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INTERRELATION OF THE MAIN HORMONAL MARKERS IN PATIENTS WITH METABOLIC SYNDROME

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Abstract

Background. The study of the relationships between the main hormonal markers in patients with metabolic syndrome is relevant due to the growing prevalence of this syndrome in the world. The metabolic syndrome is a complex of risk factors, such as obesity, insulin

resistance, hypertension and dyslipidaemia, and is known to significantly increase the risk of developing cardiovascular disease and diabetes.

The aim. The aim is to trace the relationship between hormonal markers of metabolic syndrome and assess their impact on its development.

Materials and methods. The study involved 96 participants from the Ukrainian population, comprising 53 cases of obesity and 43 non-obese individuals (controls), with no significant age and sex differences between the groups.

The hormonal markers investigated included Leptin, Ghrelin, Adiponectin, and Resistin. The determination of serum levels was performed using specific ELISA kits, and correlation analyses were conducted to assess the associations between these markers.

Results and discussion. The correlation analysis revealed a statistically significant close negative association between Ghrelin and Leptin levels ($\rho = -0.633$, $p < 0.001$). This implies that as Leptin levels decrease, Ghrelin levels tend to increase. The regression analysis demonstrated that 26.7% of the observed variance in Ghrelin levels could be explained by changes in Leptin levels. A strong negative correlation was observed between Adiponectin and Leptin levels ($\rho = -0.818$, $p < 0.001$). This indicates that as Leptin levels decrease, Adiponectin levels tend to increase. The regression analysis suggested that 54.8% of the observed variance in Adiponectin levels could be explained by changes in Leptin levels. The correlation analysis indicated a strong positive association between Resistin and Leptin levels ($\rho = 0.776$, $p < 0.001$). As Leptin levels increase, Resistin levels also tend to increase. The regression analysis suggested that 47.5% of the observed variance in Resistin levels could be explained by changes in Leptin levels.

Conclusions. The study reveals significant correlations between hormonal markers in metabolic syndrome patients

Keywords: **Metabolic syndrome; hormonal markers; Ghrelin; Leptin; Adiponectin; obesity**

Introduction. Adipocytokines are signaling molecules or cytokines produced and released by adipose (fat) tissue. These molecules play a role in the communication between adipose tissue and other organs in the body. Adipose tissue is now recognized as an active endocrine organ, secreting a variety of bioactive substances, including adipocytokines. The term "adipocytokines" is a combination of "adipo-" (related to fat) and "cytokines" (small proteins

involved in cell signaling). These molecules influence various physiological processes, including metabolism, inflammation, and immune response [1, 2].

Adipocytokines, secreted by adipose tissue, play an important role in the storage, consumption of food, energy consumption, and lipid and glucose metabolism. Adipocytokines act at the central and peripheral levels to regulate the function of various organs and tissues. There are specific ones (leptin, adiponectin), which are true adipokines, and nonspecific ones, which are secreted only in case of adipose tissue dysfunction. Adipokines are also divided into insulin sensitizers (adiponectin and leptin) and antagonists (TNF-α, IL-6, resistin, etc.). Their key role in regulating liver and pancreatic function, glucose and fat metabolism, and tissue sensitivity to insulin has been proven, and their imbalance is at the heart of MetS [3, 4, 5]

Ghrelin is a peptide hormone primarily produced by cells in the stomach and, to a lesser extent, by cells in the small intestine, pancreas, and brain. It plays a crucial role in regulating appetite and energy balance. Ghrelin appears to influence metabolism, promoting the storage of fat and reducing the burning of stored fat. It may play a role in the body's efforts to conserve energy during periods of caloric restriction. Ghrelin is a relatively new multifaceted hormone that has been found to have many physiological effects: stimulates appetite; promotes the use of carbohydrates as a fuel source while maintaining fat; inhibits lipid oxidation and promotes lipogenesis; stimulates gastric juice secretion and motility; improves heart function; lowers blood pressure; and protects the kidneys, heart and brain. It is a hormone in the endocrine system and a neurotransmitter in the nervous system. It is also called growth hormone secretion stimulator or motilin-related peptide [6, 7, 8].

