ORIGINAL RESEARCH

Individualized Weight Management and Its Impact on Pregnancy Outcomes in Overweight/Obese Infertile Women: A Retrospective Study

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ABSTRACT

Background • Previous studies link overweight/obesity to reduced fertility, highlighting weight intervention as vital for better pregnancy outcomes. However, clarity on the role and efficacy of weight loss in enhancing pregnancy is inconsistent.

Objective • This study aimed to assess the impact of individualized weight intervention on pregnancy among Chinese overweight/obese infertile women and explore body composition indexes influencing pregnancy outcomes.

Methods • This retrospective study involved 363 overweight/obese infertile women admitted to the First Affiliated Hospital of Guangxi Medical University, Guangxi, China, from June 2017 to November 2020. Among them, 249 received personalized weight intervention (intervention group), while 114 did not (control group). Pregnancy outcomes were compared between the two groups, and changes in body composition before and after intervention were measured. Multivariate logistic regression was employed to analyze factors influencing pregnancy outcomes.

Results • The intervention group exhibited significantly higher clinical pregnancy rates, natural pregnancy rates, assisted reproductive pregnancy rates, and induced ovulation (IO) pregnancy rates compared to the control group (all $P < .05$). Following weight intervention, there were significant decreases in body weight, body mass index (BMI), visceral fat area, and body fat (all $P < .01$). Logistic regression analysis identified polycystic ovary syndrome as the reason for infertility (OR=3.446, $P = .016$), Δbody weight %≥10% (OR=2.931, $P = .014$), and Δvisceral fat area% (OR=1.025, $P = .047$) as positive factors for a successful pregnancy. Conversely, age≥35 years old (OR=0.337, $P = .001$), BMI≥25 kg/m^2 after intervention (OR=0.279, $P < .001$), and visceral fat area≥100 cm^2 after intervention (OR=0.287, $P = .007$) were identified as negative factors.

Conclusions • Individualized weight management enhances pregnancy outcomes in overweight/obese infertile women. Achieving a reduction in body weight by 10% or more, combined with effective control of visceral fat, proves important in improving pregnancy outcomes. Excess visceral fat emerges as an adverse factor impacting successful pregnancy. (*Altern Ther Health Med.* 2024;30(10):78-85).

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What Does This Study Add To The Clinical Work*:*

Individualized weight intervention improves pregnancy outcomes in overweight/obese infertile women. Weight loss of 10% or more and control of visceral fat are important for pregnancy.

INTRODUCTION

Overweight and obesity present a significant global public health concern, with a rising prevalence in recent years.[1,2] It stands as a major risk factor for various chronic diseases, including type 2 diabetes, cardiovascular issues, cerebrovascular diseases, certain cancers, and infertility in women of childbearing age.[3,4] This condition detrimentally affects women's reproductive health and diminishes fertility.[4,5] Specifically, it is linked to menstrual disorders, disruption of ovulation, reduced oocyte quality, and impaired endometrial receptivity.[6,7]

Research has highlighted that obesity increases the risk of miscarriage[8] and obstetrical complications.[9] Furthermore, it is associated with a lower pregnancy rate (PR) or live birth rate (LBR) in assisted reproductive technology (ART)-supported pregnancy therapy.[10] Addressing the impact of overweight/obesity on reproductive health is imperative for public health intervention and preventive strategies.

Due to its association with reduced fertility, several studies propose weight loss as an effective method to address infertility related to overweight/obesity. However, the role and effectiveness of weight loss in improving pregnancy outcomes are inconsistently understood.[11] An earlier study in obese infertile women (BMI 35.0 to 39.9 kg/m^2) showed that those undergoing lifestyle intervention lost an average of 10% of their body weight (BW) and achieved a clinical pregnancy rate of 77%, with LBR of 67%. In contrast, the "drop-out" group, which lost only about 1% of their baseline body weight, did not achieve pregnancy.[12]

Another retrospective cohort study focused on infertile, overweight/obese women undertaking weight loss with a target of a 10% reduction in weight. Of the patients, 32% achieved this goal, correlating with significantly higher pregnancy rates.[13] In a small randomized controlled trial (RCT), obese women undergoing a 12-week intensive lifestyle intervention exhibited an average weight loss of 6.6 kg, resulting in a significantly higher LBR compared to the control group (44% vs. 14%). Additionally, the intervention group required fewer treatment cycles.[14]

In a large RCT involving obese infertile women in the Netherlands, the intervention group (receiving assisted reproductive technology when achieving 5% to 10% weight loss or BMI<29 kg/m^2, or 6 months post-intervention) and the control group (receiving assisted reproductive technology directly) exhibited no significant difference in cumulative LBR and ongoing pregnancy rate (OPR). This lack of difference might be attributed to the modest weight loss of only 3.3 kg in the intervention group.[15]

Another study focused on women undergoing assisted reproduction revealed a noteworthy weight loss (9.44 kg) in the intervention group, leading to a significant increase in the LBR through natural conception. However, no significant impact on the overall LBR was observed.[16] Several studies indicated that modest weight loss did not exhibit a significant correlation between the extent of weight loss and heightened rates of pregnancy or live births among overweight/obese infertile women.[17,18]

