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ORIGINAL PAPER

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Eating and Lifestyle Habits in Underweight Patients with Insulin Resistance

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ABSTRACT

Background: In recent years, there has been a significant increase in the prevalence of insulin resistance (IR) which has become a global health problem. Obesity is the typical clinical presentation of IR. The connection between underweight and IR is less known. **Objective:** The study aimed to investigate the characteristics of eating habits in underweight and obese patients with IR. After the obtained results, propose suitable dietary instructions specific to 2 subject groups. The task was to determine the difference in the nutritional status of underweight and obese patients with proven IR. The questionnaire was designed to collect data on diet and eating habits. **Methods:** The research included 60 subjects of both sexes between the ages of 20 and 60. Inclusion criteria for entering the study were: proven obesity (BMI ≥ 30), underweight (BMI $\leq 18,5$) and confirmed IR by assessment of the homeostatic model for insulin resistance (HOMA IR-2). BMI, waist-to-hip ratio (WHR), and visceral fat area (VFA) were calculated using the bioelectrical impedance. Data on dietary habits was collected using a questionnaire that included general patient data, physical activity, lifestyle and eating habits. Descriptive statistical methods were used to process and analyse the obtained data. **Results:** The average BMI in obese subjects was 34.32 kg/m², and in underweight subjects, 17.26 kg/m². There are statistically significant differences between BMI, WHR and VFA. The mean value of HOMA-IR in the obese patients was 2.87 and in the underweight, 2.45. Underweight subjects have a statistically significant ($p < 0.05$) tendency to lose weight, consume milk and milk products, prefer lean meat, and drink more alcohol. Obese subjects are significantly ($p < 0.05$) less physically active, more prone to insomnia, tend to

gain weight, enjoy food, consume fewer fruits and vegetables and more carbohydrate food, do not follow clinical nutritional guidelines, and mostly eat in a social setting. Both groups rarely practiced mindful eating. Consumption of highly processed food and sweets is common in both groups. **Conclusion:** There are statistically significant differences in the dietary and lifestyle habits of underweight and obese patients diagnosed with IR. It is necessary to educate healthcare workers and the general population about the importance of nutrition for preventing IR, regardless of body weight.

Keywords: insulin resistance, underweight, obesity, diet, eating habits.

1. BACKGROUND

Insulin resistance has been identified as a weakened biological response to insulin stimulation of target tissues, primarily the liver, muscle and adipose tissue. This is a generally accepted definition. However, IR can be presented as a syndrome related to a group of abnormalities that occur only in people with a weakened response to insulin. The clinical picture differs in the specificity of the organ's sensitivity to insulin. It is recognized based on central obesity and metabolic disorders, including hyperglycemia, dyslipidemia, hypertension, central obesity, elevated parameters of chronic inflammation, endothelial dysfunction and coagulation disorders (1, 2). The aetiology of insulin resistance has yet to be fully understood, but it can be divided into acquired, genetic and hereditary factors. Hereditary mutations are relatively rare, and most often, it is a mutation of the insulin receptor or one of the GLUT signaling proteins.

Disruption of glucose metabolism begins in adipocytes, where the inflammatory response primarily occurs.

Namely, adipokines are released, the most important of which are TNF-alpha and interleukins, which block the insulin receptor (3). However, the most important and common cause of IR is a sedentary lifestyle, excessive intake of sweets and simple sugars, saturated fatty acids, industrially processed food, sweetened drinks and fast food. Intuitive eating plays a vital role in the aetiology of IR. A healthy lifestyle and eating habits are crucial in preventing and treating IR (4). Glucose intolerance as the first sign of IR was detected in 7.3% of the adult population in 2017, equivalent to 352.1 million people.

By 2045, the prevalence is expected to increase to 8.3% of the global population, corresponding to an estimated 587 million (5). Studies show that almost 25% of the world's population has metabolic syndrome, and the prevalence of insulin resistance is 15.5–49.5% (6, 7).

Eating habits are acquired during life. Recommendations for preventing and treating IR must include lifestyle changes, not just nutritional interventions. The World Health Organization (WHO) defines *underweight* as “a cellular imbalance between the supply of nutrients and energy and the body's need for them to ensure growth, maintenance and specific functions”, and *overweight* and *obesity* are defined as “abnormal or excessive accumulation of fat that poses a risk for health”.

