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REVIEW

Treatment Options for Improving The Semen Quality in Obese Men: A Scoping Review

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Abstract: Obesity is a significant factor affecting male fertility. Infertility in obese men often accompanies with metabolic dysfunction and differs from idiopathic male infertility (MI) in treatment approaches. This scoping review summarizes published treatment options for affecting the semen quality in obese men. A comprehensive literature search strategy was conducted via PubMed, Web of Science, and China National Knowledge Infrastructure. Inclusion criteria encompassed clinical research articles focusing on obese men. Finally, 28 eligible clinical studies were included. Treatment options for improving the semen quality in obese male encompass bariatric surgery, lifestyle modifications (eg, exercise training, dietary adjustments), glucagon-like peptide-1 receptor agonists, selective estrogen receptor modulators, testosterone, aromatase inhibitors, nutritional supplements, traditional Chinese medicine, etc. Patients may benefit from combination therapies. Future directions should explore more effective treatment approaches, prioritize the overall health of obese infertile men, evaluate the impact of interventions on offspring and develop the standard treatment guidelines based on the high-level clinical evidence.

Keywords: semen quality, obese men, treatment, bariatric surgery, lifestyle

Introduction

Infertility is the inability to conceive naturally after one year of regular, unprotected sexual intercourse among couples of reproductive age. Among these cases, male factors account for more than half of the causes.[1] The incidence of male infertility (MI) continues to rise and may have serious negative impacts on social development.[2] Many studies have shown that MI may be associated with factors such as diabetes, smoking, and unhealthy lifestyle habits.[3,4] Also, varicocele, genetic factors, and idiopathic infertility are important factors from the EAU Sexual and Reproductive Health guidelines.[1] These factors may affect sperm production and maturation, ultimately leading to MI. Epidemiological studies have widely reported the relationship between obesity and male reproductive health.[5] And compared to men of normal weight, obese men have lower sperm concentration and motility, as well as a higher rate of sperm abnormalities.[6,7] Body Mass Index (BMI) and Waist-to-Hip Ratio (WHR) are commonly used anthropometric parameters for assessing obesity. Compared to BMI, the advantage of WHR lies in its ability to reflect abdominal (central) obesity, and an abnormal WHR has a greater negative impact on conventional semen parameters than an abnormal BMI.[8] Heat stress associated with the accumulation of adipose tissue in the suprapubic and thigh areas is common obese men, and multiple studies suggest that obesity may affect male reproductive function through various mechanisms, such as endocrine factors, adipokine effects, inflammatory responses, oxidative stress, and epigenetic changes.[9] In addition to causing male sexual dysfunction, obesity may also affect the testosterone-dependent spermatogenesis. Since adipose tissue is endocrinologically active and can induce the conversion of male sex hormones into estrogens, and this process may lead to decreased serum testosterone levels and disruption of the hypothalamic-pituitary-gonadal axis, ultimately resulting in abnormal levels of follicle-stimulating hormone and luteinizing hormone as well as impaired

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spermatogenesis.[10] Chromatin remodeling and increased oxidative stress during spermatogenesis in obese men may also contribute to higher sperm DNA fragmentation.[10]

Currently, a lot of clinical evidence supports the efficacy and safety of multiple therapies for MI.[11] However, limited attention has been directed toward fertility issues in obese men. Due to systemic metabolic abnormalities—including insulin resistance and hormonal imbalances—commonly present in obese men of reproductive age, and the treatment for these patients should differ from those for non-obese MI patients. Furthermore, previous published reviews lacked the discussion on treatment options for obese men with poor semen quality. In this review, we used a scoping review methodology to comprehensively examine recent clinical studies,[12,13] and summarized the treatment options to provide actionable recommendations for future management for obese patients with poor semen quality.

Materials and Methods

Search Strategy

The PubMed, Web of Science and China National Knowledge Infrastructure were searched for relevant studies (up to July 2025). We also reviewed the reference lists of the studies identified via our search strategy and selected those that seemed relevant based on our keywords. The search strategy was conducted in English and Chinese. The following search terms were used in the Box 1.