The inconsistency in results is coherent, considering variations in countries, locations, ethnicities, populations, patterns of weight loss, and epidemiological designs, among other factors. Notably, similar studies are infrequently observed in the Chinese population, primarily because infertility due to obesity in China has only recently become a serious concern. Another reason for the inconsistent results is the reliance on BMI as an obesity indicator. Obesity, as per the World Health Organization (WHO), is characterized by an abnormal or excessive fat accumulation that presents a health risk. Elevated body fat, particularly the accumulation of excessive visceral fat, is linked to obesity-related diseases,[19] encompassing female infertility and pregnancy complications.[20]

Currently, BMI serves as an indicator to assess obesity levels; however, it fails to reflect the distribution of various adipose tissues in the body.[21] Some infertile women, despite being underweight or having a normal BMI, may still exhibit abdominal obesity, characterized by a high percentage of body fat and visceral fat indexes.[21,22] Previous studies have highlighted that reducing visceral fat can contribute to the restoration of ovulatory function in obese patients with polycystic ovary syndrome (PCOS),[23] emphasizing that the reduction of visceral fat in obese women holds a more substantial impact on fertility.[24]

Therefore, relying solely on BMI may not adequately assess the impact of weight loss on PR and LBR. It is crucial to investigate the role of body composition indicators that reflect body fat distribution or the extent of body fat loss in evaluating the influence of weight management on pregnancy outcomes. Several studies have explored the correlation between new obesity-related indices, anthropometric and biochemical parameters, and body composition in individuals with obesity.[25] Additionally, research has explored the association of the body adiposity index and other indicators of body composition with cardiovascular risk factors.[26]

Considering the scarcity of studies on the effects of weight intervention on overweight/obese infertile women in the Chinese population and the limited data on body fat distribution post-weight management, as well as the association between visceral fat reduction and successful pregnancy, this study undertook a retrospective analysis. The focus was on the impact of individualized weight management on overweight/obese infertile women in China. Various body composition indicators were analyzed after weight management, and factors influencing pregnancy were explored. The aim is to serve as a foundation for tailored weight management strategies for overweight/obese infertile women in China.

MATERIALS AND METHODS

Study Design

The present retrospective study analyzed 363 overweight/obese infertile women who received assistance from the Reproductive Center and Nutrition Department at the First Affiliated Hospital of Guangxi Medical University, Guangxi, China, between June 2017 and November 2020. The intervention group comprised 249 infertile overweight/obese women who underwent personalized weight management along with body composition analysis. The control group comprised 114 infertile overweight/obese women who neither received individualized weight management nor continued with weight intervention beyond 2 months. All participants provided informed consent, and the study received approval from the Guangxi Medical University ethics committee.

Inclusion and Exclusion Criteria

Inclusion criteria were as follows: (1) BMI meeting international criteria for overweight and obesity per the WHO recommendations[27] (overweight: 25.0 kg/m² ≤ 5.0 < 30.0 kg/m²; obesity: ≥30.0 kg/m²); (2) Meeting diagnostic criteria for infertility: normal sexual life, no contraception, and no pregnancy for more than one year;[28] (3) Availability of complete physical examination data and clinical indicators.

Exclusion criteria were as follows: (1) Uterine malformation, intrauterine adhesion, endometrial polyps, endometriosis, submucosal fibroids, adenomyosis, or other gynecological diseases; (2) Endocrine diseases other than PCOS, including thyroid disease, congenital adrenal hyperplasia, hypercortisolism, functional hypothalamic amenorrhea, Cushing's syndrome, hyperprolactinemia, ovarian insufficiency, diabetes, or other endocrine diseases; (3) History of systemic lupus erythematosus, hypertension, hepatic and renal insufficiency, or cardiac insufficiency; or (4) Chromosome abnormalities.

Individualized Weight Management

The individualized weight management program, derived from previous studies[32,33] with minor modifications, is aimed at holistic patient care. The program encompassed personalized diet plans, exercise regimens, psychological counseling, and auxiliary tools, utilizing a co-management approach involving nutrition physicians, professional dietitians, and health managers.

Program Development. The dietitian and the patient collaboratively determined the personalized weight intervention method, considering the patient's body weight (BW) and weight loss goals established by the dietitian.

Dietary Intervention Phases. Participants in the weight intervention group underwent two phases of dietary intervention: (1) Eight weeks of dietary intervention: Emphasized caloric intake to overcome the catabolic state; (2) One-week recovery period: Gradual return to a normal diet with a focus on portion sizes and healthy food choices.[32]

Caloric Intake Calculation. The range of caloric intake was calculated as BW × 20 × 0.7 kcal to BW × 25 × 0.7 kcal, with a minimum energy target of 1,000 kcal/day. Daily caloric intake was divided into three meals, personalized based on each participant's weight.

Meal Replacement Plan. Daily meals were replaced as follows: (1) Breakfast: 200 mL soybean milk and a boiled egg; (2) Lunch and Dinner: Diet nutrition bar (106 kcal, Nutriease Health Technology Co. Ltd, Hangzhou, China), protein from meat, and non-starchy vegetables; (3) Additional recommendations and participants were instructed to: Consume at least 1.8 L of water daily, take a multivitamin and mineral supplement daily[33] and increase physical activities with a personalized exercise plan.

