

Effects of female body mass index on pregnancy during *in vitro* fertilization-embryo transfer

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Abstract. – OBJECTIVE: To investigate the effect of different body mass index (BMI) on transplantation and pregnancy outcomes during assisted reproductive therapy (ART).

PATIENTS AND METHODS: This study assessed the data on embryo transplantation from April 1, 2016, to March 31, 2021, at the Hangzhou Women's Hospital. According to the women's BMI, they were divided into three groups: the overweight, normal weight, and underweight groups. The differences in general clinical data, embryo transfer, pregnancy outcome and newborn birth weight were analyzed.

RESULTS: There was no difference in clinical pregnancy rate between the three groups, but a positive correlation between multiple pregnancy rates and BMI in the fresh cycle was observed. Although there was no significant difference in live birth rates among the three groups ($p = 0.291$), the average birth weight of newborns among the three groups was different ($p < 0.05$). Furthermore, the mean birth weight of a single fetus was positively correlated with maternal BMI, and the mean birth weight of twins was lower than that of single twins ($p < 0.001$).

CONCLUSIONS: The BMI of women treated with ART did not affect clinical pregnancy outcomes and live birth rates after embryo transfer, but differences in preterm birth rates and newborn birth weight were observed.

Key Words:

Assisted reproductive technology, Embryo transplantation, Body mass index, Multiple pregnancy, Birth weight.

Abbreviations

IART: assisted reproductive therapy; BMI: body mass index; IVF-ET: *In vitro* fertilization and embryo transfer; HCG: Human Chorionic Gonadotropin.

Introduction

Recent significant changes in people's diets, lifestyle habits, and working modes have led to an increasing number of obese and underweight

people, making health issues associated with abnormal weight one of the most important topics in medical research. The role of body weight in reproductive health is complex. Although it is believed that weight does not always have a role in fertility issues, it is considered to be a factor for infertility in some couples trying to conceive. Studies¹ have found an association between overweight or underweight with decreased fertility, decreased ovulation rate, prolonged pregnancy time, and increased abortion rate². However, *In vitro* Fertilization and Embryo Transfer (IVF-ET) has been shown to have a controversial effect on transplant outcomes in pregnant couples³. This study investigated the effects of different female body mass indices (BMI) on transplant outcomes, such as IVF-ET clinical pregnancy and birth outcomes, to provide evidence for improving clinical pregnancy outcomes.

Patients and Methods

Subjects

From April 1, 2016, to March 31, 2021, embryo transfer cycle data at the Reproductive Medicine Center of Hangzhou Women's Hospital (Hangzhou, China) were collected. Patients aged more than 40 years old were excluded from this study⁴. In all, the data of 1,086 fresh cycles and 1,524 thawing cycles were assessed.

Methods

Following the weight standards of the Asian population, the pregnant couples were divided into three groups, namely, underweight (BMI < 18.5 kg/m²), normal weight (BMI: 18.5-23.9 kg/m²) and excess body weight (BMI > 24.0 kg/m²) groups, based on their BMI indices. In the following paragraph we will assess the diagnostic criteria^{5,6}.

Clinical Pregnancy Assessment

Blood HCG access was detected on the 12th day after embryo transfer operation to determine the efficacy of pregnancy. B-ultrasound (Hitachi Prosound F37, Hitachi, Japan) was performed on the 28th day to assess the type of pregnancy, including normal intrauterine pregnancy, ectopic pregnancy, and simultaneous intrauterine pregnancy.

- Neonates with low birth weight ($\geq 1,500$ g and $< 2,500$ g)
- Neonates with very low birth weight ($< 1,500$ g)

The main indicators were:

Clinical pregnancy rate = (number of clinical pregnancy cycles/number of transplant cycles) $\times 100\%$

Multiple pregnancy rate = (number of multiple pregnancy cycles/number of clinical pregnancy cycles) $\times 100\%$

Preterm birth rate = (number of birth cycles before 37 weeks/number of clinical pregnancy cycles) $\times 100\%$

Statistical Analysis

The SPSS 17.0 software was used for data analysis (Chicago, IL, USA). Measurement data were described by $\bar{x} \pm s$. Independent sample *t*-test was used for inter-group comparison. Count data were expressed as percentages (%), and comparisons between groups were performed using the χ^2 test. A *p*-value < 0.05 was considered statistically significant.

Results

In the fresh and transplantation cycle, the average age of lighter, normal and partial recombinant women was 30.8, 31.5 and 31.1 years old, respectively. The average number of eggs obtained was 8.5, 8.9 and 8.9, and the average number of embryos transferred was 1.82, 1.88 and 1.86, respectively. No significant differences were observed among the three groups in age, number of eggs harvested and number of embryos transferred ($p > 0.05$). The clinical pregnancy rates of the three groups were similar, at 61.86%, 61.98% and 63.12%, respectively ($p = 0.969$). The rate of multiple births was highest in the overweight group (37.35%), followed by the normal weight group (35.11%), and lowest in the low weight group (18.33%). The rate of multiple births in the low weight group was statistically different from the other two groups ($p = 0.022$).