Box 1 PubMed Search Strategy

No.	Search Item
#1	Obesity [Title/Abstract]
#2	Obese [Title/Abstract]
#3	Obesities [Title/Abstract]
#4	Weight gain [Title/Abstract]
#5	Weight loss [Title/Abstract]
#6	Overweight [Title/Abstract]
#7	Weight [Title/Abstract]
#8	Or/#1-#7
#9	Male infertility [Title/Abstract]
#10	Asthenospermia [Title/Abstract]
#11	Oligospermia [Title/Abstract]
#12	Oligoasthenospermia [Title/Abstract]
#13	Teratospermia [Title/Abstract]
#14	Sperm [Title/Abstract]
#15	Semen [Title/Abstract]
#16	Or/#9-#15
#17	Clinical trial [Publication Type]
#18	Clinical article [Publication Type]
#19	Clinical study [Publication Type]

(*Continued*)

Box 1 (Continued).

No.	Search Item
#20	Controlled study [Publication Type]
#21	Randomized controlled trial [Publication Type]
#22	Or/#17-#21
#21	#8 and #16 and #22

Eligibility Criteria

We used the framework for formulating clinical research questions including the number of participant, intervention, comparison, outcome and study design, to set the eligibility criteria in Table 1.

Data Collection and Analysis

Selection of Studies

According to the search strategy, two authors (Hao Wang and Yongqing Zhao) searched for relevant articles and summarized the results. Duplicate studies were eliminated. Some studies were excluded after analyzing the title and

Table 1 Inclusion and Exclusion Criteria

	Inclusion	Exclusion
Study type	Clinical trial, interventional study, observational study	Review article, case report, letter, comment, and perspective
Population	1) Obesity diagnosed with standard criteria 2) Abnormal semen quality	1. Normal participant 2. Patients with azoospermia 3. Female 4. Adolescent
Intervention	1) Drug therapy 2) General treatment 3) Lifestyle therapy 4) Surgical therapy 5) Non-pharmaceutical intervention 6) Dietary measures 7) Physical activity	No restrictions
Comparison	1) Dietary measures 2) Physical activity 3) Lifestyle therapy 4) General treatment 5) Surgical therapy 6) Drug therapy 7) Non-pharmaceutical intervention 8) Placebo 9) No treatment 10) Or there was no control group	No restrictions
Outcome	1) Body weight, body mass index 2) Semen routine indicators such as percentage of progressive motility spermatozoa, percentage of non-progressive motility spermatozoa, sperm concentration, semen volume, percentage of normal morphology spermatozoa and DNA fragmentation index	

abstract. Furthermore, studies that did not meet the eligibility criteria were eliminated after analyzing the full text. Dissenting opinions were submitted to another author (Di Sun) for adjudication throughout the whole process.

Data Extraction

Two authors (Hongyuan Chang and Dicheng Luo) independently extracted data in a standard format. These data included the author, publication type, publication date, number of participants, interventions, and reported outcomes. The two authors checked the extracted data for accuracy and completeness. Another author (Di Sun) participated in discussions and helped resolve any disagreements.

Results

After duplicates were removed, 181 of the 332 searched studies were included in the assessment as shown in the selection flowchart (Figure 1). Following a review of the topics and abstracts, 142 studies were excluded because they were not clinical trials or were not concerned with the sperm quality or obesity. Furthermore, 11 studies were excluded after reading the full text due to incomplete data, and in vitro studies. Finally, we included 28 clinical studies in Supplementary Material Appendix 1.[14–41]

Among the 28 studies, 1528 participants were involved, all of whom had ever received or undergone different intervention methods to assess semen parameters. The average age of the majority of the participants was concentrated between 30 and 40 years old. In 6 studies, the average age of the participants was over 40, and in other 4 studies, the average age of the participants was not clearly reported. The intervention measures involved bariatric surgery, low-energy diet, exercise training, sex hormone therapy, traditional Chinese medicine (TCM) therapy, and nutritional supplements, etc. There were 11 studies involved the bariatric surgery, and there were also some combined therapies, such as the combination of diet adjustment and exercise training, the combination of letrozole and human chorionic gonadotropin, and the combination of TCM and Levocarnitine. 18 studies reported the pre- and post-comparison of the participants' body weight characteristics. Among them, the participants who underwent bariatric surgery, exercise