Exercise Plan. A personalized exercise plan was formulated, considering the patient's preferences, exercise endurance, and health status. It included moderate-intensity aerobic exercise (over 40 minutes each time) at least three times a week, combined with resistance exercise (10-15 minutes each time).

Reproductive Center Admission. After at least 2 months of weight management, patients were admitted to the Reproductive Center of the First Affiliated Hospital of Guangxi Medical University for further evaluation and care.

Assessment Parameters

Sex Hormones Measurement. Sex hormones, including follicle-stimulating hormone (FSH), luteinizing hormone (LH), estradiol (E_2), and testosterone (T), were measured and recorded in all infertile women during their initial visit.

Height and Weight Measurement. Height and weight measurements were conducted with participants on an empty stomach and bladder, adhering to anthropometric standards. BMI was calculated as weight in kilograms divided by the square of height in meters. BMI = weight (kg) / (height (m)) ^{2}

Human Body Composition Analysis. Body composition was analyzed using the Inbody 770 Body Fat Analyzer (Inbody 770, Biospace, Korea). The manufacturer's instructions were strictly followed during measurements, covering various parameters: (1) visceral fat area, (2) body fat volume, (3) body fat percentage, (4) skeletal muscle content, and (5) body water content. Data on body composition were collected before the initiation of weight management and at least 2 to 6 months before pregnancy, providing insights into changes over the intervention period.

Pregnancy Outcome Indicators

Indicators related to pregnancy outcomes were defined based on previous studies or established standards:[29-31] (1) Clinical pregnancy rate: Rate of confirmed clinical pregnancies; (2) Single live birth rate: Rate of pregnancies resulting in a single live birth; (3) Twin live birth rate: Rate of pregnancies resulting in twin live births; (4) Sustained pregnancy rate: Rate of pregnancies that progress successfully; (5) Natural pregnancy rate: Rate of pregnancies occurring naturally; (6) ART-assisted pregnancy rate: Rate of pregnancies assisted by ART; (7) Pregnancy Rate by Different ARTs: ovulation induction (OI), intrauterine artificial insemination (IUI), *in vitro* fertilization (IVF), intracytoplasmic sperm injection in oocytes (ICSI), and freeze–thaw embryo transfer (FET). These indicators provide a comprehensive assessment of the impact of weight management on both body composition and diverse aspects of pregnancy outcomes.

Interpretation of Relevant Indicators

Continuous Pregnancy: Refers to the uninterrupted growth and development of the fetus in utero until 12 weeks.

Pregnancy Outcome Rates. (1) Clinical Pregnancy Rate: Calculated as the number of clinical pregnancy cases divided by the total number of cases, multiplied by 100; (2) Sustained Pregnancy Rate: Calculated as the number of patients with intrauterine fetal growth and development up to 12 weeks divided by the total number of cases, multiplied by 100%; (3) Cumulative Live Birth Rate: Calculated as the number of patients with live births divided by the total number of cases, multiplied by 100%; (4) Clinical Pregnancy Rate per Fresh Transplantation Cycle: Calculated as the number of clinical pregnancy cycles divided by the number of fresh transplantation cycles, multiplied by 100%; (5) Clinical Pregnancy Rate per Freeze-Thaw Transplantation Cycle: Calculated as the number of clinical pregnancy cycles divided by the number of freeze-thaw transplantation cycles, multiplied by 100%; (6) Abortion Rate: Calculated as the number of patients with abortion divided by the total number of cases, multiplied by 100%.

Body Composition Index Calculations. Decreased percentage of body composition index before and after weight management: calculated as:

Visceral Fat and Body Fat Percentage Criteria. Criteria for visceral fat obesity: defined as a visceral fat area ≥100 cm^2; and Body fat percentage: calculated as (total body fat/body weight) × 100%.

Diagnostic Criteria for PCOS: 2003 Rotterdam Standard. The diagnostic criteria for polycystic ovary syndrome (PCOS), based on the 2003 Rotterdam standard, include the presence of any two of the following three criteria: (a) Sparse ovulation or anovulation: clinical manifestations include amenorrhea and sparse menstruation; (b) Clinical changes (acne, hirsutism) or biochemical changes: hyperandrogenemia is indicated by clinical changes such as acne and hirsutism or biochemical changes, with serum total testosterone and free testosterone levels higher than normal; (c) B-ultrasound examination: ovarian polycystic changes are confirmed by B-ultrasound examination. Diagnosis was established if there were ≥12 follicles with a 2–9 mm diameter in one or both ovaries and/or if the ovarian volume is ≥10 cm^3. PCOS was diagnosed when any two of these three criteria were met, providing a comprehensive approach to identifying this common endocrine disorder in women.

Follow-up Procedures

A thorough body composition analysis was conducted for all patients during the initial visit. In the weight intervention group, this analysis was repeated every 25 days throughout the intervention and after completion. After the weight intervention, patients underwent regular follow-ups, with a frequency of once a week during the intervention phase and transitioning to once every 3 months post-intervention. The follow-up process involved recording crucial metrics such as body weight (BW), BMI, body fat percentage, visceral fat area, skeletal muscle content, water content, and details on the ongoing ART-assisted pregnancy treatment and the current pregnancy situation.

