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Impact of maternal body mass index on pregnancy outcomes following frozen embryo transfer: A systematic review and meta-analysis

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Abstract

Objective

There is still a significant gap in understanding how maternal body mass index (BMI) impacts outcomes of pregnancy after frozen embryo transfer (FET). This review aims to evaluate the effects of various BMI categories on clinical pregnancy and live birth rates in women undergoing FET.

Methods

PubMed, Scopus, Embase, and Web of Science databases were searched for studies, published up to March, 2024, using the keywords "obesity", "overweight", "obese", "maternal body mass index," "pregnancy outcomes," "frozen embryo transfer,". Eligible studies were selected based on predefined inclusion criteria, statistical analysis was performed using a random-effects model, and ther results were presented as odds ratios (OR) with 95% confidence intervals (CI).

Results

A total of 17 studies were included in the meta-analysis. Pooled findings indicate significantly reduced live birth rate in underweight (OR 0.93; 95% CI: 0.89, 0.98) and obese (OR 0.85; 95% CI: 0.77, 0.93) women but not in those who were overweight (OR 0.96; 95% CI: 0.92, 1.00), compared to those with normal BMI. Further, only those women who were underweight (OR 0.91; 95% CI: 0.85, 0.97) had reduced odds of clinical pregnancy rate but not those who were overweight (OR 0.99; 95% CI: 0.94, 1.05) or obese (OR 0.92; 95% CI: 0.82, 1.03).

Conclusion

Maternal BMI impacts pregnancy outcomes after frozen embryo transfer, with underweight and obese women having lower live birth rates and only underweight women showing

reduced clinical pregnancy rates compared to those with normal BMI. These findings underscore the importance of addressing BMI in women undergoing FET to improve pregnancy outcomes.

Introduction

In recent years, there has been a growing interest in understanding the intricate relationship between maternal body mass index (BMI) and pregnancy outcomes, particularly in the context of assisted reproduction technology (ART) [1,2]. Excessive weight and obesity have been consistently linked with various adverse reproductive outcomes, ranging from disruptions in hormonal balance and ovulation to compromised embryo implantation and increased risks of pregnancy complications such as miscarriage and preeclampsia [3–6]. Conversely, low BMI may also affect fertility and pregnancy outcomes by disrupting hormonal equilibrium and impairing reproductive function, albeit through different mechanisms [7–9]. For women undergoing ART procedures, elevated BMI presents additional challenges, including the need for higher doses of fertility medications, an increased likelihood of ovarian hyperstimulation syndrome, higher rates of miscarriage, and lower rates of successful embryo implantation [10,11]. These challenges can contribute to significant emotional and financial burden on patients and on couples seeking fertility treatments [12,13].

Currently, frozen embryo transfer (FET) has emerged as a promising alternative to traditional fresh embryo transfer [14,15]. FET offers several advantages, such as the ability to better synchronize embryo transfer with the optimal uterine environment and increased flexibility in treatment scheduling [16,17]. Understanding the mechanisms through which maternal BMI may influence pregnancy outcomes following FET is crucial for improving reproductive success in patients undergoing ART [18,19]. However, the impact of maternal BMI on pregnancy outcomes following FET is still unclear [17,20]. Moreover, the existing literature often lacks comprehensive classification of outcomes based on BMI categories [17], particularly distinguishing between underweight, normal-weight, overweight, and obese patients. Therefore, it is challenging to establish specific effects of BMI on pregnancy outcomes in FET cycles [21,22], which prevents the clinicians from developing tailored treatment strategies.

This systematic review aims to address the existing gaps in the literature by evaluating the impact of BMI on specific pregnancy outcomes, including live birth rate and clinical pregnancy rate, stratified by BMI categories.

Methods

The aims and methods of this meta-analysis have been registered with the International Prospective Register for Systematic Reviews, with ID number CRD42024528123 (available from https://www.crd.york.ac.uk/PROSPERO). The meta-analysis was conducted using the guidelines and checklist outlined by the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) Group (S1 File).

Literature search

PubMed, Scopus, Embase, and Web of Science databases were systematically searched for studies, published from inception of the databases up to March 31st 2024. We used the following Medical Subject Heading and free words to determine the search strategy: "obesity", "overweight", "obese", "body mass index," "pregnancy," "frozen", "frozen embryo transfer", "blastocyst transfer", "assisted reproductive technology" "and "birth rate". Further details are presented in S1 Table. We also explored reference lists in retrieved studies and prior systematic reviews for

potentially relevant studies. Two reviewers conducted the search in all databases independently. They collated all search results and deduplicated them using EndNote. The remaining unique studies underwent further screening, first by title/abstract and then by full-texts to include relevant articles in the review. Disagreements between reviewers were resolved by discussion.

Eligibility criteria

Inclusion criteria was determined as follows: 1) Study population: adult females undergoing FET 2) Exposure group: Obese, overweight, or underweight females as determined by BMI 3) Comparator group: Normal BMI females 4) Outcomes: clinical pregnancy and live birth rates 5) Study design: All types of comparative studies. 5) Studies reporting confounder adjusted effect sizes for the outcomes of interest.