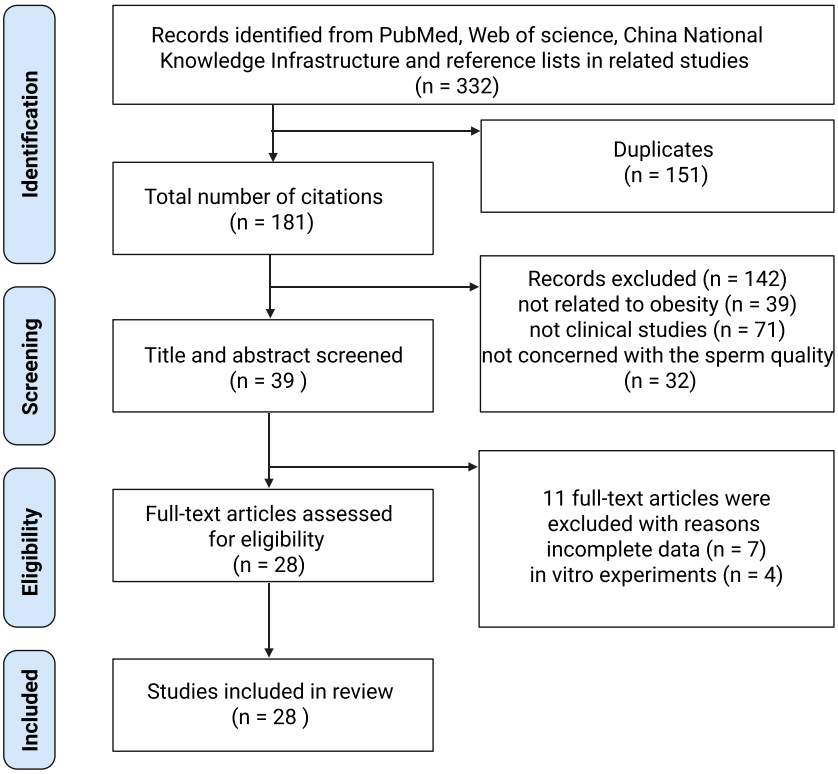

Figure 1 Flow chart of the study search.

training, dietary adjustment, and application of semaglutide all showed significant weight loss, as indicated by a significant decrease in body mass index (BMI). All studies reported changes in the indicators related to semen routine, such as the percentage of progressive motility sperm, the percentage of non-progressive motility sperm, sperm concentration, semen volume, the percentage of normal morphology sperm and DNA fragmentation index. However, the extent to which various intervention measures affect sperm quality in obese men was different.

Discussion

We have reviewed the treatment methods mentioned in Supplementary Material Appendix 1. Currently, the intervention approaches used to improve the semen quality of obese men include drug therapy, bariatric surgery, and lifestyle adjustments (Figure 2). It is worth noting that if fertility disorders are indeed obesity-dependent, weight reduction may improve reproductive outcomes. However, this is not necessarily the case, and the effects may not always be reversible. Nevertheless, regardless of fertility improvements, men undergoing these therapies related to weight reduction may reduce risks of life-threatening diseases and enhance both lifespan and quality of life.

Drug Therapy

For male patients with obesity and abnormal semen quality, in addition to lifestyle intervention, treatments also involve improving the metabolic abnormality state or sex hormone levels, antioxidant therapy, and complementary and alternative therapies. Glucagon-like peptide-1 (GLP-1) receptor agonists are hypoglycemic and weight-loss drugs that mimic the effects of GLP-1.[42] By activating the GLP-1 receptor, they promote insulin secretion (in a glucose-dependent

