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The Impact of Body Mass Index (BMI) on Fertility Outcome in Women Undergoing Assisted Reproductive Technologies (ART)

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Background: *The problem of overweight and obesity became increasingly recognized in the Iraqi community in various regions of the country during the last three decades because of changes in lifestyle and dietary habits. Significant proportions of women during reproductive life complain of obesity and overweight, which may negatively impact their reproductive potential.* ***Aim of the study:*** *The aim was to assess the impact of BMI on the outcomes of assisted reproductive technologies (ART), including intracytoplasmic injection "ICSI" and in vitro fertilization "IVF".* ***Patients and methods:*** *The sample of infertile women was selected from the population of infertile women visiting the Higher Institute for Infertility Diagnosis and Assisted Reproduction Technologies, Baghdad - Iraq. The design of the study was retrospective observational single center cohort study. Data of women were obtained from the archive unit and included medical reports from January 2022 to January 2025. All enrolled women were subjected to gonadotropin-releasing hormone (GnRH) antagonist.* ***Results:*** *Positive pregnancy tests were reported in 60 (21.1 the routine protocol of %) cases of overweight/obese group compared to 116 (40.8 %) of normal weight group. There was a significant difference between groups ($p < 0.001$). The implantation rate among the overweight/obese group was found significantly less compared to the group of normal weight patients, being 49.24 ±9.23 % and 61.42 ±13.19 %, respectively ($p < 0.001$). Average number of embryos transplanted per woman were found with no significant variation across the research groups ($p = 0.207$). However, the mean of total number of retrieved oocytes per women was significantly less in overweight/obese group compared to normal weight group, being 4.23 ±2.94 and 5.79 ±2.41, respectively ($p = 0.031$), and no variation in fertilization rate between study groups ($p = 0.297$). Investigating the quality of embryos per women showed significant reduction in number of embryos with good quality in overweight/obese group compared to normal weight group, being 71.48 ±20.17 and 77.23 ±15.61, respectively ($p = 0.031$).* ***Conclusion:*** *The clinical positive pregnancy rate following ART can be significantly affected by the BMI of women with infertility. This was found to be attributed to the reduced rate of good quality embryos and lower implantation rate.*

Key words: Body mass index, Obesity, Infertility, Fertilization, Pregnancy.

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INTRODUCTION

The problem of overweight and obesity became increasingly recognized in the Iraqi community in various regions of the country during the last three decades. This was attributed to significant changes in the lifestyle and dietary habits which have been related to higher caloric intake and reduction in physical activities (1, 2, 3). Obesity triggers higher risk of chronic medical illnesses, such as cardiovascular system diseases, osteoarthritis, insulin resistance, various metabolic conditions, and diabetes mellitus (4, 5, 6). Recent multinational epidemiologic studies reported a substantial surge in prevalence of women with obesity from 29.8% in 1980 to

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38.0% in 2013 and was witnessed in both the developed and developing nations (7). Interestingly, high percentage of women at their reproductive life were reported to complain of obesity and overweight which was negatively associated with reduced reproductive potential (8). Elevated body mass index (BMI) was found to impact women's reproductive life, including puberty, pregnancy, and delivery.

The impact extends to impact the normal physiology of the ovulation cycle, uterine endometrial development, and normal embryo implantation. The pathophysiological impact is witnessed through reported elevated abortion rates and major complications associated with pregnancy following both natural conception and ART (9). Several studies examined the impact of elevated BMI on the outcomes following ART. However, high disparities were also reported among these published reports indicating a major inconsistent in the following methodologies of infertility treatment. For instance, a raised BMI was associated with reduced IVF results, evidenced by lessened ovarian response, inferior oocyte and embryo quality, increased cancelation rates, decreased clinical pregnancy rates (CPR), lower fresh live birth rates (FLBR), and heightened miscarriage rates (10-17). Additional studies, on the other hand, found no impact of BMI on the infertility outcomes following ART (18–20). Despite extensive research in this area, there is still a need for further studies to elucidate the impact of BMI on women reproductive health. For that reason, the current analysis was aimed to assess the impact of BMI on ART outcome among infertile women.

PATIENTS AND METHODS

Infertile women were chosen from the cohort of those seeking assistance at the Higher Institute for Infertility Diagnosis and Assisted Reproduction Technologies in Baghdad, Iraq. The design of the study was obtained from the medical archive unit and included reports from January 2022 to January 2025. All enrolled women were subjected to the routine protocol of gonadotropin-releasing hormone (GnRH) antagonist. The study was approved by the committee of ethics in the Higher Institute for Infertility. The study did not include written consents due to the retrospective nature of the analysis where all the acquired data were kept confidential.