Leptin is a hormone produced by fat cells (adipocytes) and plays a key role in regulating energy balance and body weight. It is often referred to as the "satiety hormone" because it helps regulate feelings of fullness and influences appetite. Leptin acts on the hypothalamus, a region of the brain that controls hunger and energy expenditure. Leptin helps control food intake by signaling to the brain when the body has sufficient energy stores. When fat cells increase in size and release more leptin, it signals to the brain that the body has enough energy, leading to a reduction in appetite and an increase in energy expenditure. Leptin influences metabolism by promoting the breakdown of stored fat (lipolysis) and increasing energy expenditure. It plays a role in maintaining a balance between energy intake and energy expenditure. Leptin is involved in the regulation of reproductive functions, and low levels of leptin may signal to the body that

energy stores are insufficient for supporting reproduction. Leptin levels are generally proportional to the amount of body fat, with higher levels in individuals with more adipose tissue. However, in cases of obesity, a condition known as leptin resistance can occur. Leptin resistance is characterized by elevated levels of leptin in the blood, but the body's response to these high levels is diminished. As a result, the brain may not adequately receive signals of satiety, leading to continued overeating and weight gain [9, 10, 11, 12].

Disturbances in the balance between these hormones lead to a marked imbalance in energy homeostasis with the development of obesity, which is a component of MS.

The aim of the study is to trace the relationship between hormonal markers of metabolic syndrome and assess their impact on its development.

Materials and methods

This case-control study consists of 96 Ukrainians population, which was categorized as 53 obesity cases and 43 non-obesity subjects (controls). All 96 participants were considered as 42 males and 54 females. In this study, no significant age and sex differences were found between the individual groups.

Determination of serum levels was performed using Leptin ELISA kit (LDN Labor Diagnostics Nord GmbH & Co. KG, Germany), Human Ghrelin ELISA Kit (Thermo Fisher Scientific, USA), Human Adiponectin ELISA Kit (Thermo Fisher Scientific, USA), Resistin Human ELISA Kit (Thermo Fisher Scientific, USA) on Multiskan FC analyzer (Skanlt Software version 4.1 for Microplate Readers RE, ver. 4.1.0.43) at a wavelength of 620 nm.

The direction and strength of the association between two quantitative variables were estimated using Pearson's correlation coefficient (in case of the normal distribution of variables), The direction and strength of the association between two quantitative indicators were estimated using Spearman's correlation coefficient.

The prognostic model characterizing the dependence of a quantitative variable on predictors was developed using ordinary least squares linear regression.

Results and Discussion

Correlation analysis of the association between Leptin, ng/ml and Ghrelin general, ng/ml was performed (Tabl. 1).

Table 1 – Results of the correlation analysis of the association between Leptin, ng/ml and Ghrelin general, ng/ml

Variable	Correlation characteristics		
	ρ	Strength of the association assesed using Chaddock scale	p
Leptin, ng/ml – Ghrelin general, ng/ml	-0.633	Close	< 0.001*

* – differences are statistically significant ($p < 0.05$)

A close correlation negative association between Ghrelin general, ng/ml and Leptin, ng/ml was estimated. With an 1 % decrease of Leptin, ng/ml 6.638 change of Ghrelin general, ng/ml should be expected. According to the coefficient of determination R^2 of the resulting model, 26.7% of the observed variance of Ghrelin general, ng/ml were explained (fig. 1).

