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Serum irisin is positively associated with adiposity markers in obese women after single-session exercise-induced

La irisina sérica se asocia positivamente con los marcadores de adiposidad en mujeres obesas después de una sesión única de ejercicio inducido

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Abstract. The link between serum irisin levels and body fat markers has long been questioned in adult populations. However, there is scant research specifically addressing this link in obese female individuals. This study will thoroughly evaluate the relationship between serum irisin levels and adiposity indices in an obese female population. The study involved a group of 40 women, aged between 20 and 24 years, who were experiencing obesity. The correlations of serum irisin with adiposity markers measurements were determined. The statistical evaluation was conducted using a parametric linear correlation approach. Serum irisin levels, quantified in ng/mL, positively correlated with several adiposity indicators. Notably, there was a meaningful relationship with body weight in kilograms ($r = 0.385$, $p = 0.014$), body mass index (BMI) ($r = 0.588$, $p \leq 0.001$), body fat percentage ($r = 0.450$, $p = 0.004$), total fat mass in kilograms ($r = 0.342$, $p = 0.031$), and lean body mass in kilograms ($r = 0.344$, $p = 0.029$). Furthermore, waist circumference in centimeters ($r = 0.329$, $p = 0.038$), hip circumference in centimeters ($r = 0.321$, $p = 0.043$), and the waist-to-hip ratio ($r = 0.447$, $p = 0.004$) also demonstrated positive correlations with irisin concentrations. Conversely, body height in meters showed no significant correlation ($r = -0.003$, $p \geq 0.05$). Serum irisin's relationship with adiposity markers is evident, yet it does not extend to body height. Interrelationships among adiposity markers might influence serum irisin in obese women after single-session exercise.
Keywords: Serum irisin, adiposity markers, female, obesity.

Resumen. El vínculo entre los niveles séricos de irisina y los marcadores de grasa corporal se ha cuestionado durante mucho tiempo en poblaciones adultas. Sin embargo, hay poca investigación que aborde específicamente este vínculo en mujeres obesas. Este estudio evaluará exhaustivamente la relación entre los niveles séricos de irisina y los índices de adiposidad en una población femenina obesa. En el estudio participaron un grupo de 40 mujeres, de entre 20 y 24 años, que padecían obesidad. Se determinaron las correlaciones de la irisina sérica con las mediciones de los marcadores de adiposidad. La evaluación estadística se realizó mediante un enfoque de correlación lineal paramétrica. Los niveles séricos de irisina, cuantificados en ng/mL, se correlacionaron positivamente con varios indicadores de adiposidad. En particular, hubo una relación significativa con el peso corporal en kilogramos ($r = 0{,}385$, $p = 0{,}014$), índice de masa corporal (IMC) ($r = 0{,}588$, $p \leq 0{,}001$), porcentaje de grasa corporal ($r = 0{,}450$, $p = 0{,}004$) , masa grasa total en kilogramos ($r = 0{,}342$, $p = 0{,}031$) y masa corporal magra en kilogramos ($r = 0{,}344$, $p = 0{,}029$). Además, la circunferencia de la cintura en centímetros ($r = 0{,}329$, $p = 0{,}038$), la circunferencia de la cadera en centímetros ($r = 0{,}321$, $p = 0{,}043$) y la relación cintura-cadera ($r = 0{,}447$, $p = 0{,}004$) también demostraron resultados positivos. correlaciones con las concentraciones de irisina. Por el contrario, la altura corporal en metros no mostró correlación significativa ($r = -0{,}003$, $p \geq 0{,}05$). La relación de la irisina sérica con los marcadores de adiposidad es evidente, aunque no se extiende a la altura corporal. Las interrelaciones entre los marcadores de adiposidad podrían influir en la irisina sérica en mujeres obesas después de una sola sesión de ejercicio.
Palabras clave: irisina sérica, marcadores de adiposidad, mujer, obesidad.