To calculate the BMI for each patient, the height and weight of women were utilized in the equation: weight in kilograms divided by the square of height in meters (kg/m^2). Based on the computed BMI, patients were classified into two categories: the first category comprised women with normal weight (BMI ranging from 18.5 to 24.9 kg/m^2), while the second category consisted of women with elevated body weight (BMI beyond 25 kg/m^2). Sample size was calculated according to Charan and Biswas (21), where each of the two groups consisted of 284 patients. Patients for each group were randomly selected by random numbers generated by an online random number calculator. Exclusion criteria involved women with chronic disease and abnormalities such as diabetes, hypertension, autoimmunological conditions, thyroid disorders, liver and kidney disease. The study also excluded women older than 35 years of age. The outcome variables collected by the current analysis included oocyte and embryo characteristics, implantation rate, and pregnancy rate which was based on the biochemical pregnancy test. Estimating the previous rate of pregnancy in normal weight and overweight / obese women was performed according to Bhojwani et al. which were 34.7 and 24 % respectively. Statistical work was carried out with the SPSS (IBM, USA, version 16). The descriptive statistics included number of cases, percentages, mean values, and

standard deviation. Comparison of proportions was done using the test chi-square and contrasting mean values was based on unpaired-groups t-test. The significance level was set when p-value is less than 0.05.

RESULTS

Patients' demographic variables of the enrolled women to the current analysis are shown in table 1. Comparing mean age between study groups revealed no significant difference ($p = 0.432$). Comparing the mean of BMI between study groups revealed significant variation ($p < 0.001$), being 21.92 ± 3.06 kg/m2 for the first group of normal weight versus 28.81 ± 5.07 kg/m2 for the overweigh/ obese group.

Classification of patients based on infertility type indicated 201 (70.8%) cases of primary infertility and 83 (29.2%) cases of secondary infertility within the overweight/obese cohort, while the normal weight group comprised 197 (69.4%) cases of primary infertility and 87 (30.6%) cases of secondary infertility. The analysis indicated no significant difference between the groups (p = 0.714). In addition, analysis showed no significant variations in mean concentration of serum follicle stimulating hormone (FSH), mean luteinizing hormone (LH), mean serum prolactin, and mean serum thyroid stimulating hormone (TSH) between groups of overweight/obese women and women with normal weight range ($p > 0.05$) (Table 2). Regarding the impact of BMI on the ICSI outcome as shown in table 3, positive pregnancy test was reported in 60 (21.1 %) cases of overweight/obese group and in 116 (40.8 %) of normal weight group and this difference was significant ($p < 0.001$). The mean implantation rate of overweight/obese group was lower in a significant manner when contrasted to that of normal weight group, 49.24 ±9.23 % versus 61.42 ±13.19 %, respectively ($p < 0.001$).

We reported no significant variation in number of transferred embryos /women between both study groups ($p = 0.207$). The mean of total number of retrieved oocytes per women was lower in overweight/obese group when contrasted to that of normal weight group, being 4.23 ±2.94 versus 5.79 ±2.41, respectively ($p = 0.031$). There was no significant difference in the total number of fertilized oocytes % between both study groups ($p = 0.297$), and the quality of embryos % per women was lower in overweight/obese group when contrasted to that of normal weight group, 71.48 ±20.17 versus 77.23 ±15.61, respectively ($p = 0.031$).

Table 1: General characteristics of enrolled subfertile women.

Characteristic	Overweight/Obese >25 kg/m² n = 284	Normal weight 18.5-24.5 kg/m² n = 284	p
Age (years) Mean ±SD	**29.73 ± 4.09**	**29.62 ± 6.01**	**0.432 I NS**
BMI (kg/m2) Mean ±SD	**28.81 ± 5.07**	**21.92 ± 3.06**	**<0.001 I *****
Infertility Duration (years) Mean ±SD	**4.05 ± 2.32**	**4.12 ± 3.01**	**0.249 I NS**
Type of infertility			
Primary, *n* (%)	**201 (70.8 %)**	**197 (69.4 %)**	**0.714 C NS**
Secondary, *n* (%)	**83 (29.2 %)**	**87 30.6 %)**	

C: chi-square test, NS: not significant, I: independent samples t-test ,*: significant at $p \leq 0.001$.**

Table 2: Comparison of mean serum hormonal levels between overweight/obese women and normal weight women.

