

## IMPACT OF ELEVATED BODY MASS INDEX (BMI) ON FEMALE FERTILITY AND REPRODUCTIVE OUTCOMES

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### Abstract

Elevated body mass index (BMI) is increasingly prevalent among women of reproductive age and has been associated with adverse reproductive outcomes. This study aimed to synthesize original observational cohort and registry-based evidence examining the impact of elevated BMI on female fertility, assisted reproductive technology (ART) outcomes, and pregnancy outcomes. Methods: A structured literature-based synthesis was conducted using PubMed, Scopus, and Web of Science. Only original cohort and registry studies reporting empirical patient-level data were included. Outcomes assessed included live birth rate, clinical pregnancy rate, implantation rate, fertilization rate, miscarriage risk, gonadotropin dose requirement, embryo quality, and obstetric complications. Results: Fifteen original cohort and national registry studies were included, representing data from multiple countries. Elevated BMI was consistently associated with reduced live birth rates (approximately 10–30% lower), decreased clinical pregnancy and implantation rates, and increased miscarriage risk (1.3–2.0-fold higher). Higher BMI was also linked to increased gonadotropin requirements and greater obstetric complications. Large registry datasets demonstrated a clear dose–response relationship, with progressively worse outcomes across increasing BMI categories. Conclusion: Elevated BMI is a significant and modifiable risk factor for impaired reproductive outcomes. Preconception weight optimization may improve fertility and ART success while reducing pregnancy-related complications.

### Keywords

Body mass index; Female fertility; Assisted reproductive technology; Live birth rate; Pregnancy outcomes.

**Introduction.** Obesity has become a major global public health challenge, with a rapidly increasing prevalence among women of reproductive age. Elevated body mass index (BMI) is associated with significant metabolic and endocrine

disturbances, including insulin resistance, chronic low-grade inflammation, hyperandrogenism, and altered adipokine secretion. These physiological alterations adversely affect multiple components of female reproductive function, ultimately compromising fertility and pregnancy outcomes.

Excess adiposity disrupts the hypothalamic-pituitary-ovarian (HPO) axis, contributing to menstrual irregularities, anovulation, and reduced fecundability. In the setting of assisted reproductive technology (ART), strong evidence from large registry-based and cohort studies demonstrates that increasing BMI is associated with poorer treatment outcomes. An analysis of 239,127 fresh autologous IVF cycles from the United States SART registry reported a progressive decline in live birth rates as BMI increased above 25 kg/m<sup>2</sup> [2]. Similarly, a multicenter cohort study from China involving 9,587 IVF cycles found significantly reduced cumulative live birth rates in overweight and obese women [13].

Prospective cohort data from Spain showed that obese women had significantly lower implantation and pregnancy rates despite comparable embryo morphology, suggesting impaired endometrial receptivity rather than embryo quality alone [5]. Supporting this, donor oocyte registry data from the United States demonstrated that elevated recipient BMI independently reduced ART success, highlighting the contribution of uterine and metabolic factors [8].

Obesity has also been consistently associated with increased miscarriage risk. A large cohort study reported that elevated BMI significantly increased the risk of miscarriage following assisted reproduction [10]. Earlier IVF cohort studies similarly found that overweight and obesity were associated with reduced pregnancy rates and increased cycle cancellation [4,7].

Beyond conception, maternal obesity substantially increases the risk of adverse pregnancy and perinatal outcomes. Large population-based cohort data from Scandinavia demonstrated higher risks of gestational complications and adverse neonatal outcomes in obese women [12]. Additional registry-based evidence further confirmed increased perinatal risks among obese women undergoing assisted reproduction [1,2].

Collectively, original clinical and population-based evidence supports a clear dose-response relationship between increasing BMI and poorer reproductive outcomes [2,13,22]. Elevated BMI negatively influences ovulation, implantation, miscarriage risk, live birth rates, and perinatal health. These findings emphasize the importance of preconception weight optimization and metabolic risk management in women planning pregnancy or fertility treatment.

**Materials and methods.** This study was conducted as a structured literature-based synthesis of original observational cohort studies and registry analyses

investigating the association between body mass index (BMI) and female reproductive outcomes. The objective was to evaluate primary patient-level evidence examining the impact of elevated BMI on fertility, assisted reproductive technology (ART) outcomes, and pregnancy outcomes. Only original research articles reporting empirical data were included, while review articles, systematic reviews, meta-analyses, editorials, case reports, and experimental animal studies were excluded to ensure that the analysis was based solely on primary clinical evidence.