Exclusion criteria was as follows: 1) Studies on other ART modalities 2) Studies not segregating data based on BMI 3) Studies not reporting required outcomes or reporting unadjusted outcomes 4) Abstracts, unpublished data, theses, reviews and editorials.

Quality assessment and data management

Quality of the cohort studies was assessed using the ROBINS-I instrument. Two reviewers independently scrutinized the methodological quality of the included studies and any disagreements were resolved by consensus.

Data were extracted from the relevant studies, and included study name, location, design, sample size, age distribution, BMI categories (underweight, normal weight, overweight, and obese), duration of infertility (in years), and outcomes of interest (i.e., live births and clinical pregnancies) based on BMI categories.

Statistical analysis

STATA version 15.0 was used for the analysis. We adopted a random-effects model to assess the relationship between maternal BMI categories, usually defined as underweight (BMI < 18.5 kg/m^2), overweight (BMI 25-29.9 kg/m^2), and obese (BMI ≥ 30 kg/m^2), and pregnancy outcomes following FET. Specifically, we assessed the rate of live births and clinical pregnancy across different BMI categories compared to healthy normal-BMI women. Heterogeneity among the studies was evaluated by I^2 statistics [23]. Forest plot and Egger's test was used to assess the publication bias [24]. A $p < 0.05$ was used as the threshold for statistical significance.

Results

General characteristics of included studies

A total of 1084 studies were identified by the literature search. Of them, 309 studies were removed as duplicates. Of the remaining 775 studies, 582 were eliminated at the stage of the title and abstract review. Full texts of the 193 studies were assessed for eligibility. Finally, 17 studies were included in the analysis [7,19,25–39] (Fig 1, S2 File).

As summarized in Table 1, all the included studies had a retrospective cohort design. The detailed data extracted from these studies are presented in Table 1.

Participant information

The analysis included information of 237,562 women, with the mean age of around 32 years. Based on the BMI, women were categorized as underweight (n = 15,272), normal-weight (n = 130,733), overweight (n-46,767), and obese (n = 22,395).

