Eating habits among women with insulin resistance (IR) on a vegetarian vs non-vegetarian diet

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A – Study Design, **B** – Data Collection, **C** – Statistical Analysis, **D** – Data Interpretation, **E** – Manuscript Preparation, **F** – Literature Search, **G** – Funds Collection

Summary **Background.** Insulin resistance is one of the major metabolic disorders. The composition of one's diet has a crucial effect on the risk of developing this disorder and is a key component of treatment. Following a vegetarian diet seems to be promising for health benefits.
Objectives. The aim of the study is to assess the eating habits of women suffering from insulin resistance following vegetarian and non-vegetarian diets.
Material and methods. The survey was conducted among 248 women between the age of 18 to 64 in Poland from January to March 2022. The research tool was a website survey questionnaire. The analysis was performed using the Statistica 10 program. The data obtained was subjected to statistical analysis using the chi-square test. Results were considered significant at $p \leq 0.05$.
Results. Women on a vegetarian diet had the correct body weight more often (47.4%) compared to those following a traditional diet (40.5%) or not following any diet (38.5%). 69.3% of vegetarians assessed their nutritional knowledge as better than good. Women on a plant-based diet included legumes in their diet and consumed vegetables much more often than others. Attitudes towards plant-based meat substitutes and plant-based dairy substitutes were significantly more positive among vegetarians than others.
Conclusions. Women with insulin resistance on a vegetarian diet often have better nutritional choices compared to women on a traditional diet or those not following any diet. These promising findings may be helpful in preventing and treating this disorder. However, the amount of research and results is insufficient and requires further analyses on a larger group of subjects.
Key words: insulin resistance, feeding behavior, diet, vegetarians.

Background

Insulin resistance is one of the major metabolic disorders on which a lot of research is being carried out. Detection of this disorder has increased significantly in recent years. The prevalence among people shown in studies depends on population, but it is reported to be 10% to 30% [1]. Insulin resistance is highly correlated with obesity, but it has been proven that people with a healthy body weight can also struggle with it. If they are left untreated, it can also have serious health consequences, despite being non-obese [2].

Insulin resistance is defined as the lack of ability of insulin-target tissues to dispose glucose from blood and inhibition of endogenous glucose production and lipolysis. At the same time, inability of stimulating glycogen synthesis at high plasma insulin concentrations occurs. An imbalance of energy intake and expenditure is the main reason for common insulin resistance. Genetic predispositions are also important issues [3].

The frequency of this condition is associated with age, body weight, gender, physical activity, as well as genetic and lifestyle issues. Moreover, scientific research has shown that insulin resistance can be related to stress and overstimulation of the sympathetic nervous system. This condition is also correlated with the occurrence of inflammation in the body [1].

The composition of one's diet has a major effect on the risk of developing this condition and is a key component of treatment for insulin resistance. This is why the assessment of the

nutritional habits of patients is very important [1]. Diet models most suitable for patients with insulin resistance have also been investigated. The Third National Health and Nutrition Examination Survey (NHANES III) found that people who follow a diet very similar to the Mediterranean diet had lower BMI and waist circumference. These indicators correlated with lower glycated haemoglobin levels, fasting insulin levels and Homeostatic Model Assessment for Insulin Resistance (HOMA-IR) index values [4].

Referring to the individual components of the diet, lower insulin sensitivity was associated with high consumption of animal products and low intake of vegetable food. It has been shown that this is correlated with type 2 diabetes and cardiovascular disease [5]. Eating habits, physical activity and lifestyle are extremely important but also modifiable factors on which the risk of insulin resistance depends [1]. Since 1935, when Himsworth and Marshall [6] investigated and noted that a diet high in animal products and low consumption of plant-based foods increased the risk of type 2 diabetes, it has been proven that we should focus on prevention through proper and healthy eating habits.

A lot of research has been done, and now we have evidence that a nutrition model based on high consumption of animal and low-vegetable proteins promotes insulin resistance in patients with diabetes and in healthy people [7–9]. This is caused by glucagon secretion activated by amino acids, like arginine and alanine from animal protein. In the liver, glucagon is opposite to insulin and interferes with its action. High plasma glu-

cagon is maintained for at least four hours after a meal which is high in animal protein. This mechanism is very well observed in diabetic patients. Hyperglucagonemia that lasts a long time may induce insulin resistance [5].

