in developed and developing countries. From the year 2000 to 2030, the prevalence is expected to double worldwide, affecting about 439 million people [2,3] or 366 million people [4]. Other estimates, however, pointed to 556 million people by 2030 [5].

Diabetes mellitus is biochemically classified into type 1 diabetes mellitus (T1DM or insulin-dependent diabetes mellitus) and type 2 diabetes mellitus

(T2DM or non-insulin-dependent diabetes mellitus). Gestational diabetes is also described [6]. T1DM results from an absolute lack of insulin secretion due to β -cells dysfunction, while T2DM is caused by insulin deficiency and insulin resistance [7, 8]. T1DM has, generally, a genetic basis, while T2DM has a mainly environmental background that interacts with the genetic profile. However, it is known that both conditions that cause DM may occur at the same time, although with lower prevalence. T2DM is the most prevalent type in the world, present in 90-95% of DM patients, and it is actually extending towards the young population [7].

Recent advances show that T2DM is also an inflammatory disorder, and the inflammation plays a role



in numerous known complications of the pathology [8]. This disorder is the biochemical basis of long-term hyperglycemia and a cascade of degenerative complications that includes cardiovascular abnormalities, retinopathy, nephropathy, and neuropathy [2,7, 9]. It also causes psychological and sexual dysfunction in males and females [10, 11], along with gastrointestinal disorders [12]. T2DM is the leading cause of amputations in developing countries. The International Diabetes Federation estimates that 1.25 million diabetes-related amputations are performed in South and Central America [4]. So far, several therapeutic agents with a hypoglycemic effect have been developed for the treatment of T2DM [7], but dietary restrictions and practice of physical exercises play an important role in its control [4].

Many other factors, including obesity and a sedentary lifestyle, are described to be associated with T2DM. In addition, loss of first-phase of insulin release, abnormal pulsatility, and increased glucagon secretion and release also accelerate the development of T2DM [3]. On the other hand, chronic alcohol consumption is considered to be a potential risk for the development of type 2 diabetes mellitus. Chronic alcohol consumption disrupts glucose homeostasis, causes pancreatic β -cells dysfunction and insulin resistance in key metabolic tissues such as skeletal muscles, liver and adipose tissue. All these conditions are a biochemical prerequisite for the development of T2DM. However, epidemiological and controlled clinical data on the relationship between the amount of ingested alcohol and the incidence of T2MD are reported to be inconsistent in the literature. Some researchers state that heavy alcohol consumption is potentially harmful [13] whilst others report a beneficial effect of alcohol, such as a protective effect or increased insulin sensitivity, thus decreasing the risk of T2DM when consumed moderately. Others assume that there is no effect on health in case of alcohol consumption. Furthermore, whether the effect varies according to gender, no relevant data has been found [14].

Although it was a long-term controversy on the diabetogenic impact of alcohol, recent advances have elucidated this relation. Additionally, neurobiological profiles of alcoholism are linked to the effect of disruption of glucose homeostasis and insulin resistance, which are affected by the altered appetite that regulates the peptides and neurotrophic factors. Thus, T2DM is clinically recognized as a complication of alcoholism, and both alcoholism and DM affect a large population worldwide. Heavy amounts of alcohol contribute to excess caloric intake and obesity, induce pancreatitis, disturbance of the metabolism of carbo-

hydrates, and impairment of the liver function, which proves the direct diabetogenic effect of alcohol [14].

Against the above background, we investigated whether or not alcohol consumption is related to the development of type 2 diabetes mellitus in a defined group of patients at Hospital Central de Nampula [HCN], Northern Mozambique.

Material and Methods

Study design and patients

We included in the study most of the local beverages with a large circulation and type 2 diabetes mellitus patients. Our study was laboratory-based and cross-sectional, comprising two stages. For the first stage, we quantified the total sugar of distilled and undistilled beverages of large circulation in Nampula. The pH was measured only in undistilled beverages. In the second stage, we screened the deemed type 2 diabetes mellitus patients assisted in the department of endocrinology at Hospital Central de Nampula in order to bear out the family history of diabetes, previous alcohol consumption, and time of alcohol exposition. We included confounding factors in the questionnaire, such as a family history of diabetes, consumption of energy beverages, and other related metabolic diseases to avoid misinterpretation of the results.

The applicability of the questionnaire was assessed through a pretest conducted with five T2DM patients at Hospital Geral de Marrere, Nampula. All ethical procedures were respected based on the World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects, 2013. The research was conducted upon approval by the Ethics Committee of Lurio University.