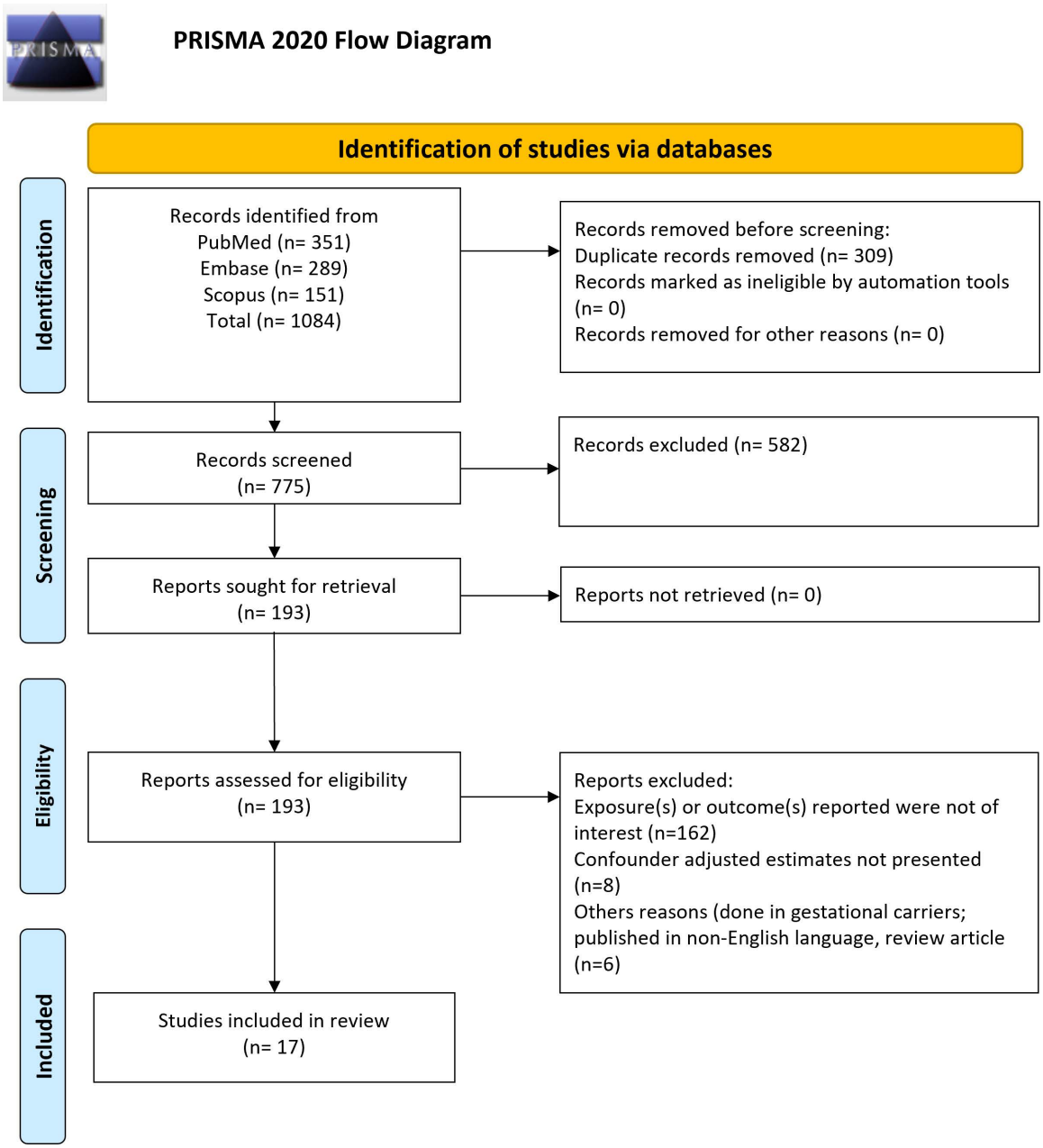

Fig 1. Flow diagram of literature screening.

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Assessment of study quality

Quality of the cohort studies was evaluated using the ROBINS-I tool, detailed by Sterne et al. (2016). As summarized in Table 2, most studies had a high risk of bias. Additionally, several studies had missing data and indications of selection bias (Table 2).

Meta-analysis outcome

Live birth rate. The analysis reported significantly reduced reduced live birth rate in underweight (OR 0.93; 95% CI: 0.89, 0.98, $I^2 = 35.5\%$, N = 13) and obese (OR 0.85; 95% CI:

Table 1. Details of included studies.

References; study design	Country	Groups	Sample size	Mean age (years)	BMI definition (kg/m²)	Infertility duration (years)	Adjustment done for
Beshar et al. (2023) [25] RC	USA	Normal Overweight Obese	229 128 68	22 26.3 33.0	18.5-24.9 25-30 >30	NR	Age at transfer, nulliparity, embryo grade, race/ethnicity, endometrial thickness on day of hCG trigger, and diagnosis of unexplained infertility
Bakkensen et al. (2024) [26] RC	USA	Underweight Normal Overweight Obese	1612 31666 13419 9867	34.3 ± 4.4 35.2 ± 4.1 35.4 ± 4.1 35.6 ± 4.1	<18.5 18.5-24.9 25-29.9 ≥30	NR	Age at transfer, race and ethnicity, prior pregnancy loss, current smoking, indication for preimplantation genetic testing, and endometrial thickness
Peterson et al. (2024) [27] RC	USA	Underweight Normal Overweight Obese	1734 33126 13068 7960	34.7 ± 4.0 35.1 ± 4.2 35.3 ± 4.2 35.6 ± 4.0	<18.5 18.5-24.9 25-29.9 >30	NR	Age, cycle order, race, male factor infertility, and female factor infertility
Liu and Shi (2024) [28] RC	China	Underweight Normal Overweight Obese	81 637 108 25	30.6 ± 4.0 31.1 ± 3.4 31.7 ± 4 30 ± 4.2	<18.5 18.5-24.9 25-30 >30	2.2 ± 2.1 2.0 ± 2.1 2.8 ± 2.5 3.0 ± 2.0	Infertility duration, endometrial thickness, infertility type (primary infertility vs secondary infertility), protocol in fresh cycle (agonist, antagonist, other), biopsied blastocysts, no result embryos
Fawarseh et al. (2022) [29] RC	Israel	Underweight Normal Overweight Obese	43 286 154 158	33.3 ± 7.2 34.9 ± 6.2 35.9 ± 7.4 36.1 ± 5.2	<18.5 18.5-24.9 25-30 >30	NR	Maternal age, endometrial thickness, and KID scores (reflecting embryo quality)
Shen et al. (2022) [30] RC	China	Underweight Normal Overweight Obese	2422 13845 6037 1178	31 ± 4.3 32.3 ± 4.8 33.1 ± 5.2 31.9 ± 4.9	<18.5 18.5- < 23 23- < 27.5 ≥27.5	3.1 ± 2.6 3.2 ± 2.9 3.5 ± 3.3 3.7 ± 3.3	Adjustment for confounders done; however, variables adjusted were not mentioned
Kidera et al. (2023) [31] RC	Japan	Underweight Normal Overweight Obese	943 3814 935 330	38 39 40 41	<18.5 18.5-22.5 22.5 to 25 >25	NR	Propensity score matched
Zheng et al. (2022) [32] RC	China	Underweight Normal Overweight Obese	1127 6925 1810 390	30.2 ± 3.9 31.9 ± 4.5 32.8 ± 5.2 31.7 ± 4.6	<18.5 18.5-24 24 to 28 ≥28	3.0 ± 1.9 3.2 ± 2.3 3.6 ± 2.6 3.8 ± 2.4	Maternal age, type of infertility, IVF indications, antral follicle count (AFC), endometrial thickness, type of endometrial preparation, expansion stage, inner cell mass, and trophectoderm
Zeng et al. (2023) [33] RC	China	Underweight Normal Overweight Obese	2136 11723 2622 495	NR	<18.5 18.5-23.9 24 to 27.9 ≥28	NR	Maternal age, paternal age, causes of infertility, protocol, number of high-quality embryos and D3/D5 transferred embryos
Hu et al. (2024) [34] RC	China	Underweight Normal Overweight Obese	137 1130 339 61	28 29 29 29	<18.5 18.5- < 25 25 to < 30 ≥30	3 3 3 4	Maternal age, number of embryos transferred, stage of embryo development, endometrial preparation protocol, fertilization method, cause of infertility, endometrial thickness, and number of oocytes retrieved
Insogna et al. (2017) [35] RC	USA	Underweight Normal Overweight Obese	8 288 106 59	34.8 ± 3.2 35.4 ± 4.2 36.6 ± 5.0 36.6 ± 3.9	<18.5 18.5-24.9 25 to 29.9 ≥30	NR	Cohort score (marker of embryo quality), uterine cause of infertility, mock transfer score, maternal age, transfer of more than one embryo, diminished ovarian reserve, and male factor infertility
Zhang et al. (2019) [19] RC	China	Underweight Normal Overweight Obese	2527 13224 5079 1213	30.5 31.3 31.6 31.1	<18.5 18.5- < 23 23 to 27.5 >27.5	3.2 ± 2.3 3.3 ± 2.7 3.6 ± 2.9 4.1 ± 2.9	Maternal age, infertility duration, gravidity, parity, main cause of infertility, number of OPU prior to FET, year of treatment, number of embryos transferred, and embryo developmental stage at transfer
Lin et al. (2019) [36] RC	China	Underweight Normal Obese	972 480 228	32.8 ± 3.4 33.1 ± 3.8 33.3 ± 3.6	18.5-24.9 25 to 29.9 ≥30	3.8 ± 2.7 42.9 4.2 ± 2.9	Maternal age, infertility duration, duration of cryopreservation, endometrial thickness, embryo quality, means of preparing the endometrium, number of embryos transferred as well as embryo developmental stage
Prost et al. (2020) [37] RC	France	Normal Obese	799 159	32.9 ± 4.1 32.9 ± 4.8	18.5- 24.9 ≥30	NR	Maternal age, smoking status, serum AMH, endometrium thickness, parity, infertility cause, double blastocyst transfer

