Original Article

Effect of paternal overweight or obesity on semen parameters, clinical pregnancy and live birth outcomes in men treated with intrauterine insemination (IUI)

Nengyong Ouyang[1,2,3#], Churu Wei[1,2,3#], Adilai Aili[4#], Xiaohui Ji[1,2,3,5], Hui Chen[1,2,3], Haijing Zhao[1,2,3]

[1]Reproductive Medicine Center, Sun Yat-sen Memorial Hospital of Sun Yat-sen University, Guangzhou, China; [2]Reproductive Medicine Center, Shenshan Central Hospital, Sun Yat-sen Memorial Hospital of Sun Yat-sen University, Shanwei, China; [3]Guangdong Provincial Clinical Research Center for Obstetrical and Gynecological Diseases, Guangzhou, China; [4]The First People's Hospital of Kashgar, Kashgar, China; [5]Department of Public Health and Preventive Medicine, School of Medicine, Jinan University, Guangzhou, China

Contributions: (I) Conception and design: N Ouyang, H Zhao; (II) Administrative support: H Chen; (III) Provision of study materials or patients: H Chen; (IV) Collection and assembly of data: C Wei; (V) Data analysis and interpretation: A Aili; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

[#]These authors contributed equally to this work as co-first authors.

Correspondence to: Haijing Zhao, MS; Hui Chen, PhD. Reproductive Medicine Center, Sun Yat-sen Memorial Hospital of Sun Yat-sen University, Yanjiang West Road 107, Guangzhou, Guangdong 510120, China; Reproductive Medicine Center, Shenshan Central Hospital, Sun Yat-sen Memorial Hospital of Sun Yat-sen University, Shanwei, China; Guangdong Provincial Clinical Research Center for Obstetrical and Gynecological Diseases, Guangzhou, China. Email: 603887536@qq.com; zheling76@163.com.

Background: Overweight and obese individuals are steadily increasing in recent years. Male overweight or obesity has adverse impact on reproductive functions. The study aimed to evaluate the potential impact of paternal overweight or obesity on sperm quality and clinical pregnancy outcome in patients undergoing intrauterine insemination (IUI) treatment.

Methods: This retrospective study included 1,036 couples from our reproductive center between July 2019 and August 2022. All males were categorized into normal weight, overweight, or obese groups according to their body mass index (BMI). Baseline characteristics and reproductive hormones were analyzed. Semen parameters, clinical pregnancy and live birth outcomes were compared among the different BMI groups.

Results: There were no significant differences in sperm concentration, total sperm motility, progressive sperm motility, normal sperm morphology and sperm DNA fragmentation index (DFI) among the three groups. However, the obese group exhibited a significantly decreased semen volume compared to the other two groups ($P<0.01$). No differences were found in clinical pregnancy rate (CPR), abortion rate (AR) and live birth rate (LBR) among the groups ($P>0.05$). Slight higher ARs were observed in overweight and obese groups compared to normal group (13.64%, 21.05% *vs.* 11.11%, $P=0.49$).

Conclusions: These data suggest that male obesity leads to a significant decrease in semen volume. It is thus recommended that male BMI should be regarded as one of the predictors for IUI treatment to avoid a decrease in semen volume.

Keywords: Intrauterine insemination (IUI); body mass index (BMI); semen quality; clinical pregnancy rate (CPR); live birth rate (LBR)

Submitted May 23, 2024. Accepted for publication Sep 05, 2024. Published online Sep 26, 2024.
doi: 10.21037/tau-24-254
View this article at: https://dx.doi.org/10.21037/tau-24-254

Introduction

Overweight and obesity have long been a major public health concern worldwide, with the number of overweight and obese people rising steadily in recent decades (1,2). Body mass index (BMI) is a classic index to evaluate health status of body weight, based on the BMI guideline for Chinese adults, men were assigned into normal weight (18.5 kg/m^2≤ BMI <24 kg/m^2), overweight (24 kg/m^2≤ BMI <28 kg/m^2), and obese (BMI ≥28 kg/m^2) groups.

Overweight and obesity are associated with increased risk of disease and adverse effects on reproductive function (3). Male obesity has been linked to infertility, although the evidence remains inconsistent. One study found that overweight men have a higher percentage of immature sperm and decreased fertilization rate and cumulative live birth rate (LBR) after *in vitro* fertilization (IVF)/ intracytoplasmic sperm injection (ICSI) treatments (4); while another study discovered that BMI is positively correlated with sperm cell apoptosis and sperm DNA damage (3). However, Ma *et al.* (5), showed that there was no significant correlation between BMI and sperm concentration.