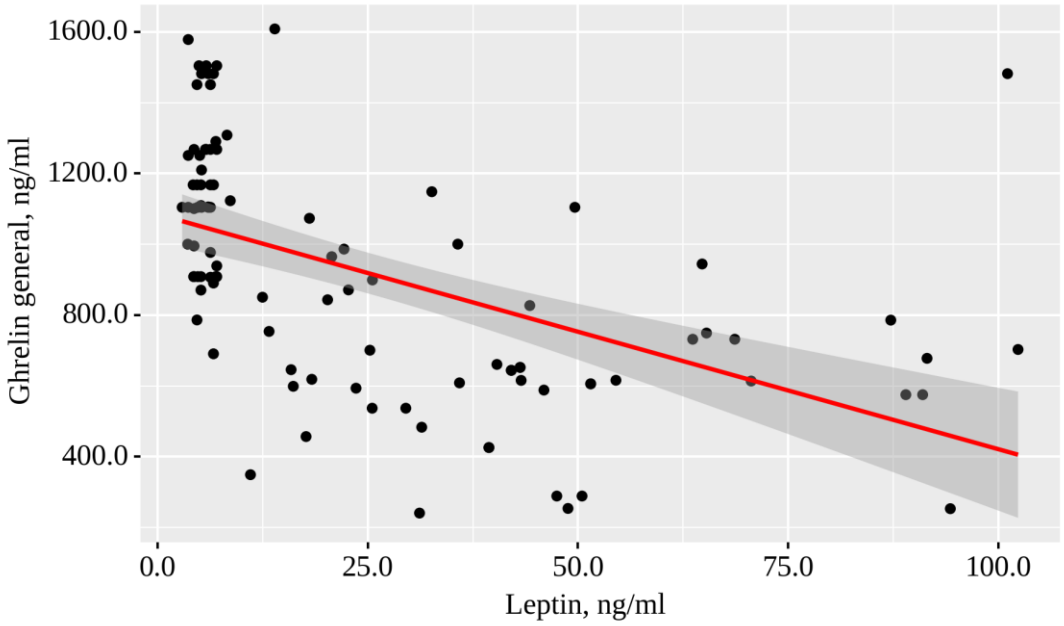

Figure 1 – Regression line characterizing the dependence of Ghrelin general, ng/ml from Leptin, ng/ml

We performed a correlation analysis of the association between Leptin, ng/ml and Adiponectin, µg/ml (Tabl. 2).

Table 2 – Results of the correlation analysis of the association between Leptin, ng/ml and Adiponectin, µg/ml

Variable	Correlation characteristics		
	ρ	Strength of the association assesed using Chaddock scale	p
Leptin, ng/ml – Adiponectin, µg/ml	-0.818	Strong	< 0.001*

* – differences are statistically significant (p < 0.05)

A strong correlation negative association between Adiponectin, µg/ml and Leptin, ng/ml was estimated. With an 1 % decrease of Leptin, ng/ml 0.061 change of Adiponectin, µg/ml should be expected. According to the coefficient of determination R^2 of the resulting model, 54.8% of the observed variance of Adiponectin, µg/ml were explained (fig. 2).

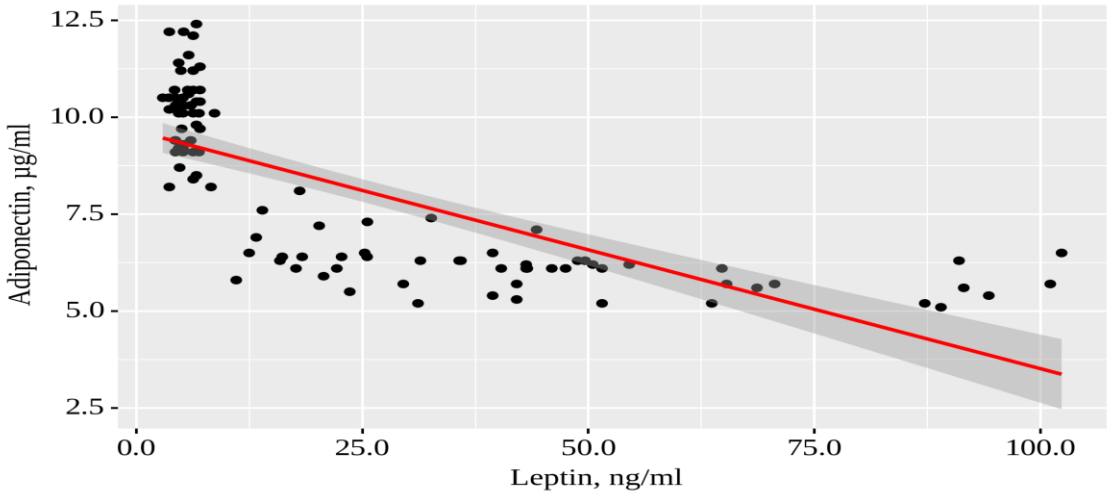

Figure 2 – Regression line characterizing the dependence of Adiponectin, µg/ml from Leptin, ng/ml

Correlation analysis of the association between Leptin, ng/ml and Resistin, ng/ml was performed (Tabl. 3).

