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Open HUB for Scientific Research

ISSN 2380-5528

Obesity: Open Access

Research Article Volume: 2.3 Open Access

Correlations among Various Foods Uptakes and Body Mass Index (BMI) or Plasma Parameters

Shimizu F[1], Ogawa M[1], Takao T[1], Ishii Y[1] and Takada A[2]*

[1]*Human Life and Environmental Sciences, Showa Women's University, Tokyo, Japan*
[2]*International Projects on Food and Health (NPO), Sumida-ku Ishiwara, Tokyo, Japan*

***Corresponding author:** Takada A, International Projects on Food and Health (NPO), Sumida-ku Ishiwara 1-30-6-802, Tokyo 130-0011, Japan, Tel: 81338291849; Fax: 81338291847; **E-mail:** takadaa@mwd.biglobe.ne.jp

Received date: 01 Sep 2016; **Accepted date:** 01 Nov 2016; **Published date:** 07 Nov 2016.

Citation: Shimizu F, Ogawa M, Takao T, Ishii Y, Takada A (2016) Correlations among Various Foods Uptakes and Body Mass Index (BMI) or Plasma Parameters. Obes Open Access 2(3): doi http://dx.doi.org/10.16966/2380-5528.123

Abstract

Foods uptakes and Body Mass Index BMI of healthy young and old men were measured by self-administered questionnaires. Blood samples were taken at fasting times and levels of various plasma parameters were measured. There were no correlations between sucrose and sweet beverage uptakes and BMI or fasting blood glucose levels. No correlations were found between sucrose and sweet beverage uptakes and TG (triglycerides) or Low density lipoprotein (LDL)-cholesterol levels. Total amino acids, total non-essential amino acids, and total essential amino acids levels decreased in young men, who took more sucrose and sweet beverage. BMI significantly increased in young and old men whose insulin levels were high. There were no correlations between BMI or plasma parameters and the amount of energy, protein, lipid or carbohydrate uptakes. These results may suggest that in healthy non-obese young and old men sucrose and sweet beverage uptakes are not related to increase in BMI and any particular kind of food uptake is not related to increase in BMI.

Keywords: Sucrose; Sweet beverage; BMI; Insulin; Amino acids; Lipids

Abbreviations: BMI: Body Mass Index; TG: Triglycerides; LDL: Low Density Lipoprotein; HDL: High Density Lipoprotein; FFA: Free Fatty Acid; RLP: Remnant lipoproteins

Introduction

Obesity is caused by increased uptakes of foods and the low extent of exercise. There have been many reports indicating mortality risks are not only high in obese people, but in lean people too [1]. So it seems to be very important to know what kinds of foods are most closely related to the cause of obesity.

The research on obesity gave rise to intriguing results. It has been said that obesity is an epidemic. The obesity epidemic in the United States was said to have proven difficult to reverse. It has not been successful to help people sustain the eating and physical activity patterns that are needed to maintain a healthy body weight [2]. On the other hand, Vischer TL et al. [3] indicated that recent epidemiologic papers are presenting prevalence data suggesting breaks and decreases in obesity rates. In Japan, energy uptakes have been slightly decreasing but the percentage of people with BMI higher than 25 kg/m^2 did not change much [4].

Sugar uptakes have been linked to increase in BMI so that sugar tax will be or has been imposed in UK or other countries [5]. In Japan, the consumption of sugar has been constantly decreasing [6]. Never the less, obesity rate has not been declined.

Although increase in energy uptake and sedentary life has been implicated to be main reason, some people are proposing hormonal mechanisms. Carbohydrate uptakes stimulate insulin release which transfers glucose into adipose tissue, causing obesity [7].

In the present research we tried to find what kind of correlations exist between foods, BMI and plasma levels of amino acids, lipids, glucose or insulin.

Methods

We asked male acquaintances older than 50 (n=44) and male college students (n=48) to join the experiments, checked their health carefully and recruited them if there were no health problems such as diabetes, hypertension and not serious diseases experienced in the past. They did not smoke in the past. We obtained informed consent prior to conducting the protocol which had been approved by the Ethical Committee of Showa Women's University (15-02) and NPO "International projects on food and health" (15-01).

Participants were given self-administered diet history questionnaires. We used BDHQ (brief-type self-administered diet history questionnaires). The characteristic of BDHQ is to use papers of questionnaires about dietary customs of past one month and participant described answers on each item by recollection of diets they took. This method is used for the dietary reference intakes in Japan. From these questionnaires, we calculated the intake of energy, carbohydrate, fat and protein.