To date, the effect of paternal overweight or obesity on semen parameters, clinical pregnancy and live birth outcomes in men undergoing IUI treatment is poorly understood. We present this article in accordance with the STROBE reporting checklist (available at https://tau.amegroups.com/article/view/10.21037/tau-24-254/rc).

Highlight box

Key findings

- Male obesity leads to a significant decrease in semen volume in intrauterine insemination (IUI) treatment.

What is known and what is new?

- Overweight and obesity are associated with increased risk of disease and adverse effects on reproductive function; overweight men have a higher percentage of immature sperm and decreased fertilization rate and cumulative live birth rate after in vitro fertilization (IVF)/ intracytoplasmic sperm injection (ICSI) treatments.
- The potential impact of paternal overweight or obesity on sperm quality and clinical pregnancy outcome in patients undergoing IUI treatment are evaluated.

What is the implication, and what should change now?

- The findings suggest the negative impact of obesity on male semen volume, it is thus recommended that male body mass index (BMI) should be regarded as one of the predictors for IUI treatment, in ordering to avoid a decrease in semen volume.

Methods

Study population

Data were collected from 1,036 couples who underwent intrauterine insemination (IUI) treatment at the Sun Yat-sen Memorial Hospital of Sun Yat-sen University, Reproductive centre, between July 2019 and August 2022. According to the BMI guideline for Chinese adults (3,6,7), men were classified into normal weight (18.5 kg/m^2≤ BMI <24 kg/m^2), overweight (24 kg/m^2≤ BMI <28 kg/m^2), and obese (BMI ≥28 kg/m^2) groups based on their BMI values.

Inclusion criteria were as follows: (I) all treatments were the first IUI cycle; (II) male age between 22–45 years; (III) male's BMI ≥18.5 kg/m^2; (IV) female partner age <38 years with no infertility factor; (V) female partner BMI: 18.5–23.9 kg/m^2. Exclusion criteria were: (I) regular alcohol drinkers and/or heavy smokers; (II) men with chronic diseases or other conditions that could affect semen quality or lead to dysmetria; (III) repeated cycles. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Institutional Ethical Committee of Sun Yat-sen Memorial Hospital (No. SYSKY-2023-1157-02) and informed consent was taken from all the patients.

Semen analysis

After 2–7 days of sexual abstinence, all male semen samples were collected in sterile containers and maintained at 37 ℃ for approximately 30 minutes to allow for liquefaction. Conical graded tubes were used to measure the semen volume. Semen parameters were assessed according to World Health Organization (WHO) 2010 standards (WHO, 2010).

Determination of normal sperm morphology

Sperm morphology was determined using Dif-Quik stain. A minimum of 200 motile spermatozoa per sample were assessed to determine the percentage of normal sperm.

Determination of sperm DNA fragmentation

Wright-Giemsa staining was conducted as follows. The concentration of semen sample was adjusted to 5–10 million/mL using phosphate buffer solution (PBS); Dye A was placed at 37 ℃ for 5 minutes after dissolving, then 30 μL semen sample was added to Dye A and mixed well. A pre-treatment slide was placed on a 4 ℃ panel, and

after cooling, 20 µL agarose semen was added to the slide and marked. The slide was covered with a cover glass and placed in a 4 ℃ refrigerator for 5 minutes. Dye B was added to 9 mL of distilled water and mixed well. The cover glass was carefully removed, and the slide was placed horizontally in solution B at room temperature for 7 minutes. The slide was then placed horizontally in 10 mL of Dye C at room temperature for 25 minutes, followed by a 5-minute rinse in distilled water. The slide was then sequentially placed in 70%, 90%, and 100% ethanol for 2 minutes each, and then allowed to dry naturally. Next, 10–12 drops of Dye D were added for staining 1–3 minutes, followed by 10–12 drops of Dye E, gently mixed with an ear wash ball, and stained for 10–15 minutes. The slide was then washed with purified water and sealed with a sealing agent. A total of 500 sperm cells were assessed at a magnification of 400× or 1,000× using an optical microscope. After processing and staining, sperm without DNA fragmentation will form characteristic halos, while sperm with DNA fragmentation will not produce such characteristic halos. The degree of DNA fragmentation in sperm was determined based on the presence and size of halos. If the DNA fragmentation index (DFI) value was more than 10%, it was considered abnormal.

