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Association between BMI and Leptin Levels in Primary Infertile Women: A Cross-Sectional Study

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Abstract

Primary infertility affects a significant proportion of couples and is often attributed to female factors. Obesity, which is associated with increased levels of the hormone leptin, is a known risk factor for female infertility. This cross-sectional study aimed to investigate the association between BMI and leptin levels in primary infertile females at Al-Nuaman Hospital and Al-Salama private hospital from September 2022 to March 2023. A total of 100 females were enrolled, and their BMI and serum leptin levels were measured. The participants were divided into four groups: Group 1 (normal weight, fertile), Group 2 (overweight infertile), Group 3 (obese infertile), and Group 4 (severely obese infertile) women, each consisting of 25 participants, categorized based on their BMI: normal BMI (18.5–24.9 kg/m²), overweight BMI (25–29.9 kg/m²), obesity BMI (≥30 kg/m²), and severely obese BMI (35-40 kg/m²). The mean leptin levels were compared between the four groups using ANOVA, and the association between BMI and leptin levels was

assessed using Pearson's correlation coefficient. The study revealed a highly significant correlation between primary infertility and the parameters (BMI and leptin) ($P < 0.001$) and showed a positive correlation between leptin and BMI. It was shown that primary infertile females with a high BMI have elevated serum leptin levels. This underscores the importance of weight management in addressing primary female infertility.

Keywords: Body mass index, Leptin, Primary infertility, Female infertility.

Introduction

Primary infertility is a prevalent reproductive issue that affects approximately 10-15% of couples worldwide (1-4). In women, obesity is a recognized risk factor for infertility as it can lead to hormonal imbalances and ovulatory dysfunction (5-7). Leptin is a hormone produced by adipose tissue that regulates energy balance and appetite (8-9). It also plays a critical role in the regulation of reproductive function, including the modulation of gonadotropin-releasing hormone (GnRH) secretion, which is essential for normal ovulation (10). Leptin levels are known to be elevated in obesity, reflecting increased adipose tissue mass (11-13). The heightened leptin levels in obesity may contribute to the development of ovulatory dysfunction, a common cause of female infertility (14-15). Several studies have explored the association between BMI and leptin levels in women with infertility. Some studies have reported a positive correlation between BMI and leptin levels in infertile women (16-18). Moreover, most of these studies have focused on women with polycystic ovary syndrome (PCOS), a common cause of infertility in women with obesity (19-23). Therefore, the relationship between BMI and leptin levels in primary infertile women with obesity remains unclear. To address this knowledge gap, we conducted a cross-sectional study to investigate the association between BMI and leptin levels in primary infertile females.

Patients and methods

This cross-sectional study was conducted at Al-Nuaman Hospital and Al-Salama Private Hospital from September 2022 to March 2023. We enrolled a total of 100 female participants and measured their BMI and serum leptin levels. Ethical approval for this study was granted by the Ethics Committee of the College of Medicine, Al-Iraqia University,

Baghdad, Iraq (Approval Number: FM/SA/107), in accordance with the ethical principles outlined in the Declaration of Helsinki. Prior to their inclusion in the study, all participants provided written informed consent. Participants were categorized into four groups: Group 1 (normal weight, fertile), Group 2 (overweight infertile), Group 3 (obese infertile), and Group 4 (severely obese infertile) women, with each group consisting of 25 individuals. The categorization was based on their BMI, with the following criteria: normal BMI (18.5–24.9 kg/m²), overweight BMI (25–29.9 kg/m²), Obesity BMI (≥30 kg/m²), and severely obese BMI (35-40 kg/m²) (23). The age of all participants ranged between 18 and 30 years old.

Sample Collection and Preparation

Five milliliters of venous blood were collected from both the patients and the healthy control women. The blood was drawn into gel tubes and left to coagulate on a bench for 20 min. Subsequently, it was centrifuged at 3000 rpm for 10 min. The obtained serum was stored in a refrigerator at 20°C for later analysis.

Statistical Analysis

Data were entered into the latest version of SPSS (Statistical Package for the Social Sciences) by the researcher. Descriptive statistics are presented in the format of "mean ± standard error." Group comparisons were made using the ANOVA method, and Pearson's correlation was employed to examine the association between the two variables. The significance threshold (P-value) for all statistical analyses was set at ≤ 0.05.