A body mass index (BMI) above 25 is considered overweight, and above 30 indicates obesity. The pandemic of excess body weight and obesity represents a significant challenge in preventing chronic diseases worldwide. According to data from 2016, 1.9 billion people over 18 were overweight, while 650 million were obese (8, 9). It is estimated that 20.3% of women and 19.4% of men in Bosnia and Herzegovina are obese. The prevalence of obesity in Bosnia and Herzegovina is lower than the regional average, 25.3% for women and 24.9% for men. It is worrying that, compared to 2002, there is a significant increase in obesity in children and the frequency of malnutrition in newborns. There are 465 million underweight people in the world today. There are 465 million malnourished people in the world today. Malnutrition is also a cause of stunted growth (8.9%). Malnutrition and anaemia are particularly pronounced in BiH in the reproductive age. 24.5% of pregnant women have anaemia and give birth to children with low body weight (11).

Unhealthy eating habits are one of the most significant risk factors for these diseases in the world (12). The latest studies show that IR occurs in underweight in almost the same percentage as in obese people. Malnutrition is associated with structural changes in pancreatic beta cells. A chronic state of malnutrition can lead to a progressive deterioration of beta cell function and the appearance of IR and diabetes mellitus type 2 (DM2). Chronic forms of being underweight have proven effects on glucose metabolism. Reduced protein intake in underweight individuals may increase the sensitivity of beta cells to pathological stimuli such as food toxins, autoimmune antibodies, and viruses (4, 8). During the fetal period, a thin-fat phenotype can develop, so in underweight indi-

viduals, it should be considered that fat cells continue to play an essential role in the development of insulin resistance (9).

Unhealthy lifestyles and diets are linked to both obesity and being underweight. Eating high-calorie food, mainly industrially processed, insufficient intake of fruits, vegetables, milk and milk products, and inadequate physical activity are the main factors in childhood obesity. Such obese children usually grow up with obese adults and take over their unhealthy eating habits (10). Along with visceral fat, a sedentary lifestyle leads to impaired glucose tolerance.

One of the principal treatments and prevention of insulin resistance is a combination of aerobic and anaerobic training. The first line of treatment for insulin resistance, along with proper nutrition, is physical activity (2,11).

2. OBJECTIVE

This study investigates the characteristics of eating habits in underweight and obese patients with IR. After the obtained results, propose suitable dietary instructions specific to 2 subject groups.

3. MATERIAL AND METHODS

Data collection included direct and indirect methods of assessing nutritional status:

- Anthropometric measurements (BMI, waist and hip ratio),
- Questionnaire on the nutritional status of the patients, and
- Biochemical analyses (HOMA-IR calculated from fasting insulin and glucose values).

Anthropometric measurement, as well as the estimation of the amount of visceral fat (VFA), was performed using the bioelectrical impedance method. An InBody 770 medical scale was used for the research.

The nutritional assessment questionnaire consists of 32 questions that provide answers about specific eating and lifestyle habits, water intake, fruits, vegetables, protein and lipid food intake, sugar and highly processed food intake, and alcohol and smoking consumption.

HOMA-IR 2 was used to diagnose insulin resistance. The mathematical model of the Oxford Center for Diabetes, Endocrinology and Metabolism was used in the study.

Statistical analysis

The difference between the underweight and the obese subjects is calculated using the chi-square test, which shows a significant level of 95%. The Mann-Whitney U test was used to test the differences between the two samples. Corresponds to the t-test for independent samples and is applied in situations of smaller samples. The analysis is performed using the statistical software IBM SPSS Statistics 23.

4. RESULTS

The study included a total of 60 subjects. Subjects were adults of both sexes between the ages of 20 and 60. There was 16 woman and 14 men in the obese group and

BMI	Woman	Men	Total
≥ 30	16 (53%)	14 (47%)	30
≤ 18,5	18 (60%)	12 (40%)	30
$\chi^2= 0.272$	$p= .602$		

Figure 1. Demographic data

	Subjects	N	Average Value	Mann – Whitney U	p-value
WHR	Underweight	30	0,83	0,5	0,000
	Obese	30	1,08		
HOMA-IR 2	Underweight	30	2,45	315,5	0,047
	Obese	30	2,87		
VFA	Underweight	30	43,64	0,0	0,000
	Obese	30	197,64		

Figure 2. Differences in WHR, HOMA and VFA depending on BMI category

18 woman and 12 men in the underweight group (Figure 1). The inclusion criteria for entering the study are proven obesity (BMI ≥30), established underweight (BMI ≤ 18.5), typical blood glucose values in several measurements, and proven insulin resistance by assessing the homeostatic model for insulin resistance 2 (HOMA-IR 2).