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Introduction

Obesity has escalated to a global health crisis, achieving epidemic proportions (Aktar et al., 2017). The condition is recognized universally as a critical public health challenge, with Shoukry et al. (2016) also regarding it as an epidemic and Windarti et al. (2019) further elevating it to pandemic status. A pivotal 2015 study by The Global Burden of Disease (GBD) 2015 Obesity Collaborators (2017) disclosed that obesity impacts 12% of the global adult population, equating to approximately 603.7 million individuals. World Health Organization (WHO) (2022) reports that the percentage of adults aged 18 years and over living with obesity has more than doubled from 7% to 16%. Moreover, Basic Health Research (2018) report indicates a significant rise in obesity rates among Indonesian adults to 21.8%, a substantial increase from 14.8% in 2013 and 10.5% in 2007. This surge in obesity prevalence is paralleled by a rise in related comorbidities, including, metabolic syndrome, hypertension, Type 2 diabetes mellitus (T2DM), insulin resistance, chronic renal disease, and many cardiovascular diseases, heart failure, and cancer, highlighted that these associated health issues contribute to increased risks of complications, disability, and premature death, affecting a diverse demographic that spans adults, children, and adolescents worldwide (Rosella et al., 2019; Al Kibria, 2019; Aktar et al., 2017; Khan & Shah, 2017; Akter et al., 2014).

Obesity emerges as a consequence of a complex interplay of factors, with a primary aspect being the disequilibrium between caloric consumption and expenditure (Spinelli et al., 2019; Fan & Evans, 2017; Rambhojan et al., 2015; Norheim et al., 2014). Furthermore, a confluence of genetic, environmental, metabolic, behavioral, psychological, cultural, and socioeconomic elements also contributes significantly to its genesis (Spinelli et al., 2019; Hernández Bautista et al., 2019). Norheim et al. (2014) have observed

that the modern lifestyle characterized by unhealthy dietary habits and sedentariness further exacerbates the condition. Unraveling the myriad contributors to obesity is an intricate endeavor; however, contemporary research has shed light on the involvement of cytokines and peptides in its multifaceted origins (Pedersen & Febbraio, 2012). Among the entities under investigation, myokine irisin has gained interest for its potential impact on obesity (Elizondo-Montemayor et al., 2017). The research conducted by Boström et al. (2012) revealed that a certain hormone is produced through the breakdown of proteins containing fibronectin type III domain (FNDC5). The coactivator γ peroxisome proliferator-activated (PGC-1α) controls this process. The process of turning white adipose tissue into brown, which is identified by elevated expression of uncoupling protein 1 (UCP1), is mostly dependent on the hormone known as irisin. In 2018, Fatouros and associates conducted more research on this process, which involves the extracellular signal-regulated kinase (ERK) and p38 mitogen-activated protein kinase (p38-MAPK) signaling pathways.

Clinical research has examined the relationship between serum irisin levels and indices of obesity; studies like those conducted by Norheim et al. (2014) and Huh et al. (2012) have clarified this relationship. Nonetheless, the literature presents a dichotomy of findings, with some research providing contradicting findings, such as Zhang et al. (2020) and Buscemi et al. (2018) reporting contradictory evidence. Elizondo-Montemayor et al. (2017) found a strong positive correlation between plasma irisin levels and several indicators of obesity, such as body mass index (BMI), fat-free mass, waist circumference (WC), and BMI percentile. Notably, even after accounting for age and gender, the association with BMI percentile was still strong. Consistent with these results, other research has also identified positive correlations of serum irisin with key obesity indicators, including total fat mass, body weight, BMI, and fat-free mass (Pardo et al., 2014; Stengel et al., 2013; Liu et al., 2013) Additional linkages were discovered between waist-to-hip ratio (WHR) and lean body mass (LBM) (Löffler et al., 2015), percentage of fat mass (Murawska-Cialowicz et al., 2015), muscle strength (Kim et al., 2015) and total muscle mass (Kim et al., 2016). In contrast, multiple studies demonstrated inverse relationships between serum irisin levels and BMI in people with diverse weight statuses (Aydin, 2013), as well as with muscle mass (Elizondo-Montemayor et al., 2017), fat mass among those overweight or obese (Kim et al., 2016), LBM in type 2 diabetic patients (Al-Daghri et al., 2015), and both WC and WHR in groups ranging from overweight to average weight (Tang et al., 2019).