Results

The mean values ± SE of parameters (BMI and Leptin), based on the collected data, are presented in Table 1 and Figure 1. The results indicated that all parameters in the infertile patient groups showed a significant increase when compared to the normal fertile group (P=0.0001).

Table 1: BMI and leptin in four study groups.

Parameters	Mean±SD				P value
	G1 NO=25	G2 NO=25	G3 NO=25	G4 NO=25	
BMI (kg/m^2)	20.91±0.24	27.81±0.26	30.71±0.27	35±0.15	0.0001
Leptin (ng/mL)	9.1±0.46	11.90±0.61	14.18±0.41	0.33±16.90	0.0001

* G1: Fertile female with normal BMI, G2: Infertile with overweight, G3: Infertile with obesity, G4: Infertile with very obesity.

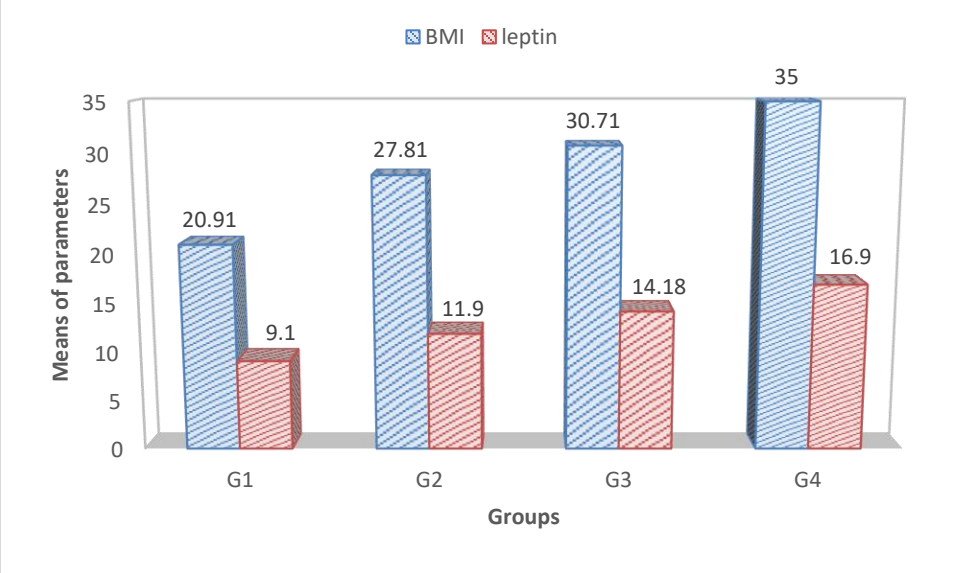

Figure 1: Means of BMI and Leptin in studied groups.

The relationship between all parameters is analyzed using Pearson correlation analysis and the results are collectively presented in Table2 and Figure 2. The present study demonstrated a highly significant positive correlation between BMI and leptin.

Table 2: Correlations between variables in infertile groups (r-value).

Parameters		BMI	Leptin
BMI	r	1	0.611*
	P-value		0.0001
Leptin	r	0.611**	1
	P-value	0.0001	

* Correlation is significant at the 0.01 level, r=Pearson correlation coefficient