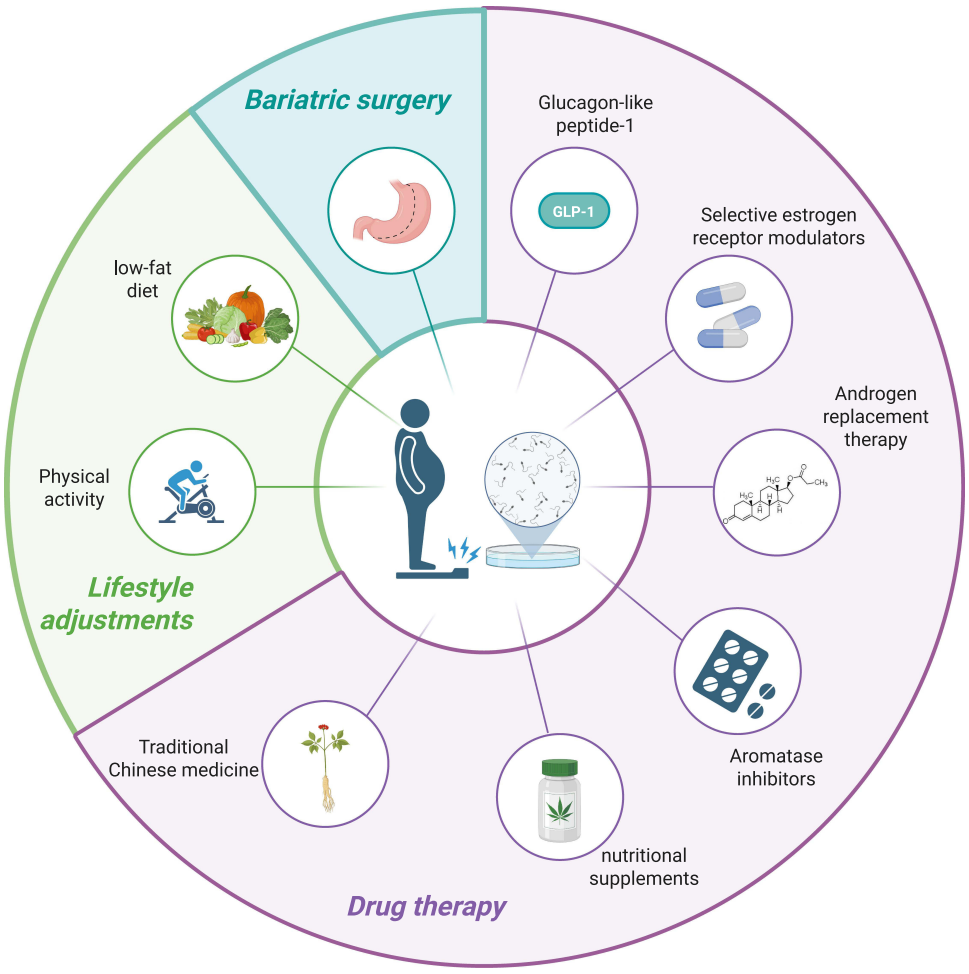

Figure 2 Treatment options for improving the semen quality of the obese men (Created in BioRender. Wang, H. (2026) https://BioRender.com/mrnqhhx).

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manner), inhibit glucagon, delay gastric emptying, and enhance satiety, and are usually used for the treatment of type 2 diabetes mellitus and obesity.[43] La Vignera et al reported patients treated with liraglutide showed significant improvement in conventional sperm parameters, total testosterone and sex hormone-binding globulin serum levels compared to the baseline.[29] Another study by Gregorič et al showed that there was a significant increase in morphologically normal sperm from the baseline to the end of the study in the semaglutide group.[30]

Selective estrogen receptor modulators primarily improve sperm quality by regulating endocrine function in the treatment of male infertility, and are mainly used for patients with idiopathic oligospermia.[44] Studies indicated that both Enclomiphene citrate and testosterone gel can elevate serum total testosterone levels in overweight men, and Enclomiphene citrate maintained sperm concentration within the normal range throughout the treatment period.[31] From the study by Panner Selvam et al, after three months of treatment, clomiphene citrate also significantly improved sperm concentration in obese men.[32]

Testosterone exerts negative feedback regulation on the hypothalamic-pituitary-gonadal axis.[45] By binding to androgen receptors on testicular supporting cells and spermatogenic cells, it maintains the spermatogenic microenvironment, promotes spermatocyte meiosis, and facilitates spermatocyte maturation. Existing evidence supports testosterone replacement therapy in improving total testosterone levels among obese patients.[31] However, its efficacy in enhancing semen quality in obese men remains limited and may even result in a reduction in spermatogenesis.[30]