This careful monitoring persisted until delivery. To ensure a comprehensive conclusion to the study, a final contact with all enrolled women was conducted in February 2021, during which relevant clinical data was obtained. This systematic follow-up approach aimed to capture the longitudinal impact of weight management on diverse body composition metrics and pregnancy-related factors.

Data Analysis and Statistics

All data underwent analysis using the statistical package SPSS 25.0 software (International Business Machine, Armonk, NY). The initial assessment involved testing the quantitative data for normality. For normally distributed data, mean ± standard deviation ($\bar{x} \pm s$) was employed, while skewed distribution data were presented as a median with quartiles (P25, P75). Group comparisons for normally distributed data were conducted using the *t*-test, while the Mann–Whitney U test was employed for skewed distribution data. Count data were described as rates [n (%)], and between-group comparisons utilized χ^2 inspection. Univariate analysis and multivariate binary logistics regression were employed to analyze factors associated with successful pregnancy in the weight intervention group. A significance level of 95% confidence interval ($P < .05$) was considered indicative of statistical significance.

RESULTS

Baseline Parameters and Group Comparisons

Table 1 presents the baseline parameters for both groups. No statistically significant differences were observed between the two groups across various factors, including age, basal sex hormone levels (FSH, LH, E2, T), years of infertility, type of infertility (primary or secondary), causes of infertility (PCOS, pelvic/fallopian tube factors, male factors, and other factors), basal body weight, basal BMI, basal visceral fat area, basal skeletal muscle content, basal body water content, basal body fat, and basal body fat percentage of patients ($P > .05$). The intensive weight intervention duration in the intervention group ranged from 2 to 6 months, with an average of 2.97 ± 1.02 months and a median of 3 months. The follow-up time for all patients spanned from 4 to 46 months, with a median follow-up duration of 21 months.

Table 1. The Baseline Information of Subjects Included in this Study

Indicators	Intervention Group (n = 249)	Control Group (n = 114)	Z / χ^2	*P* value
Age (years)	31.00 (29.00, 35.00)	31.00 (28.00, 34.25)	-0.926	0.355
Basic FSH (IU/L)	6.31 (5.34, 7.44)	6.04 (5.03, 7.40)	-1.329	0.184
Basic LH (IU/L)	5.88 (3.61, 9.51)	5.90 (4.15, 9.50)	-0.337	0.736
Basic E2 (pg/L)	41.17 (31.29, 52.61)	38.6 (28.37, 51.42)	-1.285	0.199
Basic T (ng/mL)	0.31 (0.17, 0.49)	0.30 (0.17, 0.52)	-0.246	0.805
Years of Infertility (years)	4 (3.00, 5.00)	4.00 (3.00, 5.00)	-1.488	0.137
Type of Infertility (%)				
Primary Infertility	50.60 (126/249)	44.74 (51/114)	1.077	0.299
Secondary Infertility	49.40 (123/249)	55.26 (63/114)		
Causes of Infertility (%)			2.025	0.567
PCOS	47.70 (117/249)	40.35 (46/114)		
Pelvic/Fallopian Tube Factors	31.33 (78/249)	38.60 (44/114)		
The Man Factors	9.64 (24/249)	9.65 (11/114)		
Others	12.05 (30/249)	11.40 (13/114)		
Base weight (kg)	69.60 (65.00, 74.90)	71.10 (67.15, 76.70)	-1.669	0.095
Basic BMI (kg/m^2)	28.48 (27.00, 29.97)	28.40 (26.63, 30.93)	-0.460	0.646
Basal Visceral Fat Area (cm^2)	132.81 (116.09, 154.52)	136.10 (110.50, 150.90)	-0.150	0.881
Basal Body Fat (kg)	27.00 (24.20, 31.80)	27.95 (24.40, 32.03)	-0.381	0.703
Basal Body Fat Percentage (%)	39.00 (36.00, 42.00)	39.00 (35.75, 41.00)	-0.198	0.843
Basic Skeletal Muscle Content (kg)	23.80 (22.00, 26.00)	24.30 (22.45, 26.10)	-1.494	0.135
Basal Body Water Content (L)	31.70 (29.70, 34.40)	32.40 (30.00, 34.70)	-1.342	0.179

Abbreviations: FSH, follicle-stimulating hormone; LH, luteinizing hormone; E2, estradiol; T, testosterone; PCOS: polycystic ovary syndrome; BMI, body mass index.

Comparison of Pregnancy Outcomes between Intervention and Control Groups

The intervention group exhibited significantly higher rates in various pregnancy outcomes compared to the control group, as detailed in Table 2. The clinical pregnancy rate, cumulative single live birth rate, and sustained pregnancy rate were notably elevated in the intervention group (57.03% vs. 27.19%, 43.37% vs. 20.18%, 6.83% vs. 1.75%, respectively, all $P < .05$). However, there were no statistically significant differences in the cumulative live twin birth rate (3.21% vs. 0.88%) and abortion rate (3.52% vs. 9.68%) between the two groups ($P > .05$).