While most research supports the correlation between irisin levels and adiposity, there are exceptions. For instance, Blüher and colleagues (2014) observed a 12% elevation in serum irisin levels following a year-long lifestyle intervention in obese individuals. Despite this rise, no simultaneous changes in Body Mass Index (BMI) were recorded, implying that variations in irisin levels may not reliably reflect alterations in BMI. This underscores the need for an in-depth analysis of the intricate dynamics between lifestyle modifications and biomarkers such as irisin, highlighting the need for a comprehensive approach to evaluating physiological reactions to obesity interventions. Anastasakis et al. (2014) discovered an absence of connection between serum irisin levels and Body Mass Index (BMI) and Waist-to-Hip Ratio (WHR), within a population of youthful, healthy subjects. Hecksteden et al. (2013) observed a lack of relationship between changes in serum irisin concentrations and factors such as age, gender, or body mass index (BMI) within a sedentary cohort. Similarly, Ellefsen et al. (2014) discovered no significant relationship between serum irisin levels and fat mass after exercise in untrained young women. Given these findings, the current study is meant to extensively evaluate the probable correlation between serum irisin and several measures of adiposity in obese female participants, with the idea that serum irisin levels have a substantial connection with these body fat markers.

Material and Methods

Study design

This study utilized a cross-sectional analytical framework. The study involved 40 obese women, with inclusion criteria of age 19-23 years and BMI ≥ 25.0 kg/m^2 (Asia-Pacific BMI classification) (Lim et al., 2017) or fat percentage ≥ 30%, and have a low level of physical activity. Meanwhile, the inclusion parameters were stringent, requiring participants to have normotensive blood pressure readings—both systolic (SBP) and diastolic (DBP)—alongside a standard resting heart rate. The study excluded individuals with severe illnesses or metabolic dysfunctions necessitating medical therapy. Additionally, the research subjects were characterized by their non-engagement in smoking or alcohol consumption, absence of hypertensive or diabetic conditions in their familial lineage, and adherence to a non-smoking, non-alcoholic lifestyle. Before their study enrollment, all subjects provided full informed consent, either orally or in writing. This study was conducted at the Sports Health Service Center, Malang, East Java, Indonesia in November-December 2019. The study's ethical concerns were duly accepted by the Health Research Ethics Commission of the Faculty of Medicine at Universitas Airlangga in Surabaya, as demonstrated by approval No:309/EC/KEPK/FKUA/2019.

Single-session exercise protocol

The exercise protocol included a 40-minute treadmill jogging session at moderate-intensity, defined as 60-80% of maximum heart rate (HRmax). This was preceded and followed by 5-minute warm-up and cool-down sessions, respectively, performed at a light intensity corresponding to 50% HRmax (Rejeki et al., 2024). HRmax was calculated using the established formula: HRmax – age in years (220 - age in the year)

(Susanto et al., 2023). Monitoring heart rate during exercise using Polar H-10 (Siantoro et al., 2024; Raharjo et al., 2024).

Adiposity markers measurements

Height was measured accurately to within 0.5 cm (Portable Seca® Stadiometer, North America). The advanced TANITA Body Composition Analyzer DC-360 was used to investigate adiposity markers such as body weight, body mass index (BMI), fat percentage (fat%), fat mass (FM), and fat-free mass. The waist circumference (WC) was measured precisely by wrapping an anthropometric tape measure around the midpoint between the lower rib border and the iliac crest, keeping the midaxillary line in alignment. Similarly, hip circumference (HC) was determined by wrapping a tape measure around the greater trochanter, the body's most visible feature. To find the waist-to-hip ratio (WHR), divide the waist circumference by the hip circumference. This ratio serves as a crucial indicator for evaluating body fat distribution across different body regions.