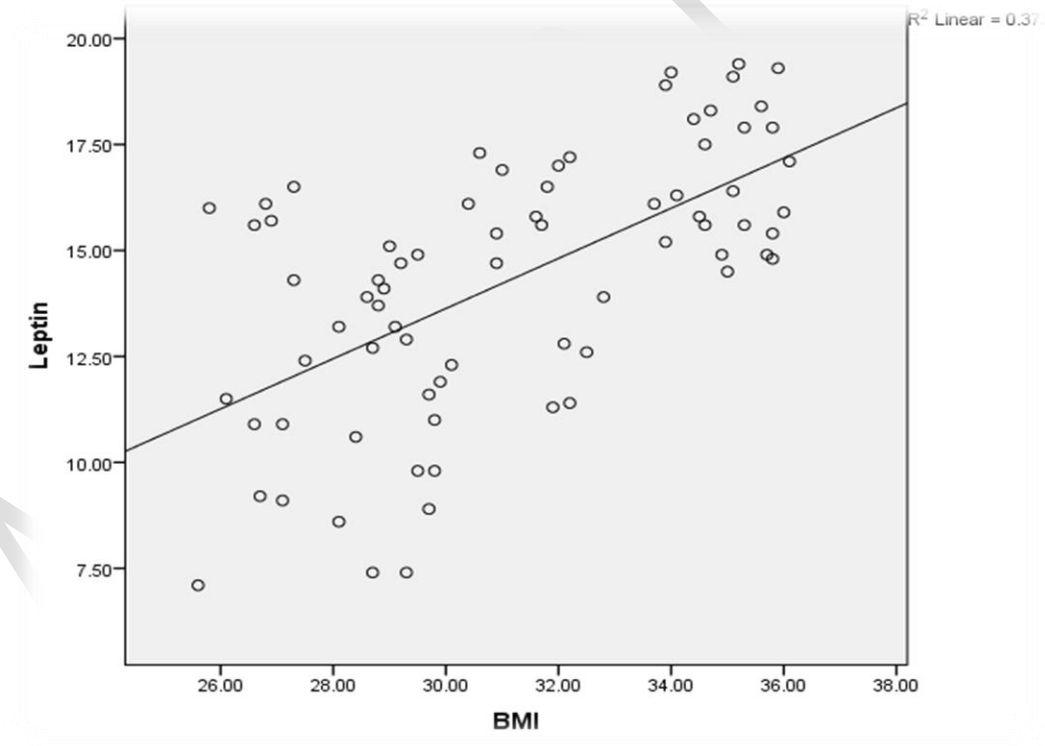

Figure 2: Positive Correlation between leptin level and BMI with fertility state.

Discussion

Our study aimed to investigate the association between BMI and leptin levels in primary infertile females. We found that primary infertile females with a high BMI had significantly higher serum leptin levels compared to those with a normal BMI. Moreover, we observed a positive correlation between BMI and serum leptin levels, indicating that the higher the BMI, the higher the levels of leptin. Our findings align with previous studies that have reported a positive association between BMI and leptin levels in women with infertility (24-25). Leptin is primarily produced by adipose tissue, and its levels are known to increase with adiposity (26). Thus, the higher levels of leptin in women with a high BMI may reflect increased adipose tissue mass. Elevated leptin levels in obesity may contribute to the development of ovulatory dysfunction, a common cause of female infertility (27-28). Leptin has been shown to modulate the secretion of GnRH, which is essential for normal ovulation (29-31). In women with obesity, elevated leptin levels may disrupt the GnRH pulse generator, resulting in ovulatory dysfunction and infertility (32). Furthermore, a majority of studies have found a positive association between BMI and leptin levels in women with infertility. Abdullah *et al.* showed a significant positive correlation between BMI and serum leptin levels in women with unexplained infertility (17). Kargasheh *et al.* reported that a higher BMI was associated with higher serum leptin levels in women with a history of infertility (18). The overall consensus is that obesity is linked to elevated leptin levels, which may contribute to ovulatory dysfunction and female infertility. The mechanisms underlying this association are complex and involve multiple pathways, including the modulation of GnRH secretion (28-33), inflammation, and insulin resistance (34-35).

Our study has several strengths, including a relatively large sample size and the inclusion of only primary infertile females, which eliminates the confounding effects of previous infertility treatments. However, our study also has some limitations that should be considered. Firstly, we did not assess other potential mediators of the association between obesity and infertility, such as insulin resistance or inflammation. Secondly, our study was cross-sectional, which does not allow for causal inferences to be made. Thus, further longitudinal studies are needed to confirm the relationship between BMI and leptin levels in primary infertile females.

Conclusion

Our study demonstrated a significant increase in leptin levels with increasing BMI among female primary infertility patients. Additionally, we observed a robust positive correlation between BMI and leptin. In conclusion, our study provides evidence of a positive association between BMI and leptin levels in primary infertile females. These findings underscore the significance of weight management in addressing primary female infertility. Further research is warranted to explore the role of leptin in the pathogenesis of female infertility and its potential as a therapeutic target.

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Authors' contributions

Each author participated in data analysis, drafting, and revising of the manuscript, and consented to assume responsibility for all aspects of this project.

Conflict of Interest

The author has stated that they do not have any conflicts of interest.

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