A meta-analysis that included 19 trials showed that a diet rich in fruits, vegetables, whole grains, nuts, legumes, fat-free/low-fat dairy and a diet low in saturated fat, cholesterol, red and processed meats, refined grains and sweets had a good effect in improving insulin sensitivity. It is also important that a diet should be based on products with a low glycaemic index (GI) as low GI diets have been reported to improve insulin sensitivity and lower blood glucose. Foods rich in dietary fibre and micronutrients are essential in diet for insulin resistance. It has also been found that a calorie-restricted diet may have positive effect for glycaemic control by improving insulin sensitivity and β-cell function. Moreover, treatment and following a diet duration also had an important influence on the positive effects for glyceamic control by improving insulin sensitivity and β-cell function [10].

Objectives

The aim of the study is to assess the eating habits of people suffering from insulin resistance following vegetarian and non-vegetarian diets.

Material and methods

The survey was carried out in Poland from January to March 2022. The questionnaire was completed by 356 individuals. Incomplete data was rejected, and 248 participants aged 18–64 were enrolled in the study.

A survey was prepared by the authors. The questions concerned one's behaviours and eating habits, the frequency of meals, the subjective frequency of eating snacks, the consumption of vegetable, meat and dairy substitutes, the frequency of meat consumption and stimulants used, the type and amount of physical activity. Besides these, the KomPAN® questionnaire was used to assess the frequency of food consumption [11]. Moreover, there were questions concerning anthropometric parameters (body weight and height, waist circumference), as well as questions related to socio-demographic characteristics. There were 97 questions in the survey, 11 of which concerned anthropometric and socio-demographic data, and the rest concerned the frequency of food consumption and eating behaviours. The percentage of analysed questions with a $p < 0.05$ level was 45.3.

The exclusion criteria were being under 18 years of age, body mass index (BMI) below or equal to 18, anorexia, bulimia, malnutrition, as well as severe diseases (alcoholism, severe and extensive surgery, kidney failure), cancer in the last 5 years and the use of enteral and parenteral nutrition. Inclusion criteria were age and BMI over 18 and being diagnosed with insulin resistance, which the respondents declared in the survey. The study participants were people that voluntarily consented to take part in the study, which was announced on social media.

Statistical analysis was carried out with the use of the Statistica 10 program. The division of people into three groups was introduced due to type of diet (traditional, vegetarian and non-diet) and was verified using the chi-square independence test. In all analyses, a significance level of $\alpha = 0.05$ was assumed.

Results

248 women aged 18–64 suffering from insulin resistance participated in the study. More than a half of them were on a traditional diet, while 31.5% were on a vegetarian diet, and 15.7% declared to be non-dieters. BMI (body mass index) range was 18.0–46.4 kg/m². A large majority of participants (68.5%) had high education. The exact population data is presented in Table 1.

Table 1. General description of the studied population	
Number of participants	**$n = 248$**
Age (year) (age range)	18–64
BMI (kg/m²) (BMI range)	18.0–46.4
Smoking (%)	21.8
Age groups (%) 18–20 years 21–40 years 41–60 years	4.3 85.0 10.7
Physical activity (%) low level middle level high level	44.8 43.5 11.7
Commune size (%) < 10,000 inhabitants 10,000–20,000 inhabitants 20,001–100,000 inhabitants > 100,000 inhabitants	14.9 6.0 13.7 65.3
Level of education (%) under middle middle high vocational	1.6 28.2 68.5 1.6
Type of diet (%) traditional vegetarian non-diet	52.8 31.5 15.7

Nutritional habits

Women on a vegetarian diet were much more likely to not consume milk and milk drinks (53.8%) than those on a traditional diet (19.1%) and those who do not follow any diet (10.3%). 52.7% of the respondents on a traditional diet chose low-fat dairy products compared to 26.9% of vegetarian women and 51.3% of non-dieters ($p < 0.01$). In contrast, 77.0% of the respondents on a vegetarian diet consumed dairy alternatives (e.g. drinks, yoghurts, vegetable spreads) once a week or more often ($p < 0.01$). The data is presented in Tables 2 and 3.

Regarding the frequency of eating alternatives to meat products, such as vegetable sausages, burgers, meatballs, nuggets, etc., 68.0% of the surveyed women on a vegetarian diet consumed those products more often than once a week. Compared to them, this was 16.0% of the respondents on a traditional diet and 23.1% of the women who do not follow any diet ($p < 0.01$). The data is presented in Table 4.