Sample collection and blood analysis

Blood samples were collected from the median cubital vein immediately after a single exercise session. These samples were then centrifuged at a speed of 3000 rpm for 10 minutes. Following centrifugation, the serum was collected and stored at -80°C for irisin level determination the following day. Serum irisin was quantified using an ELISA, particularly the kit coded EK-067-29 and lot number 608791 supplied by Phoenix Pharmaceuticals, Inc., Burlingame, CA 94010 USA. This test detected irisin in the standard range of 1.9 to 1000 ng/mL, with the analyte having a minimum detectable limit of 1.9 ng/mL.

Statistical analysis

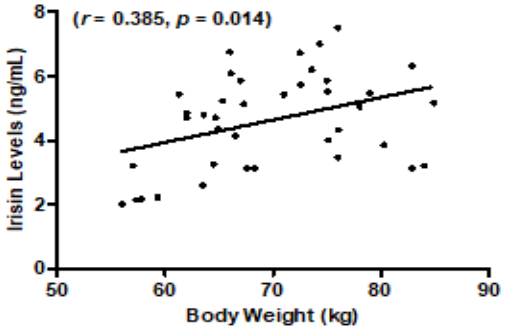
A detailed computation of the number of subjects was taken from prior research conducted by Elizondo-Montemayor et al. (2017), which included 40 subjects. Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) software, version 23.0. The Shapiro-Wilk test was used to assess the normality of data distributions. The Pearson product-moment correlation coefficient was utilized to determine the connection between adiposity indexes and serum irisin levels. The data is presented as Mean ± Standard Deviation (SD), with statistical significance defined as a p-value of 0.05 or lower.

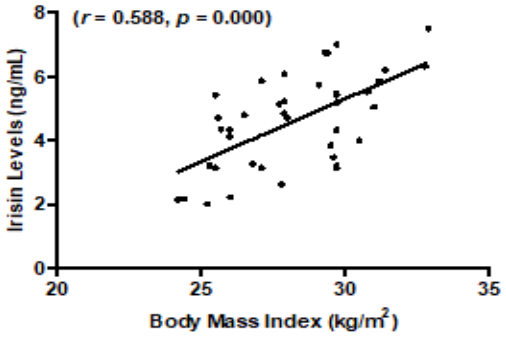
Results

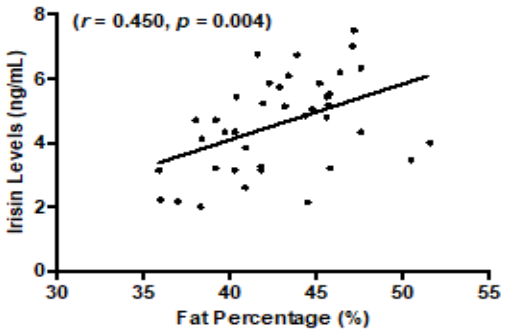
Descriptive analysis results of demographic, anthropometric, adiposity markers, and metabolic parameters presents in Table 1.

Table 1.
The descriptive analysis of demographic, anthropometric, adiposity markers, and metabolic parameters

Parameters	Unit	Mean±SD (n=40)
Age	years	21.56±0.20
Systolic blood pressure	mmHg	115.00±0.80
Diastolic blood pressure	mmHg	77.50±1.06
Resting heart rate	bpm	73.43±0.84
Fasting blood glucose	mg/dL	91.28±0.84
Hemoglobin	g/dL	14.57±0.16
Body height	m	1.57±0.01
Body weight	kg	69.56±1.27
Body mass index	kg/m^2	28.31±0.34
Fat percentage	%	42.96±0.60
Fat mass	kg	30.83±0.92
Free fat mass	kg	40.21±0.54
Waist circumference	cm	84.38±1.82
Hip circumference	cm	104.02±1.35
Waist-to-hip ratio	-	0.80±0.01
Serum irisin	ng/mL	4.61±0.23