(Continued)

Table 1. (Continued)

References; study design	Country	Groups	Sample size	Mean age (years)	BMI definition (kg/m²)	Infertility duration (years)	Adjustment done for
Qiu et al. (2019) [7] RC	China	Underweight Normal Overweight Obese	184 1911 780 204	28.9 ± 3.2 29.9 ± 3.4 30.5 ± 3.9 30 ± 3.7	<18.5 18.5-24.9 25 to 29.9 ≥30	3.1 ± 2.0 3.5 ± 2.6 3.9 ± 2.8 4.2 ± 2.9	Female age, duration of infertility, gravidity, parity, history of preterm delivery, indication combined with PCOS, previous IVF failures, AFC, fertilization methods, embryo stage at transfer, endometrial thickness on ET day, endometrial preparation, and the number of embryos transferred
Tang et al. (2021) [38] RC	China	Underweight Normal Overweight	1315 6230 1210	33.6 33.8 33.7	<18.5 18.5-24.9 ≥25	NR	Age of embryo transfer, age of oocyte retrieval, infertility duration, endometrial thickness, embryo quality, number of embryos transferred, and embryo developmental stage
Oliva et al. (2021) [39] RC	USA	Underweight Normal	314 4420	NR	<18.5 18.5-24.9	NR	Maternal age, markers of ovarian reserve, total gonadotropin dose, stimulation type, trigger type, estradiol and progesterone at the time of surge, number of embryos transferred, day of embryo transfer, endometrial type, and morphologic grade

RC, retrospective cohort; NR, not reported; BMI, body mass index; PCOS, polycystic ovary syndrome.

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0.77, 0.93, $I^2 = 61.2\%$, N = 14) women but not in those who were overweight (OR 0.96; 95% CI: 0.92, 1.00, $I^2 = 65.0\%$, N = 14), compared to those with normal BMI (Figs 2–4).

There was no evidence of publication bias for comparison of live birth in any of the three BMI categories (underweight, Egger's p = 0.71; overweight, p = 0.66 and obese, p = 0.56). The funnel plots also support lack of potential publication bias (S1–S3 Figs).

Clinical pregnancy rate. The pooled analysis showed that only those women who were underweight (OR 0.91; 95% CI: 0.85, 0.97, $I^2 = 53.2\%$, N = 12) had reduced odds of clinical pregnancy rate. Those who were overweight (OR 0.99; 95% CI: 0.94, 1.05, $I^2 = 67.6\%$, N = 13) or obese (OR 0.92; 95% CI: 0.82, 1.03, $I^2 = 64.6\%$, N = 12) had similar clinical pregnancy rate compared to women with normal BMI (Figs 5–7).

There was no evidence of publication bias for comparison of live birth in any of the three BMI categories (underweight, Egger's p = 0.43; overweight, p = 0.92 and obese, p = 0.79). The funnel plots also support lack of potential publication bias (S4–S6 Figs).