Subgroup analysis further explored the clinical pregnancy rate based on different pregnancy modes, revealing no significant difference in the proportion of patients expecting natural pregnancy and ART-assisted pregnancy between the groups ($P > .05$). Notably, the intervention group demonstrated a significantly higher natural pregnancy rate (13.25% vs. 0.88%, $P < .05$) and ART-assisted pregnancy rate (43.78% vs. 26.32%, $P < .05$) compared to the control group. The pregnancy composition ratio of OI, IUI, IVF/ICSI fresh cycle, and FET did not significantly differ between the groups ($P > .05$).

Within the weight management group, gestation time ranged from 3 to 31 months, with a median of 6.5 months, and in the control group, pregnancy time varied from 6 to 32 months, with a median pregnancy time of 12 months. These findings underscore the positive impact of weight management on diverse pregnancy outcomes, providing valuable insights into the effectiveness of the intervention.

Comparison of ART Pregnancy Rates in Intervention and Control Groups

Table 3 outlines the pregnancy rates per cycle for different ART modalities in the intervention and control groups. The intervention group comprised 76 OI cycles, 31 IUI cycles, 98 IVF/ICSI fresh cycles, and 74 FET cycles, while the control group encompassed 51 OI cycles, 15 IUI cycles, 42 IVF/ICSI fresh cycles, and 38 FET cycles. The OI pregnancy rate in the weight intervention group significantly increased compared to the control group (35.53% vs. 11.76%, $P < .05$).

However, no statistically significant differences were observed in the IUI pregnancy rate, IVF/ICSI fresh cycle pregnancy rate, and FET pregnancy rate between the two groups ($P > .05$). These detailed comparisons shed light on the differential impacts of weight intervention on specific ART procedures, emphasizing the substantial improvement in the OI pregnancy rate.

Changes in Body Composition Indexes Following Weight Intervention

Following 2 to 6 months of dedicated weight management, significant improvements were observed in various body composition-related indexes within the weight intervention group. Notably, there were substantial reductions in body weight, BMI, visceral fat area, skeletal muscle content, body water content, body fat, and body fat percentage among patients in the weight management group ($P < .05$), as illustrated in Table 4. These findings underscore the effectiveness of the weight intervention program in positively influencing a comprehensive array of body composition metrics.

Table 2. Comparison of Clinical Pregnancy Rate And Cumulative Live Birth Rate Between the Groups

Indicators	Intervention Group (n = 249) (%)	Control Group (n = 114) (%)	χ^2	*P* value
Clinical Pregnancy Rate (%)	57.03 (142/249)	27.19 (31/114)	27.904	<.001
Treatment Method (%)			3.199	.074
Expecting To Conceive Naturally	24.10 (60/249)	15.79 (18/114)		
Assisted Reproduction Pregnancy	75.90 (189/249)	84.21 (96/114)		
Method of Conception (%)				
Natural Conception Rate	13.25 (33/249)	0.88 (1/114)	14.109	<.001
Assisted Reproduction Pregnancy Rate	43.78 (109/249)	26.32 (30/114)	10.088	.001
Assisted Reproduction Method In Successful Pregnancies (%)			0.777	.855
OI	24.77 (27/109)	20.00 (6/30)		
IUI	5.50 (6/109)	3.33 (1/30)		
IVF/ICSI[a]	36.70 (40/109)	36.67 (11/30)		
FET	32.73 (36/109)	40.00 (12/30)		
Cumulative Single Live Birth Rate (%)	43.37 (108/249)	20.18 (23/114)	18.245	<.001
Cumulative Twin Live Birth Rate (%)	3.21 (8/249)	0.88 (1/114)	0.931	.335
Continued Pregnancy Rate (%)	6.83 (17/249)	1.75 (2/114)	4.057	.044
Abortion Rate (%)	3.52 (5/142)	9.68 (3/31)	1.013	.314

[a]fresh cycle

Abbreviations: OI, Ovulation Induction; IUI, Intrauterine Artificial Insemination; IVF, *In Vitro* Fertilization; ICSI, Intracytoplasmic Sperm Injection in Oocytes; FET, Freeze–Thaw Embryo Transfer.

Table 3. Pregnancy Rate per Cycle of Different Assisted Reproductive Technologies in the Intervention and Control Groups

Indicators	Intervention Group (%)	Control Group (%)	χ^2	*P* value
OI	35.53 (27/76)	11.76 (6/51)	8.960	.003
IUI	19.35 (6/31)	6.67 (1/15)	1.261	.399
IVF/ICSI[a]	40.82 (40/98)	26.19 (11/42)	2.716	.099
FET	48.65 (36/74)	31.58 (12/38)	2.987	.084

[a]stands for fresh cycle

Abbreviations: OI, Ovulation Induction; IUI, Intrauterine Artificial Insemination; IVF, *In Vitro* Fertilization; ICSI, Intracytoplasmic Sperm Injection in Oocytes; FET, Freeze–Thaw Embryo Transfer.

