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ORIGINAL CONTRIBUTION

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No evidence of insulin resistance in normal weight vegetarians

A case control study

Summary *Background* Diets rich in carbohydrates with a low glycemic index and with high fiber content are associated with flat post-prandial rises of blood glucose, minimal post-prandial insulin secretion and maintenance of insulin sensitivity. Protective food commodities in the prevention of cardiovascular disease, insulin resistance syndrome or diabetes are crucial components of the vegetarian diet. *Aim of the study* Insulin resistance values were assessed in relation to different nutrition. Metabolic abnormality is a predictor of age-related diseases and can be more pronounced in obese subjects. Insulin resistance values in normal weight subjects of two different nutritional habits were correlated with age. *Methods* Fasting concentrations of glucose and insulin as well as calculated values of insulin resistance IR (HOMA) were assessed in two nutritional groups of apparently healthy adult subjects (age range 19–64 years) with normal weight (body mass index 18.6–25.0 kg/m^2): a vegetarian group (95 long-term lacto-ovo-vegetarians; duration of vegetarianism 10.2 ± 0.5 years) and a non-vegetarian control group (107 subjects of general population on traditional western diet). Intake of energy and main nutrients (fats, saccharides, proteins) was similar in both groups. *Results* Glucose and insulin concentrations and IR (HOMA) values were significantly lower in vegetarians (glucose 4.47 ± 0.05 vs. 4.71 ± 0.07 mmol/l; insulin 4.96 ± 0.23 vs. 7.32 ± 0.41 mU/l; IR (HOMA) 0.99 ± 0.05 vs. 1.59 ± 0.10). IR (HOMA) dependence on age was only significant in subjects on a western diet. A significant increase of IR was found already in the age range 31–40 years, compared to vegetarians and it continued in later age decades. Age independent and low insulin resistance values in vegetarians are a consequence of an effective diet prevention by long-term frequent consumption of protective food. Vegetarians had a significantly higher consumption of whole grain products, pulses, products from oat and barley. *Conclusion* The results of age independent and low values of insulin resistance document a beneficial effect of long-term vegetarian nutrition in prevention of metabolic syndrome, diabetes and cardiovascular disease.

Key words insulin resistance – age – vegetarian diet – traditional western diet

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Introduction

Hyperinsulinemia, a manifestation of insulin resistance, plays a significant role in the development and progression of diabetes [1]. Insulin resistance means that insulin loses its normal physiological action. A high insulinogenic nutrition represents a chronic stimulus to the beta cells that may induce an adaptive hypertrophy and a progressive dysregulation of the cells, resulting in post-prandial hyperinsulinemia. Significant evidence suggests that post-prandial hyperinsulinemia promotes the development of insulin resistance syndrome that is composed of risk factors for cardiovascular disease in-

cluding insulin resistance with hyperinsulinemia, atherogenic dyslipidemia, hypertension and abdominal obesity [1, 2]. Low glycemic index food characterized by slowly absorbed carbohydrates has a beneficial effect on glucose control, hyperinsulinemia, insulin resistance and blood lipids [1–3].

The aim of this study was to assess insulin resistance values in normal weight subjects with different nutritional habits with respect to age. Alternative nutrition subjects (vegetarians) were compared with a general population group on a traditional western diet.

Subjects and methods

Randomly selected group of vegetarians consisted of 95 apparently healthy adult normal-weight long-term lacto-ovo-vegetarians, who consumed plant food, dairy products and eggs. A control group of 107 apparently healthy normal-weight non-vegetarians (general population) consumed a traditional western diet. The group characteristics are presented in Table 1. The probands had approximately a similar physical activity (psychic work, no sports) and a higher education level (secondary school and university).

Blood samples were collected in the standard way. Serum fasting insulin concentrations were measured by electrochemiluminiscence immunoassay (Roche Elecsys Insulin Test). Glucose serum fasting concentration was assessed by standard laboratory method on a Vitros 250 autoanalyzer (Johnson & Johnson, USA). Insulin resistance IR (HOMA) values (HOMA – homeostasis model assessment) were calculated from fasting glucose and insulin concentrations – IR (HOMA) = insulin × glucose/22.5 [4]. The survey was carried out in the spring. The intake of vitamins, mineral and trace elements only in natural form was allowed (no supplementation). The Student t-test was used for final evaluation.

Daily intake of energy and nutrients was calculated from dietary questionnaires. The questionnaire contained 114 food items. The frequency of consumption was measured using 4 categories: almost never, times per day, per week or per month depending on food item. Trained workers checked the completeness of questionnaires. Conversion to nutrients was done by using a self-developed software Nutrition based on the Slovak food composition database compiled by the Food Research Institute [5].