In the thawing cycle, the average age of the women in the low weight group, normal group and partial reorganization group were 31.2, 31.9 and 32.1 years old, and their corresponding average number of embryos transferred was 1.86, 1.91 and 1.91, respectively. No significant differences were observed in age and number of embryos transferred between the three groups ($p > 0.05$). The clinical pregnancy rates of the three groups were 51.69%, 55.34% and 55.35%, respectively, but the difference was not statistically significant ($p = 0.6176$). The highest rate of multiple births in the overweight group was 30.39%, compared to 29.46% and 27.10% in the normal and low weight groups, but the difference was not statistically significant. The results are shown in Table I.

Table I. Clinical data and follow-up outcomes of fresh/resuscitation transplantation.

	Low weight group	Normal weight group	Over weight group	χ^2/F	<i>p</i>
Fresh cycle transplant cycles (n)	481	345	257	-	-
Average age (years)	30.8 \pm 3.69	31.5 \pm 3.85	31.1 \pm 3.82	3.036	0.219
Average number of eggs harvested (n)	8.5 \pm 3.37	8.9 \pm 3.46	8.9 \pm 3.78	2.168	0.338
AMH (ng/mL)	3.65 \pm 2.55	3.76 \pm 2.61	3.59 \pm 2.51	5.63	0.122
Average number of embryos transferred (n)	1.82 \pm 0.38	1.88 \pm 0.34	1.86 \pm 0.35	0.755	0.685
clinical pregnancy rate (%)	61.86 (60/97)	61.98 (450/726)	63.12 (166/263)	0.1127	0.9452
Multiple pregnancy rate (%)	18.33 (11/60)	35.11% (158/450)	37.35 (62/166)	7.613	0.022
Thawing cycle transplant cycles (n)	207	1012	327	-	-
Average age (years)	31.2 \pm 3.56	31.9 \pm 3.87	32.1 \pm 4.02	9.579	0.008
AMH (ng/mL)	2.95 \pm 1.89	3.12 \pm 2.06	2.89 \pm 1.93	0.89	0.109
Average number of embryos transferred (n)	1.86 \pm 0.36	1.91 \pm 0.34	1.91 \pm 0.34	3.445	0.179
clinical pregnancy rate (%)	51.69 (107/207)	55.34 (560/1012)	55.35 (181/327)	0.964	0.6176
Multiple pregnancy rate (%)	27.10 (29/107)	29.46 (165/560)	30.39 (55/181)	0.3578	0.8362

In the birth follow-up, the live birth cycle of the low weight group, normal group, and overweight group was 143, 863 and 278 respectively. The corresponding live birth cycle rate was 45.54%, 49.65% and 47.12%, and the difference was not statistically significant between the three groups ($p = 0.291$). Further, no statistical difference was observed in the cycle rate of preterm birth in single pregnancy (8.77% vs. 9.11% vs. 16.06%) and the cycle rate of preterm birth in twin pregnancy (55.17% vs. 56.96% vs. 54.12%) between the three groups. However, the cycle rate of premature birth in females with a single fetus and twin fetuses was 8.77% vs. 55.17%; 9.11% vs. 56.96%, 16.06% vs. 54.12%, $p < 0.001$). A positive association between the weight of the newborn born in a single pregnancy and the weight of the mother was observed, which was statistically different between the three groups ($p = 0.013$). In the three groups, the weight of the newborn in single pregnancy was significantly higher than that in twin pregnancy ($p < 0.001$). The proportion of twins with low birth weight and very low birth weight was significantly higher than that of single twins. The results are shown in Table II.

Discussion

Weight is an important indicator of a person's health, and being overweight or underweight might not be beneficial for maintaining good

health status. Further, an imbalance in height and weight might lead to psychological and physical disorders and an increase in the risk of diseases⁷. BMI is widely used in clinics as a referential value for assessing a person's health status and has been shown to be a reliable indicator. Some studies^{8,9} have shown that maternal obesity and overweight before pregnancy could have adverse effects on perinatal infants and are closely related to the occurrence of gestational hypertension, gestational diabetes, premature delivery, and children older than their gestational age. However, the effects of low maternal weight before pregnancy on perinatal birth defects are inconsistent in various studies^{10,12}.

In assisted reproductive treatment, body weight is also an important factor. Literature has shown that people with different BMI groups could have different clinical outcomes. In this study, although no significant difference in the clinical pregnancy rate of women with different BMI was observed, the multiple pregnancy rate of women with low BMI was significantly lower than those with normal and high BMI during the ovulation cycle ($p < 0.001$). This could be related to the fact that women with low BMI have lesser adipose tissues, leading to a lack of steroid hormone secretion from peripheral adipose cells and affecting embryo implantation. However, Schliep et al¹³ reported that although high BMI in pregnant women could affect the pregnancy of IVF-ET, however, it did not

Table II. Newborn births in the fresh/resuscitation transplant cycle.