Table 4. Changes in Body Composition in the Intervention Group Before and After Weight Intervention

Indicators	Before Intervention (n=249)	After Intervention (n=249)	Z	*P* value
Weight (kg)	69.60 (65.00, 74.90)	62.15 (57.34, 67.220	-10.267	<.001
BMI (kg/m^2)	28.48 (27.00, 29.97)	25.45 (24.11, 27.02)	-12.204	<.001
Visceral Fat Area (cm^2)	132.81 (116.09, 154.52)	91.40 (71.10, 115.30)	-11.838	<.001
Skeletal Muscle (kg)	23.80 (22.00, 26.00)	23.10 (21.25, 24.80)	-3.227	.001
Body Water Content (L)	31.70 (29.70, 34.40)	31.00 (28.70, 33.30)	-2.906	.004
Body Fat (kg)	27.00 (24.20, 31.80)	20.40 (17.72, 23.68)	-13.259	<.001
Body Fat Percentage (%)	39.00 (36.00, 42.00)	33.00 (30.00, 37.00)	-11.555	<.001

Abbreviations: BMI: Body Mass Index. Values are presented as median (interquartile range). Statistical significance was determined using the Wilcoxon signed-rank test.

Univariate Analysis of Factors Influencing Successful Pregnancy in the Weight Intervention Group

The women in the weight intervention group were stratified into pregnancy and non-pregnancy groups based on clinical pregnancy outcomes to discern the factors

Table 5. Univariate Analysis of Pregnancy-Related Factors After Weight Intervention

Indicators	Pregnancy Group (n = 142)	Non-Pregnancy Group (n = 107)	t/Z/ χ^2	*P* value
Age (years)			15.674	<.001
≥35	17.61 (25/142)	40.19 (43/107)		
<35	82.39 (117/142)	59.81 (64/107)		
Basic FSH (IU/L)	6.29 (5.30, 7.15)	6.31 (5.54, 7.87)	-1.661	.097
Basic LH (IU/L)	6.28 (3.83, 9.35)	5.66 (3.36, 9.71)	-0.600	.549
Basic E2 (pg/L)	41.94 (31.18, 52.61)	39.9 (31.32, 52.91)	-.0520	.959
Basic T (ng/mL)	0.32 (0.18, 0.52)	0.28 (0.17, 0.45)	-0.807	.420
Years of Infertility (years)	3.49 (2.52, 4.78)	3.92 (2.77, 5.18)	-1.556	.120
Type of Infertility (%)			0.086	.769
Primary Infertility	51.41 (73/142)	49.53 (53/107)		
Secondary Infertility	48.59 (69/142)	50.47 (54/107)		
Causes of Infertility (%)			19.901	<.001
PCOS	57.04 (81/142)	33.64 (36/107)		
Pelvic/Fallopian Tube Factors	30.28 (43/1420	32.71 (35/107)		
The Man Factors	4.93 (7/142)	15.88 (17/107)		
Others	7.75 (11/142)	17.76 (19/107)		
Weight After Intervention (kg)	60.27 (57.26, 65.81)	63.1 (58.64, 67.74)	-1.857	.063
BMI After Intervention (kg/m²)			28.419	<.001
≥25	40.85 (58/142)	74.77 (80/107)		
< 25	59.15 (84/142)	25.23 (27/107)		
Visceral Fat Area After Intervention (cm²)			5.006	.025
≥100	40.85 (58/142)	55.14 (59/107)		
< 100	59.15 (84/142)	44.86 (48/107)		
Body Fat Percentage After Intervention (%)	32.28±4.03	34.73±5.76	18.447	<.001
Skeletal Muscle Content After Intervention (kg)	22.85 (21.20, 24.72)	23.6 (21.85, 24.98)	-1.676	.094
Body Water Content After Intervention (L)	30.65 (28.68, 32.95)	31.6 (29.40, 33.40)	-1.875	.061
Δ Visceral Fat Area %	32.25 (19.75, 41.57)	19.13 (7.50, 34.13)	-4.339	<.001
Δ Body Moisture Content %	2.71 (0.80, 5.24)	1.94 (-4.22, 7.36)	-1.390	.165
Δ Skeletal Muscle %	2.78 (0.93, 6.24)	2.02 (-3.91, 7.69)	-1.452	.146
Δ Weight %			26.751	<.001
< 5%	11.27 (16/142)	33.64 (36/107)		
5% ~ 9.9%	23.94 (34/142)	31.78 (34/107)		
≥10%	64.79 (92/142)	34.58 (37/107)		

Abbreviations: FSH: Follicle-stimulating hormone; LH: Luteinizing hormone; E2: Estradiol; T: Testosterone; PCOS: Polycystic ovary syndrome; BMI: Body Mass Index; Δ Index %: Represents the percentage decrease in body composition index before and after weight management.

Table 6. Quantification and Assignment of Factors Related to Successful Pregnancy After Weight Intervention

Factors	Assignment Instructions
Dependent Variable	
Pregnancy	1= pregnant, 0= not pregnant
Independent Variables	
Age (years)	1≥35, 2<35
Infertility reasons	1=PCOS, 2= pelvic/tubal factors, 3= male factors, 4= other factors
BMI after intervention (kg/m²)	1≥25, 2<25
Visceral Fat Area After Intervention (cm²)	1≥100, 2<100
Δ Weight %	1<5%, 2=5%~9.9%, 3≥10%

Note: Δ Weight %: Represents the percentage decrease in weight before and after weight management.

contributing to successful pregnancy post-weight intervention. Employing univariate analysis, we examined the impact of various factors on successful pregnancy, as explained in Table 5. The results reveal statistically significant differences in age (grouping: ≥35 years old, <35 years old), causes of infertility, BMI after intervention (grouping: BMI<25.0 kg/m², BMI≥25.0 kg/m²), visceral fat area after intervention (grouping<100 cm² and ≥100 cm²), and Δ body weight % (grouping:[34,35] <5%, 5% ~ 9.9%, and ≥10%) between the pregnancy and non-pregnancy groups (*P* < .05). Furthermore, the pregnant group exhibited a significantly lower body fat percentage and a higher Δ visceral fat area % after intervention compared to the non-pregnant group (*P* < .05) see Table 5.