Table 3 – Results of the correlation analysis of the association between Leptin, ng/ml and Resistin, ng/ml

Variable	Correlation characteristics		
	ρ	Strength of the association assesed using Chaddock scale	p
Leptin, ng/ml – Resistin, ng/ml	0.776	Strong	< 0.001*

* – differences are statistically significant ($p < 0.05$)

A strong correlation positive association between Resistin, ng/ml and Leptin, ng/ml was estimated. With an 1 % increase of Leptin, ng/ml 0.072 change of Resistin, ng/ml should be expected. According to the coefficient of determination R^2 of the resulting model, 47.5% of the observed variance of Resistin, ng/ml were explained (fig. 3).

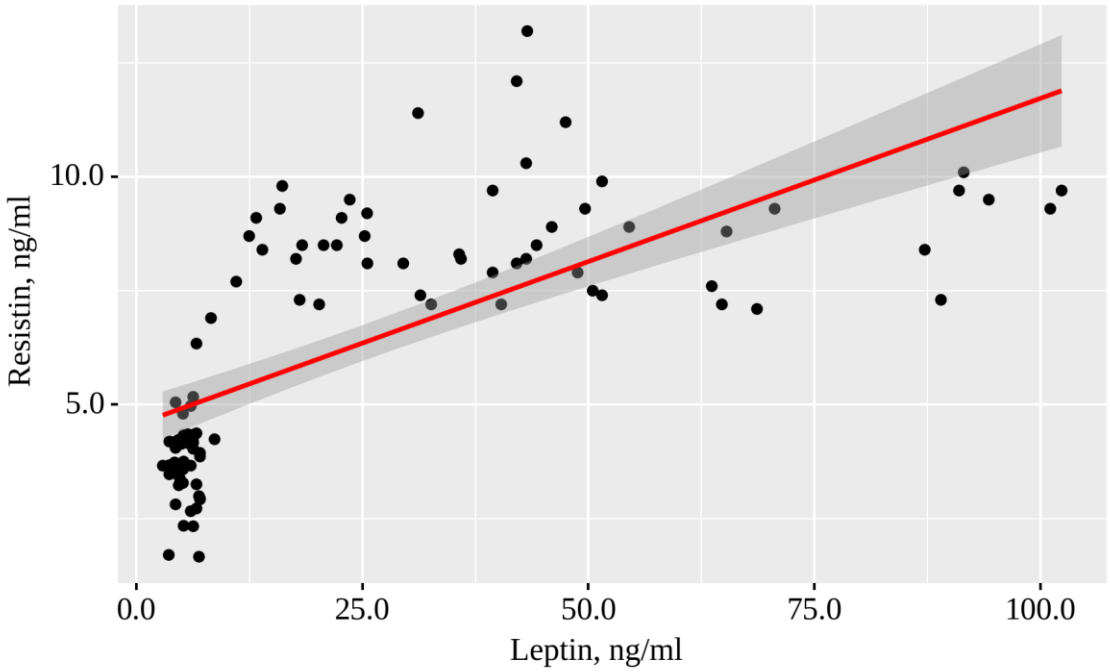

Figure 3 – Regression line characterizing the dependence of Resistin, ng/ml from Leptin, ng/ml

Conclusions

1. The negative association between Ghrelin and Leptin implies a potential counter-regulatory mechanism, where a decrease in Leptin (associated with increased adiposity)

corresponds to an increase in Ghrelin, promoting appetite and potentially contributing to the development of obesity.

2. The strong negative association between Adiponectin and Leptin suggests an inverse relationship between adiposity and insulin sensitivity. Decreased Leptin levels may be associated with improved insulin sensitivity, as reflected by increased Adiponectin levels.

3. The positive association between Resistin and Leptin implies a potential synergistic effect in promoting inflammation and insulin resistance, both of which are associated with metabolic syndrome.

Author Contribution

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Institutional Review Board Statement

This case report did not require IRB approval, patient provided verbal and written consent for publication of this report.

Informed Consent Statement

Written informed consent has been obtained from the patient to publish this paper.

Data Availability Statement

All information is publicly available and data regarding this particular patient can be obtained upon request from corresponding senior author.

Conflicts of Interest

The author declare no conflict of interest.

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