Aromatase inhibitors suppress estradiol production, thereby releasing the negative feedback on the hypothalamic-pituitary-gonadal axis.[46] This elevates follicle-stimulating hormone and luteinizing hormone levels, stimulating the testes to produce more testosterone and sperm. Letrozole is commonly used in male infertility patients involving secondary hypogonadism with estrogen excess.[47] Studies indicated that letrozole monotherapy significantly improved sperm quality in obese men,[34] however, combining letrozole with human chorionic gonadotropin demonstrates superior efficacy to letrozole monotherapy in enhancing sperm quality in obese men.[34]

Previous studies confirmed the adjunctive therapeutic value of nutritional supplements in improving MI.[48] Levocarnitine serves as the transporter for long-chain fatty acids entering mitochondria for β-oxidation, optimizing fatty acid utilization and providing enhanced energy for sperm motility.[49] Furthermore, levocarnitine may benefit obese individuals by improving energy metabolism and regulating insulin sensitivity.[50,51] Ji et al demonstrated that sperm concentration, semen volume, percentage of progressive motility, and total sperm count significantly increased in obese MI patients following 3-month treatment.[39] Also, L-carnitine plus aerobic exercise can also be an effective way to improve the rates of sperm malformation and DNA fragmentation index for those obese men.[41] Vitamin E, as a potent fat-soluble antioxidant, enhances male fertility by protecting sperm cell membranes, reducing sperm DNA fragmentation rates, and improving sperm motility and morphology.[52,53] Studies by Chen et al and Wang et al demonstrated that patients in the vitamin E plus Letrozole and Fufangxuanju Capsule group, or those in the Clomifene plus Fufangxuanju Capsule plus Vitamin E group, both showed improvements in semen volume, sperm concentration, and the percentage of forward motility.[37,38]

Traditional Chinese medicine (TCM) therapies are widely used in East and Southeast Asian countries. From the perspective of TCM, male infertility in obese patients is related to the deficiency of the kidney and spleen. Individualized treatment is provided through the formulation of corresponding Chinese herbal prescriptions.[54] Qijing Formula is a representative prescription for tonifying the kidney and spleen.[36] Research indicates that compared with baseline measurements, semen volume, total sperm count, and concentration demonstrated statistically significant improvements following treatment with Qijing Formula.[36] Furthermore, Qijing Formula exhibited significantly superior efficacy in enhancing semen quality among obese males compared to Huanshao Capsule (a proprietary Chinese medicine).[36] TCM can improve semen quality in MI patients and enhance the physical condition of obese individuals. And it is often combined with other therapies for obese men with infertility. Studies showed that the improvement degrees of forward motility sperm rate, normal morphology sperm rate and sperm DNA fragmentation index in the TCM plus Levocarnitine group were superior to those in the Levocarnitine group.[39,40]

Bariatric Surgery

Bariatric surgery has long-lasting weight loss effects, few complications, and a low mortality rate.[55] However, it may lead to symptoms such as constipation, pain, malnutrition, and the need for reoperation.[56] Clinical evidence supported that bariatric surgery can effectively improve the semen volume, sperm concentration, proportion of forward-moving sperm, proportion of normal sperm morphology and sperm DNA fragmentation rate of obese men.[18,22] Bariatric surgery can also benefit obese men with infertility, as it improves their high-quality embryos, implantation rate, pregnancy rate and live birth rate.[23] In the aspect of the hormonal profile, sex hormone binding globulin, total and free testosterone improved significantly after 12- and 18-months following sleeve gastrectomy.[15] However, Carette et al found that after obese men underwent gastric bypass surgery or sleeve gastrectomy, the sperm count decreased significantly.[20] In addition to the decrease of total ejaculated sperm count, the sperm concentration was also reduced after the bariatric surgery in Wood et al's study.[21] Calderón et al evaluated 20 severely obese men (with BMI $\geq$ 35 kg/m^2) before and 2 years after bariatric surgery, and found that the semen volume slightly decreased after the surgery, while the other sperm parameters remained basically unchanged.[19] It is difficult to speculate whether the changes in these semen parameters are caused by medications administered during and after bariatric surgery, as they are not explicitly mentioned in the studies.[19–21] Although the parameters of sperm concentration, total motility, survival rate, and sperm morphology showed a trend of decreasing temporarily in some clinical studies,[19–21] some of these parameters (such as sperm concentration, total motility, etc) may recover with time going by.[14] There were also some clinical studies indicated that bariatric surgery has no significant impact on semen parameters, but the sexual function and sex hormone levels were improved in these obese men.[16,24] Although evidence from meta-analyses suggests that weight loss may improve the qualitative and quantitative characteristics of sperm, providing evidence for recommending weight loss to change semen analysis in obese men and couples attempting conception.[57] However, a meta-analysis from Lee et al reported that sustained weight loss induced by bariatric surgery had a significant impact on increasing testosterone and reducing estradiol in obese men, but sperm quality did not improve after surgery.[58] Therefore, the outcome of bariatric surgery in improving semen quality in men is still unclear, and it is difficult to place the bariatric surgery in the formal treatment strategy for infertility in obese men.