Quantification of total sugar

The total sugar of distilled and undistilled beverages was quantified from beverages of large circulation and easy-to-get for the local population. The beverages were codified by a combination of letters and numbers (the letter "A" for undistilled beverages followed by numbers from 1 to 8 and the letter "B" for distilled beverages followed by numbers from 1 to 2). For beverages included in the A group, we analyzed the total sugar and pH of canned and bottled beverages to exclude a possible difference among them.

For group B, no additional procedure was held. Sugar and pH were measured by refractometer and pH meter, respectively. For sugar quantification, we made three copies, and the mean was calculated.

Data analysis

We applied the statistical software (SPSS, v. 20) for the processing of quantitative data and the chi-square test for qualitative variables. We fixed a confidence level of 95% and a probable error of 5% ($p = 0.05$).

Results

Distilled beverages have higher amount of sugar than undistilled ones.

We quantified the total sugar using 500uL from 16 types of beverages (3 distilled and 13 undistilled) to

assess which group of beverages may offer a higher risk for the development of type 2 diabetes mellitus. We found a higher amount of sugar in distilled beverages (Figure 1) than undistilled ones (Figure 2). The acidity of undistilled beverages showed no relevant difference (mean values was 3.734).

Type 2 diabetes mellitus generally occurs in elderly and men are the most affected

We inquired 74 T2DM patients (44 men and 30 women) in order to understand alcohol consumption in relation to the development of T2DM. We found that 40-years-old and above (Figure 3) was the age with a high prevalence of T2DM (91.89%, $n = 68$), and men (59.5%, $n = 44$) seem to be more affected by diabetes compared to women. Most of the participants went to school (93.2%, $n = 69$), and a considerable amount of them (47.3%, $n = 35$) were unemployed. We furthermore explored whether alcohol consumption by the

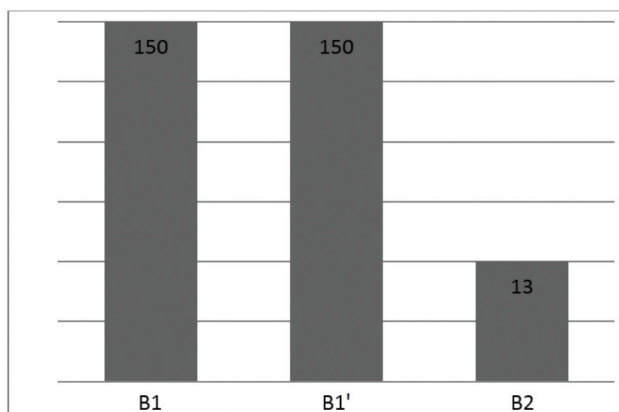


Figure 1: Total sugar in grams of distilled beverages. Acidity was not measured. The B1 and B' refers to same brand but the samples were collected in different places to assess possible fabrication divergences.

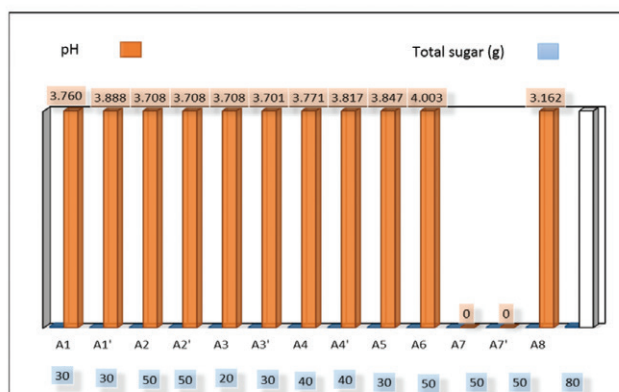


Figure 2: pH and total sugar in grams of undistilled beverages. The lower sugar amount was found in A3 with 20 g and the highest in A8, with 80 g. The A1 and A1' represent bottled and canned beverages, respectively, which show no difference in sugar content, suggesting that the formula may be similar. The difference between the A1 and A2 groups may be explained by the time and amount of each component (malt, hop, water and yeast) is added or by the fermentation time. No relevant differences in pH were found in this group of beverages. A3 and A3' are the same brand but were produced using different raw materials. For the A7 and A7' beverages, pH was not measured.