Obese patients have, on average, statistically significantly higher WHR, HOMA-IR and VFA compared to underweight patients (Figure 1).

Obese subjects were more prone to insomnia (p=0.01). Sleep disturbance and insomnia are characteristics of

the clinical picture of the disease associated with excess weight. The majority of subjects in both groups provide information on everyday stress. It occurs more often in obese (93%) compared to underweight (86%), but there is no statistical significance (p=0.654).

There are significant differences (p=0.000) in the physical activity of obese and underweight people. Most people who are obese have very little physical activity, which can be an essential factor in developing insulin resistance. People with obesity tend to continue to gain body weight, while underweight people tend to continue to lose weight (p=0.04). Underweight patients are more inclined to follow expert guides and recommendations on healthy lifestyles and diets (p=0.000).

Underweight patients also avoid eating in a social setting, while obese patients prefer eating with family or friends (p=0.04). There is statistical significance in the distribution of responses when talking about the desire for food (p=0.000). Obese patients, in most cases, enjoy eating food (87%), while only a small number of underweight patients feel satisfied (27%). Most patients of both groups do not think about the importance of eating certain types of food.

Regarding the question about the importance of mindful eating, there were no statistically significant deviations in the distribution of answers. Neither obese nor

Questions	Answers	Total N=	Underweight		Obese		P Value
			N=	%	N=	%	
How physically active are you during the day?	I spend most of the day sitting	18	0	0	18	60	0.0001
	I walk up to half an hour a day	20	12	40	8	27	
	I walk more than one hour a day	18	16	35	2	7	
	I do sports recreationally	4	2	7	2	7	
	I do sports professionally	0	0	0	0	0	
How often do you eat fruit?	Rarely	8	0	0	8	27	0.004
	2-3 portions/day	50	28	93	22	73	
	5 or more portions/day	2	2	7	0	0	
How often do you eat vegetables?	Rarely	12	2	7	10	33	0.02
	Once a week	30	16	53	14	47	
	More than twice a week	18	12	40	6	20	
How much bread do you eat on a daily basis?	More than 8 slices	10	0	0	10	33	0.0001
	3-5 slices	22	8	27	14	47	
	2 or less slices	28	22	73	6	20	
How often do you eat whole grains?	Once a month	32	8	27	24	80	0.0001
	Once a week	20	16	53	4	13	
	Every day	8	6	20	2	7	
Do you consume milk and milk products on a daily basis	Yes	50	28	93	22	73	0.04
	No	10	2	7	8	27	
How often do you eat poultry?	Once a month	28	4	13	24	80	0.0001
	Once a week	16	10	33	6	20	
	2-3 times a week	16	16	53	0	0	
How often do you eat red meat?	Every day	22	2	7	20	67	0.0001
	2-3 times a week	14	6	20	8	27	
	Once a week	24	22	73	2	7	
How often do you eat sweets?	Every day	28	8	27	20	67	0.001
	2-3 times a week	24	14	47	10	33	
	Once a week or never	8	8	27	0	0	
Do you have food craving during the night?	Yes	28	20	67	8	27	0.002
	No	32	10	33	22	73	
Do you take food only for energy needs or do you enjoy it while consuming food	Only for energy needs	26	22	73	4	13	0.0001
	I enjoy eating	34	8	27	26	87	

Figure 3. Patients' responses to questions related to their lifestyle and eating practices, including eating habits, meal patterns, fruit and vegetable, bread and whole grains, and sugar intake.

underweight patients thought about the importance of taking certain types of food, which can be a vital sign in the aetiology of insulin resistance. Only a small number of patients take the recommended amount of water (30 ml/body weight). Patients in both groups do not adhere to important nutritional recommendations on the frequency of fruit consumption because only 2 (7%) patients in the underweight group take five servings of fruit daily. Underweight subjects are more inclined to consume fruit ($p=0.04$). Frequent use of vegetables in the diet significantly impacts the prevention and treatment of insulin resistance. Underweight patients are more inclined to consume vegetables.

Statistically significant ($p=0.000$) is bread consumption in obese subjects because 80% of the subjects consume bread in an amount greater than 250 g. Underweight subjects are likelier to consume milk and milk products ($p=0.04$). Protein food related to poultry is more often consumed by underweight patients ($p=0.000$).

In contrast to poultry, red meat is significantly ($p=0.000$) more often consumed by obese people, while underweight people use this protein food per nutritional guidelines (once a week).