Lifestyle Adjustments

Physical Activity

Physical activity reduces inflammation and oxidative stress, enhances cardiovascular functioning, and contributes to oxygen and nutrient supply to the reproductive organs.[59] From an observational study, higher moderate-to-vigorous activity and less television watching were significantly associated with higher total sperm count and sperm concentration.[60] Rosety et al found that aerobic exercise (16-week aerobic training program in a treadmill, three sessions per week, consisting of a 10–15 minutes warm-up and 35–50 minutes tread-mill exercise) significantly improved sperm concentration, the proportion of progressively motile sperm, and the proportion of sperm with normal morphology in sedentary obese men, with a significant increase in testosterone levels.[33] Rafiee et al randomly divided 200 obese men into an exercise group (a six-month daily intensive exercise program designed under a coach's supervision) and a vitamin C group, with 50 men with normal sperm as the control group.[35] They found that semen volume and sperm concentration increased significantly in the exercise group. Also, sperm motility and the proportion of sperm with normal morphology increased in all three groups. In the vitamin C group, sperm concentration and motility in all BMI subgroups improved significantly, but there was no significant change in semen volume and the proportion of sperm with normal morphology.[35] For some obese men, calorie restriction can lead to a decrease in lean body mass and bone density, thereby increasing the risk of sarcopenia and osteoporosis.[61] And exercise, particularly multimodal regimens combining aerobic and resistance training, is the cornerstone for improving body composition and physical function in sarcopenic obesity.[61] Obese men's semen quality and physical condition can benefit from the daily exercise (14-week residential weight loss program) plus a healthy diet.[25] At present, the mechanism by which moderate exercise improves semen quality in obese men remains unclear. There is a significant positive correlation between testosterone levels and semen volume as well as the proportion of immature sperm.[62] Follicle-stimulating hormone and luteinizing hormone are also

involved in the process of spermatogenesis.[63] Exercise such as endurance activity or has been confirmed to affect the levels of various sex hormones, including testosterone, follicle-stimulating hormone, and luteinizing hormone.[64,65] In addition, long-term regular exercise—rather than excessively intense training may enhance the body's antioxidant and anti-inflammatory capabilities by increasing the production of antioxidant enzymes and anti-inflammatory factors, effectively reducing the levels of oxidative stress and inflammatory markers in semen.[66]

However, an excessively high level of physical activity, increased pressure in the reproductive area, high temperature, and insufficient oxygen intake may adversely affect male reproductive health.[59,67] Physical activities associated with hypoxia risks, including high-altitude sports or deep saturation dive, may reduce sperm motility and concentration.[68,69] Prolonged cycling may also diminish male fertility by affecting local blood flow, pressure, and temperature in the reproductive region.[70]