Measurements of blood parameters

Participants were asked not to eat anything after 9.00 PM of the previous night and not to take breakfast. Blood was taken between 9.00 AM and 10.00 AM. We measured blood glucose from a finger stick (TERUMO kit) and other plasma factors were measured after the separation of plasma from the blood. Plasma of these samples was obtained by centrifugation and levels of amino acids and insulin were measured for backgrounds of these participants.

The samples were analyzed by Special Reference Laboratory SRL, Inc. (Tokyo Japan) using the UF-Amino Station®, which is the LC/MS system with an automated pre-column derivatization for simultaneous determination of amino acids (Shimadzu Corporation, Kyoto Japan). The original concept of this system were developed by Ajinomoto Co., Inc. (Tokyo Japan) for an automated method of major free amino acids in human plasma in the field of clinical chemistry [8,9].

The human plasma samples under the condition with EDTA-2Na were cryopreserved before the analysis. The thawed samples were deproteinized with acetonitrile followed by the amino acid analysis. Pre-column derivatization in the UF-Amino Station was automatically performed using an automated sample injector with the regent APDSTAG® (Wako Pure Chemical Industries, Ltd., Osaka Japan). Target free amino acids as derivatized compounds were separated under a reversed phase UHPLC condition and determined by the liquid chromatography mass spectrometer.

Insulin was measured by CLEIA (chemiluminescent immunoassay) method, Lipid and lipoprotein concentrations such as total cholesterol, HDL (high density lipoprotein), LDL (low density lipoprotein), and TG (triglyceride) were determined using a Polychem Chemistry Analyzer (Polymedco Inc.). FFA (free fatty acid) concentrations were measured by a gas chromatography.

Remnant lipoproteins (RLPs) were isolated from the serum to an immunoaffinity mixed gel containing Anti-apolipoprotein A1 and Anti-apolipoprotein B100 monoclonal antibodies (Japan Immunoresearch Laboratories, Takasaki, Japan) and the cholesterol and triglyceride concentrations of the unbound fraction were measured as RLP cholesterol and RLP-triglyceride, respectively.

Statistics

The results are presented as means ± SEM. Statistical significance of the differences between groups was calculated according by one-way ANOVA. When ANOVA indicated a significant difference ($p<0.05$) the mean values of the treatment were compared using Tukey's least significant difference test at ($p<0.05$). Spearman's correlation tests were used to examine statistical significance.

Results

Basic parameters of participants

Table 1 shows basic parameters of participants. Young men take more protein, lipid and carbohydrate than aged men. Blood glucose levels are higher in aged men than young men, but insulin levels are similar between aged and young men.

Correlation between sucrose and sweet beverage uptake and BMI or various plasma factors

Table 2 shows correlations between the uptake of sucrose and sweet beverage and BMI or various blood parameters. The uptake of sucrose and sweet beverage resulted in higher HDL-cholesterol levels in aged men. Total amino acids, essential amino acids non-essential amino acids levels decreased significantly when sucrose and sweet beverage uptakes increased in young men.

Subjects	Aged (n=44)	Young (n=48)	Significant difference
Age (years)	62.4 ± 9.6	20.8 ± 1.6	**
Length (m)	1.68 ± 0.07	1.72 ± 0.06	*
Weight (kg)	68.8 ± 10.9	65.5 ± 10.2	
BMI	24.3 ± 3.2	22.2 ± 3.3	*
Protein intake (g/day)	66.6 ± 28.8	69.3 ± 25.1	
Lipid intake (g/day)	49.1 ± 22.6	60.4 ± 24.8	*
Carbohydrate intake (g/day)	198.6 ± 89.4	271.5 ± 91.3	**
Blood glucose (mg/dl)	91.7 ± 16.3	78.9 ± 13.1	**
Insulin (μIU/ml)	6.19 ± 3.79	6.87 ± 4.19	

Table 1: Basic parameters of participants-Protein, lipid, and carbohydrate uptakes were calculated from self-administered questionnaires (Tukey's test was used for statistical analysis).
*$p<0.05$; **$p<0.01$
Ethanol uptakes were not shown here.