A comprehensive literature search was performed using electronic databases including PubMed/MEDLINE, Scopus, and Web of Science. The search strategy incorporated both Medical Subject Headings (MeSH) and free-text keywords related to BMI and reproductive outcomes. Search terms included combinations of "body mass index," "BMI," "obesity," and "overweight" with "fertility," "in vitro fertilization," "IVF," "assisted reproductive technology," "ART," "live birth," "implantation," "miscarriage," and "pregnancy outcomes." The search was limited to studies involving human participants and published in the English language. No strict lower limit on publication year was applied in order to capture both foundational and contemporary cohort data.

Following database retrieval, titles and abstracts were screened for relevance. Full-text articles were then assessed against predefined eligibility criteria. Studies were considered eligible if they were prospective or retrospective cohort studies or registry-based analyses that evaluated BMI as an exposure variable and reported reproductive outcomes such as live birth rate, clinical pregnancy rate, implantation rate, fertilization rate, miscarriage risk, gonadotropin dose requirements, embryo quality, or obstetric complications. Studies that did not report reproductive outcomes or did not stratify results according to BMI were excluded.

Data were extracted systematically from eligible studies, including author name, publication year, country of origin, study design, sample size, BMI classification method, reproductive outcomes assessed, main findings, and reported effect estimates when available. The extracted data were organized into comparative summary tables to facilitate cross-study evaluation. Due to heterogeneity in BMI categorization, outcome definitions, statistical adjustments, and IVF protocols across studies, a formal quantitative meta-analysis was not conducted. Instead, findings were synthesized narratively, with emphasis placed on consistency of associations, magnitude of effect, and evidence of dose-response relationships.

During interpretation, methodological limitations of individual studies were carefully considered. Most included studies were retrospective registry-based

analyses, which may be subject to residual confounding and selection bias. BMI was typically measured at a single time point and may not reflect long-term metabolic status or body fat distribution. Variability in adjustment for lifestyle, socioeconomic, and metabolic factors was also noted. Despite these limitations, the inclusion of large national datasets and multicenter cohorts strengthened the overall robustness and generalizability of the synthesized findings.

**Results.** A total of fifteen original observational cohort studies and national registry analyses were included, representing data from the United States, United Kingdom, Spain, Norway, Sweden, Finland, France, China, and Australia [1-15]. Sample sizes ranged from approximately 1,000 IVF cycles to 239,127 cycles in national registry datasets [2]. Across all included studies, elevated BMI was consistently associated with adverse reproductive outcomes.

Reduced live birth rates among overweight and obese women were reported in nearly all large cohorts. In the U.S. SART database analysis of 239,127 IVF cycles, women with BMI  $\geq 35$  kg/m<sup>2</sup> had significantly lower live birth rates compared with women of normal BMI [2]. Similarly, Luke et al. demonstrated reduced live birth rates across racial groups among obese women undergoing ART [1]. European cohorts, including those from Norway and Finland, confirmed these findings, showing that elevated BMI negatively affected live birth outcomes [7,10]. A large Chinese multicenter study further demonstrated a clear dose-response decline in live birth rates with increasing BMI categories [13].

Overall, obese women experienced approximately 10-30% lower live birth rates compared to women with normal BMI [1,2,7,13].

Impaired implantation was consistently observed in women with elevated BMI. Prospective and retrospective cohort studies from Spain and the United Kingdom reported significantly lower implantation and pregnancy rates in obese women undergoing IVF [3,5]. Additional studies from Australia and France documented reduced fertilization rates and poorer embryo quality in women with elevated BMI [14,15].

Importantly, donor oocyte cycle analyses demonstrated that higher recipient BMI was associated with reduced success rates despite controlled oocyte quality, suggesting that endometrial or systemic metabolic factors independently contribute to impaired reproductive outcomes [8].

An increased risk of miscarriage was consistently reported among overweight and obese women. Adjusted analyses demonstrated that obesity independently increased miscarriage risk [6]. Registry-based data reported miscarriage risk increases ranging from 1.3- to 2.0-fold compared with normal-weight women [2,10].

Several large datasets further demonstrated a graded increase in miscarriage risk across increasing BMI categories [2,13].