	Low weight group	Normal weight group	Over weight group	X ² /F	p
Fresh and/ Thawing cycle birth outcome transplant cycles (n)	314	1738	590		
Number of newborns born (n)	172	1100	363		
Number of live birth cycles [n (%)]	143 (45.54)	863 (49.65)	278 (47.12)	2.468	0.291
Single birth	114 (79.72)	626 (72.54)	193 (69.42)	7.346	0.025
Twins birth	29 (20.28)	237 (37.86)	85 (30.58)	3.074	0.215
Number of premature births [n (%)]					
Single birth	10 (8.77)	57 (9.11)	31 (16.06)	5.904	0.056
Twins birth	16 (55.17)	135 (56.96)	46 (54.12)	2.070	0.321
Average birth weight (g)					
Single birth	3161 ± 482	3276 ± 531	3305 ± 704	476.201	0.013
Twins birth	2521 ± 393	2443 ± 482	2452 ± 557	367.161	0.000
Number of newborns with low birth weight [n (%)]					
Single birth	8 (7.02)	35 (5.59)	17 (9.91)	2.612	0.271
Twins birth	22 (37.93)	212 (44.73)	54 (31.76)	8.938	0.011
Number of newborns with very low birth weight [n (%)]					
Single birth	1 (0.88)	5 (0.80)	6 (3.11)	6.372	0.040
Twins birth	1 (1.72)	18 (3.80)	16 (9.41)	9.745	0.010

affect birth outcomes after pregnancy. In the follow-up of newborn birth weight, it was found that the average birth weight of single pregnancy was positively correlated with maternal BMI, and the difference was statistically significant ($p = 0.013$). The average birth weight of twin-pregnancy cycles was highest in the low weight group, and the difference was statistically significant among the three groups, possibly related to the fewer cycles in the low-weight group. In normal unassisted pregnancy, the probability of twin pregnancy is about 1 in 90, while the twin rate of assisted reproductive treatment varies from 10 to 30%¹⁴. There is a consensus among researchers that the birth weight of a twin pregnancy is lower than that of a single¹⁵. Numerous studies¹⁶⁻¹⁸ have shown that newborns with low birth weight are at increased risk of complications such as hypoglycemia, hyperbilirubinemia, retinopathy, and neonatal respiratory distress syndrome. In this study, we observed that the proportion of newborns with very low birth weight was positively correlated with the BMI of their mother. However, due to the insufficient number of newborns in this study, we could not determine a correlation between the incidence of very low birth weight newborns and maternal BMI. As it has been shown that reducing twin pregnancies could reduce the birth rate of low/very low birth weight newborns, an optimal strategy could be to reduce the number of single-cycle embryo transfers. Through education and guidance, more awareness could be raised in pregnant couples on mother-infant risk of twin pregnancy to accept single embryo transfer and reduce the incidence of twin pregnancy^{19,20}. Leill et al²¹ also found that the preterm birth rate of assisted pregnancy was significantly higher in both age-appropriate women and older women compared with those who had unassisted pregnancies. Therefore, the indications of IVF-ET should be fully assessed to reduce unnecessary assisted pregnancy. With the continuous development of assisted reproductive technology (ART), the field of reproductive medicine has gradually changed from the pursuit of clinical pregnancy rate to a new era of pursuing healthy live birth. The ultimate goal of assisted pregnancy treatment is to obtain full-term, healthy and defect-free babies.

Conclusions

This study showed that although body weight was not the main factor affecting IVF-ET preg-

nancy, higher body weight could increase the loss rate of the pregnancy cycle, leading to a lower baby holding rate and increased probability of premature delivery. Furthermore, although underweight women had similar outcomes in IVF-ET to normal-weight women, we recommend prepregnancy nutrition counseling in this population to reduce possible adverse outcomes during pregnancy²². For recipients of assisted reproductive treatment, medical personnel should provide the couples with detailed information to expand the scope of the treatment. In addition, increased awareness should be made on the risk of multiple pregnancy so that couples who accept ART of single embryo transplantation are also given appropriate guidance and psychological counseling on the risk of multiple pregnancy. These could help the couples to pay lesser attention to the possibility of pregnancy but more attention to maternal and perinatal risks for obtaining a healthy baby and simultaneously maintaining the mother and the child's safety.

Conflict of Interest

The Authors declare that they have no conflict of interests.

Availability of Data and Material

The data used to support the findings of this study are included within the article.

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Authors' Contribution

Z.-J. Cheng carried out the design of the study and drafted the manuscript. W.-J. Zhou participated in data collection and management. C. Wang was involved in statistics and data review. Y. Feng participated in data collection and management. Y. Zhou carried out the design of the study helped to draft the manuscript. All authors read and approved the final manuscript.

Ethics Approval and Consent to Participate

The research protocol was established, according to the ethical guidelines of the Helsinki Declaration and was approved by the Human Ethics Committee of Hangzhou Women's Hospital [Hangzhou Women's Hospital Ethics Approval No. (5) - 08].

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