Correlation between lipid uptake and plasma lipids levels

Table 3 shows that lipids uptakes had nothing to do with plasma levels of cholesterol, TG, and RLP (remnant like lipoprotein). Since obese people have large amounts of fats, it is important to know whether increase in lipids uptakes may result in significant increase in plasma lipids levels. Our results do not support this hypothesis.

Correlation between lipid uptake and plasma amino acids levels

Table 4 shows that protein uptake had nothing to do with plasma levels of total AA (amino acids), total EAA (essential amino acids), and total NEAA (non- essential amino acids).

Correlation between carbohydrate uptake and plasma insulin, TG and blood glucose level

Table 5 shows that carbohydrate uptakes rather decreased plasma insulin levels I aged men. Carbohydrate uptakes are considered to result in obesity [7] and carbohydrate restriction diets are recommended by some people to reduce body weight. Our results do not support that increase in carbohydrate uptakes may result in increase in BMI.

Correlation between BMI and plasma factors

Table 6 shows that BMI is significantly correlated with insulin levels in aged and young men. BMI is correlated with LDL cholesterol and TG in young men. HDL-cholesterol is negatively correlated with BMI in aged men and LDL-cholesterol and TG were positively correlated with BMI in young men. These results may indicate that increase in BMI results in atherosclerosis by decreasing HDL-cholesterol in aged men or increasing LDL-cholesterol or TG in young men.

Correlation between BMI and various foods uptakes

Table 7 shows BMI had nothing to do with sucrose and sweet beverage uptake, or energy, protein, lipids, and carbohydrate uptakes.

Discussion

Recently, obesity is world-wide concern for health. In UK, new figures released by Cancer Research UK and Diabetes UK underline the current and likely future effect of the obesity epidemic. Obesity has been on the public health agenda for more than a decade in many countries without effect. A so called sugar tax will be imposed in UK in the forthcoming national UK childhood obesity strategy [6].

Are there any scientific evidences to prove that sugar uptake is a cause of obesity? As indicated before, in Japan, sugar consumption is constantly decreasing, but obesity rate and diabetes morbidity rate are increasing. We have shown that sucrose and sweet beverage uptake had nothing to do with BMI, fasting blood glucose levels [10].

In fact table 5 shows that increased uptakes of sucrose and sweet beverage not only do not increase BMI, but do not increase fasting blood glucose levels or insulin levels. Since insulin is a major factor to increase BMI, no increase in insulin levels by the uptakes of sucrose and sweet beverage does not support that sucrose is a major factor to cause obesity or that banning of sucrose uptakes alleviate obesity.

Recently, carbohydrate restriction diet has been very popular not only in Japan but world-widely. There are many papers indicating that carbohydrate restricted diet is more effective than fat restricted diet in reducing body weight [11-13]. However, meta-analysis of carbohydrate restriction showed that carbohydrate restriction brought about increase in total mortality and death rates by cardiovascular diseases [14].

	BMI and plasma factors	Aged (n=44) Correlation coefficient	Aged (n=44) Significance	Young (n=48) Correlation coefficient	Young (n=48) Significance
Sucrose and sweet beverage *vs.*	BMI (kg/m^2)	0.051	ns	0.166	ns
	Blood glucose (mg/dl)	-0.137	ns	-0.378	ns
	Insulin (μIU/ml)	-0.024	ns	-0.303	*
	HDL Chol. (mg/dl)	0.423	**	-0.067	ns
	LDL-Chol. (mg/dl)	-0.017	ns	-0.161	ns
	TG (mg/dl)	-0.193	ns	0.009	ns
	Total amino acids (μM)	0.221	ns	-0.496	**
	Total non essential AA (μM)	0.268	ns	-0.425	**
	Total essential AA (μM)	0.009	ns	-0.472	**

Table 2: Correlation between sucrose and sweet beverage uptake and BMI or various plasma factors
*p<0/05; **p<0.01; ns-non significance

	Analyses	Aged (n=44)		Young (n=48)	
		Correlation coefficient	Significance	Correlation coefficient	Significance
Lipids uptake *vs.*	HDL-Chol. (mg/dl)	0.150	ns	0.230	ns
	LDL-Chol. (mg/dl)	0.097	ns	-0.263	ns
	Total Chol. (mg/dl)	0.201	ns	-0.143	ns
	TG (mg/dl)	-0.044	ns	-0.133	ns
	RLP-Chol. (mg/dl)	-0.130	ns	-0.036	ns
	RLP-TG (mg/dl)	-0.233	ns	-0.140	ns