IUI treatment and clinical outcomes

The female partner's vagina, cervix, and surrounding area were cleaned with physiological using saline cotton balls. The artificial insemination catheter was connected with a 1 mL sterile syringe, and 0.3–0.5 mL of the processed sperm suspension was slowly aspirated. The artificial insemination catheter was inserted slowly along the uterine cavity through the external cervix to about 1 cm above the internal cervix, and the sperm suspension was slowly injected into the uterine cavity.

The serum beta-human chorionic gonadotropin (β-HCG) levels were measured 14 days after IUI to determine clinical pregnancy, defined by the presence of age stational sac. Clinical outcomes assessed included clinical pregnancy rate (CPR) (number of pregnancy cycles/number of IUI cycles), abortion rate (AR) (number of abortion cycles/number of clinical pregnancy cycles) and LBR (number of live birth cycles/number of IUI cycles).

Statistical analysis

Data analyses were performed using SPSS version 25.0. Continuous variables were presented as mean ± standard deviation (SD), while categorical variables were expressed as frequency and percentage. Differences among groups were assessed using one-way analysis of variance (ANOVA) for continuous variables and Chi-squared test or Fisher's exact test for categorical variables. A P value of <0.05 was considered statistically significant.

Results

Baseline characteristics

A total of 1,036 males were included in this study, of whom 514 were of normal weight, 362 were overweight and 160 were obese. Baseline data and reproductive hormones of the couples were analyzed in the three groups (*Table 1*). The normal weight group had a longer duration of infertility compared to the overweight and obese groups (P<0.01). Females in the obese group had significantly higher basal follicle stimulating hormone (FSH) levels compared to those in the other two groups (P<0.01). There were significant differences in basal FSH and luteinizing hormone (LH) levels of males between normal weight and overweight groups (P<0.01). Additionally, the overweight and obese groups had considerably lower testosterone (T) levels than the normal weight group (P<0.001).

Semen parameters analysis

Table 2 displays the sperm characteristics of the different BMI groups. There were no significant differences in sperm concentration, total sperm motility, progressive sperm motility, normal sperm morphology and sperm DNA fragmentation index (DFI) among the groups. However, it is noteworthy that the semen volume in the obese group was significantly lower than that in the other two groups (P<0.01).

Clinical outcomes

No significant differences in CPR, AR, LBR, premature birth rate (PBR) and birth weight were observed across the different BMI categories (P>0.05). Slight higher ARs were observed in overweight and obese groups compared to normal group (13.64%, 21.05% *vs.* 11.11%, P=0.49) (*Table 3*).

Discussion

The proportion of people worldwide who are overweight

Table 1 Baseline data and reproductive hormones of couples underwent IUI

Characteristics	Normal weight (18.5 kg/m^2 ≤ BMI <24 kg/m^2) (n=514)	Overweight (24 kg/m^2≤ BMI <28 kg/m^2) (n=362)	Obese (BMI ≥28 kg/m^2) (n=160)	P value
Female				
Age (years)	31.20±3.76	31.67±3.32	31.40±3.57	0.16
Infertility time (years)	3.55±2.05	3.22±1.96	3.07±1.82	0.009[a]
BMI (kg/m^2)	21.20±2.96	21.35±2.98	21.51±2.34	0.47
FSH (mIU/mL)	7.57±2.32	7.71±2.20	8.35±2.41	0.001[b]
LH (mIU/mL)	5.25±3.05	5.13±3.16	5.04±2.94	0.70
PRL (ng/mL)	16.19±8.81	16.32±9.18	17.31±9.23	0.40
E_2 (pg/mL)	49.65±45.80	47.63±36.79	43.06±22.35	0.21
Male				
Age (years)	32.75±4.09	33.24±3.72	33.13±3.95	0.17
Abstinence time (days)	4.28±1.41	4.17±1.47	4.34±1.51	0.37
FSH (mIU/mL)	5.84±3.25	5.20±2.09	5.42±2.14	0.003[c]
LH (mIU/mL)	3.92±1.70	3.48±1.71	3.80±1.70	0.001[c]
PRL (ng/mL)	10.60±5.45	10.10±3.88	10.83±6.49	0.23
E_2 (pg/mL)	34.64±24.32	32.73±13.38	33.12±14.72	0.41
T (ng/mL)	15.19±5.32	12.28±3.99	11.08±3.83	<0.001[d]

Data are presented as mean ± standard deviation. [a], normal weight *vs.* overweight; normal weight *vs.* obese; [b], normal weight *vs.* obese; overweight *vs.* obese; [c], normal weight *vs.* overweight; [d], normal weight *vs.* overweight; normal weight *vs.* obese; overweight *vs.* obese. IUI, intrauterine insemination; BMI, body mass index; FSH, follicle stimulating hormone; LH, luteinizing hormone; PRL, prolactin; E_2, estradiol; T, testosterone.