Table 2. Type of milk				
Type of diet				
	Traditional ($n = 131$)	**Vegetarian ($n = 78$)**	**Non-diet ($n = 39$)**	**p**
I do not consume milk or milk drinks	25 (19.1%)	42 (53.8%)	4 (10.3%)	$p < 0.01$
Fat-free milk	3 (2.3%)	2 (2.6%)	2 (5.1%)	$p < 0.01$
Low-fat milk	69 (52.7%)	21 (26.9%)	20 (51.3%)	$p < 0.01$
Full-fat milk	34 26.0%	13 (16.7%)	13 (33.3%)	$p < 0.01$

Table 3. Frequency of consumption of dairy alternatives (e.g. plant-based soy and coconut yoghurts, plant-based drinks, vegetable spreads)

Type of diet				
	Traditional (*n* = 131)	Vegetarian (*n* = 78)	Non-diet (*n* = 39)	*p*
Never	35 (26.7%)	2 (2.6%)	18 (46.2%)	*p* < 0.01
1–3 times a month	37 (28.2%)	16 (20.5%)	7 (17.9%)	*p* < 0.01
Once a week	19 (14.5%)	6 (7.7%)	4 (10.3%)	*p* < 0.01
A few times a week	31 (23.7%)	24 (30.8%)	7 (17.9%)	*p* < 0.01
Once a day	6 (4.6%)	13 (16.7%)	2 (5.1%)	*p* < 0.01
A few times a day	3 (2.3%)	17 (21.8%)	1 (2.6%)	*p* < 0.01

Table 4. Frequency of consumption of meat alternatives (e.g. vegetable cutlets, sausages, burgers, meatballs, schnitzels, nuggets)

Type of diet				
	Traditional (*n* = 131)	Vegetarian (*n* = 78)	Non-diet (*n* = 39)	*p*
Never	61 (46.6%)	7 (9.0%)	22 (56.4%)	*p* < 0.01
1–3 times a month	49 (37.4%)	18 (23.1%)	8 (20.5%)	*p* < 0.01
Once a week	11 (8.4%)	20 (25.6%)	6 (15.4%)	*p* < 0.01
A few times a week	10 (7.6%)	30 (38.5%)	3 (7.7%)	*p* < 0.01
Once a day	0 (0%)	1 (2.6%)	0 (0%)	*p* < 0.01
A few times a day	0 (0%)	1 (1.3%)	0 (0%)	*p* < 0.01

Table 5. Frequency of consumption of legumes, e.g. beans, peas, soybeans, lentils

Type of diet				
	Traditional (*n* = 131)	Vegetarian (*n* = 78)	Non-diet (*n* = 39)	*p*
Never	18 (13.7%)	1 (1.3%)	2 (5.1%)	*p* < 0.01
1–3 times a month	46 (35.1%)	6 (7.7%)	11 (28.2%)	*p* < 0.01
Once a week	25 (19.1%)	23 (29.5%)	14 (35.9%)	*p* < 0.01
A few times a week	31 (23.7%)	30 (38.5%)	10 (25.6%)	*p* < 0.01
Once a day	8 (6.1%)	14 (17.9%)	2 (5.1%)	*p* < 0.01
A few times a day	3 (2.3%)	4 (5.1%)	0 (0%)	*p* < 0.01

Table 6. Self-assessment of nutritional knowledge

Type of diet				
	Traditional (*n* = 131)	Vegetarian (*n* = 78)	Non-diet (*n* = 39)	*p*
Very Good	15 (11.5%)	19 (24.4%)	1 (2.6%)	*p* < 0.01
Good	42 (32.1%)	35 (44.9%)	12 (30.8%)	*p* < 0.01
Bad	50 (38.2%)	18 (23.1%)	16 (41.0%)	*p* < 0.01
Very bad	24 (18.3%)	6 (7.7%)	10 (25.6%)	*p* < 0.01

Another point is that more of the surveyed women on a vegetarian diet (25.6%) stated that they never eat fried foods (meat or flour) compared to those on a traditional diet (10.7%) and non-diet (12.8%) (*p* < 0.01).

A large majority of participants (89.7%) on a vegetarian diet declared that they include legumes in their diet at least once a week. In the case of people following a traditional diet, this was 51.9%, while those not following any diet – 46.2%. Among the respondents on a vegetarian diet, there was not a single person who declared to never consume legumes (*p* < 0.01). The data is presented in Table 5.

Regarding the frequency of eating vegetables, most people on a plant-based diet consumed vegetables several times a day (75.6%) compared to those on a traditional diet, with less than half of the respondents – 49.6%, and people not following any diet – 51.3% (*p* < 0.02).

Attitude to plant-based products

We examined the association between the type of diet and attitudes towards plant-based meat substitutes and plant-based dairy substitutes. A large majority of participants on a vegetar-

ian diet (82.1%) declared that plant-based meat substitutes are for them a wholesome alternative to meat products. However, the same was stated only by 36.6% of respondents on a traditional diet and 28.2% of women not following any diet (*p* < 0.01).