Table 7. Multivariate Binary Logistic Regression Analysis of Influencing Factors of Successful Pregnancy After Weight Intervention in the Intervention Group

Variable	Regression Coefficient	Standard Error	Wald	*P* value	OR	95% CI	
Age (years)							
≥35	-1.088	0.340	10.267	.001	0.337	0.173	0.655
<35 (Reference)	-	-	-	-	1	-	-
Infertility Reasons			11.332	.010			
PCOS	1.237	0.512	5.846	.016	3.446	1.264	9.395
Pelvic/Fallopian Tube Factors	0.891	0.515	2.989	.084	2.438	0.888	6.693
Male Factors	-0.252	0.673	0.140	.709	0.778	0.208	2.908
Others (Reference)	-	-	-	-	1	-	-
BMI After Intervention (kg/m²)							
≥25	-1.275	0.351	13.203	.000	0.279	0.140	0.556
<25 (reference)	-	-	-	-	1	-	-
Visceral Fat Area After Intervention (cm²)							
≥100	-1.247	0.462	7.273	.007	0.287	0.116	0.711
<100 (reference)	-	-	-	-	1	-	-
Body Fat Percentage After Intervention (%)	-0.096	0.047	4.108	.043	0.908	0.828	0.997
Δ Weight %			6.069	.048			
<5% (reference)	-	-	-	-	1	-	-
5% ~ 9.9%	0.713	0.439	2.635	.105	2.040	0.863	4.825
≥10%	1.075	0.437	6.067	.014	2.931	1.246	6.895
ΔVisceral Fat Area %	0.024	0.012	3.938	.047	1.025	1.001	1.050

Note: Δ Weight %: Represents the percentage decrease in body composition index before and after weight management.

Multivariate Binary Logistic Regression Analysis of Factors Influencing Successful Pregnancy Following Weight Intervention

Incorporating variables with *P* < .05 from the univariate analysis, we conducted a comprehensive multivariate binary logistic regression analysis to delineate the factors influencing successful pregnancy post-weight intervention. The quantification and assignment of key variables, encompassing age, infertility cause, BMI after intervention, visceral fat area after intervention, and Δ weight %, are elucidated in Table 6. The outcomes of the binary logistic regression analysis are presented in Table 7.

The analysis unveiled several noteworthy findings. Positive factors associated with successful pregnancy included infertility attributed to PCOS (OR=3.446, *P* = .016), Δ body weight %≥10% (OR=2.931, *P* = .014), and Δ visceral fat area% (OR=1.025, *P* = .047). Conversely, negative factors encompassed ages≥35 years (OR=0.337, *P* = .001), BMI≥25 kg/m² (OR=0.279, *P* < .001), and visceral fat area≥100 cm² (OR=0.287, *P* = .007).

DISCUSSION

The escalating prevalence of overweight and obesity poses a substantial public health concern, notably in North America and Europe. Recent data (2017-2018) reveals a staggering 42% obesity rate among U.S. adults, with 9% classified as severely obese (BMI≥40 kg/m²).[38] Although currently behind the U.S., European nations are experiencing a similar upward trend.[37-38]

In China, despite historically lower rates, a noticeable change is occurring. Ma et al.[2] compellingly depict a swift rise in obesity, especially abdominal obesity, indicating a significant transformation in the country's health landscape. This phenomenon emphasizes the urgency of addressing and comprehending the multifaceted implications of overweight and obesity on a global scale.

The consequences of diseases related to obesity, including infertility, have undergone extensive research. Concurrently, numerous studies in North America and Europe have explored the effects of weight interventions on infertility resulting from overweight/obesity. However, comparable studies are scarce in China. Consequently, the findings of this study serve as fundamental data for guiding weight intervention and infertility treatment associated with overweight/obesity in China.

In the present study, within the weight intervention group, the average weight loss amounted to 10.25%, resulting in significantly higher total clinical pregnancy rates, natural pregnancy rates, and cumulative single birth rates compared to the control group. Additionally, binary logistic regression analysis indicates that △body weight % ≥10% serves as an independent factor promoting pregnancy, while a weight loss of 5–9.9% showed no significant difference compared to a weight loss of < 5%. This suggests that a weight loss of ≥10% may serve as a valid criterion for restoring fertility and enhancing pregnancy outcomes.

These findings align with the findings of certain prior studies[12,34] but differ from other research suggesting that a weight loss of 5–10% can effectively enhance pregnancy outcomes[36,37] or that there is no significant correlation between the degree of weight loss and increased rates of pregnancy or live birth.[17] Subgroup analysis revealed a notably higher assisted reproductive pregnancy rate in the intervention group compared to the control group.