Women with elevated BMI required significantly higher total gonadotropin doses during controlled ovarian stimulation. Reduced ovarian responsiveness and increased medication requirements were observed consistently across multiple cohorts [11]. Earlier prospective data also reported higher cycle cancellation rates and reduced responsiveness in obese women [4].

Population-based cohort studies demonstrated that obesity was associated with increased obstetric complications, indicating that the adverse impact of elevated BMI extends beyond conception and implantation [12]. These findings were consistent with ART-based cohorts showing increased pregnancy-related risks in women with higher BMI.

The overall pattern of findings across included studies is summarized in Table 1. As shown in Table 1, elevated BMI was consistently associated with reduced live birth, clinical pregnancy, implantation, and fertilization rates, as well as increased miscarriage risk, higher gonadotropin requirements, and greater obstetric complications [1-15]. A clear dose-response relationship was observed in most large-scale datasets, with progressively worse outcomes across increasing BMI categories [2,13].

**Table 1. Summary of Reproductive Outcomes Associated with Elevated BMI in Original Cohort Studies**

Outcome	Direction of Association with High BMI	Approximate Effect Size Reported	Consistency Across Studies
Live birth rate	Decreased	10-30% lower	Very consistent (1,2,7,13)
Clinical pregnancy rate	Decreased	Significant reduction	Consistent (3,5,15)
Implantation rate	Decreased	Significant reduction	Consistent (3,5,14)
Fertilization rate	Decreased	Moderate reduction	Moderate consistency (14,15)
Miscarriage risk	Increased	1.3-2.0× higher	Very consistent (2,6,10)
Gonadotropin dose requirement	Increased	Higher total dose required	Consistent (4,11)
Embryo quality	Reduced	Lower quality embryos	Moderate consistency (14)
Obstetric complications	Increased	Higher rates reported	Consistent (12)
Dose-response relationship	Present	Worsening with higher BMI	Strong evidence (2,13)

Collectively, the included original patient-level studies demonstrate a robust and consistent association between elevated BMI and impaired reproductive outcomes [1–15]. The convergence of findings across diverse populations and study designs strengthens the validity of the observed associations. Furthermore, the repeated demonstration of a dose–response gradient in large registry datasets supports biological plausibility and suggests that increasing adiposity progressively worsens reproductive success [2,13].

**Discussion.** The present synthesis of original cohort and registry-based studies demonstrates a consistent association between elevated BMI and impaired reproductive outcomes. Across large national datasets and multicenter cohorts, higher BMI was associated with reduced live birth rates, increased miscarriage risk, impaired implantation, and greater ovarian stimulation requirements [1,2,5,7,13,22]. The consistency of these findings across diverse populations strengthens the reliability and external validity of the observed relationship.

The reduction in live birth rates among obese women was one of the most robust findings, particularly in large registry analyses from the United States and China [2,13,22]. European cohorts reported similar trends, confirming that elevated BMI negatively affects ART success across different healthcare systems [7,10,19]. The presence of a dose–response relationship, with progressively worse outcomes across increasing BMI categories, further supports biological plausibility [2,13,22].

Increased miscarriage risk was also consistently reported, with obese women demonstrating a significantly higher risk compared with normal-weight women [2,10,23]. Additionally, reduced implantation rates and poorer embryo outcomes suggest that obesity may affect both ovarian and endometrial function [5,14,25]. Evidence from donor oocyte cycles, where oocyte quality is standardized, indicates that uterine or systemic metabolic factors likely contribute independently to reduced success rates [8].

Although most included studies were retrospective and subject to residual confounding, the convergence of findings across independent cohorts and large registry datasets strengthens the overall evidence base [1–15,17,19,20,22,23,25]. The repeated observation of graded associations across BMI categories suggests that increasing adiposity progressively compromises reproductive potential.

**Conclusion.** In conclusion, original observational cohort studies and national registry analyses consistently demonstrate that elevated BMI adversely affects female reproductive outcomes. Higher BMI is associated with reduced live birth rates, impaired implantation, increased miscarriage risk, and greater ovarian stimulation requirements [1,2,6,13]. The presence of a dose–response relationship

across multiple high-powered datasets further supports the robustness of this association.

These findings highlight elevated BMI as a significant and potentially modifiable risk factor in reproductive medicine. Addressing excess adiposity prior to conception or assisted reproductive treatment may improve fertility outcomes and reduce pregnancy-related complications. Further prospective research is warranted to determine the impact of targeted weight optimization strategies on live birth outcomes.

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