Smoking is a relatively common habit in both groups, although obese patients are statistically insignificantly smokers in a higher number of cases.

In contrast to the habit of smoking, underweight patients are more inclined to consume alcohol ($p=0.01$).

There are statistically significant deviations in the distribution of responses, according to which it is more likely that underweight patients are, on average, more inclined to consume pies. The difference is also evident in the daily consumption of this type of food in obese patients ($p=0.006$). Sweets such as cakes and confectionery are consumed by both groups, although this type of food is more common among obese patients ($p=0.001$).

5. DISCUSSION

Malnutrition occurs in underdeveloped countries (15). However, in recent years, the prevalence has also increased in developed countries. Bad eating habits and insufficient energy intake are evident during the student period. A cross-sectional study in Cameroon interrogated the eating habits of malnourished students (16). Cereals were the main foods consumed among students. Consumption of protein foods (regardless of origin) is very low, and consumption of fruits and vegetables was below average. The total daily caloric intake among the students in this study mainly comes from carbohydrates, which indicates an unbalanced diet. Among the students, there is also a higher intake of alcohol, which can contribute to a lower intake of food. In another study, the eating habits of malnourished children and adolescents were examined, a low intake of fruits, vegetables and fibre, a high intake of fat, sugar-sweetened beverages, sweets and salty snacks (17). Deficiencies of iron, calcium, magnesium, vitamin A, zinc, folic acid and vitamin B are the main manifestations of being underweight. (15, 17, 18).

This study has shown that both groups have insufficient consumption of fruits and vegetables and adequate

proteins and insufficient physical activity. Neither the obese nor the underweight subjects followed dietary guidelines or thought about proper nutrition. Disturbed food consumption habits were observed in both groups. Emotional overeating and emotional avoidance of food were recorded as eating disorders. Ways of taking food have the same importance as the quality and quantity of food.

A proper diet should include an average of 15% protein, 25% fat and 60% carbohydrates. However, it is necessary to consume foods rich in nutrients such as raw vegetable fibres and other polysaccharides, lean forms of protein, and polyunsaturated fatty acids, which is different for most people with insulin resistance (15).

According to the American Diabetes Association (ADA) guidelines, acceptable diet types for managing DM2 and prediabetes/IR include Mediterranean, DASH, and plant-based diets (19). Emphasis is placed on long-term changes in lifestyle habits.

The study showed that obese people spend most of their time sitting without physical activity. For this group of subjects, when setting up a treatment program for insulin resistance and body weight correction, particular emphasis should be placed on active resistance training.

Intuitive food consumption and full awareness help recover from emotional eating, which is more common in underweight patients (19).

According to food guides, steaming is most recommended, followed by baking, and frying is least recommended (15). Drinking enough water positively affects glucose metabolism and reduces the possibility of metabolic syndrome (21). Specific diets such as the Mediterranean diet, in which poultry and fish are the dominant protein sources, have proven positive effects on preventing and treating insulin resistance (22-25). It is recommended to consume red meat once a week and fish and chicken more often (26).

A diet with a low glycemic index has a very beneficial effect on insulin resistance. It is recommended to eliminate full-fat foods, simple sugars, fruits and vegetables with a high glycemic index in all persons with IR (22).

Dietary supplements such as vitamins A, D, and E, vitamins B1, B6, B9 and B12 and chromium are recommended for obese people suffering from insulin resistance. Water-soluble vitamins, vitamin A and trace elements such as calcium, magnesium and iron are especially recommended for underweight people. Supplementation with zinc and selenium is recommended for all people suffering from IR (27). Biologically active components that help with treatment are polyphenols (resveratrol, quercetin, genistein, epigallocatechin-3-gallate, hesperidin, anthocyanins, curcumin, rutin and naringin and the carotenoid lycopene) (28).

Introducing two more abundant meals with a low glycemic index can increase the sensitivity of cells to insulin.

6. CONCLUSION

Underweight and obese people have specific eating habits that influence the development of IR. Prevention

and treatment of insulin resistance is a complex process that begins with gradual and permanent changes in lifestyle and dietary habits. Assessment of lifestyle and dietary habits can help implement specific nutritional interventions and recommendations for lifestyle changes. A healthy diet and increased physical activity can prevent or mitigate the development of insulin resistance. Adequate physical activity according to needs is one of the most important methods in preventing insulin resistance and the consequent occurrence of chronic non-communicable diseases. Educating healthcare workers and the general population about the importance of nutrition for preventing IR is necessary regardless of body mass.

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