As for the same claim regarding plant-based dairy alternatives, the results were similar. 76.9% of vegetarians declared that plant-based substitutes for dairy products were a full-fledged alternative. Only 42.0% of non-vegetarians and 38.5% of non-dieters agreed with this statement.

Self-assessment of nutritional knowledge and nutrition, well-being, physical activity, sleep habits

Additionally, we examined the respondents' opinion on their nutritional knowledge. 69.3% of vegetarians defined it as good or very good, only 43.6% of women following a traditional diet had the same opinion about their own knowledge, and this was even less (33.4%) for respondents who did not follow any diet (*p* < 0.01). The data is presented in Table 6.

The results related to the amount of sleep, physical activity, well-being and self-assessment of nutrition were not statistically significant (*p* > 0.05).

Body Mass Index

Body mass index (BMI) was calculated based on the data concerning the height and weight of the surveyed women. Correct BMI was within the range of 18.5–24.99 kg/m². The results showed that 47.4% of the women on a vegetarian diet had the correct body weight compared to those following a traditional diet (40.5%) and those not following any diet (38.5%). BMI over 24.9 kg/m² (overweight or obesity) amounted to 55.0% of the respondents on a traditional model of nutrition, 44.9% of women eating plant-based foods and 61.5% of non-dieters ($p < 0.02$).

Discussion

As far as we know, there is no other study comparing the eating habits of women suffering from insulin resistance on a vegetarian or non-vegetarian diet. From the results that we were able to collect, we obtained data confirming our research hypothesis that the eating habits of women on a non-vegetarian diet differ from those on a plant-based diet, and this has further consequences.

The respondents on a plant-based diet displayed healthier eating habits by consuming more legumes and vegetables and more often chose low-fat milk or plant-based substitutes for meat and dairy products. Similar results were obtained in a study among Argentinean vegetarians and non-vegetarians. In this survey, the respondents on a plant-based diet were also more likely to eat legumes and vegetables more often, as well as fruit, whole grains, seeds and nuts. Researchers compared adherence to healthy vegan lifestyle habits according to the vegetarian diet pattern category and presented results that indicated that non-vegetarians scored significantly lower than the vegetarian groups [12]. On this basis, we can assume that vegetarians may have better eating habits.

In our research, we discovered that women following a plant-based diet had normal BMI more often than non-vegetarians. The same results were found in the Rotterdam Study [13], which also examined this relationship. In this study, they constructed an overall plant-based dietary index measured by the food frequency questionnaires (FFQs) divided into 23 food categories. A higher score on the plant-based dietary index was related to lower longitudinal HOMA-IR and BMI. Referring to our results and those of the the Rotterdam Study, it can be assumed that a plant-based model of eating probably has a positive effect on the occurrence and course of the disease.

Another study, a 16-week randomised clinical trial, showed that switching to a plant-based diet reduced the mean body weight of participants by 6.4 kg compared to the control group on a non-vegetarian diet, which amounted to only 0.5 kg during the study. This difference was the most significant in terms of reducing body fat. Moreover, HOMA-IR (a measure of insulin resistance) decreased significantly, and insulin sensitivity increased significantly, whilst neither changed significantly in the control group [14].

Our study found that women on a vegetarian diet much more often chose plant-based dairy and meat substitutes and did not consume milk and dairy drinks as well. This can be combined with the study results of Kahleova et al., which showed that the vegetarian group consumed less fats, less saturated fats and more mono- and polyunsaturated fats than non-vegetarians. Moreover, after the intervention, the biggest changes in general fat and fatty acid intake were observed in the group of subjects on a plant-based diet. A significant reduction of intake of saturated fatty acids and increase in polyunsaturated fatty acids was also observed in this group [15]. It can be assumed that the more frequent choice of plant-based substitutes for dairy and meat could have caused this.

The amount of research in this area is insufficient and requires further analysis. However, insulin resistance is an increasingly frequently diagnosed disease. This proves that further research on this topic is very important. It would be worthwhile to conduct a study on a larger research group and focus on the impact of plant-based diets on tissue insulin sensitivity and other related diseases. Such analyses would certainly be useful for creating more accurate dietary recommendations and would be very useful in clinical dietetics and when working with patients.

Conclusions

Based on the results of the research, we can conclude that the following of a vegetarian diet is associated with better nutritional choices compared to women on a traditional diet or those not following any diet. Equally important is that these women also had a healthy BMI much more often. These promising findings require further research into general plant-based dietary recommendations for the prevention and treatment of insulin resistance. However, the positive effect of a plant-based diet in this disease also requires further investigation.

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