Low-Fat Diet

The low-fat diet has grown in popularity owing to multiple health and environmental benefits.[71] Numerous studies have shown that a high-fat diet can not only impair semen parameters in many kinds of animal models,[72] but may also affect the reproductive pattern of male offspring resulting in impairments in the subsequent generations.[73] Sharma et al randomly assigned 67 obese men (24 with normal sperm count and 43 with oligozoospermia) to either a low-energy diet group (800 kcal/day low-energy diet) or a brief dietary intervention group (a single, brief intervention consisting of National Health Service standard dietary recommendations), and found that both groups showed significant improvements in total sperm motility and progressive motility.[26] In the clinical practice, many researchers tend to combine adjusting dietary structure with formulating physical exercise plans. Faure et al conducted personalized diet and exercise interventions on 6 men with high sperm DNA fragmentation rates and excessive abdominal fat, and found that their abdominal fat was reduced, the sperm DNA fragmentation rate decreased significantly, and some sperm parameters were improved.[28] Also, Håkonsen et al conducted a 14-week weight loss program involving a healthy diet and daily exercise on 43 severely obese men, and they tested their semen parameters and reproductive hormones before and after the program, and found that total sperm count, semen volume, testosterone, and sex hormone-binding globulin increased significantly.[25] Evidence from meta-analysis suggests that dietary intervention has a positive effect on both male reproductive function in terms of seminal quality parameters and weight loss.[74,75] The benefits of healthy diet (such as Mediterranean diet) on semen characteristics are due to the high consumption of fruits and vegetables rich in antioxidant vitamins, minerals, and polyphenols.[76] Since sperm membranes are very sensitive to oxidative damage caused by reactive oxygen species, the benefits of low-fat diet on semen quality may be due to higher consumption of natural foods rich in antioxidants and carotenoids.[77]

Future Directions of the Treatment of Infertility in Obese Men

MI in obese men is a systemic disease manifested in the reproductive system, involving multiple factors such as metabolism, endocrine, nutrition, and psychology. There has been a lack of comprehensive management. The main approach to treating obesity-related MI is natural weight loss, starting with regular exercise.[78] While bariatric surgery leads to superior weight loss to non-surgical methods, more research is needed on its impact in MI. Also, the results in Supplementary Material Appendix 1 indicates that the treatment of MI in obese men primarily involves a combination of therapeutic approaches, such as TCM combined with nutritional supplements, lifestyle modifications combined with surgical interventions, and GLP-1 receptor agonists combined with lifestyle adjustments. The combined use of these treatment methods also implies that the management of MI in obese men should shift from a focus on reproductive health to a holistic approach to overall health. The collaborative participation and regular consultation of multiple disciplines, including reproductive medicine, endocrinology, nutrition, psychology, and sexual medicine, can dynamically adjust the treatment based on the patient's weight changes, metabolic indicators, and improvements in semen quality. Although there is a lack of multidisciplinary research on MI, it is undeniable that the multidisciplinary treatment plan for MI combined with sexual dysfunction has been recommended in the published expert consensus.[79] Similarly, throughout the entire treatment process for MI in

obese men, all treatment options should be discussed and implemented based on the patient's individual needs, beliefs, and preferences.

Due to limited clinical evidence, exploring effective treatment approaches remains a critical direction in addressing MI associated with obesity. Furthermore, published studies lack long-term follow-up data on treatments for male infertility in obese men. The long-term efficacy of certain therapeutic approaches and their potential impact on offspring remain unknown. Therefore, high-level clinical evidence is still needed to evaluate the efficacy of current treatment strategies in improving reproductive health among obese men and to determine whether these improved reproductive results have positive effects on their offspring as well.

Conclusion

This review provides potential evidence and trends for improving the semen quality in obese men with specific focus upon current treatments. These approaches include bariatric surgery, lifestyle modifications, medication, nutritional supplements, and TCM. Although bariatric surgery is a commonly used clinical treatment, existing evidence makes it difficult to determine its specific impact on male reproductive function. This requires validation through high-level clinical evidence. Meanwhile, combining multiple therapies has become a trend and shows positive effects for obese MI patients. Future research should further evaluate the overall health and offspring outcomes of these therapies, extending beyond reproductive health considerations. In addition, research on the mechanisms by which obesity affects sperm production and fertilization capacity is still necessary, which is crucial for the development of new diagnostic methods and treatment options.

Data Sharing Statement

The authors confirm that the data supporting the findings of this study are available within the article.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflicts of interest in this work.

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