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Effects of pure ethanol and alcopops on glucose, insulin, and the insulin-like growth factor system in healthy subjects

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Abstract

Introduction: Alcohol induces disturbances in insulin-like growth factor-I (IGF-I) and IGF binding protein-1 (IGFBP-1) levels. The aim of the present study was to compare pure ethanol and alcopop effects on total and free IGF-I, IGFBP-1, IGF-I:IGFBP-1 complex, insulin and plasma glucose levels in healthy subjects.
Methods: Five males and seven females (21–51 years) consumed pure ethanol and alcopops with identical alcohol content in a cross-over design after 6 h fasting. Blood samples were obtained for determination of serum ethanol and plasma glucose at 0, 30, 60, 90, 120 and 180 min. Serum total and free IGF-I, IGFBP-1, IGF-I:IGFBP-1 complex, and insulin were measured at 0, 60 and 180 min.
Results: Area under the curve for serum ethanol concentration was significantly less following alcopop compared to pure ethanol (1124 ± 201 vs. 1691 ± 359 mmol/L h, $P < 0.01$). Serum insulin and glucose levels were unchanged by ethanol while alcopop intake was followed by a transient increase in glucose and insulin levels ($P < 0.05$). Pure ethanol and alcopop reduced free IGF-I levels by the end of the study period ($P = 0.05$). IGFBP-1 and the IGF-I:IGFBP-1 complex increased following ethanol intake ($P < 0.05$) while only a small transient IGFBP-1 increase was observed following alcopop intake. No change in total IGF-I was observed.
Conclusion: Both drinks resulted in reduced free IGF-I levels, however, only pure ethanol increased IGFBP-1 and the IGF-I:IGFBP-1 complex. Alcopop intake was associated with a transient increase in IGFBP-1 and unchanged IGF-I:IGFBP-1 complex levels probably due to marked changes in insulin and glucose levels.

Keywords: IGF-I; Free IGF-I; Glucose; IGFBP-1; Insulin; Ethanol; Alcopops

1. Introduction

The Danish Department of Health and International Surveys have observed Danish teenagers to have one of the highest alcohol intakes in the world [1]. During the last few years alcopops, a soft drink or lemonade containing both alcohol (5.6 vol%) and sugar (88 g sucrose/L) have dominated the market and they are especially popular among teenagers.

Several studies on acute and chronic alcohol ingestion have been performed in rodents and humans. It has been a consistent observation that alcohol reduces circulating levels of insulin-like growth factor I (IGF-I) and increases IGF binding protein 1 (IGFBP-1), probably via an effect mediated at the hepatic level [2]. Changes in IGF-I levels during alcohol intake may have significant effects on protein metabolism directly or indirectly via reduced bioactivity of IGF-I.

Circulating IGF-I is bound to specific IGFBPs, which may function as carriers of IGF-I and inhibitors as well as stimulators of the biological effects of IGF-I [3].

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IGFBP-1 is inversely correlated to insulin levels and is a major determinant for free IGF-I levels, which is believed to be the biologically active form of IGF-I. Recently, we have developed an assay for the binary complex of free IGF-I and IGFBP-1, which may be used to study the role of IGFBP-1 as a dynamic regulator of free IGF-I [4]. Both ethanol and alcopops, the latter containing ethanol and sugar, may influence IGFBP-1 and insulin levels and thus modulate free IGF-I levels. However, no clinical data on changes in free IGF-I after alcohol consumption have been published so far. Further, as alcopops are most frequently consumed by teenagers it is interesting to examine changes in glucose, insulin, and the IGF system as this may have an impact on their body growth.

The aim of the present study, therefore was to examine the effect of pure ethanol and alcopops on plasma glucose and circulating total and free IGF-I, IGFBP-1, and insulin levels in fasting healthy individuals. In addition, we examined the binary IGF-I:IGFBP-1 complex formation, which has never been examined following alcohol intake.

2. Materials and methods

Twelve healthy subjects, five men and seven women, were invited to participate in the study (Table 1). They had no familial history of diabetes, liver disease, and received no daily pharmaceutical drugs. Clinically no hepatomegaly or other signs of liver disease was observed. History of alcohol consumption was carefully recorded and none of the subjects were alcohol abusers as alcohol intake were below maximum recommended intake by The Danish Department of Health (<252 g alcohol/week for men and 168 g/week for women). The participants were not allowed to drink alcohol within 48 h before the day of investigation, which took place at two occasions separated by two weeks in a randomised cross-over design. On one occasion pure ethanol was ingested and on the other alcopop. Men received at each occasion 36 g ethanol and women 24 g regardless of intake of pure ethanol or alcopop. This is equivalent to the recommended daily maximum dose by The Danish Department of Health. The study was performed following at least 6 h of fasting in the afternoon and the two products were consumed within 15 min.

Table 1
Age, weight, body mass index (BMI), and the minimum and maximum (special occasion's) weekly alcohol consumption (g) in the 12 healthy individuals

	Men	Women
Number	5	7
Age (years)	36.5 (21–52)	35.4 (22–51)
Body weight (kg)	88.1 (80.0–96.5)	75.7 (54.2–87.0)
BMI (kg/m^2)	26.0 (23.3–27.5)	23.9 (18.4–26.3)
Smoker	1	1
Medical drugs	0	1[a]
Natural medicine	0	0
Minimum alcohol consumption (g/week)	108 (24–180)	72 (24–96)
Maximum alcohol consumption (g/week)	156 (72–240)	120 (72–168)

In addition, smoking and prescription medicine is provided. (Data are given as mean and range.)
[a] Periodic glucocorticoid inhalation due to mild asthma.

Table 2
Shows the quantity of pure ethanol and alcopop consumed by the healthy individuals

	Men	Women
Alcohol quantity	36 g	24 g
Pure ethanol 40.0 vol%	113 ml	75 ml
Energy intake pure ethanol	1.080 kJ	0.720 kJ
Smirnoff Ice 5.6 vol%	804 ml	536 ml
Energy intake Smirnoff Ice	2.247 kJ	1.499 kJ

Men received 36 g ethanol and women 24 g, which is recommended as daily maximum dose by The Danish Department of Health. The amount of energy (kilo Joule, kJ) of pure ethanol and alcopop are given as well.

Table 2 shows the ingested volume and content of the two drinks to obtain a similar blood alcohol concentration in men and women. Venous blood samples were obtained for determination of serum ethanol, and plasma glucose concentrations at 0, 30, 60, 90, 120 and 180 min post drinking, whereas serum total and free IGF-I, IGFBP-1, IGF-I:IGFBP-1 complex, and insulin were measured at 0, 60 and 180 min.

3. Standard laboratory tests

Hemoglobin, hematocrit, mean corpuscular volume (MCV), leukocytes, C-reactive protein, albumin, thrombocytes, ethanol, alanine aminotransferase/aminase (ALAT), γ-glutamyltransferase (GGT), alkaline phosphatase, levels of bilirubin, coagulation factors II, VII, X, were measured using standard laboratory methods, traceable to international reference.

4. Specific immunoassays

Measurement of serum total IGF-I was performed after acid ethanol extraction of the IGFBPs using non-competitive time-resolved monoclonal immunofluorometric assays (DELFIA, Perkin–Elmer Life Sciences, Turku, Finland) as previously described [5] with intra- and interassay coefficient of variation (CV) less than 5% and 10%, respectively. Serum-free IGF-I was determined using ultrafiltration by centrifugation as