Discussion

Our systematic review and meta-analysis provides evidence of the association between the maternal body weight and FET outcomes.

Live birth rates

Our meta-analysis revealed a significant association between abnormal maternal BMI and live birth rates for underweight and obese women but not for those who were overweight. These findings underscore the importance of considering maternal BMI as a critical determinant of pregnancy success in FET procedures. Firstly, the observed reduction in live birth rates among underweight women highlights the potential adverse effects of insufficient maternal weight on embryo implantation and subsequent pregnancy maintenance [40]. Underweight women may experience hormonal imbalances and inadequate uterine receptivity, impairing embryo implantation and leading to lower live birth rates [41].

Conversely, significant reduction in live birth rates in obese women underscores the detrimental effects of excessive maternal weight on fertility outcomes post-FET [42]. Elevated BMI levels are associated with various metabolic and endocrine dysregulations, including insulin

Table 2. Bias risk assessment for inclusion in the study.

References	Confounding	Selection	Deviation	Missing data	Measurement of outcomes	Reporting	Classification	Risk of bias
Beshar et al. (2023) [25]	+	+	–	+	+	?	+	Some concerns
Bakkensen et al. (2024) [26]	+	?	?	+	+	+	+	Some concerns
Peterson et al. (2024) [27]	–	+	+	+	+	+	+	Low
Liu and Shi (2024) [28]	+	+	+	+	–	?	+	Some concerns
Fawarseh et al. (2022) [29]	+	+	+	+	+	–	+	Low
Shen et al. (2022) [30]	+	+	–	+	+	?	+	Some concerns
Kidera et al. (2023) [31]	+	?	?	+	+	+	+	Some concerns
Zheng et al. (2022) [32]	+	?	?	+	+	+	+	Some concerns
Zeng et al. (2023) [33]	+	?	+	+	+	+	+	Some concerns
Hu et al. (2024) [34]	–	+	–	+	–	?	?	Very low
Insogna et al. (2017) [35]	+	?	?	+	–	+	+	Some concerns
Zhang et al. (2019) [19]	–	+	–	+	+	?	+	Low
Lin et al. (2019) [36]	+	?	?	+	–	+	+	Low
Prost et al. (2020) [37]	+	?	?	+	+	+	+	Some concerns
Qiu et al. (2019) [7]	+	+	–	+	+	?	+	Some concerns
Tang et al. (2021) [38]	+	?	?	+	–	+	+	Low
Oliva et al. (2021) [39]	+	?	?	+	+	+	+	Some concerns

https://doi.org/10.1371/journal.pone.0319012.t002

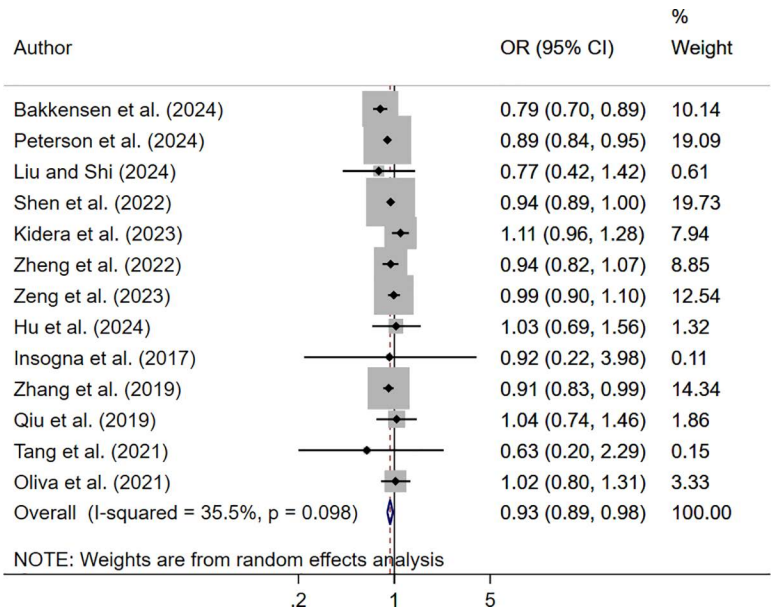

Fig 2. Forest plot comparing live birth rate in underweight and normal-BMI women.

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resistance and altered hormonal profiles, which can negatively impact oocyte quality, embryo development, and implantation [32,43]. Moreover, excessive increase in maternal adiposity may contribute to chronic inflammation and oxidative stress, further compromising reproductive outcomes [44,45]. Overweight women might not reach the threshold of physiological disturbances seen in obesity, such as hormonal imbalances and inflammatory responses, which can adversely affect implantation and pregnancy maintenance. Additionally, variations in study populations and methodologies might have contributed to the observed lack of association.