The OI pregnancy rate was also notably higher than that in the control group, deviating from the conclusions drawn in prior studies.[12,17] This difference might stem from variations in weight loss, sample size, follow-up duration, and the research emphasis among different studies. Furthermore, while the IUI, IVF/ICSI fresh cycle and FET pregnancy rates were higher in the intervention group compared to the control group, the differences were not statistically significant.

Another potential explanation for these disparate findings is that weight loss merely signifies a general reduction in body mass without directly indicating changes in body fat content or distribution. These factors could also play a role in influencing pregnancy outcomes [39]. Various clinical studies have indicated that the distribution of body fat, particularly visceral fat accumulation, is more closely associated with the onset of obesity-related conditions, including infertility.[40]

Until now, there has been a dearth of data concerning the influence of changes in body composition post-weight intervention on successful pregnancy. Our study observed notable decreases in body weight, BMI, visceral fat area, body fat, and body fat percentage after weight intervention, indicating that the weight loss attributed to the intervention primarily results from reduced body fat.

Through multivariate logistic regression analysis, we identified that a visceral fat area of ≥100 cm^2 post-intervention was a detrimental factor for a successful pregnancy, aligning with its significance as a key indicator of visceral fat obesity.[41] Changes in visceral fat area may serve as a scientific indicator for predicting pregnancy outcomes in overweight or obese infertile patients.

We also identified several other factors associated with successful pregnancy, such as age≥35 years as a negative factor and PCOS as a positive factor. Age as a risk factor is well established and is linked to a diminished likelihood of spontaneous pregnancy and ART pregnancy, along with an elevated risk of adverse pregnancy outcomes, maternal chromosomal abnormalities, aneuploidy, and spontaneous abortion.[42] Our findings suggest that pre-pregnancy weight intervention in overweight or obese infertile patients may be more suitable for those under 35 years of age.

As a contributing factor to successful pregnancy, PCOS may be primarily attributed to the central role of insulin resistance in PCOS, with 50% ~ 70% of PCOS patients exhibiting insulin resistance, which is closely linked to abdominal body fat distribution.[43] A decrease in the visceral fat area enhances insulin sensitivity, potentially serving as the key factor in weight management to restore spontaneous ovulation in obese PCOS patients. In this context, obese PCOS patients may represent the population most likely to benefit clinically from weight intervention.

One notable strength of our study is the implementation of an individualized, comprehensive approach to weight loss through a combination of personalized diet and exercise. Currently, weight interventions for overweight or obese women facing infertility predominantly encompass lifestyle modifications, such as dietary adjustments and physical exercise, pharmaceutical interventions involving insulin sensitizers and α-glycosidase inhibitors, and surgical procedures such as sleeve gastrectomy, adjustable band gastric volume reduction, and Roux-en-Y gastric bypass.

While certain studies indicate that drug or surgical interventions can yield improvements in fertility and mitigate adverse pregnancy outcomes to varying extents,[44,45] lifestyle management remains the recommended initial approach.[46] Drug treatments are generally reserved for obese infertility patients with PCOS, and surgical interventions may carry certain side effects.[47] Therefore, the individualized weight intervention model rooted in the Chinese lifestyle adopted in this study serves as a noteworthy example of the management of overweight or obese infertile women in China.

Study Significance and Future Perspective

This study offers several notable advantages compared to previously reported findings. Firstly, the substantial sample size employed here contributes to a more robust statistical foundation in comparison to most prior studies. Secondly, the Reproductive Center of the First Affiliated Hospital of Guangxi Medical University stands as the largest reproductive medical institution in Guangxi, annually serving over 100 000 patients from across the region. Despite being a single-center study, the extensive patient population and diverse sources ensure the sample's representativeness.

In the future, leveraging the comprehensive data from this study could guide the development of tailored interventions for overweight/obese infertile individuals, fostering advancements in personalized fertility management.

Additionally, the findings pave the way for collaborative research initiatives, aiming to expand our understanding of the intricate relationship between body composition changes and successful pregnancies in diverse populations.

Study Limitations

While our study provides valuable insights into factors associated with successful pregnancy, it is essential to acknowledge certain limitations. Firstly, the retrospective nature of the study restricts our ability to establish causation, emphasizing the need for future prospective investigations. Secondly, the omission of potential confounding factors, notably the male partner's age, weight, and health status, along with considerations for partner weight control, warrants attention in future research.

CONCLUSION

In summary, our study underscores the positive impact of individualized weight management on clinical pregnancy outcomes in overweight/obese infertile women. Notably, achieving a weight reduction of 10% or more emerges as a crucial factor in enhancing clinical pregnancy rates. While the specific mechanisms linking excess visceral fat to infertility warrant further investigation, our findings emphasize the significance of tailored weight interventions, focusing on body composition, especially visceral fat, as a viable treatment approach for overweight/obese women facing infertility challenges.

CONFLICTS OF INTEREST

The authors have no relevant financial or non-financial interests to disclose.

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AUTHORS' CONTRIBUTIONS

Huimei Wu and Xiaoli Wang contributed equally to this work and shared first authorship; H Wu and X Wang: Project development, Data Collection, Manuscript writing; R Sun, X Fu, B Zeng, F Hang, and Q Huang: Data collection; L Jiang, Q Ou, and A Qin: Data analysis, Statistical support; L Li and M Li: Project development, Manuscript revision. All authors read and approved the final manuscript.

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