Characteristic	Overweight/Obese >25 kg/m2 *n* = 284	Normal weight 18.5-24.5 kg/m2 *n* = 284	*p*
FSH (mIU/ml)			
Mean ±SD	**7.08 ± 3.01**	**7.11 ± 2.93**	**0.706 I NS**
LH (mIU/ml)			
Mean ±SD	**5.79 ± 2.56**	**5.68 ± 2.18**	**0.283 I NS**
Prolactin (µg/dl)			
Mean ±SD	**17.29 ± 8.03**	**17.31 ± 7.05**	**0.428 I NS**
TSH (mIU/ml)			
Mean ±SD	**2.03 ± 0.81**	**2.17 0.72**	**0.392 NS**

I: independent samples t-test, NS: not significant.

Table 3: Comparison of ICSI outcomes between overweight/obese women and normal weight women .

Characteristic	Overweight/Obese >25 kg/m2 *n* = 284	Normal weight 18.5-24.5 kg/m2 *n* = 284	*p*
Pregnancy test			
Positive, *n* (%)	**60 (21.1 %)**	**116 (40.8 %)**	**<0.001 C *****
Negative, *n* (%)	**224 (78.9 %)**	**168 (59.2 %)**	
Implantation rate (%)			
Mean ±SD	**49.24 ±9.23**	**61.42 ±13.19**	**<0.001 I *****
Number of embryos transferred/patient			
Mean ±SD	**1.79±0.42**	**1.81±0.29**	**0.207 I NS**
Total number of oocytes			
Mean ±SD	**4.23 ±2.94**	**5.79 ±2.41**	**0.038 I ***
Total number of fertilized oocytes %			
Mean ±SD	**67.31 ±24.01**	**65.08 ±19.28**	**0.297 I NS**
Good quality embryos %			
Mean ±SD	**71.48 ±20.17**	**77.23 15.61**	**0.08 ****

C: chi-square test, NS: not significant, I: independent samples t-test, *: significant at $p \leq 0.05$, **: significant at $p \leq 0.01$, *: significant at $p \leq 0.001$.**

DISCUSSION

The impact of weight of subfertile women on ICIS outcomes was assessed by the current analysis through comparing two groups of infertile women according to their BMI, a group of women characterized as overweight / obese versus a group of women characterized as women with normal weight. Our results showed that elevated BMI imposes a significant negative impact on infertility treatment outcome. Those women were presented with lower rate of pregnancies, lower implantation rate, lower number of total retrieved oocytes, and lower number of good quality embryos. The findings are corroborated by the research conducted by García-Ferreyra et al. (23), which elucidated those

females with a BMI surpassing normative values (encompassing the overweight and obesity classifications) experienced markedly diminished rates of pregnancy, implantation, and live births during in vitro fertilization procedures. Additional studies such as those reported by Vural et al. (24), Provost et al. (25), Kudesia et al. (26) and Moragianni et al. (27) have also highlighted the significant impact of elevated BMI on pregnancy and implantation rates. The findings also align with two substantial prior meta-analyses encompassing 47,967 and 682,532 cycles, which both studies illustrated that being a woman with overweight and obesity characteristics should have a serious impact on pregnancy rates (28) and on FLBR (29) subsequent to ART. In contrast to the current findings, earlier investigations involving overweight or obese women who underwent in IVF utilizing their own oocytes did not reveal diminished pregnancy and implantation rates when compared to a group of normal-weight women (30-37). The mechanisms underlying inadequate reproductive outcomes in overweight and obese women have been correlated to significantly impact normal folliculogenesis in ovaries, MII oocyte quality, alteration in embryonic development, and reduced receptivity of the endometrial stroma. Research conducted in both human and animal models have demonstrated that BMI could dysregulates normal hormonal supply, resulting in higher levels of insulin, androgen, estrogen, and leptin, which collectively could adversely affect ovarian folliculogenesis and oocyte quality (23). As previously elucidated, obesity exerts a detrimental impact on oocyte and pre-implantation embryo development through metabolic perturbations in lipids, proteins, and growth factors, which culminate in elevated oxidative stress and an imbalance in specific free fatty acids that compromise the functionality of granulosa cells (38), the chromosomal arrangement at the stage of meiotic spindles formation (39), and the metabolism of glucose and triglycerides in blastocysts (40).

CONCLUSION

As indicated in the literature, this study further examines how a mother's body mass index affects the outcomes of assisted reproductive technologies. Women with higher BMI showed significantly lower rates of achieving pregnancy and implantation, a lower number of oocytes collected, and a lower percentage of high-grade embryos compared to women with normal weight. These findings are consistent with other research demonstrating that excess weight adversely affects a number of important physiological factors related to conception and, to some extent, embryonic development, especially in the later stages. Considering the rising rates of overweight and obesity populations, particularly among women of childbearing age, our research strongly supports the incorporation of proactive measures that foster improvement in fertility levels while maintaining weight control. Utilizing BMI in the preconception phases of management may increase the success rate of ART procedures and enhance reproductive health of the patients.

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