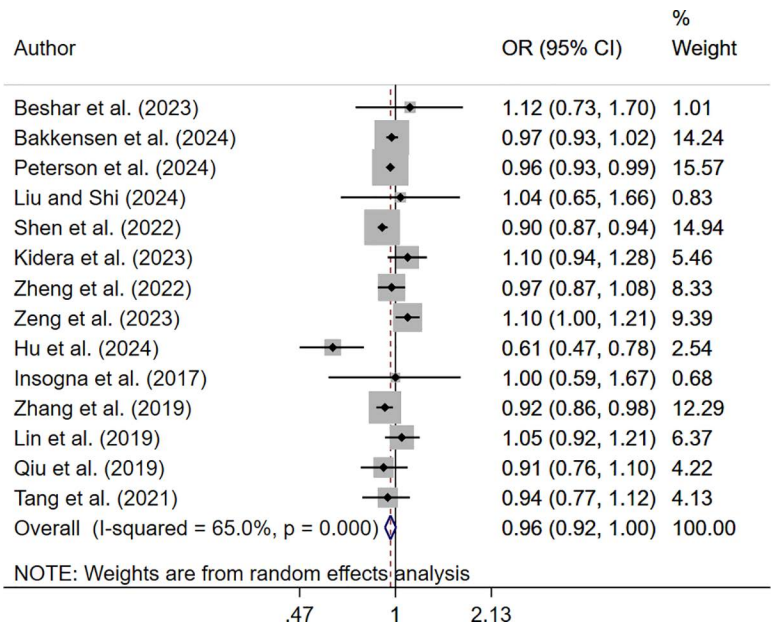

Fig 3. Forest plot comparing live birth rate in overweight and normal-BMI women.

https://doi.org/10.1371/journal.pone.0319012.g003

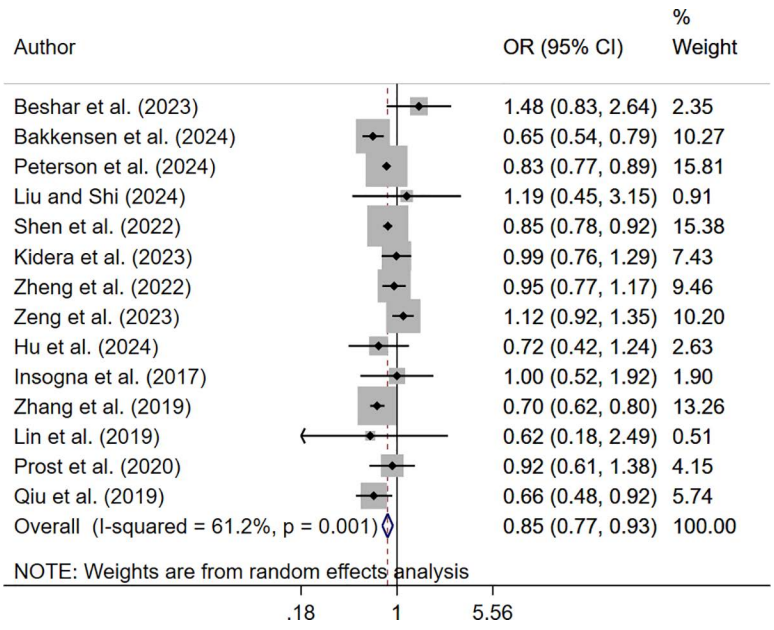

Fig 4. Forest plot comparing live birth rate in obese and normal-BMI women.

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Clinical pregnancy rate

Our results showed, that being underweight was associated with decreased clinical pregnancy rates, compared to those of the normal-weight group. However, clinical pregnancy rate in the obese and overweight group was comparable to that of the normal-weight group. We may speculate that while obesity is widely recognized as a risk factor for adverse pregnancy

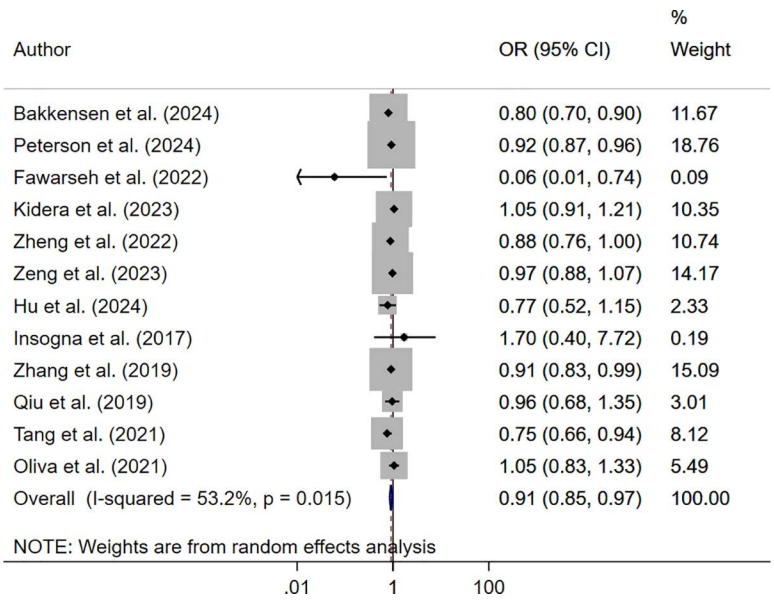

Fig 5. Forest plot comparing clinical pregnancy rate in underweight and normal-BMI women.