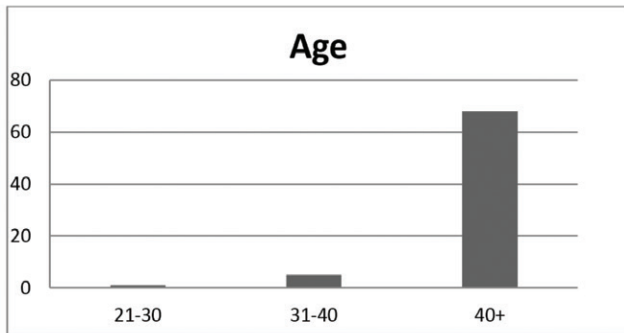


Figure 3: The prevalence of diabetes mellitus by age. The age of 40-years-old and above showed a higher prevalence of T2DM. In addition, the data also show clearly that T2DM may also occur in early ages.

patients was associated with gender, but no statistically significant difference was found ($p > 0.05$) between men and women (Figure 4). On the other hand, we found a relationship between the socioeconomic status with the type of alcohol consumed more frequently. Employed people had the tendency to drink more undistilled beverages than distilled (data are not shown), and drank moderately; eventually, this group might have a lower risk of developing T2DM. We then tested whether employment could have increased the risk of developing T2DM in those patients. The chi-square test has shown no statistically significant difference ($p > 0.05$) between employment and unemployment related to alcohol consumption, and consequently, the development of type 2 diabetes mellitus.

Family history of diabetes mellitus is a key risk factor for the development of diabetes mellitus in the relatives

Literature studies have stated that T2DM is mainly environmental, but the genetic profile can also play an important role in the development of the disease [3]. We sought to explore whether there was a DM genetic trait for those patients deemed to have T2DM because we suppose an error in diagnosing could mislead our conclusions with regard to the role of alcohol on the development of T2DM. We found that 35 (47.3%) of the patients had at least a family member with a type of diabetes mellitus. When asked the degree of kinship, we established that 97% (34) had a first-degree relative, including father, mother, brother, uncle, cousin and grandfather. Only one had a brother-in-law with diabetes (Table 1). Additionally, a huge number of patients learned about their condition in the last five years. This fact may, on the other hand, increase the risk of com-

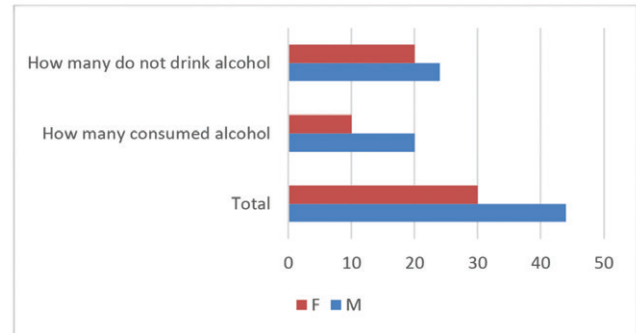


Figure 4: Alcohol consumption by gender. Data show that male and female consume alcohol almost equally. Similarly, the number of non-alcoholic does not differ between them.

plications of the disease. A chi-square test showed a statistically significant relation ($p < 0.05$) between family history of diabetes and T2DM. Thus, people with diabetes mellitus genetic profiles are more likely to develop T2DM than those with no family history of the disease. Indeed, the World Health Organization (WHO) states that individuals with a family history of diabetes have two to six times increased chances of developing T2DM.

Alcohol consumption may be a risk factor for type 2 diabetes mellitus

We shortlisted 27 patients with no diabetes mellitus family history to understand whether or not alcohol consumption could be considered a causal factor for T2DM. Results showed that 16 (59.3%) reported having consumed alcohol before the disease was diagnosed, and undistilled beverages were more frequently consumed. The other 11 (40.7%) stated that they did not consume alcohol. From those who answered positively, 62.5% ($n = 10$) had been consuming alcohol for more than five years, 31.25% ($n = 5$) within five years, and one (6.25%) for less than three years. In fact, for this small group (10), the five years of alcohol consumption curiously overlaps the time they had learned about their T2DM condition. This finding stresses the claim that alcohol may represent a risk factor for the development of T2DM. However, this fact contradicts with the frequency, and the level of alcohol they stated to have consumed (Table 2). We additionally explored the type of beverage, time exposition of those patients with no diabetes mellitus family history in order to hint a cause-effect relationship between alcohol consumption and T2DM. Among undistilled beverages, the A1 (3% sugar) beverage was the most consumed, whereas for distilled, B1 (15%) was the most consumed. Some used to

combine A1 and B1. The main reasons behind the choice are the social status and cultural aspects. Regarding the amount of undistilled beverage, a few participants (16.7%, n= 5) said that they usually took six or more bottles (550mL) each time they had to drink, mainly on the weekends. The greatest part (50%, n= 14), therefore, stated that they used to take about two bottles (550mL) by the time they had to drink, mainly on weekends as well. On the subject of distilled beverages, 50% (n= 3) consumed about six bottles (200mL) and the other 50%

(n= 3) consumed two to four bottles (200mL). A combination of those took distilled and distilled (100%, n= 2). Although some participants (16.7%) used to drink about six or more bottles of alcohol (what exceeded the 21 g/day for male and 11 g/day for female recommended by the World Health Organization), they usually affirmed to not drink every day. The same condition is applied to the other frequencies. However, it is also largely known that a high amount of alcohol intake is in the origin of cell toxicity.