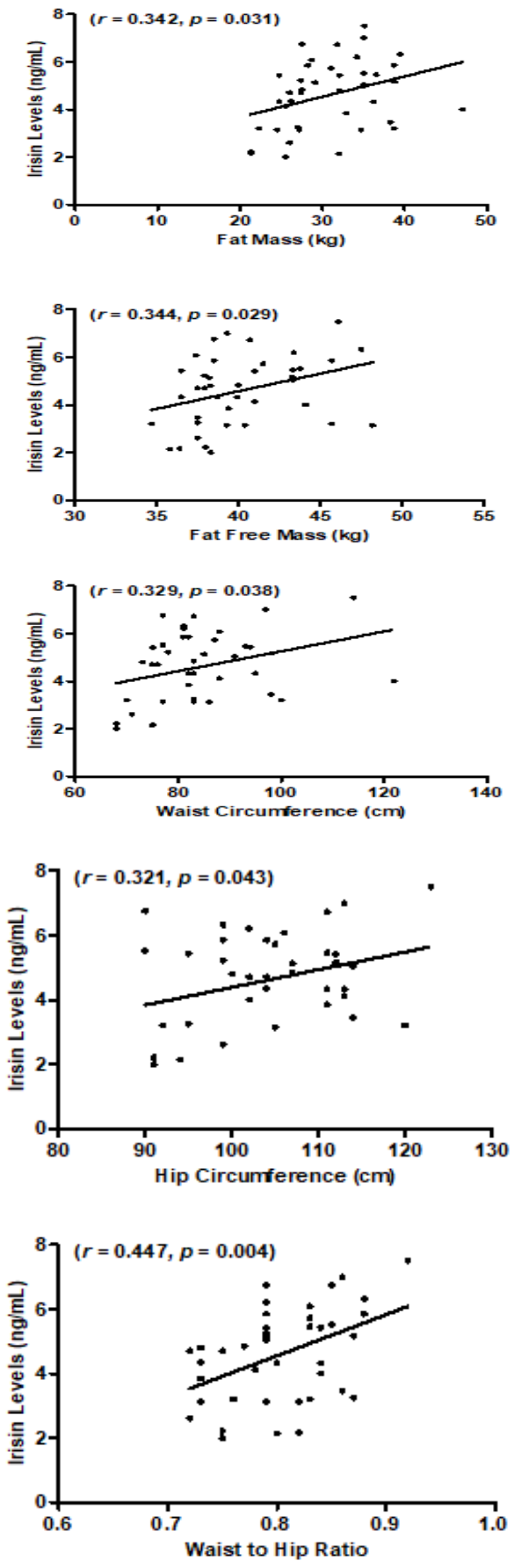


Figure 1. Serum irisin (ng/mL) correlated favorably with body weight (kg), body mass index (kg/m2), fat mass (%), fat mass (kg), free fat mass (kg), hip circumference (cm), and waist to hip ratio. Pearson correlation coefficients (r) and p-values are displayed in each graph.

Figure 1 shows the positive connection between serum irisin levels and several indices of obesity. As depicted, serum irisin was positively correlated with body weight in kilograms ($r = 0.385$, $p = 0.014$), body mass index (BMI) in kg/m² ($r = 0.588$, $p \leq 0.001$), fat percentage ($r = 0.450$, $p = 0.004$), fat mass in kilograms ($r = 0.342$, $p = 0.031$), fat-free mass in kilograms ($r = 0.344$, $p = 0.029$), waist circumference in centimeters ($r = 0.329$, $p = 0.038$), hip circumference in centimeters ($r = 0.321$, $p = 0.043$), and the waist-to-hip ratio ($r = 0.447$, $p = 0.004$). Serum irisin levels did not directly correlate with body height, a correlation coefficient indicates ($r = –0.003$, $p \geq 0.05$).