Table 3: Correlation between lipid uptake and plasma lipids levels
*p<0.05; **p<0.01; ns: non significance; Cho.l: Cholesterol; TG: triglyceride; RPL: Remnant-like lipoprotein

	Amino acids	Aged (n=44)		Young (n=48)	
		Correlation coefficient	Significance	Correlation coefficient	Significance
Protein uptake *vs.*	Total AA (μM)	-0.189	ns	-0.142	ns
	Total EAA (μM)	-0.178	ns	-0.042	ns
	Total NEAA (μM)	-0.148	ns	-0.173	ns

Table 4: Correlation between protein uptake and plasma amino acids levels.
*p<0.05; **p<0.01; ns: non significance; AA: Amino acids; EAA: Essential amino acids; NEAA: Non-essential amino acids

	Plasma factors	Aged (n=44)		Young (n=48)	
		Correlation coefficient	Significance	Correlation coefficient	Significance
Carbohydrate uptake *vs.*	Blood glucose (mg/dl)	-0.388	**	-0.015	ns
	Insulin (μIU/ml)	0.009	ns	-0.129	ns
	TG (mg/dl)	-0.114	ns	-0.010	ns

Table 5: Correlation between carbohydrate uptake and plasma insulin, TG and blood glucose level.
*p<0.05; **p<0.01; ns: non significance

	Plasma factors	Aged (n=44)		Young (n=48)	
		Correlation coefficient	Significance	Correlation coefficient	Significance
BMI *vs.*	Blood glucose (mg/dl)	0.151	ns	-0.142	ns
	Insulin (μIU/ml)	0.646	**	0.698	**
	HDL-Chol (mg/dl)	-0.303	*	-0.263	ns
	LDL-Chol (mg/dl)	0.177	ns	0.346	*
	TG (mg/dl)	0.221	ns	0.609	**

Table 6: Correlation between BMI and plasma factors.
*p<0.05; **p<0.01; ns: non significance

	Various foods uptakes	Young men		Aged men	
		Correlation coefficient	Significance	Correlation coefficient	Significance
BMI *vs.*	Sucrose and sweet beverage uptake (g/day)	0.051	ns	0.166	ns
	Estimated energy uptake (g/day)	0.075	ns	0.042	ns
	Estimated protein uptake (g/day)	0.111	ns	0.005	ns
	Estimated lipid uptake (g/day)	-0.207	ns	0.187	ns
	Estimated carbohydrate uptake (g/day)	0.085	ns	0.034	ns
	ns: non significance				

Table 7: Correlation between BMI and various foods uptakes.

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It is very important to know if increased uptakes of carbohydrate really increase BMI. Our results show in table 6 does not support the contention that increased uptakes of carbohydrate really increase BMI.

We wanted to know if increase in BMI is related to sugar and sweet beverage uptake and any specific food uptakes. Table 2 shows that sucrose and sweet beverage uptake did not cause increase in BMI. Total amino acids, essential amino acids, non-essential amino acids levels decreased upon uptake of sucrose and sweet beverage in young men. Decrease in amino acids levels was shown by Wurtman's group [15-17], and shown by our group. The decrease in amino acids levels after the administration of sugar is considered to be cause by increase in plasma levels of insulin [18,19]. Probably, young men are more sensitive to insulin in decreasing amino acids upon uptake of sugar. We found that insulin increased BMI significantly in age and young men.

As to relationship between insulin levels and obesity, a hormonal theory of obesity has been proposed [19-21]. Increase in insulin levels causes fat cells to incorporate glucose and to convert glucose to fat. Thus obesity is considered to be caused by increase in insulin levels. The data shown in table 6 show that BMI is closely related to increase in insulin levels.

The present data clearly show that no specific foods uptakes cause obesity in a normal range.

Acknowledgments

Experiments were designed and performed by all of the authors. AT wrote a manuscript. Statistical analyses were done by TT. All authors read the manuscript and approved the final version. All the authors had responsibilities for the final content.

Ethics

This work has been approved by the Ethical committees of Showa Women's University and NPO "International projects on food and health" and has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments.

Conflict of Interest

Authors declare there is no conflict of interest.

Financial Support

This study was supported by grants by Ito Memorial Foundation and NPO "International Projects on Food and Health."

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