Table 1: Family history of diabetes mellitus. Most of the patients reported to have a family member with a type of diabetes mellitus. The majority of cases involved a first-degree family member and a brother-in-law was mentioned in only one case.

Do/did you have/had a family member with diabetes mellitus?	Frequency	Percentage
Yes	35	47.3
No	27	36.5
I do not know	12	16.2
Total	74	100
If yes, what is the kinship?		
Father	12	34.3
Brother	11	31.4
Father and mother	4	11.4
Mother	3	8.6
Uncle	2	5.7
Brother-in-law	1	2.9
Cousin	1	2.9
Grandfather	1	2.9

Table 2: Alcohol consumption associated with time of exposition. Most of the inquired stated that they have been drinking for more than five years, which shows the large time of exposure to alcohol.

Question	Frequency	Percentage
Did you drink alcohol before you were diagnosed with T2DM?		
Yes	16	59.3
No	11	43.7
Total	27	100
If yes, how long have you been drinking?		
Below 3 years	1	6.3
3 - 5 years	5	31.3
More than 5 years	10	62.5
Total	16	100

Consumption of energy beverages is a common practice among alcohol drinkers

It is a common belief among alcohol drinkers that taking energy beverages after, or sometimes before, the consumption of alcohol reduces the effect of hangover. Others also believe that a combination of dry beverages with a soft drink or any sweetened drink decreases the effect of drunkenness. So, we sought to rule out the possibility of reaching an erroneous conclusion about the development of T2DM due to a confounding factor. Firstly, we quantified the total sugar of two energy drinks, C1 and C1', and found 10% of sugar in both. Secondly, we questioned the participants whether they used to drink energy drinks before the disease and the frequency of drinking. We inquired 27 patients with no DM family history, and 85.2% (16) of the patients admitted to consuming energy drinks, and 14.8 (11) did not. The most ingested drink was C1, 68.8% (11), and most of them affirmed to drink between two and four cans within a month. Additionally, they used to drink the beverages whenever they needed to get appetite after drinking and when they worked night shifts. The high amount of sugar (20 or 40%) might have increased the risk for the development of T2DM rather than alcohol consumption in those patients.

Other metabolic disorders can be considered risk factors of diabetes mellitus or appear as a complication of the disease.

Similarly, to prevent the risk of having misconceptions, we explored the possibility of the T2DM to appear as a consequence of metabolic diseases and not necessarily to be caused by alcohol consumption

or other factors. As a result, 60.8% (n= 45) affirmed to suffer from another pathology, but the rest (39.2%, n= 29) did not have any. Most of those who responded positively had arterial hypertension (53%, n= 39). The remaining (47%, n= 6) are distributed among infectious and heart disease. When questioned about which disease they had first, 43.2% (n= 32) referred to diabetes mellitus, and the other 56.8% (42) had hypertension, heart, and infectious diseases (Figure 5). These data highlight that, in fact, there is a chance that those metabolic and infectious diseases may have acted as risk factors for T2DM and are not a complication of DM.

Discussion

Type 2 diabetes mellitus describes a group of metabolic disorders caused by insulin resistance [5] in the cells. T2DM is a worldwide important public health problem that is expected to double in the next years [15]. Its risk factors include obesity, sedentary lifestyle, and alcohol consumption. Although there is a discrepancy regarding the effect of alcohol in the organism, some literature studies have associated chronic alcohol consumption with the development of T2DM [13].