https://doi.org/10.1371/journal.pone.0319012.g005

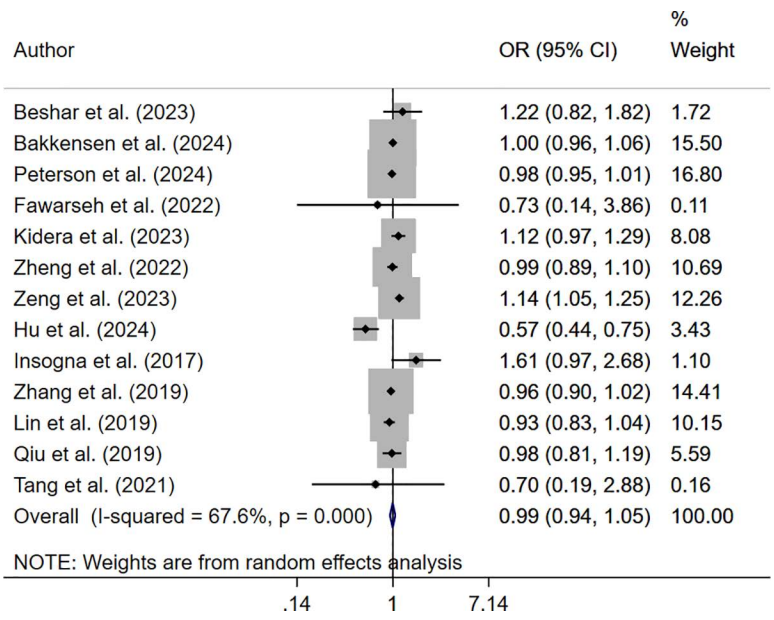

Fig 6. Forest plot comparing clinical pregnancy rate in overweight and normal-BMI women.

https://doi.org/10.1371/journal.pone.0319012.g006

outcomes, the impact of being obese on fertility is less clear-cut. Similar clinical pregnancy rate in overweight and obese women, compared to normal BMI women, might be linked to the presence of adipose tissue, which could provide a more favorable hormonal and metabolic milieu for embryo implantation and development [7,46–48]. Additionally, increased availability of energy reserves in these women might have a supportive effect [49,50]. However, these studies caution that despite a possible protective benefit of the overweight or obese status, a

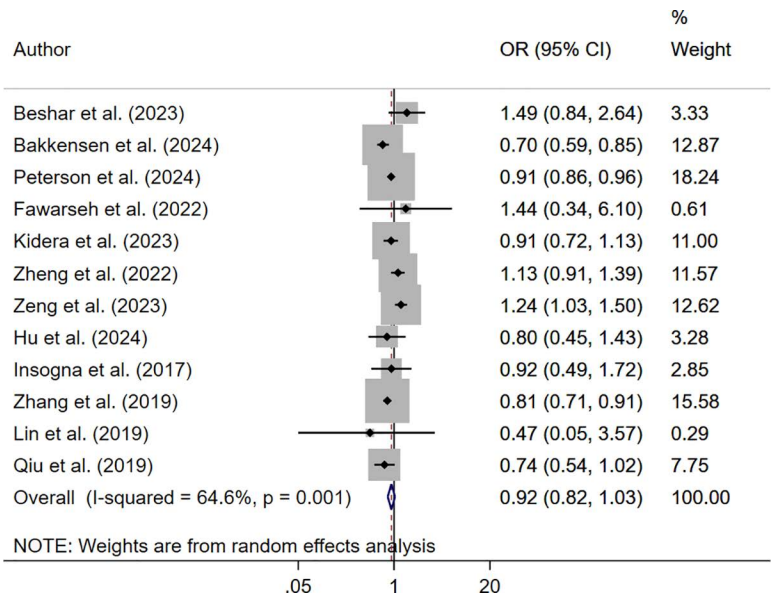

Fig 7. Forest plot comparing clinical pregnancy rate in obese and normal-BMI women.

https://doi.org/10.1371/journal.pone.0319012.g007

higher BMI might negatively impact pregnancy outcomes, as observed in our study. At the same time, reduced rate of clinical pregnancy in underweight women may stem from potential changes in hormonal profiles and reproductive function associated with low BMI [51,52]. Studies have shown that inadequate energy reserves in underweight patients might compromise follicular development and oocyte quality, thereby affecting the likelihood of successful implantation and clinical pregnancy [53,54].

Additionally, it's crucial to consider the potential role of confounding variables and effect modifiers that may influence the association between maternal weight and live birth rates. Factors such as age, parity, underlying medical conditions, lifestyle factors, and access to healthcare services could confound or modify the observed relationship. For instance, older women, who are more likely to be overweight or obese, may also face age-related declines in fertility, which could attenuate the negative impact of excess weight on clinical pregnancy rates. Similarly, socioeconomic disparities and disparities in healthcare access could contribute to variations in pregnancy outcomes across different weight categories.