Table 2 Semen parameters analysis in the different BMI groups

Characteristics	Normal weight (18.5 kg/m^2≤ BMI <24 kg/m^2) (n=514)	Overweight (24 kg/m^2≤ BMI <28 kg/m^2) (n=362)	Obese (BMI ≥28 kg/m^2) (n=160)	P value
Semen volume (mL)	2.81±1.21	2.67±1.06	2.31±0.95	<0.001[a]
Sperm concentration (×10^6/mL)	51.14±29.15	54.92±31.51	53.24±30.35	0.19
Total sperm motility (%)	55.26±11.85	55.76±11.85	55.12±10.65	0.78
Progressive sperm motility (%)	41.28±11.98	42.35±12.70	40.50±10.74	0.22
Normal sperm morphology (%)	4.26±1.91	4.28±1.93	4.21±2.03	0.94
Sperm DNA fragmentation index (DFI) (%)	11.53±6.56	11.39±7.07	11.57±8.03	0.95

Data are presented as mean ± standard deviation. [a], normal weight *vs.* obese. BMI, body mass index.

or obese is steadily increasing. In the field of assisted reproduction, numerous studies have investigated the impact of obesity on oocytes, sperm quality, embryo development and pregnancy outcomes. However, the risk associated with paternal overweight or obesity in IUI treatment is still poorly understood.

In our study, basal FSH levels in overweight and obese groups were lower than in the normal weight group. These findings are consistent with a previous study, which reported lower FSH levels in males with a BMI ≥25 kg/m^2 compared

Table 3 Clinical pregnancy and live birth outcomes of the three BMI groups

Characteristics	Normal weight (18.5 kg/m^2 ≤ BMI <24 kg/m^2) (n=514)	Overweight (24 kg/m^2 ≤ BMI <28 kg/m^2) (n=362)	Obese (BMI ≥28 kg/m^2) (n=160)	P value
Clinical pregnancy rate	12.26 (63/514)	12.15 (44/362)	11.88 (19/160)	0.99
Abortion rate	11.11 (7/63)	13.64 (6/44)	21.05 (4/19)	0.49
Live birth rate	10.89 (56/514)	10.50 (38/362)	9.38 (15/160)	0.86
Premature birth rate	12.50 (7/56)	18.42 (7/38)	13.33 (2/15)	0.76
Birth weight (kg)				
Single	3.03±0.53	3.08±0.51	3.06±0.40	0.90
Twins	2.38±0.19	3.00±1.58	2.60±0.00	0.75

Data are presented as mean ± standard deviation or % (n/N). BMI, body mass index.

to those with a BMI <25 kg/m^2 (P<0.001) (8). Additionally, our results indicated that the overweight and obese groups had considerably lower T levels compared to the normal weight group (P<0.01). This finding aligns with the study by Esmaeili *et al.* (2), they reported that T levels in the overweight and obese groups were significantly lower than in the normal weight group (P=0.006).

Karamazak *et al.* (9), found no significant difference in the ejaculate volume between the BMI ≥25 kg/m^2 group and the normal weight group. However, our data showed that the obese group had a significantly decreased semen volume compared to the other two groups (P<0.01). The differences of the above-mentioned studies may be related to differences in the study populations, sample sizes, and groupings. Another study supported our findings, reporting that males with higher BMI had lower semen volume (10), which is consistent with ours. Obesity leads to lower T levels (11), which is likely the main reason for the decrease in semen volume.

Equivalent CPRs (P=0.99) and gradually decreased LBRs (10.89% *vs.* 10.50% *vs.* 9.38%, P=0.86) were observed among the three groups in our study. These findings align with those of Li *et al.* (8), who demonstrated that the CPR in the BMI ≥25 kg/m^2 group was comparable to that of the normal weight group (P=0.25), while the LBR was lower in the BMI ≥25 kg/m^2 group (P=0.03). They also reported a slightly higher AR in the BMI ≥25 kg/m^2 group compared to the normal weight group (P=0.29). Similarly, our data also showed slight higher ARs in overweight and obese groups compared to normal group (13.64%, 21.05% *vs.* 11.11%, P=0.49). Furthermore, a recent report demonstrated that decreased CPR, increased AR and reduced LBR were observed in males with BMI ≥24 kg/m^2 group compared to those with BMI <24 kg/m^2 group (P>0.05) (10), which strongly supports our results.