In this study, we investigated whether or not alcohol was a causal factor of type 2 diabetes mellitus in the patients assisted at the Hospital Central de Nampula. Similar to what other reports have established, we found that distilled beverages have a higher amount of sugar compared to undistilled ones. The prevalence of T2DM was higher in men (59.5%) than women (40.5%), similar to the study by Marín-Peñalver et al. [9,16] where a higher prevalence of T2DM was found in older men. We also found that almost half of the participants

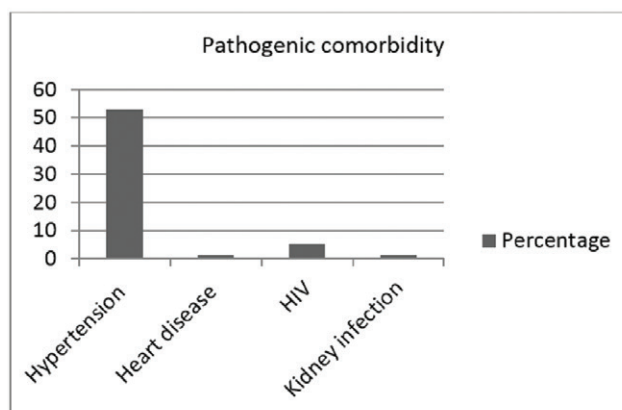


Figure 5: Metabolic diseases and infections in patients with T2DM. The most prevalent disease among those patients was hypertension. A low prevalence was found in the other reported comorbidities, including infectious diseases.

47.3% (35) had a family member with DM, and in 97% (34) of cases, a first-degree relative was involved, suggesting that type 2 diabetes genes may contribute to the risk for T2DM if environmental factors are present.

Thus, we speculate that those patients develop T2DM as a result of a genetic predisposition rather than alcohol consumption.

Although the genetic risk of T2DM is considered low compared to T1DM, a family history of diabetes is important to be considered in T2DM [17]. Indeed, ample pieces of evidence show that type 1 and 2 diabetes are genetically determined. Despite the divergence on the effect of alcohol on DM [13], there is evidence of increased risk of DM development among alcoholics. Our study found that most of the inquired patients with no family history (59.3%) consumed alcohol during their life, which suggests that this environmental factor may have impacted, but not determined, type 2 diabetes mellitus. Different results were found in a review conducted by Koppes *et al.*, who pointed that alcohol consumers have a 21-36% lower relative risk of total mortality and 25-66% lower relative risk of total and fatal coronary heart disease (CHD) in T2DM alcoholic consumers compared to non-consumers [18]. This difference may be based on the consideration of the quantity of alcohol consumed, type of alcohol, and frequency of consumption, as indicated by Carlsson *et al.*, [13]. These authors stated that increased risk results from higher alcohol consumption. In this study, distilled beverages had a higher amount of sugar, and they were less consumed than undistilled. The frequency of consumption was moderate based on the WHO parameters, the reason why the results suggested that there might be no relationship between alcohol consumption and the development of T2DM in those patients.

In addition, it is a belief among alcohol consumers to consume energy drinks to resolve the effect of a hangover or minimize the strength of alcohol. Thus, we explored if the patients have also used energy drinks before their DM diagnosis to rule out an important confounding factor. With this exercise, we wanted to verify whether T2DM was eventually caused by alcohol consumption and not by energy drinks. We found that most of the patients (with no diabetes mellitus family history) consumed energy drinks before the disease, suggesting that it might have a contribution to T2DM, in concurrence with other factors. A similar study conducted by Palmer and coworkers investigating the association of sugar-sweetened drinks with type 2 diabetes mellitus found that regu-

lar consumption of sugar-sweetened soft drinks and fruit drinks was associated with an increased risk of type 2 diabetes mellitus in African American women [19]. Another study by Malik, Popkin and Bray from 2010 found a strong and consistent association between sugar-sweetened beverages and type 2 diabetes mellitus [20]. Although a huge number of literature studies have associated alcohol consumption and the incidence of type 2 diabetes mellitus, we found no statistically significant association in this regard in the analyzed patients. These results suggest that, rather than alcohol, any other factor such as energy drinks may have played an important role in the development of T2DM, specifically those with no diabetes mellitus family history. Thus, further contextual studies are needed to gather a couple of other factors to understand the biochemical basis of the pathology. Finally, we are also fully aware that each of these factors alone might have no relevance or have a weak role in the development of T2DM, but altogether the effect may be powerful.

Conclusions

The laboratory assay showed that distilled beverages had a higher amount of sugar compared to undistilled ones. Most of the T2DM patients with and without DM family history stated they do not consume alcohol. Although a great number of patients with no family history of diabetes mellitus reported consuming alcohol, the frequency was moderate. In addition, a considerable number of those classed as people with diabetes had a first-degree family member with diabetes mellitus. Thus, we found no direct relationship between alcohol consumption and the development of type 2 diabetes mellitus in those patients. Thus, other relevant factors triggering type 2 diabetes mellitus should be unveiled in the patients. Secondly, diagnosing type 2 diabetes mellitus should be as accurate as possible to prevent the disease's long-term complications.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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