Discussion

This is the first cross-sectional study that shows a favorable connection between serum irisin levels and adiposity markers in obese teenage females following a single session of exercise-induced effort. The primary finding of this study is a favorable connection between serum irisin concentrations and several adiposity markers. This includes body weight in kilograms, body mass index in kg/m², body fat percentage, fat mass, fat-free mass, waist circumference, hip circumference, and waist-to-hip ratio among obese adolescent females. The results of this investigation support the conclusions of Zhang et al. (2020), who found a favorable connection between serum irisin levels and obesity markers in a middle-aged Chinese sample. This study extends the understanding of irisin's role, similar to the associations found by Shoukry et al. (2016) in obese patients with Type 2 Diabetes Mellitus. Tabak et al. (2017) discovered beneficial associations between BMI, waist circumference, and waist-to-hip ratio in people with metabolic syndrome, which supports the possible link between irisin and obesity indicators. However, the literature presents a dichotomy of evidence, as exemplified by Gonzalez-Gil et al. (2019), who identified an inverse connection in pediatric individuals with obesity and metabolic syndrome. Similarly, Tang et al. (2019) reported negative correlations in overweight and normal-weight individuals, while Jameel et al. (2015) found no significant relationship in women of average weight. These disparate findings emphasize the complexities of irisin's interaction with obesity and the need for more study to understand its involvement in metabolic control. These findings may be due to differences in the criteria of subjects used. Prior research has predominantly focused on cohorts comprising pediatric individuals presenting with obesity and metabolic syndrome. Comparative studies have included participants categorized as overweight and of average weight, while others have specifically investigated females with a weight classification within the average range. In contrast, our study focused only on obese adolescent females. In light of the empirical evidence, it is posited that adipose tissue may serve as a principal contributor to irisin secretion in conjunction with muscular tissue, particularly within the demographic of obese female adolescents. Many academic studies have been systematically undertaken to

explore the potential correlation between the circulatory concentration of irisin and the manifestation of obesity, as substantiated by empirical evidence in existing scholarly publications (Zhang et al., 2020; Pardo et al., 2014). The bulk of studies indicates a constant positive connection between serum irisin concentrations and both body mass index (BMI) and body weight, with some studies showing conflicting results (Zhang et al., 2020; Shoukry et al., 2016; Yin et al., 2020; Perakakis et al., 2017; Sahin-Efe et al., 2018). This trend persists even in cases of markedly elevated BMI (Pardo et al., 2014). Furthermore, irisin levels are associated with fat mass, fat-free mass, waist circumference, waist-to-hip ratio, and muscle mass (Tabak et al., 2017; Löffler et al., 2015; Crujeiras et al., 2014), a pattern that is also seen in Asian populations (Yin et al., 2020; Jang et al., 2017; Zhang et al., 2020). The new study adds to the data by showing a robust positive connection between serum irisin and adiposity indices in a sample of obese adolescent females. These findings suggest irisin as a possible biomarker for obesity, as evidenced by body composition measurement using the TANITA Body Composition Analyzer. The investigation indicates a positive association between serum irisin concentrations and numerous indices of fat mass, including total fat mass in kilograms, relative fat percentage, and mass of fat-free tissue, also measured in kilograms. The research posits that adiposity may exert a regulatory influence on serum irisin concentrations. Consequently, it is hypothesized that beyond skeletal muscle mass, adipose tissue mass constitutes a substantial determinant of the observed fluctuations in serum irisin levels among obese adolescent females.

Several limitations in this study need to be addressed to reinforce the conclusions of this research. Initially, it should be noted that the sample size of this study is relatively limited, encompassing only 40 obese adolescent females. Consequently, it is imperative to expand the cohort size in subsequent studies to more comprehensively ascertain the correlation between serum irisin concentrations and adiposity indicators among obese female adolescents. Second, this study was only cross-sectional, so it is still very vulnerable to information or bias in the research results. Third, the adiposity indicators used in this study were body weight, fat mass, fat percentage, free fat mass, waist circumference, body mass index, hip circumference, and waist-to-hip ratio; therefore, future research should include both direct and indirect adiposity indicators.

Conclusions

It can be inferred that serum irisin has a positive correlation with adiposity markers but not with height. The reciprocal link between adiposity markers may influence serum irisin in women who develop obese following a single session of exercise induction, perhaps leading to an increase in fat browning.

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