Implications for clinical practice

The observed associations between maternal BMI and pregnancy outcomes carry implications for clinical practice. Rather than adopting a one-size-fits-all approach, personalized interventions that meticulously consider individual BMI profiles are essential. By tailoring treatment plans to accommodate the specific needs and challenges associated with varying BMI categories, clinicians can significantly enhance the likelihood of successful outcomes in fertility treatments. For instance, healthcare providers should prioritize pre-conception counseling and interventions aimed at optimizing maternal BMI to enhance the success of FET procedures [55]. In underweight women, nutritional supplementation and lifestyle modifications may improve fertility outcomes [56]. Similarly, overweight and obese women may benefit from weight management strategies, including diet modifications, physical activity interventions, and, in some cases, bariatric surgery, to mitigate the adverse effects of excess adiposity on fertility and pregnancy [57].

Challenges and considerations in BMI stratification

While our meta-analysis offers valuable insights into the association between maternal BMI and FET outcomes, it is crucial to acknowledge the challenges inherent in BMI stratification that require careful consideration. One notable challenge is the lack of standardized classification of outcomes based on BMI categories across the existing literature. This deficiency affects our the ability to accurately evaluate specific effects of varying BMI levels on pregnancy outcomes.

Indeed, numerous studies included in our analysis utilized different cutoff values to define BMI categories, further complicating the interpretation of results. This variability in classification criteria not only hampers the comparability of findings across studies but also introduces potential inconsistencies in clinical decision-making. Without a standardized approach to BMI stratification, clinicians may face challenges in accurately assessing the impact of maternal BMI on FET outcomes and in tailoring treatment strategies. To address these challenges, future research should prioritize the implementation of harmonized classification criteria across BMI categories. Establishing universally accepted cutoff values for defining BMI categories would facilitate more precise clinical decision-making and enhance the comparability of findings across studies. Additionally, efforts to standardize outcome measures related to pregnancy outcomes in relation to maternal BMI would enhance the robustness of future research in this area. By addressing these challenges and promoting standardized approaches to BMI stratification, future studies can advance our understanding of the complex relationship between maternal BMI and FET outcomes, ultimately improving the quality of care for individuals undergoing ART.

Future directions

The observed associations between maternal BMI and FET outcomes raise intriguing questions regarding underlying mechanisms and potential research directions. Mechanistic studies exploring the impact of BMI on endometrial receptivity, embryo quality, and implantation potential can provide deeper insights into the biological pathways mediating these associations. Furthermore, investigations into epigenetic modifications and gene expression patterns influenced by maternal BMI during embryonic development could identify additional factors that may contribute to pregnancy outcomes. Longitudinal studies investigating the effects of maternal BMI on long-term offspring health outcomes following FET are warranted to comprehensively assess intergenerational implications and inform clinical practice.

Limitations and strengths of the study

It is imperative to recognize both the limitations and strengths inherent in our systematic review and meta-analysis. While the incorporation of a substantial number of studies reinforces the robustness of our findings, it's crucial to acknowledge the potential biases and confounding factors introduced by the retrospective design of the included studies. Moreover, variations in study methodologies, including differences in sample sizes and BMI categorization criteria among the included studies, may affect the generalizability of our results.

Variability in sample sizes across studies underscores the need for cautious interpretation, as studies with larger sample sizes may have more substantial influence on the overall outcomes. Additionally, variations in cut-off values used to define BMI categories among the included studies pose challenges in synthesizing findings and may contribute to heterogeneity in results. However, despite these limitations, our study provides invaluable insights into the intricate association between maternal BMI and FET outcomes. By systematically synthesizing data from a diverse range of studies, our analysis offers a comprehensive overview of

this complex relationship, laying a solid foundation for future research and the development of clinical practice guidelines. Moving forward, efforts to address these limitations, such as employing more rigorous study designs and standardizing methodologies for BMI categorization, will be essential to further enhance the reliability and applicability of findings in this critical area of research.

In conclusion, our systematic review and meta-analysis provide compelling evidence of the significant influence of maternal BMI on pregnancy outcomes following FET. These findings emphasize the need to consider maternal BMI as a critical determinant of reproductive success and advocate for personalized clinical approaches tailored to individual BMI profiles. By addressing gaps in existing literature and highlighting avenues for future research, our study contributes to advancing understanding of the complex interplay between maternal BMI and FET outcomes, with the ultimate goal of optimizing fertility treatment strategies and improving patient outcomes.

Supporting information

S1 Table. Search strategy.
(DOCX)

S1 Fig. Forest plot comparing live birth rate in underweight and normal-BMI women.
(JPG)

S2 Fig. Forest plot comparing live birth rate in overweight and normal-BMI women.
(JPG)

S3 Fig. Forest plot comparing live birth rate in obese and normal-BMI women.
(JPG)

S4 Fig. Forest plot comparing clinical pregnancy rate in underweight and normal-BMI women.
(JPG)

S5 Fig. Forest plot comparing clinical pregnancy rate in overweight and normal-BMI women.
(JPG)

S6 Fig. Forest plot comparing clinical pregnancy rate in obese and normal-BMI women.
(JPG)

S1 File. PRISMA 2020 Checklist.
(DOCX)

S2 File. List of excluded studies.
(XLS)

S3 File. Data extraction variables and all the eligible studies from which data extraction was done (20/4/2024 till 15/5/2024).
(DOC)

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