Nevertheless, this study has its own drawbacks. Firstly, it lacks inflammatory cytokines detection in seminal plasma, although inflammatory adipocytokines in overweight and obese males are known to be increased and can result in sperm apoptosis (3). Secondly, female FSH level in male obese group was significantly higher than that in male normal group and overweight group, this indicated that the partners of male obese group had a lower ovarian reserve, which may be related to a higher AR. Thirdly, this study includes a small sample size. We aim to conduct a study with a larger sample size in the future to verify the current findings.

Conclusions

In conclusion, the present research indicated that male obesity leads to a significant decrease in semen volume. Therefore, male BMI should be considered as one of the predictors for IUI treatment to avoid a decrease in semen volume and achieve satisfactory clinical outcomes.

Acknowledgments

Funding: The project received support from the Natural Science Foundation of Guangdong Province (grant number: 2022A1515011152), the Yixian Clinical Research and Cultivation Project (grant number: SYS-Q-202103), and the "Retrospective cohort study on the efficacy of hydroxychloroquine in patients with unexplained recurrent miscarriage who are positive for thyroid autoantibodies

and have normal thyroid function" (grant number: LX-HG-2023062).

Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://tau.amegroups.com/article/view/10.21037/tau-24-254/rc

Data Sharing Statement: Available at https://tau.amegroups.com/article/view/10.21037/tau-24-254/dss

Peer Review File: Available at https://tau.amegroups.com/article/view/10.21037/tau-24-254/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://tau.amegroups.com/article/view/10.21037/tau-24-254/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Institutional Ethical Committee of Sun Yat-sen Memorial Hospital (No. SYSKY-2023-1157-02) and informed consent was taken from all the patients.

References

1. Yanovski JA. Obesity: Trends in underweight and obesity - scale of the problem. Nat Rev Endocrinol 2018;14:5-6.
2. Esmaeili V, Zendehdel M, Shahverdi A, et al. Relationship between obesity-related markers, biochemical metabolic parameters, hormonal profiles and sperm parameters among men attending an infertility clinic. Andrologia 2022;54:e14524.
3. Zhu G, Zhang Y, Dong J, et al. Association Between Body Mass Index and Male Sperm Apoptosis and Apoptosis-Related Factors. Diabetes Metab Syndr Obes 2021;14:1043-51.
4. Bibi R, Jahan S, Afsar T, et al. The influence of paternal overweight on sperm chromatin integrity, fertilization rate and pregnancy outcome among males attending fertility clinic for IVF/ICSI treatment. BMC Pregnancy Childbirth 2022;22:620.
5. Ma JX, Wang B, Li HS, et al. Association between obesity-associated markers and semen quality parameters and serum reproductive hormones in Chinese infertile men. Reprod Biol Endocrinol 2020;18:95.
6. Zhou BF. Cooperative Meta-analysis group of the working group on obesity in C. Biomedical and Environmental Sciences 2002;15:83-96.
7. Chen C, Lu FC; . The guidelines for prevention and control of overweight and obesity in Chinese adults. Biomed Environ Sci 2004;17 Suppl:1-36.
8. Li F, Yang Q, Shi H, et al. Effects of obesity on sperm retrieval, early embryo quality and clinical outcomes in men with nonobstructive azoospermia undergoing testicular sperm aspiration-intracytoplasmic sperm injection cycles. Andrologia 2019;51:e13265.
9. Karamazak S, Kızılay F, Bahçeci T, et al. Do body mass index, hormone profile and testicular volume effect sperm retrieval rates of microsurgical sperm extraction in the patients with nonobstructive azoospermia? Turk J Urol 2018;44:202-7.
10. Qi L, Liu YP, Wang SM, et al. Abnormal BMI in Male and/or Female Partners Are Deleterious for Embryonic Development and Pregnancy Outcome During ART Process: A Retrospective Study. Front Endocrinol (Lausanne) 2022;13:856667.
11. Souteiro P, Belo S, Oliveira SC, et al. Insulin resistance and sex hormone-binding globulin are independently correlated with low free testosterone levels in obese males. Andrologia 2018;50:e13035.

Cite this article as: Ouyang N, Wei C, Aili A, Ji X, Chen H, Zhao H. Effect of paternal overweight or obesity on semen parameters, clinical pregnancy and live birth outcomes in men treated with intrauterine insemination (IUI). Transl Androl Urol 2024;13(9):1899-1904. doi: 10.21037/tau-24-254