Table 1 Characteristic of groups, values of insulin, glucose, insulin resistance and consumption of energy, selected nutrients and food

	Vegetarians	Non-vegetarians
n (m + w)	95 (39 + 56)	107 (45 + 62)
Age range (y)	19–64	19–62
Average age (y)	37.8 ± 1.2	38.7 ± 1.1
BMI range (kg/m^2)	18.6–25.0	18.8–25.0
Average BMI (kg/m^2)	22.1 ± 0.2	22.5 ± 0.2
Period of vegetarianism (y)	10.2 ± 0.5	–
Smokers	0%	0%
Insulin (mU/l)	4.96 ± 0.23*	7.32 ± 0.41
Glucose (mmol/l)	4.47 ± 0.05**	4.71 ± 0.07
Insulin resistance (IR HOMA)	0.99 ± 0.05*	1.59 ± 0.10
> 3.8	0 %	6%
Daily intake of energy, selected nutrients and food		
Total energy (kJ)	9847 ± 151	10267 ± 147
Fats (g)	64.2 ± 1.4	67.0 ± 2.1
Saccharides (g)	377 ± 17	397 ± 13
Proteins (g)	54.8 ± 1.2	56.2 ± 1.6
Fiber (g)	36.2 ± 0.5*	26.7 ± 0.7
Legumes (g)	18.9 ± 1.1*	8.0 ± 0.6
Oat (flakes, porridge) (g)	20.3 ± 1.0*	2.4 ± 0.2
Barley pearls (g)	10.6 ± 0.6*	0
Whole grain products (g)	176 ± 11*	41 ± 2

Results are expressed as mean ± SEM
** P < 0.01; * P < 0.001

Results and discussion

Prevention of insulin resistance syndrome, diabetes and cardiovascular disease consists of physical activity, weight loss, high fiber diet, consumption of unsaturated fats and low intake of saturated fats, consumption of whole grain products, legumes, oil seeds, fruit and vegetables [2, 3, 6], which can result in reduced insulin concentrations and improved risk lipid parameters. Recommended nutritional commodities are the current components of vegetarian nutrition [7]. On the contrary, some of these components are rare in the nutritional regimen of non-vegetarians [7]. The beneficial effect of vegetarian diet in prevention of chronic degenerative diseases is well documented [6, 8, 9].

Diets rich in carbohydrates with low glycemic index and a high fiber content – whole grain, pulses, oats, barley, fruit, vegetables [2, 3, 10, 11] produce a slow carbohydrate absorption and thus flat post-prandial rises of blood glucose, minimal post-prandial insulin secretion and maintenance of insulin sensitivity. The effect of high fiber diet is highly dependent on the type of fiber. Diet from insoluble fiber sources had a much less marked effect compared with the effects of diet containing soluble fiber [11]. Intake of fiber is significantly higher in vegetarians (Table 1). Rich sources of soluble fiber are legumes and whole grain products mainly oats and barley. This food is significantly more consumed in our vegetarian group (Table 1).

In the group of normal-weight vegetarians, the significantly decreased values of insulin, glucose and insulin resistance were recorded in comparison to the

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Table 2 Insulin resistance values IR (HOMA) with respect to age

Age range (y)	Vegetarians			Non-vegetarians		
	n	average age (y)	IR (HOMA)	n	average age (y)	IR (HOMA)
19–30	30	24.4±0.6	0.97±0.07	32	24.2±0.4	1.14±0.08
31–40	24	35.1±0.6	0.91±0.08	21	35.8±0.5	1.41±0.22**
41–50	25	45.3±0.6	1.14±0.10	38	45.6±0.4	1.85±0.18*
51–64	16	55.1±0.9	0.91±0.08	16	55.2±0.8	2.09±0.33*

** $P < 0.05$; * $P < 0.001$

non-vegetarian group with normal BMI (Table 1). The occurrence of risk IR (HOMA) value >3.8 [12] was found in 6% of the general population group but in no vegetarian. Our previous study [13] confirmed a strong direct dependence of IR on BMI values in general population groups (significantly increased IR (HOMA) in the overweight group and in the three obese groups with BMI 30.1–51.6 in comparison to the normal weight group). In the present study groups of normal weight probands, the IR (HOMA) – BMI correlation was non-significant (vegetarians $r = 0.05$; non-vegetarians $r = 0.11$; horizontal trend line). This result documents that the IR (HOMA) value in normal weight subjects of two nutritional habits and with similar intake of energy and main nutrients (fats, saccharides, proteins) (Table 1) is only influenced by different nutritional composition.

Risk values of insulin resistance predict an incidence of age-related diseases. Significant increases of the incidence of type 2 diabetes (eight-fold), hypertension (two-fold) or coronary heart disease (three-fold) were reported in the group with the highest insulin response in comparison to the situation in the same group before 15 years [14]. We noted a significant positive linear correlation between IR (HOMA) values and age in the general population group on traditional western diet ($r = 0.31$, $P < 0.001$). This correlation in the vegetarian group was non-significant ($r = 0.03$). The significant increase of IR (HOMA) values in non-vegetarians was found already in the age decade 31–40 years, compared with vegetarians, and it continued in further age decades (Table 2). The HOMA model was based on the assumption that normal weight healthy subjects aged <35 years have an insulin resistance of 1 and β-cell function of 100% [4]. Our vegetarian subjects have an IR (HOMA) of approximately 1 in all age decades (0.91–1.14), the non-vegetarian subjects have an IR (HOMA) = 1.14 only in the age group 19–30 years. The fact that insulin resistance in vegetarians was low and independent of age is a consequence of effective nutritional prevention by long-term and frequent consumption of protective food (Table 1).

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